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«Белорусский государственный университет
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Кафедра иностранных языков №1

АНГЛИЙСКИЙ ЯЗЫК: ПОСОБИЕ ПО ОБУЧЕНИЮ ЧТЕНИЮ НАУЧНОЙ ЛИТЕРАТУРЫ ДЛЯ СТУДЕНТОВ ВТОРОЙ СТУПЕНИ ВЫСШЕГО ОБРАЗОВАНИЯ БГУИР

ENGLISH FOR READING SCIENCE AND TECHNOLOGY

Рассмотрено УМО по образованию в области информатики и радиоэлектроники для специальностей, закрепленных за УМО в качестве пособия

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Английский язык : пособие по обучению чтению научной
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Пособие представляет собой систематизированный курс английского языка, предназначенный для развития умений чтения и смыслового восприятия научного письменного текста. Состоит из 6 разделов, каждый из которых включает по 4 текста для развития конкретного вида чтения. Охватывает темы «Usability», «Information Security», «Ecology», «Telecommunications», «Semiconductor Technologies», «Nanotechnologies».

Предназначено аспирантам, студентам второй ступени высшего образования, научным работникам, а также разным категориям пользователей, работающих с научно-технической литературой.

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ПРЕДИСЛОВИЕ

Данное пособие предназначено аспирантам, студентам второй ступени высшего образования, научным работникам, а также разным категориям пользователей, работающих с научно-технической литературой.

В пособии представлены различные формы подачи научно-технической информации (статьи, рецензии, научные образцы, материалы зарубежных учебных пособий и т. д.), что даёт возможность преподавателю иметь общий для всей группы учебный материал, а студентам – использовать сформированные умения чтения научной литературы в дальнейшей научной деятельности при подготовке рефератов, аннотаций, научных докладов, отчётов и т. д.

Задача данного пособия – научить студентов читать научную литературу в соответствии с определёнными установками, т. е. совершенствовать умения различных видов чтения – ознакомительного, изучающего, просмотрового и поискового. Владение всеми видами чтения и лёгкость перехода от одного вида к другому в зависимости от изменения цели получения информации из данного текста характеризует зрелое чтение, которое должно быть сформировано у студентов продвинутого уровня обучения.

Для овладения технологией чтения с различными целевыми установками в пособии используется соответствующий комплекс упражнений – предтекстовых, текстовых, послетекстовых.

Пособие состоит из шести разделов (Units), каждый из которых включает четыре части (Parts), содержащие по четыре текста – Text A, Text B, Text C, Text D, предназначенные для развития умений работы над соответствующим видом чтения. Text A предназначен для работы над ознакомительным чтением. Text B направлен на развитие умений изучающего чтения. Text C используется для обучения просмотровому чтению. Text D развивает умения поискового чтения.

При определении тематического содержания учебных текстов предпочтение отдаётся материалам, информация которых может представлять интерес для студентов учреждения образования «Белорусский государственный университет информатики и радиоэлектроники» факультетов компьютерного проектирования, телекоммуникаций, радиотехники и электроники, а также военного факультета.

Использованный в данном пособии подход к обучению чтению научной литературы не ограничивает творческую инициативу преподавателя в поиске новых дидактических приёмов и методов обучения.

UNIT I
USABILITY

Part A

I. Study the vocabulary related to the text «More than Usability: the Four Elements of User Experience»:

1) UX (user experience) – восприятие пользователем;
2) usability – удобство и простота использования;
3) to perceive – воспринимать, осознавать, понимать;
4) appeal – привлекательность, притягательность;
5) framework – база, основа, структура;
6) value – ценность, важность, полезность;
7) adoptability – пригодность, приемлемость;
8) desirability – желательность;
9) credibility – достоверность;
10) accessibility – доступность;
11) findability – обнаруживаемость;
12) honeycomb – гексагональный, сотовый;
13) to hinder – затруднять, мешать, препятствовать;
14) affordance – предрасположенность;
15) learnability – изучаемость, обучаемость;
16) discoverability – открытость, понятность;
17) readability – удобочитаемость, читабельность;
18) alignment – выравнивание;
19) explicit – эксплицитный, ясный, точный;
20) implicit – имплицитный, неявный, подразумеваемый;
21) toolbar – панель инструментов;
22) irrelevant – неуместный, неподходящий, не относящийся к делу;
23) to embed – встраивать, вставлять;
24) workflow – последовательность выполняемых действий;
25) robust – надёжный, прочный, устойчивый;
26) to reveal – выявлять, обнаруживать;
27) cognitive – когнитивный, познавательный;
28) engaging – привлекательный, притягательный;
29) to distract – отвлекать, уводить в сторону;
30) to encounter – сталкиваться;
31) holistic – холистический, целостный;
32) facet – грань, аспект, сторона;
33) emphasis – акцент;
34) to overlook – не заметить, просмотреть, пропустить.

II. Read the sentence below and locate the information that can be deleted. Read out your shortened version.

However, unlike traditional marketing, which focuses on marketing campaigns, Web promos, marketing email messages, and so on, adoptability is a user experience element that you should consider as an integral component of a product's design.

III. Read the following sentence and name the key words reflecting the principal information.

Perceived value is closely related to the other elements of user experience such as usability and desirability, but the key drivers of value are a product's functionality and features.

IV. In the following words define the suffixes with the help of which they are formed and the meaning they attribute to these words:

a) player, manufacturer, consumer, winner, shopper, user;

b) usability, adoptability, desirability, credibility, accessibility, findability, learnability, discoverability, readability.

V. Translate the sentences paying attention to the functions of the auxiliary verb «do».

1. But usability ***does*** encompass all of the UX elements relating to ease of use.
2. Because mobile phones do not provide the value to users that smartphones ***do***.
3. The four elements to form this framework are not completely orthogonal to one another; they ***do*** overlap somewhat.

VI. Analyze the following sentence and single out the information that can be deleted.

In general, usability has less business impact relative to the other three elements of user experience, which focus on the access and motivation aspects of product usage, while usability is more about repeated usage.

VII. Translate the underlined expression in the sentence below. Think of a word similar in meaning.

In ***meeting*** users' unexpressed ***needs***, they are not only easy-to-use products, but also devices that add much value to users' daily lives.

VIII. Translate the sentences below paying attention to the inversion.

1. Nor is there a field into which he can enter the number.
2. Not only is this important in helping us to deliver delightful user experiences, it is also important in driving business success through UX strategy.

IX. Translate the sentence below into Russian. Think of the appropriate way of translating the word «once».

In other words, adoptability is about that stage when a user has not yet used a product, while usability becomes most relevant ***once*** a user has begun using a product.

X. ***Translate the sentences paying attention to the function of the correlative conjunction* «*both … and*».**

1. The Yahoo Web browser toolbar might be ***both*** easy to use ***and*** valuable to a typical Internet user, but if users don't install it, all of the product's good features become irrelevant.

2. Often, products that are ***both*** easy to use ***and*** useful prove to be failures in the marketplace because of their lack of desirability.

XI. ***Translate the sentences in the passages paying attention to the role of connectors* «*so far*», «*thus*», «*therefore*», «*nevertheless*».**

1. ***So far***, cognitive, or rational, aspects of user experience have been examined. But desirability relates to emotional appeal.

2. ***Thus***, desirability is not just about nice-looking graphics and sleek designs. A desirable product must engage users in relation to their intended uses of the product. ***Therefore***, many designs that don't appear desirable to people who aren't a product's target users ***nevertheless*** score high on desirability with its target users.

XII. ***In the following sentences focus your attention on Complex Subject. Translate them into Russian starting with the predicate in the Active Voice***.

1. Usability plays an important role in enabling desirability, because users who encounter problems when attempting to perform their tasks using a product would almost certainly find that product to be less desirable as a result.

2. For example, in the honeycomb model Peter Morville has proposed that the UX elements, including findability, credibility, value, usability, and accessibility, all appear to have equal importance.

XIII. ***Translate the sentence with the construction* «*It's worth doing*…»:**

It is worth noting that desirability should be defined within the context of users' tasks.

XIV. ***Before reading the text below discuss in pairs or in small groups the following issues***:

a) constituent elements of user experience;
b) the role of these elements in a product design;
c) the differentiation of the UX elements in relation to business impact;
d) driving business success through UX strategy.

XV. ***Now read the text quickly paying attention to the principal information. After reading do the tasks that follow***.

Text A

More than Usability: **the Four Elements of User Experience**

Some people mistakenly use the terms *user experience* and *usability* almost interchangeably. However, *usability* is increasingly being used to refer specifically to the ease with which users can complete their intended tasks, and is closely associated

with *usability testing*. Therefore, many perceive *usability* to be a rather tactical aspect of a product design. In contrast, UX professionals use the term *user experience* much more broadly, to cover everything ranging from ease of use to user engagement to visual appeal. *User experience* better captures all of the psychological and behavioral aspects of users' interactions with products.

To help define the objectives and scope of user experience efforts, as well as enable their meaningful measurement, a conceptual framework that describes four distinct elements of user experience and how they interact with one another is shown in Figure 1.

Value Is it useful?	**Usability** Is it easy to use?
Adoptability Is it easy to start using?	**Desirability** Is it fun and engaging?

Figure 1. The four elements of user experience

In attempting to achieve conceptual simplicity, many aspects of user experience have been reduced to the four elements that are believed to be the most fundamental. It's possible to treat additional aspects of user experience as subcategories of these elements – for example, credibility, accessibility, and findability from Peter Morville's user experience honeycomb.

Usability – Is It Easy to Complete Tasks?

While people sometimes use the term usability to refer to all elements relating to user experience, it should more appropriately be viewed as just a subset of user experience.

Usability is about how easily users can complete their intended tasks using a product. There are many types of usability issues that hinder users' ability to complete the tasks that they intend to perform. Let's look at some examples.

A person takes out his iPhone because he wants to dial a phone number to call a person who's not in his contacts, so he has to input the number. He taps iPhone at the bottom of the screen. It's easy. What's next? Well, there is no keypad on the screen. Nor is there a field into which he can enter the number. In interaction design terms, there is a lack of any call to action, affordance, or contextual cue. So, he spends some time inspecting the screen, and after about 30 seconds, he discovers the Keypad button at the bottom. He's solved the problem, but discovering how to enter a phone number, one of the primary functions of a phone, should not take that long! This is a usability problem.

Usability is not about user intention, user engagement, or visual appeal – the other elements in a user experience framework. But usability does encompass all of the UX elements relating to ease of use. Things like learnability; content

discoverability, findability, and readability; and the ease with which users can recognize information and affordances all fall into this category.

Usability, in itself, is a vast topic, and an entire generation of human/computer-interaction professionals has devoted their careers to advancing the field and improving digital-product user experiences. However, user experience goes far beyond users' being able to complete their tasks, learn about new features, and find their way around a Web site. In fact, some other aspects of user experience are probably more important when it comes to driving business success.

Value – Does a Product Provide Value to Users?

While usability is an important aspect of a product design, it is certainly not the most critical aspect of user experience when it comes to driving business success. There are many products that have good usability, but do not enjoy success in the marketplace. For example, traditional mobile phones are giving way to smartphones, even though many phones are very easy to use. Why? Because mobile phones do not provide the value to users that smartphones do. Consumers want the ability to surf the Web, use instant messaging, play games, and use GPS services on their mobile devices. Here, we are talking about the value aspect of user experience.

What drives a product's value to users? – Alignment between product features and user needs. If a product's features are designed in such way that they support user needs, users will consider the product valuable. User needs encompass more than just their explicit needs – things that users know they want. They also include users' implicit needs – things that users don't express as needs. Apple products like iPhone and iPad are excellent examples of satisfying implicit needs. In meeting users' unexpressed needs, they are not only easy-to-use products, but also devices that add much value to users' daily lives.

Perceived value is closely related to the other elements of user experience such as usability and desirability, but the key drivers of value are a product's functionality and features. Value forms the cornerstone of a good user experience. A product that does not add value by fulfilling user needs does not provide a meaningful user experience – regardless of how well it might be designed.

Adoptability – Will People Start Using the Product?

«Adoptability relates to users' buying, downloading, installing, and starting to use a product».

The Yahoo Web browser toolbar might be both easy to use and valuable to a typical Internet user, but if users don't install it, all of the product's good features become irrelevant. This is the adoptability element of user experience. Let's look at some other examples of adoptability issues. When companies launch their iPhone apps, they typically embed links to the apps on their desktop Web sites. However, this is a very problematic design decision: a user is visiting such a Web site on a computer, so how can he click the link to the application and download it to his iPhone?

The right way to introduce, for example, Vanguard's iPhone app would be to place a link to it on their mobile site, which shows up by default on the iPhone. However, their mobile site doesn't provide such a link. So, here's a failure of adoptability: users simply don't have a straightforward way of downloading the Vanguard iPhone app. So they need to go to the Apple iTunes store, search for the keyword Vanguard, select the right Vanguard iPhone app, and install it – not the most spontaneous way for users to get on board.

Based on the above examples, it's clear that adoptability has a lot to do with the design of workflows. In addition, adoptability depends on things like credibility and brand perception. Content that does not look authentic or that is associated with a weak brand will have problems drawing users.

Adoptability is very closely related to usability. To improve adoptability, UX professionals employ robust usability techniques to ensure that they design a product's workflows to support users' natural ways of discovering its features. However, these two elements are also fundamentally different. Adoptability relates to users' buying, downloading, installing, and starting to use a product. In other words, adoptability is about that stage when a user has not yet used a product, while usability becomes most relevant once a user has begun using a product. By making this distinction, an often neglected aspect of UX strategy is revealed: providing easy access to a product.

Adoptability is also clearly different from value. Even if a product brings great value to users, they still might not choose to use it because of difficulties relating to access and installation. In other words, adoptability relates to obtaining access to a product, while value relates to a product's features and content. To improve adoptability, a product team must consider the natural context in which a user first gets exposed to their product and how it impacts the design of the installation flow.

At first glance, adoptability seems to relate to a product marketing – both are about promoting product usage. However, unlike traditional marketing, which focuses on marketing campaigns, Web promos, marketing email messages, and so on, adoptability is a user experience element that you should consider as an integral component of a product's design.

Desirability – Is the Experience Fun and Engaging?

«Desirability relates to emotional appeal».

So far, cognitive, or rational, aspects of user experience have been examined. But desirability relates to emotional appeal. Often, products that are both easy to use and useful prove to be failures in the marketplace because of their lack of desirability. Examples include traditional MP3 players versus iPod and consumer electronics products made by all other manufacturers versus Sony products.

In fact, people often enjoy using products that have poor usability. For example, many video games have really poor usability: their instructions are hard to understand, their navigation is very confusing, their settings menus are hard to

discover, and the readability of their content is poor. But that hasn't stopped users from playing them, because they are just so engaging.

A large part of desirability is attributable to innovative visual design. It is worth noting that desirability should be defined within the context of users' tasks. Thus, desirability is not just about nice-looking graphics and sleek designs. A desirable product must engage users in relation to their intended uses of the product. Therefore, many designs that don't appear desirable to people who aren't a product's target users nevertheless score high on desirability with its target users. For instance, Excel is desirable to users when they need to perform data analysis. They have a great time using the software because its simplistic user interface lets them perform the tasks well, despite the fact that it doesn't look pretty. If Microsoft added pretty graphics to Excel, users might find the experience less desirable if the graphics distracted them from what they intended to do.

Examples That Illustrate the Differences between the Elements of UX

It may have been noticed that, in some ways, the four elements of user experience look rather similar to one another. Let's look at a few examples of problems that can help to distinguish these elements from one another:

– a problem relating to adoptability: a user hears from his friends that an iPhone app is very useful and would like to try it, but he doesn't know how to install it on his iPhone;

– a problem relating to usability: a user is actively using a product, but has problems with completing his intended tasks;

– a problem relating to desirability: a user finds his experience with a product rather enjoyable despite the fact that he has difficulties performing his tasks with it; thus, the product has good desirability, but needs usability improvements;

– a problem relating to user value: a user can perform all of his tasks with ease, but doesn't find a product's features valuable in relationship to his needs.

Conclusion

Breaking down user experience into its four constituent elements – Value, Usability, Adoptability, and Desirability – can help UX professionals to identify and work on the key elements of a product design. There are certainly many other equally valid ways of conceptualizing user experience. The four elements to form this framework are not completely orthogonal to one another; they do overlap somewhat. For example, desirability plays an important role in driving adoptability, just as visual appeal motivates prospective users to try out a product. Usability plays an important role in enabling desirability, because users who encounter problems when attempting to perform their tasks using a product would almost certainly find that product to be less desirable as a result.

It is important that UX professionals have a clear understanding of the constituent parts of user experience. By focusing on these four very important and distinctive elements of users' interactions with digital products, we can develop

design solutions that address all facets of user experience in a holistic manner. Not only is this important in helping us to deliver delightful user experiences, it is also important in driving business success through UX strategy.

A key advantage of this conceptual model over other models of user experience is that it offers a way to prioritize UX efforts based on their business impact. For example, in the past, UX professionals placed great emphasis on usability while overlooking adoptability, an element which is often more important than usability when it comes to driving business results. In general, usability has less business impact relative to the other three elements of user experience, which focus on the access and motivation aspects of product usage, while usability is more about repeated usage.

Unlike this model, other models of user experience make little differentiation between UX elements in relation to business impact. For example, in the honeycomb model Peter Morville has proposed that the UX elements, including findability, credibility, value, usability, and accessibility, all appear to have equal importance. While they might actually have equal importance in terms of user experience, they affect business results differently. This is the key message that the model delivers.

XVI. Check your understanding of the essential details by answering the following questions:

1. What is the difference between the terms «user experience» and «usability»?
2. What are the most fundamental elements of user experience?
3. What makes a product valuable to users?
4. How is adoptability related to usability?
5. What distinguishes adoptability from value?
6. What does desirability imply?
7. Why are the elements of user experience important for a product design?
8. What are the advantages of the conceptual model suggested by the author?

XVII. Write a short summary of the text, covering only the principal information. No more than 200 words should be used.

Part B

I. The following words and word-combinations are essential for understanding the text. Learn their meaning and pronunciation:

1) acceptability – приемлемость, годность, допустимость;
2) interaction – взаимодействие;
3) prototyping – макетирование, разработка прототипа;
4) commitment – обязательство;
5) flaw – дефект, недостаток;
6) metaphor – метафора, модель;
7) navigation – навигация, передвижение, перемещение;
8) appearance – вид, появление, возникновение;

9) to attain – достигать, добиваться;
10) memorability – запоминаемость;
11) trade-off – компромисс, альтернатива, выбор, соотношение выгод и потерь;
12) heuristic evaluation – эвристическая оценка;
13) cognitive walk-through – сквозной контроль;
14) action analysis – анализ действий пользователя;
15) to aggregate – собирать в одно целое, объединять;
16) unbiased – беспристрастный, объективный, непредубежденный;
17) heuristics – эвристика;
18) rapidity – скорость, быстрота, быстродействие;
19) validity – достоверность, точность, обоснованность;
20) salient – заметный;
21) inherent – неотъемлемый, присущий, свойственный;
22) bias – предвзятость;
23) back-of-the-envelope action analysis – предварительный, приблизительный анализ действий пользователя;
24) keystroke-level analysis – анализ на уровне нажатия клавиши;
25) to move-mouse-to-menu – перемещать показатель курсора на меню;
26) to type-on-the-keyboard – печатать на клавиатуре;
27) tediousness – трудоемкость, длительность;
28) unwieldy – большой, громоздкий.

II. Quickly look through the text to know what it deals with and do the tasks that follow.

Text B

Usability Engineering Methods for Software Developers

1. Usability is most often defined as the ease of use and acceptability of a system for a particular class of users carrying out specific tasks in a specific environment. Ease of use affects the users' performance and their satisfaction, while acceptability affects whether the product is used. Thus, it is of great importance for every software practitioner not only to be aware of various usability methods, but be able to quickly determine which method is best suited to every situation in a software project.

2. One of the basic lessons we have learned in human-computer interaction (HCI) is that usability must be considered before prototyping takes place. There are techniques (such as usability context analysis) intended to facilitate such early focus and commitment. When usability inspection, or testing, is first carried out at the end of the design cycle, changes to the interface can be costly and difficult to implement, which in turn leads to usability recommendations. These are often ignored by developers who feel, «We don't have usability problems». The earlier critical design flaws are detected, the more likely they can be corrected. Thus, user interface design

should more properly be called user interface development, analogous to software development, since design usually focuses on the synthesis stages, and user interface components include metaphors, mental models, navigation, interaction, appearance, and usability.

3. It is generally accepted that the following five essential usability characteristics should be part of any software project: learnability, so the user can rapidly begin working with the system; efficiency, enabling a user who has learned the system to attain a high level of productivity; memorability, allowing the casual user to return to the system after a period of non-use without having to relearn everything; low error rate, so users make fewer and easily rectifiable errors while using the system, and no catastrophic errors occur; and satisfaction, making the system pleasant to use. There are trade-offs among these criteria, and some are more important than others, although this ranking depends on the situation.

Usability Inspection Methods

4. This is a set of methods for identifying usability problems and improving the usability of an interface design by checking it against established standards. These methods include heuristic evaluation, cognitive walk-throughs, and action analysis. Heuristic evaluation (HE) is the most common informal method. It involves having usability specialists judge whether each dialogue or other interactive element follows established usability principles. The original approach is for each individual evaluator to inspect the interface alone. Only after all the evaluations have been completed are the evaluators allowed to communicate and aggregate their findings. This restriction is important in order to ensure independent and unbiased evaluations. During a single evaluation session, the evaluator goes through the interface several times, inspects the various interactive elements, and compares them with a list of recognized usability principles. There are different versions of HE currently available; for example, some have a cooperative character. The heuristics must be carefully selected so they reflect the specific system being inspected, especially for Web-based services where additional heuristics become increasingly important. Usually 3–5 expert evaluators are necessary (increasing the cost of this technique); less-experienced people can perform an HE, but the results are not as good. However, HE using non-experts is appropriate at times, depending on who is available to participate.

5. Advantages include the application of recognized and accepted principles; intuitiveness; usability early in the development process; effective identification of major and minor problems; rapidity; and usability throughout the development process.

6. Disadvantages include separation from end users; inability to identify or allow for unknown users' needs; and unreliable domain-specific problem identification. Also, HE does not necessarily evaluate the complete design, since there is no mechanism to ensure the entire design is explored, and evaluators can focus too much on one section; and the validity of Nielsen's guidelines has been questioned.

7. A cognitive walkthrough (CW) is a task-oriented method by which the analyst explores the system's functionalities; that is, CW simulates step-by-step user behavior for a given task. CW emphasizes cognitive issues, such as learnability, by analyzing the mental processes required of the users. This can be achieved during the design by making the repertory of available actions salient, providing an obvious way to undo actions, and offering limited alternatives. The background is derived from exploratory learning principles. Several versions of CW exist, including pluralistic walkthroughs wherein end users, software developers, and usability experts go through the system, discussing every single dialogue element.

8. Advantages include independence from end users and a fully functioning prototype, helping designers to take on a potential user's perspective, effective identification of problems arising from interaction with the system, and the ability to help to define users' goals and assumptions.

9. Disadvantages of CW include possible tediousness and the danger of an inherent bias due to improper task selection, emphasis on low-level details, and noninvolvement of the end user.

10. The action analysis method is divided into formal and back-of-the-envelope action analysis; in both, the emphasis is more on what the practitioners do than on what they say they do. The formal method requires close inspection of the action sequences a user performs to complete a task. This is also called keystroke-level analysis. It involves breaking the task into individual actions such as move-mouse-to-menu or type-on-the-keyboard and calculating the times needed to perform the actions. Back-of-the-envelope analysis is less detailed and gives less precise results, but it can be performed much faster. This involves a similar walkthrough of the actions a user will perform with regard to physical, cognitive, and perceptual loading. To understand this thoroughly we must keep in mind that goals are external, and we achieve goals. Tasks are those processes applied through some device in order to achieve the goals, and we perform tasks. Actions are tasks with no problem-solving and no internal control structure. We do actions. The main problem of task analysis is the difficulty in accommodating complicated tasks completed by more than one individual. Furthermore, the representation of task analysis is complex, even when a simple task is studied, and tends to become unwieldy very rapidly. Such representations can often only be interpreted by those who conducted the analysis.

11. Advantages include precise prediction of how long a task will take, and a deep insight into users' behavior.

12. Disadvantages of action analysis are the following: it is very time-consuming and requires high expertise.

III. Read the words with one and the same affix. Define the root from which they are formed. Pay attention to the meaning attributed to the words by this affix:

a) individual, perceptual, external, internal, critical, casual, informal, additional, potential, essential;

b) interactive, effective, cooperative, perspective;

c) satisfaction, interaction, inspection, navigation, evaluation, restriction, application, separation, identification, assumption.

IV. Think of a word that is associated with the given words:

perform, achieve, conduct, predict, interact.

V. In passages 1, 2, 3, 4, 5, 6, 7, 8, 10 find equivalents of the following words:

to conduct, to influence, different, to occur, to realize, expensive, defects, indispensible, mistake, limitation, acknowledged, estimation, to comprise, benefits, drawbacks, to investigate, noticeable, purposes, to demand, accurate, with respect to, bulky.

VI. Give Russian equivalents of the following nouns paying attention to the meanings of the words from which they are derived:

satisfaction (satisfy – удовлетворять), interaction (interact – взаимодействовать), inspection (inspect – проверять, осматривать), evaluator (evaluate – оценивать), restriction (restrict – ограничивать), assumption (assume – предполагать), involvement (involve – вовлекать), prediction (predict – предсказывать), productivity (produce – производить), performance (perform – выполнять), representation (represent – представлять).

VII. Look through the whole text and find the words similar to the Russian ones that you can understand without translation. Read them aloud.

VIII. In passage 2 find the sentence with the structure «the + comparative … the + comparative» and translate it into Russian.

IX. Read the fourth sentence of passage 2 carefully. What is the function of the pronoun «these»? Give explanations and translate the sentence into Russian.

X. In passage 3 find participles I and translate the whole passage into Russian.

XI. In passage 4 find the sentence with a Causative construction «have + object + past participle». Translate the sentence into Russian.

XII. Continue working with passage 4. Find the sentence with «only» and translate it into Russian. Pay attention to the inversion in this sentence.

XIII. In passage 5 find the word with the suffix -ness. From what root is this word formed? What other words with the same suffix do you know?

XIV. In passage 6 you will find 2 words with the same root. Say to what part of speech they belong.

XV. The last sentence of passage 6 consists of the main and additional clauses. Split the sentence according to formal indications. Bear in mind the function of the conjunction «since» in this sentence. Translate the sentence into Russian.

XVI. In passage 7 find participles II and translate the whole passage into Russian.

XVII. Find nouns in the possessive case in passage 8 and translate them into Russian.

XVIII. In passage 10 find 2 adjectives and 3 nouns with similar meaning. Translate them into Russian. Think of some other words similar in meaning to these adjectives and nouns.

XIX. Continue working with passage 10. Study it carefully and try to find the sentence where the conjunction between the parts of the sentence is omitted. Translate it into Russian.

XX. In the same passage the author also used several cases of gerund. Find them and translate the sentences where they are used into Russian.

XXI. Find some connectors in passages 1, 4 and 10. What role do they usually play? Give your comments and translate the sentences into Russian.

XXII. In passage 12 you will come across the word-combination «a deep insight». Think of a possible variant of replacing it without the change in meaning.

XXIII. Go back to the text, find and read aloud the sentences illustrating the author's point of view on the fact that:

a) usability inspection should be conducted as early as possible;

b) the most important usability qualities should be included into any software project;

c) each individual evaluator must first test the interface alone;

d) heuristic evaluation (HE) has its disadvantages;

e) cognitive issues considered by a cognitive walkthrough (CW) are useful during a product design;

f) a task analysis has its difficulties and limitations.

XXIV. Look through the text once more and say if the author gave complete and full coverage of the usability inspection methods, their advantages and disadvantages.

XXV. Say whether the following statements are true (T) or false (F). Turn to the text to make your decision:

1. Usability deals with how easily users can complete intended tasks using a product.

2. Software developers should understand the importance of different usability techniques and their role in a product design.

3. Usability testing performed at the end of a design cycle is very effective in detecting and correcting errors.

4. Heuristic evaluation carried out by non-experts always gives reliable results.

5. A cognitive walkthrough allows user's behavior for a given task to be analysed.

6. The action analysis method involves the inspection of the actions a user will do to finish the task.

7. The drawback of the action analysis method is that it takes a long time to implement.

XXVI. Write a short summary of the text (***about 100 words***).

Part C

I. Study the words related to the text «***Usability Test Methods***»:

1) end user – конечный пользователь;
2) indispensible – важный, необходимый, обязательный;
3) field observation – полевое наблюдение;
4) to facilitate – облегчать, содействовать, способствовать;
5) vivid – яркий, ясный, чёткий;
6) simultaneously – одновременно;
7) to anticipate – предвидеть, предвосхищать, предугадывать;
8) strenuous – напряжённый, требующий усилий;
9) to interfere – вмешиваться;
10) obtrusive – навязчивый, назойливый;
11) glaring – заметный, бросающийся в глаза;
12) perusal – рассматривание, прочтение;
13) iteration – итерация, повтор;
14) data logging – регистрация данных;
15) Human-Computer Interface (HCI) – интерфейс «человек – компьютер»;
16) supplementary – дополнительный, добавочный;
17) query – запрос;
18) anxiety – беспокойство, тревога;
19) precedence – приоритет;
20) claim – требование, претензия;
21) validity – достоверность, обоснованность;
22) discrepancy – расхождение, отклонение, несоответствие, противоречие.

II. Quickly scan the text «***Usability Test Methods***» ***and find the words with prefixes -mis and -dis. Translate them into Russian. Say what kinds of words they usually form. Think of your own examples of words formed with these prefixes.***

Text C

Usability Test Methods

1. Testing with end users is the most fundamental usability method and is in some sense indispensable. It provides direct information about how people use our systems and their exact problems with a specific interface. There are several methods

for testing usability, the most common being thinking aloud, field observation, and questionnaires.

2. Thinking aloud (THA) may be the single most valuable usability engineering method. It involves having an end user continuously thinking out loud while using the system. By verbalizing their thoughts, the test users enable us to understand how they view the system, which makes it easier to identify the end users' major misconceptions. By showing how users interpret each individual interface item, THA facilitates a direct understanding of which parts of the dialogue cause the most problems. In THA the time is very important, since the contents of the users' working memory contents are desired. Retrospective reports are much less useful, since they rely on the users' memory of what they had been thinking some time ago. A variant of THA called constructive interaction involves having two test users use a system together (co-discovery learning). The main advantage is that the test situation is much more natural than standard THA with single users working alone, since people are used to verbalizing their thoughts when trying to solve a problem together. Therefore, users may make more comments when engaged in constructive interaction than when simply thinking aloud for the benefit of an experimenter.

3. Advantages of THA include revealing why users do something; providing a close approximation to how individuals use the system in practice; provision of a wealth of data, which can be collected from a fairly small number of users; user comments often contain vivid and explicit quotes; preference and performance information can be collected simultaneously; THA helps some users to focus and concentrate; and early clues can help to anticipate and trace the source of problems to avoid later misconceptions and confusion in the early stage of design.

4. Disadvantages include a failure to lend itself well to most types of performance measurement; the different learning style is often perceived as unnatural, distracting, and strenuous by the users; non analytical learners generally feel inhibited; and this method is time-consuming since briefing the end users is a necessary part of the preparation.

5. Causing users to focus and concentrate is both an advantage and a disadvantage since it results in less-than-natural interactions at times and causes THA to be faster due to the users' focus.

6. ***a***. Field observation is the simplest of all methods. ***b***. It involves visiting one or more users in their workplaces. ***c***. Notes must be taken as unobtrusively as possible to avoid interfering with their work. ***d***. Noise and disturbance can also lead to false results. ***e***. Ideally, the observer should be virtually invisible to ensure normal working conditions. ***f***. Sometimes video is used to make the observation process less obtrusive, but it is rarely necessary. ***g***. Observation focuses on major usability catastrophies that tend to be so glaring they are obvious the first time they are observed and thus do not require repeated perusal of a recorded test session. ***h***. Considering the time needed to analyze a videotape is approximately 10 times that of a user test, the time is better spent testing more subjects or testing more iterations of the design. ***i***. Video is, however, appropriate in some situations. ***j***. For example, a

complete record of a series of user tests can be used to perform formal impact analysis of usability problems.

7. Another means of electronic observation is data logging, which involves statistics about the detailed use of a system. Data logging can provide extensive timing data, which is generally important in HCI and usability. Normally, logging is used to collect information about the field use of a system after release, but it can also be used as a supplementary method of collecting more detailed data during user testing. Typically, an interface log will contain statistics about the frequency with which each user has used each feature in the program and the frequency with which various events of interest (such as error messages) have occurred.

8. Many aspects of usability can best be studied by querying the users. This is especially true for issues related to the subjective satisfaction of the users and their possible anxieties, which are difficult to measure objectively. Questionnaires are useful for studying how end users use the system and their preferred features, but need some experience to design. They are an indirect method, since this technique does not study the actual user interface: it only collects the opinions of the users about the interface. One cannot always take user statements at face value. Data about people's actual behavior should have precedence over people's claims of what they think they do.

9. A simpler form of questionnaire is the interview. The form of the interview can be adjusted to respond to the user and encourage elaboration.

10. Advantages include that subjective user preferences, satisfaction, and possible anxieties can be easily identified; and questionnaires can be used to compile statistics.

11. Disadvantages include that indirect methods result in low validity (discrepancies between subjective and objective user reactions must be taken into account); this method needs sufficient responses to be significant (we are of the opinion that 30 users is the lower limit for a study); and it identifies fewer problems than the other methods.

12. Usability inspection needs to be combined with usability test methods. For example, a cognitive walk-through can be supplemented with a task-independent method, such as heuristic evaluation. Indirect usability tests, such as questionnaires or interviews, must be supplemented with direct usability tests; thinking aloud or observation would be suitable. An absolute must is understanding the user's task, culture, and capabilities; involving the users in the design early on; and testing and iterating, with or without users.

III. Read the title of the text and say what the text might be about. What words helped you to form your opinion.

IV. Scan passage 1 and explain the importance of testing with end users. Use the words «testing», «usability», «methods».

V. In the same passage find the information about the methods used for testing usability. Enumerate them. Pay attention to the Absolute Participial Construction.

VI. Look through passage 2 and speak in short about the effectiveness of thinking aloud (THA). Compare it with the variant of THA called «constructive interaction». Pay attention to the meaning of the words «since» and «therefore» and their function in the passage.

VII. In passage 2 find comparative adjectives. Analyse which words are used to emphasize them and translate the sentences into Russian.

VIII. What are the main advantages and disadvantages of THA? Look for the answer in passages 3 and 4.Concentrate your attention on the topical sentences of the passages. Reduce them by deleting additional information.

IX. Scan passage 6, characterize the method of field observation and name the means used by it.

X. Compress the sentence under letter g in passage 6 by deleting secondary information. Say what the method of observation concentrates on.

XI. Look through passage 7 and name the issues raised in it. Single out the key words which help you to form your opinion.

XII. Which methods are used to collect the users' opinions about the interface? Can they be called objective? Why or why not? Look for information in passages 8 and 9.

XIII. Find the key words that reflect the main drawbacks of indirect methods. Look for the answer in passage 11.

XIV. What is the main idea of passage 12? Where is it concentrated? What is the role played by the words «for example»? Do you agree with the author's opinion? Look through the passage and give your comments.

XV. And, finally, generalize the issues raised in the text. Express your opinion, add the information you possess, give examples, facts in favour or against the information given by the author. While speaking use the words of the active vocabulary.

XVI. Say if the information of the text is new to you? Can it be applicable in your future professional activities?

Part D

I. Quickly look through the text below to get acquainted with its structural composition – subtitles, figures, etc. Do they tell you anything? Discuss it with your partner.

II. Quickly scan the text again for words in italics. Make sure you know them. If you don't, look them up in the dictionary or ask your teacher for help.

Text D

The Importance of the Four Elements of User Experience in Driving UX Success

When *assessing* your product's user experience, keep in mind that not all elements of user experience are of equal importance. As it has been mentioned a product's usability often matters less than its adoptability, value, and desirability, because these three elements play a large role in getting users to start using the product. However, that's not always the case; it depends on the type of a product you're developing. Let's look at a few common product categories.

Enterprise Software: It's All about Value

For enterprise software such as *accounting software*, *CRM solutions*, or financial-analysis tools, the most important UX element is the value the product provides in relation to users' needs. Does your product address *indispensable* job-related tasks? Does it provide *comprehensive* functionality that is well suited to users' *workflows*? Does it interface well with *in-house tools*? Is it secure? Enterprise software meets a very practical need; therefore, value plays a key role in its design.

In addition to value, usability is, of course, a very important consideration. Users need to be able to complete their tasks with efficiency and *accuracy*. *Otherwise*, the software simply fails to deliver value.

Desirability is less important in driving the usage of enterprise software. Users do not expect to have fun using the software. They are required to use it as part of their job. Of course, making the software fun to use wouldn't hurt, but that's far from a key request from users. As research has shown corporate users often perceive fancy visual design as *gimmicky*. After all, they just want to complete their designated tasks in the most efficient way possible, with little *distraction*. Nor does adoptability play an important role, because users have no say in what software they'll use.

Figure 2 is a diagram that shows the relative importance of the four UX elements for a hypothetical enterprise software product. The numbers indicate the weightings of the four elements. In this hypothetical example, the following weights have been assigned: desirability – 0.3; adoptability – 0.5.

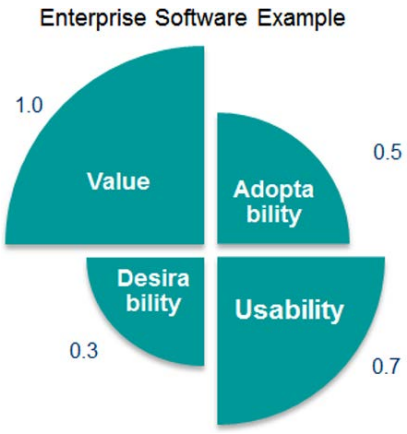


Figure 2. Relative weightings of the four UX elements for an enterprise software product

Product teams should work out such weightings based on their own understanding of their product and its users. Assigning weightings is optional. You don't need them to see the relative importance of the UX elements. However, weightings could be useful if product team members react better to numbers – especially if the team intends to create some kind of *scorecard* to measure a product's success.

Games: *Desirability Is the Name of the Game*

Developing games is a completely new story. Unlike enterprise software, most games are intended to provide entertainment rather than practical value. Sure, there are some games that meet practical needs, but value is not a key UX element driving the usage of the majority of the games that we see today. The success of games in the marketplace is all about desirability and adoptability.

However, to be playable, a game must be easy to use. Good usability is especially important for casual gamers learning new games. But usability is not nearly as important as adoptability. There are millions of games out there that are competing to get users' attention, but only *an easy-to-adopt game* will find its way to prospective users. That is why it is so critical for game developers to think of ways to make the features of their games discoverable. Desirability also *overshadows* usability. If a game is really, really fun to play, users will tolerate or find ways to *overcome* poor usability.

Therefore, when designing and developing games, the first thing to do is to identify an *engaging*, even addictive, game concept. Next, you must implement that concept with an attractive visual design and fun user interactions. You'll also need to figure out how to distribute the game to reach a large audience. While you must *refine* the user interface to support ease of use, whenever ease of use is in conflict with desirability, you'll need to compromise on ease of use.

Figure 3 shows the relative weightings of the four UX elements for a hypothetical game.

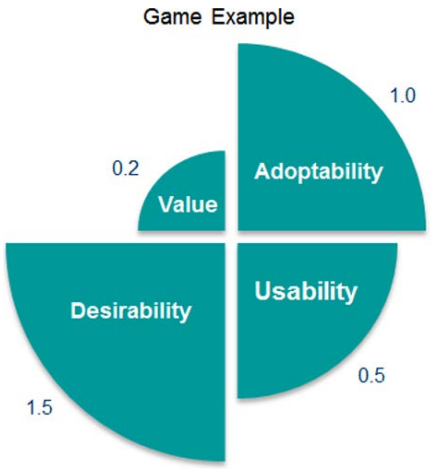


Figure 3. Relative weightings of the four UX elements for a game

Social Networks: *Adoptability and Desirability Are Keys to Success*

As an industry, social networking has seen great success during recent years. In addition to the *hugely* successful Facebook and LinkedIn, we have seen *up-and-comers* like Path, RunKeeper, and Quora – among many others – all finding their way to the mass market. What defines a social-networking experience, first and foremost, is adoptability. A social network, *regardless of* its features, content, and usability, has to be very, very easy to discover and sign up for.

Adoptability cannot depend just on marketing. A well-designed social network – for instance, Instagram – can spend very little money on advertising, yet gain a huge user base. The network effect, that is, users acting as the distribution agents for a social network by sending invitations to their friends and even to strangers, is *a cornerstone* of a social network's adoptability.

Desirability also plays a critical role. The main reason for people to use social networks is to kill time and have some fun; therefore, the experience has to be very engaging. Activities such as viewing pictures, updating status, and playing social games all contribute to the desirability of a social network.

Social networks do need to have *robust* usability, so users can easily carry out their tasks. But adoptability and desirability overshadow the role of usability. Social networks that feature so-so usability – notably Facebook and LinkedIn – can still attract *hordes* of users. People often complain about being *overwhelmed* by Facebook's vast array of features and content and the confusing Timeline, but that don't stop them from using it. Why? Simply because all of their friends are on Facebook, so it's fun to view their pictures and posts. Adoptability and desirability trump usability here.

What about value? Unlike games, social networks do provide *substantial* value to users. LinkedIn addresses the need for professional networking. RunKeeper lets runners track and share their activities. Twitter satisfies people's need to instantly distribute and share information. However, the value that social networks provide is typically less important than that of enterprise software. Why is that? Enterprise software is valuable because it addresses essential needs such as *submitting timecards*

and *expense* reports. In other words, enterprise software provides *must-have functionality*, while social networks provide *nice-to-have convenience*.

Figure 4 shows the relative weightings of the four UX elements for a hypothetical social network.

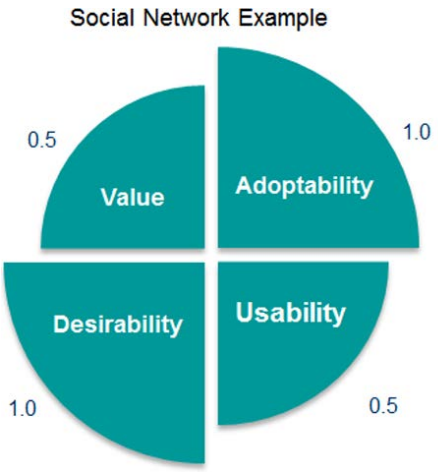


Figure 4. Relative weightings of the four UX elements for a social network

Ecommerce: *All Four UX Elements Are Equally Important*

With ecommerce, there is a balanced need for all four UX elements. For one thing, successful online stores provide value to their customers by addressing their essential shopping needs: lower prices, convenient access to a broad selection of *merchandise*, and ease in finding items for sale.

Adoptability is also a critical element in the ecommerce user experience ecosystem. Given that there are so many online *retailers*, a store that's easily discoverable has a huge advantage. This is why many merchants do well by continuously improving their *search-engine optimization* (*SEO*), through effective marketing, and by setting up *an eBay storefront* or becoming an Amazon merchant.

Given the vast inventory many online stores have, good usability – that lets users easily navigate product categories, find specific items to purchase, and complete a transaction – is essential to delivering a great user experience. An online store can have a great selection of merchandise at low price points, but without robust usability, users *will abandon* the site sooner rather than later.

Shopping is not just about fulfilling a practical need. Fun is an *intrinsic* aspect of shopping. Getting a great deal is fun. Winning an auction is fun. Finding a rare collectible item is fun. This shows the importance of desirability in driving ecommerce usage. Presenting large pictures of items for sale, suggesting good deals, and recommending high-quality products are just a few common ways of making shopping a fun experience.

Figure 5 shows the relative weightings of the four UX elements for a hypothetical ecommerce site.

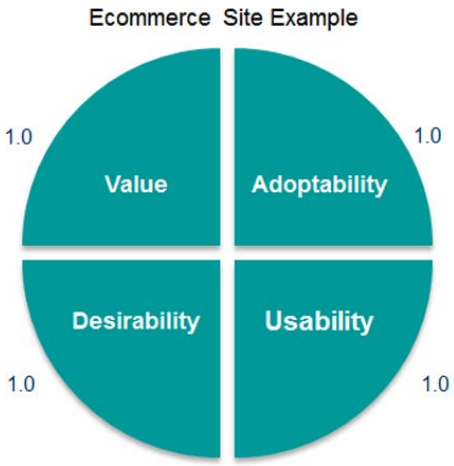


Figure 5. Relative weightings of the four UX elements for an ecommerce site

Which UX Elements Are Important*? *It's Your Call

The above examples illustrate how the importance of different UX elements can vary depending on the type of a product you're designing. You can apply the same type of analysis to other product categories. To give a few more brief examples, *search engines* should focus on value and usability, multimedia sites and consumer electronics products should place a bit more emphasis on desirability, and software that comes with hardware – for example, *a wireless router setup site* – should feature robust value and usability.

In the examples, numeric weightings have been assigned to the four UX elements to make the points clear. But this type of analysis is not really about quantifying the weightings of the UX elements. It's about understanding what elements are important and are not important in driving a great user experience – thinking in relative terms – then applying that knowledge in prioritizing your product design efforts.

So, first, you should realize that the four elements of user experience do not always have the same importance. The deeper your knowledge about a product and its *target users*, the easier it will be for you to recognize which UX elements are of greater importance for that product. Then, keeping their relative importance in mind, you can prioritize the appropriate UX elements when *allocating* the resources that are available to you – which are often limited in the real world. By doing this, you can ensure that you develop products that customers will love to use.

III. Now turn your attention to the introduction of the text and using key words related to the topic give its main idea.

IV. Look for some specific information contained in the part entitled «Enterprise Software: It's All about Value». Which UX elements are essential for software design and which of them are of minor significance?

V. In the part entitled «Games: Desirability Is the Name of the Game» give a short characteristics of elements of user experience that provide success of games

in the market. ***While scanning the text find the information about the tips the author gives to game developers***. ***Is this information useful for you***?

VI. ***How important is adoptability and desirability for social networks***? ***Give examples of social networks that meet essential user's needs***. ***Look for the answer in the part entitled «Social Networks: Adoptability and Desirability Are Keys to Success»***.

VII. ***What is the proportion of the UX elements for ecommerce***? ***Search for the information in the part «Ecommerce: All Four UX Elements Are Equally Important», share it with your partner***.

VIII. ***What conclusion is drawn in the final part of the text***? ***Do you agree with it***? ***Express your opinion in short (preferably in one sentence)***.

IX. ***Say whether the following statements are true (T) or false (F).Turn to the text to make your decision***:

1. Enterprise software is valuable because it satisfies the most important users' needs.
2. Assigning rates to UX elements can help product teams to evaluate their design efforts.
3. In developing games the first thing to do is to identify an attractive visual design and fun user interactions.
4. Social networks with poor usability can't find their way to the market.
5. In ecommerce ease of use is of primary importance.
6. The role of each of the four elements in driving UX success is defined by the type of a product the team thinks the users will like to use.
7. Understanding the relative importance of the four elements is critical for correct prioritizing a product design and development efforts.

UNIT II
INFORMATION SECURITY

Part A

I. Study the vocabulary related to the topic «Information Security»:

1) confidentiality – конфиденциальность, секретность;
2) integrity – целостность;
3) availability – доступность;
4) unauthorized access – несанкционированный доступ;
5) IT security – информационная безопасность;
6) information assurance – гарантия сохранения информации;
7) off-site backup – внешняя резервная копия;
8) black hat hacker – «черная шляпа» – хакер, который работает со злыми или криминальными намерениями;
9) application – приложение;
10) information systems auditing – аудит информационной службы (систем);
11) business continuity planning – планирование непрерывности бизнеса;
12) Caesar cipher – шифр Цезаря;
13) digital forensics – цифровая экспертиза;
14) tampering – преступное использование;
15) to intercept – перехватывать (например информацию);
16) sensitive information – секретная информация;
17) Official Secrets Act – закон о государственной тайне;
18) Government code – правительственный код/государственный индекс;
19) alignment of classification systems – выравнивание систем классификации;
20) procedural control – контроль (управление) процедурой;
21) to encrypt – шифровать;
22) authenticity – подлинность;
23) accountability – подотчётность (ответственность);
24) non-repudiation – безотказность;
25) reliability – надёжность;
26) threat – угроза;
27) log-file – журнал регистрации событий;
28) referential integrity – ссылочная целостность;
29) failure – отказ;
30) denial-of-service attack (Do.S) – атака отказа в обслуживании; компьютерная атака, обычно запланированная, имеющая своей целью нарушение доступа к всемирной паутине;
31) digital signature – цифровая подпись;
32) to allege – утверждать, заявлять.

II. Read the sentence below and locate the information that can be deleted. Read out your shortened version.

Critical issues include but are not limited to: natural disasters, computer malfunction, physical theft, or any other instance where data has the potential of being lost.

III. Read the following sentence and name the key words reflecting the principal information.

One of the common methods of providing information assurance is to have an off-site backup of the data in case one of the mentioned issues arise.

IV. Translate the sentence below paying attention to the function of the word «should». Think of a possible substitute to this word.

Should confidential information about business customers or finances or new product line fall into the hands of a competitor or a black hat hacker, a business and its customers could suffer widespread, irreparable, financial loss, not to mention damage to the company's reputation.

V. Go back to the sentence above, analyse it and single out the information that can be deleted.

VI. Translate the underlined word in the sentence below. Think of a word similar in meaning.

For the individual, information security has a significant effect on privacy, which is viewed very differently in different cultures.

VII. Translate the sentence below paying attention to the emphatic construction it is (was) … that (which) … who … .

Procedures evolved to ensure documents were destroyed properly and it was the failure to follow these procedures which led to some of the greatest intelligence coups of the war.

VIII. Before reading the text below discuss in pairs or in small groups the following issues:

a) importance of information security, its defence from unauthorized access, use, discolosure, disruption, modification, perusal, inspection, recording, etc.;

b) development and implementation of security mechanisms of all available types;

c) basic principles of information security;

d) possible definition(s) of InfoSec;

e) some facts from the history of information protection development. Ask your teacher for help if you have difficulty.

IX. Now read the text quickly paying attention to the principal information. After reading do the tasks that follow.

Text A

Information Security

Information Security Attributes: or qualities, i.e., *Confidentiality*, *Integrity* and *Availability* (CIA).

Information Systems are composed in three main portions: hardware, software and communications with the purpose to help identify and apply information security industry standards, as mechanisms of protection and prevention, at three levels or layers: *physical*, *personal* and *organizational*. Essentially, procedures or policies are implemented to tell people (administrators, users and operators) how to use products to ensure information security within the organizations.

Information security, sometimes shortened to **InfoSec**, is the practice of defending *information* from unauthorized access, use, disclosure, disruption, modification, perusal, inspection, recording or destruction. It is a general term that can be used regardless of the form the data may take (electronic, physical, etc…).

Two major aspects of information security are:

– **IT security**: Sometimes referred to as *computer security*, Information Technology Security is information security applied to technology (most often some form of computer system). It is worthwhile to note that a *computer* does not necessarily mean a home desktop. A computer is any device with a *processor* and some memory (even a calculator). IT security specialists are almost always found in any major enterprise/establishment due to the nature and value of the data within larger businesses. They are responsible for keeping all of the *technology* within the company secure from malicious cyber attacks that often attempt to breach into critical private information or gain control of the internal systems;

– **Information assurance**: The act of ensuring that data is not lost when critical issues arise. These issues include but are not limited to: natural disasters, computer/server malfunction, physical theft, or any other instance where *data* has the potential of being lost. Since most information is stored on computers in our modern era, information assurance is typically dealt with by IT security specialists. One of most common methods of providing information assurance is to have an off-site backup of the data in case one of the mentioned issues arise.

Governments, *military*, *corporations*, *financial institutions*, *hospitals*, and private *businesses* amass a great deal of confidential information about their employees, customers, products, research and financial status. Most of this information is now collected, processed and stored on electronic computers and transmitted across *networks* to other computers.

Should confidential information about a business' customers or finances or new product line fall into the hands of a competitor or a black hat hacker, a business and its customers could suffer widespread, irreparable financial loss, not to mention

damage to the company's reputation. Protecting confidential information is a business requirement and in many cases also an ethical and legal requirement.

For the individual, information security has a significant effect on *privacy*, which is viewed very differently in different *cultures*.

The field of information security has grown and evolved significantly. There are many ways of gaining entry into the field as a career. It offers many areas for specialization including securing network(s) and allied *infrastructure*, securing *applications* and *databases*, *security testing*, information systems *auditing*, *business continuity planning* and *digital forensics*, etc.

History

Since the early days of communication, diplomats and military commanders understood that it was necessary to provide some mechanism to protect the confidentiality of correspondence and to have some means of detecting *tampering*. *Julius Caesar* is credited with the invention of the *Caesar cipher* ca. 50 B.C., which was created in order to prevent his secret messages from being read should a message fall into the wrong hands, but for the most part protection was achieved through the application of procedural handling controls. Sensitive information was marked up to indicate that it should be protected and transported by trusted persons, guarded and stored in a secure environment or strong box. As postal services expanded, governments created official organizations to intercept, decipher, read and reseal letters (e. g. the UK Secret Office and Deciphering Branch in 1653).

In the mid 19th century more complex *classification systems* were developed to allow governments to manage their information according to the degree of sensitivity. The British Government codified this, to some extent, with the publication of the *Official Secrets Act* in 1889. By the time of the First World War, multi-tier classification systems were used to communicate information to and from various fronts, which encouraged greater use of code making and breaking sections in diplomatic and military headquarters. In the United Kingdom this led to the creation of the *Government Code and Cypher School* in 1919. Encoding became more sophisticated between the wars as machines were employed to scramble and unscramble information. The volume of information shared by the Allied countries during the *Second World War* necessitated formal alignment of classification systems and procedural controls. An arcane range of markings evolved to indicate who could handle documents (usually officers rather than men) and where they should be stored as increasingly complex safes and storage facilities were developed. Procedures evolved to ensure documents were destroyed properly and it was the failure to follow these procedures which led to some of the greatest intelligence coups of the war (e. g. *U-570*).

The end of the 20th century and early years of the 21st century saw rapid advancements in *telecommunications*, computing *hardware* and *software*, and data *encryption*. The availability of smaller, more powerful and less expensive computing

equipment made *electronic data processing* within the reach of *small business* and the home user. These computers quickly became interconnected thorough *the Internet.*

The rapid growth and widespread use of electronic data processing and *electronic business* conducted through the Internet, along with numerous occurrences of international *terrorism*, fueled the need for better methods of protecting the computers and the information they store, process and transmit. The academic disciplines of *computer security* and *information assurance* emerged along with numerous professional organizations – all sharing the common goals of ensuring the security and reliability of information systems.

Definitions of InfoSec

1. «Preservation of confidentiality, integrity and availability of information. Note: In addition, other properties, such as authenticity, accountability, non-repudiation and reliability can also be involved».

2. «The protection of information and information systems from unauthorized access, use, disclosure, disruption, modification, or destruction in order to provide confidentiality, integrity, and availability».

3. «Ensures that only authorized users (confidentiality) have access to accurate and complete information (integrity) when required (availability)».

4. «Information Security is the process of protecting the intellectual property of an organization».

5. «… information security is a risk management discipline, whose job is to manage the cost of information risk to the business».

6. «A well-informed sense of assurance that information risks and control are in balance».

7. «Information security is the protection of information and minimises the risk of exposing information to unauthorised parties».

8. «Information Security is a multidisciplinary area of study and professional activity which is concerned with the development and implementation of security mechanisms of all available types (technical, organisational, human-oriented and legal) in order to keep information in all its locations (within and outside the organisation’s perimeter) and, consequently, information systems, where information is created, processed, stored, transmitted and destroyed, free from threats. Threats to information and information systems may be categorised and a corresponding security goal may be defined for each category of threats. A set of security goals, identified as a result of a threat analysis, should be revised periodically to ensure its adequacy and conformance with the evolving environment. The currently relevant set of security goals may include: confidentiality, integrity, availability, privacy, authenticity & trustworthiness, non-repudiation, accountability and auditability».

Basic principles

Key concepts

The CIA triad (*confidentiality*, *integrity* and *availability*) is one of the core principles of information security. (The members of the classic InfoSec triad – confidentiality, integrity and availability – are interchangeably referred to in the literature as *security attributes*, properties, security goals, fundamental aspects, information criteria, critical information characteristics and basic building blocks.) There is continuous debate about extending this classic trio. Other principles such as *Accountability* have sometimes been proposed for addition – it has been pointed out that issues such as *Non-Repudiation* do not fit well within the three core concepts, and as regulation of computer systems has increased (particularly amongst the Western nations) *Legality* is becoming a key consideration for practical security installations.

Confidentiality

Confidentiality refers to preventing the disclosure of information to unauthorized individuals or systems. For example, a *credit card transaction* on the Internet requires the *credit card number* to be transmitted from the buyer to the merchant and from the merchant to a *transaction processing* network. The system attempts to enforce confidentiality by encrypting the card number during transmission, by limiting the places where it might appear (in databases, log files, backups, printed receipts, and so on), and by restricting access to the places where it is stored. If an unauthorized party obtains the card number in any way, a breach of confidentiality has occurred. Confidentiality is necessary for maintaining the *privacy* of the people whose personal information is held in the system.

Integrity

In information security, data integrity means maintaining and assuring the accuracy and consistency of data over its entire life-cycle. This means that data cannot be modified in an unauthorized or undetected manner. This is not the same thing as *referential integrity* in *databases*, although it can be viewed as a special case of consistency as understood in the classic *ACID* model of *transaction processing*. Integrity is violated when a message is actively modified in transit. Information security systems typically provide message integrity in addition to data confidentiality.

Availability

For any information system to serve its purpose, the information must be *available* when it is needed. This means that the computing systems used to store and process the information, the *security controls* used to protect it, and the communication channels used to access it must be functioning correctly. *High availability* systems aim to remain available at all times, preventing service

disruptions due to power outages, hardware failures, and system upgrades. Ensuring availability also involves preventing *denial-of-service attacks*, such as a flood of incoming messages to the target system essentially forcing it to shut down.

Authenticity

In computing, *e-Business*, and information security, it is necessary to ensure that the data, transactions, communications or documents (electronic or physical) are genuine. It is also important for authenticity to validate that both parties involved are who they claim to be. Some information security systems incorporate authentication features such as «digital signatures», which give evidence that the message data is genuine and was sent by someone possessing the proper signing key.

Non-repudiation

In law, *non-repudiation* implies one's intention to fulfill their obligations to a contract. It also implies that one party of a transaction cannot deny having received a transaction nor can the other party deny having sent a transaction.

It is important to note that while technology such as cryptographic systems can assist in non-repudiation efforts, the concept is at its core a legal concept transcending the realm of technology. It is not, for instance, sufficient to show that the message matches a digital signature signed with the sender's private key, and thus only the sender could have sent the message and nobody else could have altered it in transit. The alleged sender could in return demonstrate that the digital signature algorithm is vulnerable or flawed, or allege or prove that his signing key has been compromised. The fault for these violations may or may not lie with the sender himself, and such assertions may or may not relieve the sender of liability, but the assertion would invalidate the claim that the signature necessarily proves authenticity and integrity and thus prevents repudiation.

X. Check your understanding of the essential details by answering the following questions:

1) What are the principal information security attributes?

2) What is:

a) information security;

b) information assurance?

3) What were the principal means of detecting tampering in the early days of communication?

4) What made electronic data processing within the reach of small business and home user?

5) What are possible synonyms to the word-combination *security attributes*?

6) What is your understanding of the terms *confidentiality*, *integrity*, *availability*, *authenticity*, *non-repudiation*? The information from the text will help you to do this task.

XI. Write a short summary of the text, covering only the principal information. No more than 200 words should be used.

Part B

I. The following words and word-combinations are essential for understanding the text. Learn their meaning and pronunciation:

1) host-based intrusion detection system (HIDS) – хостовая система обнаружения вторжений;
2) network packets – сетевые пакеты (вид представления информации для передачи по телекоммуникационным сетям);
3) network-based intrusion detection system (NIDS) – сетевая система обнаружения вторжений;
4) hacker – хакер, злоумышленник;
5) keystroke logging – запись набираемого на клавиатуре текста;
6) identity theft – кража личных данных;
7) spamming – рассылка бесполезной информации;
8) botnet activity – активность бот-сетей/сетей компьютеров, контролируемых злоумышленниками;
9) spyware usage – тайное использование;
10) best practice security techniques – лучшие методы организации безопасности;
11) object database – объектная база данных;
12) call table – таблица системных вызовов;
13) vtable structure – виртуальные таблицы структуры (например MS Windows);
14) attribute – знак, атрибут;
15) checksum – проверочная сумма;
16) MD5hash – название алгоритма вычисления хэш-функции;
17) SHA1 hash – название алгоритма вычисления хэш-функции (проверочная сумма);
18) update – модернизация;
19) file-attribute – атрибут файла, его свойства;
20) log-file – журнал регистрации событий;
21) tampering – преступное использование;
22) worm – червь – программа, размножающаяся на компьютере, а также при переходе с компьютера на компьютер, обычно путём копирования себя в память каждого компьютера;
23) CD-ROM – компакт-дисковое запоминающее устройство;
24) ROM (read-only memory) – постоянное запоминающее устройство, (ПЗУ);
25) to militate – свидетельствовать против … (или в пользу);
26) off-systems – внешний (по отношению к системе);
27) VPN (Virtual Private Network) channel – канал виртуальной частной сети;
28) central management system – централизованная система управления.

II. Quickly look through the text to know what it deals with and do the tasks that follow.

Text B

Host-based intrusion detection system

1. A host-based intrusion detection system (HIDS) is an intrusion detection system that monitors and analyzes the internals of a computing system as well as (in some cases) the network packets on its network interfaces (just like a network-based intrusion detection system (NIDS) would do). This was the first type of intrusion detection software to have been designed, with the original target system being the mainframe computer where outside interaction was infrequent.

2. The principle operation of a HIDS depends on the fact that successful intruders (hackers) will generally leave a trace of their activities. In fact, such intruders often want to «own» the computer they have attacked, and will establish their «ownership» by installing software that will grant the intruders future access to carry out whatever activity (keystroke logging, identity theft, spamming, botnet activity, spyware-usage etc.) they envisage.

3. In theory, a computer user has the ability to detect any such modifications, and the HIDS attempts to do just that and reports its findings.

4. Ideally a HIDS works in conjunction with a NIDS, such that a HIDS finds anything that slips past the NIDS. Commercially available software solutions often do correlate the findings from NIDS and HIDS in order to find out about whether a network intruder has been successful or not at the targeted host.

5. Most successful intruders, on entering a target machine, immediately apply best-practice security techniques to secure the system which they have infiltrated, leaving only their own backdoor open, so that other intruders can not take over their computers.

6. In general a HIDS uses a database (object-database) of system objects it should monitor – usually (but not necessarily) file system object. A HIDS could also check that appropriate regions of memory have not been modified – for example, the system call table for Linux, and various vtable structures in Microsoft Windows.

7. For each object in question a HIDS will usually remember its attributes (permissions, size, modifications dates) and create a checksum of some kind (an MD5, SHA1 hash or similar) for the contents, if any. This information gets stored in a secure database for later comparison (checksum database).

8. At installation time – and whenever any of the monitored objects change legitimately – a HIDS must initialize its checksum-database by scanning the relevant object. Persons in charge of computer security need to control this process tightly in order to prevent intruders from making un-authorized changes to the database(s). Such initialization thus generally takes a long time and involves cryptographically locking each monitored object and the checksum databases or worse. Because of this, manufacturers of HIDS usually construct the object-database in such a way that makes frequent updates to the checksum database unnecessary.

9. Computer systems generally have many dynamic (frequently changing) objects which intruders want to modify – and which a HIDS thus should monitor – but their dynamic nature makes them unsuitable for the checksum technique. To overcome this problem, HIDS employ various other detection techniques: monitoring changing file-attributes, log-files that decreased in size since last checked, and numerous other means to detect unusual events.

10. Once a system administrator has constructed a suitable object-database – ideally with the help and advice from the HIDS installation tools – and initialized the checksum-database, the HIDS has all it requires to scan the monitored objects regularly and to report on anything that may appear to have gone wrong. Reports can take the form of logs, e-mails or similar.

11. A HIDS will usually go to great lengths to prevent the object-database, checksum-database and its reports from any form of tampering. After all, if intruders succeed in modifying any of the objects the HIDS monitors, nothing can stop such intruders from modifying the HIDS itself – unless security administrators take appropriate precautions. Many worms and viruses will try to disable anti-virus tools, for example.

12. Apart from crypto-techniques, HIDS might allow administrators to store the databases on a CD-ROM or on other read-only memory devices (another factor militating for infrequent updates) or storing them in some off-system memory. Similarly, a HIDS will often send its logs off-system immediately – typically using VPN channels to some central management system.

III. Read the words with one and the same affix. Define the root from which they are formed. Pay attention to the meaning attributed to the words by this affix:

a) detection, interaction, modification, information, conjunction, solution, installation, initialization;

b) computer, intruder, hacker, user, server, manufacturer, administrator.

IV. Think of a word that is associated with the given words: intrude, take over, infiltrate, penetrate, get in.

V. In passages 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 find equivalents of the following words: to control, sign, changes, in collaboration with, goal, to correspond, to protect, different, corresponding, branches, besides, to keep, likewise.

VI. In passage 8 find the sentence showing that … people responsible for computer protection must follow this process very attentively not to let hackers make unlawful changes to databases. Read the sentence aloud and translate it into Russian.

VII. Look through the whole text and find the words similar to the Russian ones that you can understand without a translation. Read them aloud.

VIII. In passage 1 find the sentence with Perfect Infinitive in the function of an attribute and an Absolute Participial construction. Translate the sentence into Russian.

IX. In passage 2 find the word with the suffix -ship. From what root is this word formed? Look for it in the same passage. What other words with the suffix -ship do you know?

X. Read the second sentence of passage 4 carefully. What is the function of the verb* do *in this sentence? Give explanations and translate the sentence into Russian.

XI. In passage 5 you will find 2 words with the same root. Say to what part of speech they belong.

XII. The sentence making passage 5 is a long one and consists of the main and additional clauses. Split the sentence according to formal indications into the main part and additional clauses. Bear in mind the function of the conjunction* so that *in this sentence. Translate the sentence into Russian.

XIII. In passage 6 find the verb in Perfect Passive. Translate the sentence into Russian, paying attention to the possible ways of translating Passive Voice.

XIV. Read the first sentence of passage 7. Think of a possible variant of replacing the word combination «object in question» without the change in meaning.

XV. Read carefully passage 8. Find the Gerunds in this passage and give the possible variants of their translation into Russian.

XVI. Find some connectors in passage 8. What role do they usually play? Give your comments and translate the whole passage into Russian.

XVII. In passage 9 find 2 adjectives with similar meaning. Translate them into Russian. Think of some other words similar in meaning to these adjectives.

XVIII. Continue working with passage 9. Study it carefully and try to find the clause with the Infinitive in the function of an adverbial modifier of purpose. Translate it into Russian.

XIX. Translate into Russian the initial part of passage 10: Once a system administrator has constructed … . Think of the appropriate way of translating the word «once». What other words could be used instead of it? Give your suggestions.

XX. Give possible variants of translating the expression «go to great lengths» in the first sentence of passage 11. In this passage the author also used several cases of the Gerund. Find them and translate the sentences where they are used into Russian. Bear in mind the meaning and the function of the word «unless» used in this passage.

XXI. In passage 12 you will come across the words «apart from» and «similarly». Speak about the function they are used in. What is their role in the sentence? Translate the whole passage into Russian.

***XXII. Look through the whole text, find and read aloud the sentences illustrating the author's opinion on the fact that*: a) *the intruders often want to take over the computer they have infiltrated*; b) *both intrusion detection systems combine their activities to protect the information*; c) *in certain instances a HIDS must put into operation its checksum-database to …*; d) *a HIDS will do everything possible not to let the object-database, checksum-database, etc be hacked in any way*.**

XXIII. Go back to the text again and say if the author gave a complete and full coverage of the problems raised in the text.

***XXIV. Answer the following questions*:**

1) What will the intruders try to do when they plan to establish their «ownership» over the computer they have attacked?
2) What is the reason for the intruders to apply best-practice security techniques when they enter a target machine?
3) What is similar and what differentiates a HIDS from a NIDS?
4) Why do manufacturers of HIDS construct the object-database eliminating the necessity of frequent updates to the checksum database?
5) What is the reason for HIDS to employ various types of detection techniques?
6) What are the forms of reports the HIDS initiates when something goes wrong on the monitored objects?
7) Where can administrators store their databases?
8) Do you think a HIDS is reliable enough to monitor, detect and prevent possible types of tampering? Give you comments on the problem.
9) Do you know any other forms (systems) of intrusion detection and prevention?

***XXV. Write a short summary of the text* (*about 100 words*).**

Part C

***I. Study the words related to the text* «*Antivirus Software*»:**

1) malware – вредоносное программное обеспечение;
2) malicious BHOs (Browser Helper Object) – вредоносные объекты помощи браузеру;
3) hijacker – вредоносное программное обеспечение для несанкционированного выполнения команд;
4) ransomeware – вредоносная программа-вымогатель;
5) keylogger – программное обеспечение, регистрирующее различные действия пользователя – нажатия клавиши на клавиатуре и т. д.;

6) backdoor – программа, которую устанавливает взломщик на взломанном ею компьютере после получения первоначального доступа с целью повторного получения доступа к системе;
7) rootkit – программа или набор программ для злоумышленника или вредоносной программы в системе;
8) trojan horse – троянская программа (вредоносная программа, выдающая себя за безвредную);
9) worm – разновидность вредоносной программы, самостоятельно распространяющейся через локальные и глобальные компьютерные сети;
10) malicious LSPs – вредоносные многоуровневые поставщики услуг (вредоносное использование технологий Microsoft);
11) dialer – программа дозвона, делающая попытку установить модемное соединение с модемным пулом;
12) fraudtool – мошенническая программа;
13) adware – рекламное программное обеспечение;
14) spyware – шпионское программное обеспечение;
15) social engineering – социотехника (искусство обмана пользователей сети или администраторов);
16) signature – подпись, сигнатура;
17) heuristic-based – основанный на эвристике, эвристический (алгоритм решения, не имеющий строгого обоснования, но тем не менее дающий приемлемое решение задачи);
18) emulation – эмуляция, моделирование;
19) virus signature – сигнатура вируса – часть уникального компьютерного кода, заключённая в вирусе;
20) upload – отправлять, передавать копию файла с локального компьютера на удалённый;
21) outbreak – взрыв, вспышка;
22) oligomorphic code – олигоморфный код (вирус, шифрующий сам себя олигоморфным методом);
23) polymorphic code – полиморфный код (вирус, шифрующий сам себя полиморфным методом);
24) metamorphic code – метаморфный код (вирус, изменяющий свой собственный код);
25) to encrypt – шифровать;
26) disguise – маскировка;
27) strain – разновидность, происхождение;
28) generic – характерный для определённого класса, общий;
29) non-contiguous – несмежный;
30) wildcard – групповой символ (заменяющий один или несколько символов);
31) padding – заполнение;
32) tampering – преступное использование;
33) on-access scanning – поиск данных с перебором;
34) background guard – фоновая защита;

35) resident shield – резидентная защита;
36) browsing – просмотр (веб-страниц);
37) cloud-based antivirus – «облачный» антивирус (основанный на обычных технологиях);
38) firewall – брандмауэр (программа для защиты от сетевых атак);
39) on-line scanner – сканер, работающий в оперативном режиме (т. е. режиме реального времени);
40) lightweight – легковесный (занимающий малый объём памяти);
41) engine – приспособление, устройство, механизм;
42) network cloud – облачная сеть, распределённая система;
43) to spawn – порождать, распространять;
44) TCP/IP – Transmission Control Protocol/Internet Protocol – протокол управления передачей/межсетевой протокол;
45) critical area – критически важная область памяти и дискового пространства;
46) folder – папка, контейнер для программ и файлов в графических пользовательских интерфейсах;
47) pop-up – всплывающее окно;
48) benign – правильный, качественный;
49) threat – угроза.

II. Quickly scan the text «Antivirus Software» and find the words with suffixes -ware and -er/or. Translate them into Russian. Say what kind of nouns they usually form. Think of your own examples of words formed with these suffixes.

Text C

Antivirus software

1. Antivirus or anti-virus software is software used to prevent, detect and remove malware (of all descriptions), such as: computer viruses, malicious BHOs, ransomware, keyloggers, backdoors, rootkits, trojan horses, worms, malicious LSPs, dialers, fraudtools, adware and spyware. Computer security, including protection from social engineering techniques, is commonly offered in products and services of antivirus software companies. This text discusses the software used for the prevention and removal of malware threats, rather than computer security implemented by software methods.

2. There are several methods which antivirus software can use to identify malware: signature based detection, heuristic-based detection and file emulation.

3. Traditionally, antivirus software heavily relied upon signatures to identify malware. This can be very effective, but cannot defend against malware unless samples have already been obtained and signatures created. Because of this, signature-based approaches are not effective against new, unknown viruses. As new viruses are being created each day, the signature-based detection approach requires

frequent updates of the virus signature dictionary. To assist the antivirus software companies, the software may allow the user to upload new viruses or variants to the company, allowing the virus to be analyzed and the signature added to the dictionary. Although the signature-based approach can effectively contain virus outbreaks, virus authors have tried to stay a step ahead of such software by writing «oligomorphic», «polymorphic» and, more recently, «metamorphic» viruses, which encrypt parts of themselves or otherwise modify themselves as a method of disguise, so as to not match virus signatures in the dictionary.

4. Some more sophisticated antivirus software uses heuristic analysis to identify new malware or variants of known malware. Many viruses start as a single infection and through either mutation or refinements by other attackers, can grow into dozens of slightly different strains, called variants. Generic detection refers to the detection and removal of multiple threats using a single virus definition. While it may be advantageous to identify a specific virus, it can be quicker to detect a virus family through a generic signature or through an inexact match to an existing signature. Virus researchers find common areas that all viruses in a family share uniquely and can thus create a single generic signature. These signatures often contain non-contiguous code, using wildcard characters where differences lie. These wildcards allow the scanner to detect viruses even if they are padded with extra, meaningless code. A detection that uses this method is said to be «heuristic detection».

5. File emulation is another heuristic approach. File emulation involves executing a program in a virtual environment and logging what actions the program performs. Depending on the actions logged, the antivirus software can determine if the program is malicious or not and then carry out the appropriate disinfection actions.

6. Anti-virus software can attempt to scan for rootkits; a rootkit is a type of malware that is designed to gain administrative-level control over a computer system without being detected. Rootkits can change how the operating system functions and in some cases can tamper with the anti-virus program and render it ineffective. Rootkits are also difficult to remove, in some cases requiring a complete re-installation of the operating system.

7. Real-time protection, on-access scanning, background guard, resident shield, autoprotect, and other synonyms refer to the automatic protection provided by most antivirus, anti-spyware, and other anti-malware programs. This monitors computer systems for suspicious activity such as computer viruses, spyware, adware, and other malicious objects in «real-time», in other words while data is loaded into the computer’s active memory: when inserting a CD, opening an email, or browsing the web, or when a file already on the computer is opened or executed.

8. Anti-virus programs are not always effective against new viruses, even those that use non-signature-based methods that should detect new viruses. The reason for this is that the virus designers test their new viruses on the major anti-virus applications to make sure that they are not detected before releasing them into the wild. Some new viruses, particularly ransomware, use polymorphic code to avoid detection by virus scanners.

9. Installed antivirus software running on an individual computer is only one method of guarding against viruses. Other methods are also used, including cloud-based antivirus, firewalls and on-line scanners.

10. Cloud antivirus is a technology that uses lightweight agent software on the protected computer, while offloading the majority of data analysis to the provider's infrastructure. One approach to implementing cloud antivirus involves scanning suspicious files using multiple antivirus engines. Programs or documents are sent to a network cloud where multiple antivirus and behavioral detection programs are used simultaneously in order to improve detection rates.

11. Parallel scanning of files using potentially incompatible antivirus scanners is achieved by spawning a virtual machine per detection engine and therefore eliminating any possible issues. Retrospective detection can also be performed whereby the cloud detection engine rescans all files in its file access history when a new threat is identified thus improving new threat detection speed. Finally, cloud antivirus is a solution for effective virus scanning on devices that lack the computing power to perform the scans themselves.

12. Network firewalls prevent unknown programs and processes from accessing the system. However, they are not antivirus systems and make no attempt to identify or remove anything. They may protect against infection from outside the protected computer or network, and limit the activity of any malicious software which is present by blocking incoming or outgoing requests on certain TCP/IP ports. A firewall is designed to deal with broader system threats that come from network connections into the system and is not an alternative to a virus protection system.

13. Some antivirus vendors maintain websites with free online scanning capability of the entire computer, critical areas only, local disks, folders or files. Periodic online scanning is a good idea for those that run antivirus applications on their computers because those applications are frequently slow to catch threats. One of the first things that malicious software does in an attack is disable any existing antivirus software and sometimes the only way to know of an attack is by turning to an online resource that is not installed on the infected computer.

14. Studies showed that the effectiveness of antivirus software had decreased. According to an FBI survey, major businesses lose many millions annually dealing with virus incidents. The problem is magnified by the changing intent of virus authors. Some years ago it was obvious when a virus infection was present. The viruses of the day, written by amateurs, exhibited destructive behavior or pop-ups. Modern viruses are often written by professionals, financed by criminal organizations. Independent testing on all the major virus scanners consistenly shows that none provide 100 % virus detection. Many virus scanners produce false positive results as well, identifying benign files as malware.

III. Read the title of the text. Translate it into Russian paying attention to the negative prefix -anti. Look through the text and find the words with some other negative prefixes. Translate the words into Russian.

IV. Judging by the title say what the text might be about. What word helped you to form your opinion?

V. Now read the first sentence of passage 1 to find out what types of malware virus authors develop. Enumerate them.

VI. In passage 2 find the information about the methods used to identify malware. Name them.

VII. Look through passage 3 and name the issues raised in it. Single-out key words which help you to form your opinion.

VIII. Scan passage 4 and speak in short about the effectiveness of the «heuristic detection method». Analyse the last sentence of this passage and say what construction is used in it. Translate it into Russian.

IX. What is file emulation? Look for the answer in passage 5.

X. In passage 6 find the information about the malware named «rootkit». What do virus authors use it for? Pay attention to the Complex Subject construction used in the last sentence of the passage. Translate it into Russian.

XI. What are the synonyms used to refer to the automatic protection provided by anti-malware programs? Look for the information in passage 7.

XII. Express the main idea of passage 8 using the following words and word-combinations: «anti-virus programs», «non-signature-based methods», «test», «ransomware».

XIII. What are the methods used to guard against viruses. Look for the answer in passage 9. Enumerate them.

XIV. Compress the first sentence of passage 10 by deleting secondary information. Say in short what «cloud antivirus» technology is.

XV. Look through passage 11. What are the words «therefore», «thus» used for? Translate them into Russian. Then describe in short the process of parallel scanning of files by compressing the first sentence of passage 11.

XVI. What two sentences in your opinion express the main idea of passage 12? Read them aloud. Pay attention to the word «however» and its role in the passage.

XVII. Why is periodic online scanning a good idea? In what cases is it usually used? Find the information in passage 13.

XVIII. In passage 14 the author mentions some reasons for the decrease in effectiveness of antivirus software. Do you agree with the author's opinion? Can you think of some other reasons for this? Look through the passage and give your comments.

XIX. And, finally, generalize the issues raised in the text. Express your opinion, add the information you possess, give facts, examples in favour or against the information given in the text. While speaking use the words of the active vocabulary.

XX. Say if the information of the text is new to you? Can it be used in your future professional activities?

Part D

I. Quickly look through the text below to get acquainted with its structural composition – subtitles, words in bold type, italics, etc. Do they tell you anything? Discuss it with your partner.

II. Quickly scan the text again for the words in italics. Make sure you know them. If you don't look them up in the dictionary or ask your teacher for help.

Text D

What is Network intrusion detection system?

To understand what a *network intrusion detection system* is one should first know what intrusion is. When a hacker tries to make way into your system, it is known as intrusion, and a network intrusion detection system is a system, which detects such intrusions. The word network is used for this system, because it keeps an eye on packets on a network wire and its *main objective* is to find out whether a cracker or a hacker is breaking into your system. It analyzes the traffic on your network to monitor signs of different *malicious activity*.

1. Main objectives and functions of such systems

The main functions of a network intrusion detection system include:

– *detecting attacks*: such a system detects security threats and attacks as and when they happen by providing real-time network monitoring;

– *offer information*: If this system detects an attack, then it puts forward information about the attack;

– *take corrective steps*: once an attack is detected by the system, the active systems also take measures to tackle the attack;

– *storage*: It also stores the events either locally or otherwise in case of an attack.

Primary types of network intrusion detection system

A network intrusion detection system is mostly placed at strategic points in a network, so that it can monitor the traffic travelling to or from different devices on that network. While choosing such a system, you should compare the main types of a network intrusion detection system. There are mainly *two types* of such system. One is *signature based system* and the other is *anomaly based system*. A signature based intrusion detection system is tuned towards a particular vulnerability, so it has less numbers of false positives (FP), whereas anomaly based system will search for

attacks that are out of the norms, leading to higher rate of false positives. Therefore, you should choose a system as per your specific requirements.

2. **Signature detection**

Signature detection involves searching network traffic for a series of *malicious bytes or packet sequences*. The main advantage of this technique is that *signatures* are very easy to develop and understand if we know what network behavior we are trying to identify. For instance, we might use a signature that looks for particular strings within exploit particular *buffer overflow vulnerability*. The events generated by signature based IDS can communicate the cause of the alert. As pattern matching can be done more efficiently on modern systems so the amount of power needed to perform this matching is minimal for a rule set. For example if the system that is to be protected only communicates via *DNS, ICMP* and *SMTP,* all other signatures can be ignored. Limitations of these signature engines are that they only detect attacks whose signatures are previously stored in database; a signature must be created for every *attack*; and novel attacks cannot be detected. This technique can be easily deceived because they are only based on regular expressions and string matching. These mechanisms only look for strings within packets transmitted over wire. Moreover signatures work well against only the fixed behavioral pattern, they fail to deal with attacks created by a human or a worm with self-modifying behavioral characteristics. Signature based detection does not work well when the user uses advanced technologies like *nop generators*, *payload encoders* and *encrypted data channels*. The efficiency of the signature based systems is greatly decreased, as it has to create a new signature for every variation. As the signatures keep on increasing, the system engine performance decreases. Due to this, many intrusion detection engines are deployed on systems with multi processors and multi Gigabit network cards. *IDS developers* develop the new signatures before the attacker does, so as to prevent the novel attacks on the system. The difference of speed of creation of the new signatures between the developers and attackers determines the *efficiency of the system*.

3. **Anomaly based detection**

The anomaly based detection is based on defining the *network behavior*. The network behavior is in accordance with the *predefined behavior,* then it is accepted or else it triggers the event in the anomaly detection. The accepted network behavior is prepared or learned by the specifications of the network administrators. The important phase in defining the network behavior is the *IDS engine capability* to cut through the various protocols at all levels. The engine must be able *to process the protocols* and understand its goal. Though this protocol analysis is computationally expensive, *the benefits* it generates like increasing *the rule set* helps in less *false positive alarms*. The major drawback of anomaly detection is defining its rule set. The efficiency of the system depends on how well it is implemented and tested on all *protocols*. Rule defining process is also affected by various protocols used by various vendors. Apart from these, custom protocols also make *rule defining* a difficult job. For detection to occur correctly, the detailed knowledge about the accepted network behavior needs to be developed by the administrators. But once the rules are defined

and protocol is built then anomaly detection systems work well. If the *malicious behavior* of the user falls under the accepted behavior, then it goes unnoticed. An activity such as directory traversal on a targeted vulnerable server, which complies with network protocol, easily goes unnoticed as it does not trigger any *out-of-protocol*, *payload* or *bandwidth limitation flags*. The major advantage of anomaly based detection over signature-based engines is that a novel attack for which a signature does not exist can be detected if it falls out of the normal traffic patterns. This is observed when the systems detect new *automated worms*. If the new system is infected with a worm, it usually starts *scanning* for other *vulnerable systems* at an accelerated rate filling the network with *malicious traffic*, thus causing the event of a TCP connection or bandwidth abnormality rule.

4. **Pros of the system**

The main benefits of a network intrusion detection system include:

– *Easy deployment*: Deploying such a system is easier, as you will not have to change your existing infrastructure or system. This is because such systems are autonomous operating systems.

– *Less cost*: These systems can be installed for all the network segments, so it eliminates the requirement of software at each host in a network segment lowering down the cost of ownership.

– *Detecting attacks*: these systems can easily detect attacks, which have escaped from the scanners of host-based sensors.

– *Retain evidence*: Such a system detects real-time intrusion, so it does give the attacker a chance for removing the evidence of such attack.

5. **Cons to look for**

Apart from the pros, there are some cons that come with network intrusion detection systems. These are:

– these systems can collect a large number of alerts in a day, overloading your work;

– *FP alerts* can also be very high, which leads to less confidence on alerts;

– if you try to cut down *FP rate*, then this can affect NIDS reliability;

– tasks like *analyzing* and *filtering* have to be done manually.

6. Although IDSs should be used as part of *defense in depth* (DiD), they should not be used alone. Other *techniques, procedures, and policies* should be used to protect the network. IDSs have made *significant improvements*, but some *concerns* still plague security administrators. These problems will continue to be addressed as IDS technologies improve.

III. ***Now turn your attention to the introduction in the text and using key words related to the topic give its main idea***.

IV. ***Look for some specific information contained in the part entitled «Main objectives and functions of such systems». What systems and their objectives, functions are described? Is this information of vital importance or it can be neglected?***

V. In the part entitled «Signature based detection» study the first 2 sentences and give a short characteristics of malicious bytes or packet sequences detection. While scanning the text find the information about the facts that determine the efficiency of the system.

VI. What is important in «Anomaly based detection»? What are its advantages and disadvantages? Try to find the sentence speaking in favour of its advantage over signature based engines.

VII. What prevails in a Network intrusion detection system – pros or cons? To find an answer to this question look through passages 4 and 5 and discuss your variant with your partner.

VIII. What conclusion is drawn in the final passage of the text? Do you agree with it? Express your opinion in short (preferably in one sentence).

IX. Say whether the following statements are true (T) or false (F). Turn to the text to make your decision:

1. The principal goal of a network intrusion detection system is to make sure whether your system is broken or intact.
2. A signature based intrusion detection system searches for out of the norm attacks which lead to higher rate of false positives.
3. Advanced technologies work well within signature based detection system.
4. The major advantage of anomaly detection is defining its rule set.
5. One can't observe any important advantages of anomaly based detection over signature based detections.
6. Cons of the system prevail over its pros.
7. IDSs are quite reliable and don't need any other additional protection techniques to facilitate their operation.

UNIT III
ECOLOGY

Part A

I. Study the vocabulary related to the topic «Defining and Exploring the Key Questions»:

1) shift – изменение, перемещение, сдвиг;
2) sediment – осадок, отстой;
3) to impede – препятствовать, мешать, задерживать;
4) highlight – ярко освещать, выдвигать на первый план;
5) implication – вовлечение, причастность;
6) albedo – альбедо (характеристика отражательной способности поверхности);
7) amplitude – амплитуда, широта;
8) sustainability – поддержка;
9) mean – средний;
10) Holocene – голоцен (современная геологическая эпоха, начало которой – окончание последнего материкового оледенения Северной Европы; послеледниковая эпоха);
11) to surge – подниматься, вздыматься;
12) appraisal – оценка;
13) flux – течение, поток;
14) relevance – уместность;
15) controversial – спорный, дискуссионный;
16) arrow – стрела;
17) hemisphere – полушарие;
18) latitude – широта;
19) pervasive – проникающий, распространяющийся повсюду;
20) salinity – солёность;
21) to scatter – разбрасывать;
22) elusive – неуловимый, уклончивый;
23) to persist – упорствовать, настойчиво упорно продолжать;
24) threshold – порог, преддверие;
25) plausible – правдоподобный, вероятный;
26) to ascribe – приписывать;
27) insight – проницательность, способность проникновения;
28) aggregate – совокупность;
29) incidence – сфера действия, охват;
30) pest – бич, паразит, вредитель;
31) prevalence – широкое распространение;
32) urge – толчок;
33) vulnerability – уязвимость, ранимость;
34) standpoint – точка зрения;
35) perturbation – волнение, расстройство, смятение;
36) inherent – присущий, неотъемлемый.

II. Translate the sentence below paying attention to the function of the verb «would». What other functions of this verb do you know?

Any of our ancestors living a full three score years and ten in Western Europe some 11600 years ago would have experienced, during their life time truly remarkable changes in climate.

III. Read the following sentence and name the key words reflecting the principal information.

Another way of highlighting the unique nature of the global changes currently under way is to consider present-day and projected greenhouse-gas concentration in relation to the values typical of the Earth system over the last four glacial cycles.

IV. Read the sentence below and locate the information that can be deleted. Read your shortened version.

Central to any understanding of how the Earth system operates and how it changes on timescales of greatest relevance to future human welfare, are the processes that control changes in the fluxes of energy within the atmosphere and between atmosphere, hydrosphere, cryosphere and biosphere.

V. Read the sentence below. What is the function of the verb «to do» in this sentence? Give your explanations and translate the sentence. Take into account the function of the word «hence» in the sentence.

Not only does this change albedo and thermal capacity of the surface, it also modifies salinity, hence the density gradients within the water column.

VI. Translate the underlined word in the sentence below. Think of a word similar in meaning.

It is important to note here that we cannot simply regard these changes, brought about by the combination of population growth, exploding technology and the urge for economic development at any cost as somehow separate and detached from climate change.

VII. Translate these sentences. What is the function of the word «these»?

We must consider the major forces responsible for redistributing the energy received around the globe. These are shown schematically in Figures 7 and 8.

VIII. Before reading the text below discuss in pairs or in small groups the following issues:

a) rapid environmental changes;
b) possible dangerous effects of global warming;
c) global warming impact on people's health, soil, animals, plants and economy;
d) dangerous effects of global warming.

IX. Now read the text quickly paying attention to the principal information. After reading do the tasks that follow.

Text A

Defining and Exploring the Key Questions

Global changes present and past

Any of our ancestors living a full three score years and ten in Western Europe some 11 600 years ago would have experienced, during their life time, truly remarkable changes in climate. Evidence from that time shows that the main changes took place over a period of 50 years at most. Although different lines of evidence give different figures for the degree of warming, it would be difficult to argue for an increase of less than 4°C in mean annual temperature over much of Western Europe. In many areas, the shift would have been substantially greater. Parallel changes varying in nature and amplitude, but often synchronous in timing, took place over much of the Earth. The stratigraphic signal of these changes in the records from sediments and ice cores marks the transition from glacial times to the opening of the Holocene, the interglacial in which we live. Here then, was a period of rapid «global change». We may infer from this that there is nothing so very special about what we now think of as global change, that is, the current and impending changes in the Earth system driven by human activities. We would be quite wrong. The changes under way at the present day are of a different kind. At this stage, we need consider only three key differences:

– the rate of change in atmospheric CO_2 concentrations exceeds the mean rate during glacial-interglacial transitions by one to two orders of magnitude;

– the human population is now many orders of magnitude greater than it was at the opening of the Holocene;

– the degree to which the full range of human activities has transformed the world and the way it functions, especially over the last 50 years, has created a biosphere with no past analogues. Humans have become agents of change with diverse and increasing impacts on almost every aspect of the Earth system;

– another way of highlighting the unique nature of the global changes currently under way is to consider present-day and projected greenhouse-gas concentrations in relation to the values typical of the Earth system over the last four glacial cycles.

Earth-system science

Central to any exploration of environmental change is the concept of an integrated Earth system of which climate is a part and in which human activities now play a major, integral role. Climate interacts with all the other components of the Earth system in complex ways involving multiple feedbacks between ocean, terrestrial biosphere, cryosphere and atmosphere. To view climate as a self-contained atmospheric component of global change, separated from all the other processes that interact with it, is unrealistic. Equally, to view human activities as separated from or running counter to the «natural» world, rather than as key agents in the processes that are transforming the

Earth system, would be to revive an earlier and now totally inappropriate conceptual framework.

It follows from the above that any realistic scientific appraisal of present and future global change, indeed the whole field of study that we are addressing under the heading «global change» rests on the emerging field of Earth system science.

Key Earth-system processes

Central to any understanding of how the Earth system operates and how it changes on timescales of greatest relevance to future human welfare, are the processes that control changes in the fluxes of energy within the atmosphere and between atmosphere, hydrosphere, cryosphere and biosphere. These in turn largely control climate. Figure 6 is a schematic representation of the main processes driving change in the climate system. Even at this level of generalisation, many processes and transformations are involved.

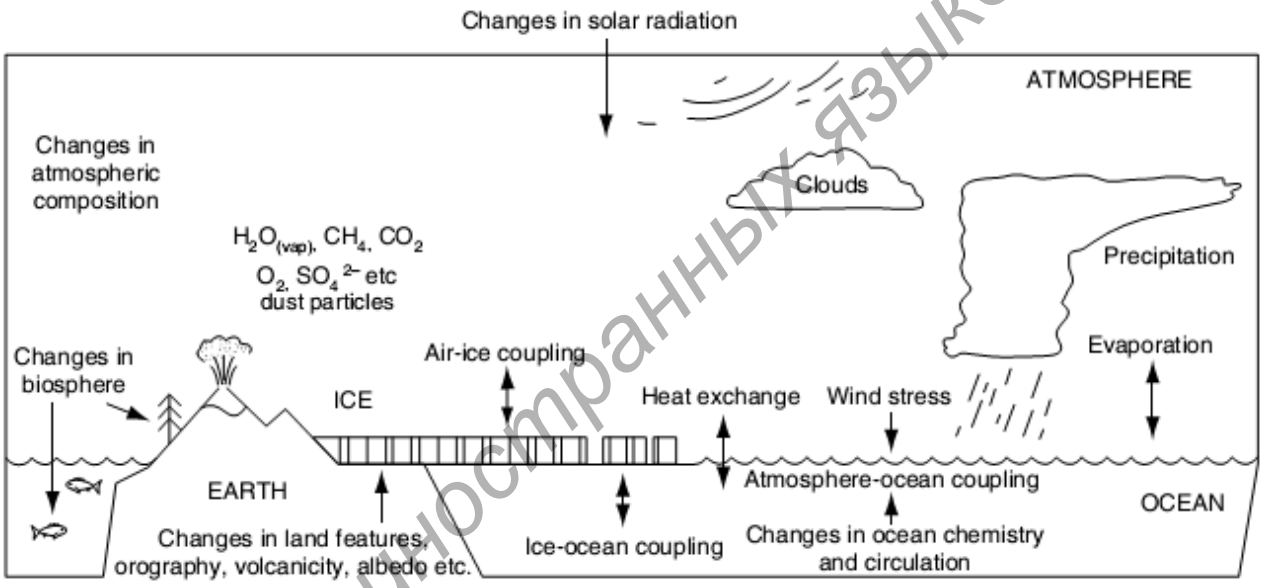


Figure 6. Schematic diagram of the main components of the climate system, showing many of the linkages and exchanges that play an important role in climate variability

We must next consider briefly the major forces responsible for redistributing the energy received around the globe – the large-scale systems of atmospheric and ocean circulation. These are shown schematically in Figures 7 and 8. The response times of the two types of system vary across many orders of magnitude. The radiative balance of the atmosphere equilibrates in a matter of hours or days, whereas in the deep ocean it may take hundreds of years. The ocean provides both storage and transport of heat on a massive scale. Coupling through time between these two systems is complex. Both systems are strongly influenced by the actual configuration of land and sea, leading to major contrasts in circulation between, for example, the atmosphere in the northern and southern hemispheres and between the Atlantic and Pacific oceans.

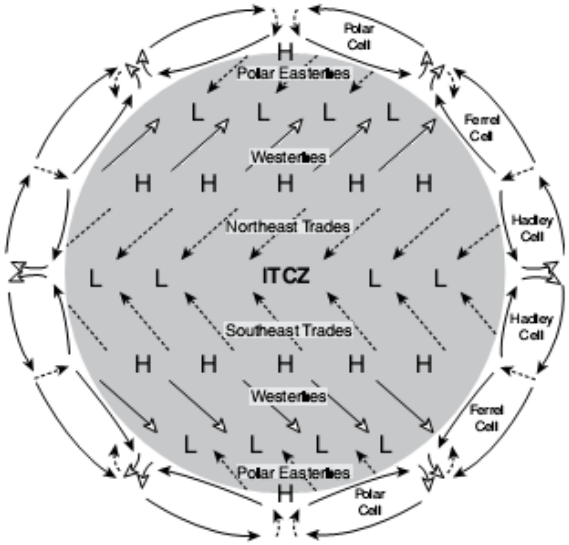


Figure 7. A schematic diagram of the main components of atmospheric circulation:
H – high pressure; L – low pressure; ICTZ – intertropical convergence zone

Changes in climate that affect snow and ice cover and vegetation thus lead to changes in albedo that may reinforce or counter the initial change. Where ice extent varies through time over the ocean, there are at least equally significant consequences. Not only does this change the albedo and thermal capacity of the surface, it also modifies salinity, hence the density gradients within the water column. This can affect heat exchange between surface and deep water and the pattern of ocean circulation. These, in turn, have important implications for climate.

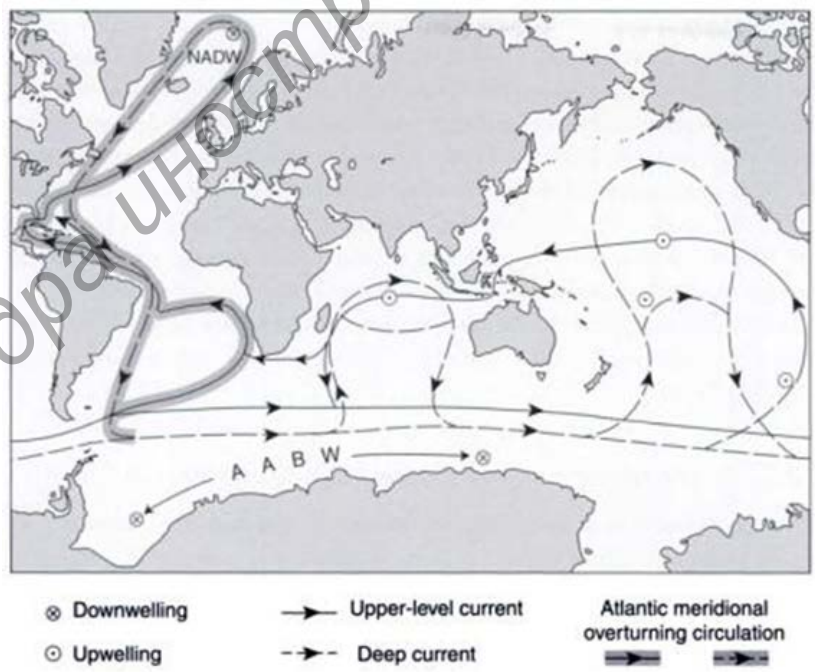


Figure 8. The main features of ocean circulation (Based on WMO/WCRP sources):
NADW – North Atlantic deep water; AABW – Antarctic bottom water

The circulation within the Atlantic is marked by southerly flowing deep water and northerly flowing upper-level water. Together these comprise the meridional overturning circulation system, which, in turn, exerts a dominant influence on the thermohaline circulation that links the Atlantic circulation to that in the Indian and Pacific oceans.

Feedbacks arise from processes within the atmosphere and the oceans as well as in the boundary layer between the two. Clouds have the effect of both screening the Earth from incoming radiation and reflecting back to Earth outgoing long-wave radiation. The balance between the two varies for any given cloud type and the altitude at which it develops. Indeed, the role of clouds in the climate system continues to be notoriously difficult both to measure and to model. Dust and aerosols also serve to absorb and scatter incoming radiation. Over the last two decades especially, the role of greenhouse gases and more recently aerosols has attracted great attention. Water vapour, carbon dioxide and methane are the most important and commonly considered greenhouse gases. Recent, rapid increases in the atmospheric concentration of the latter two as a result of human activities are beyond doubt. The rate of any future increases remains uncertain. The precise implications of any given increase in terms of surface warming remain controversial, partly because quantifying the past and likely future role of water vapour as a greenhouse gas has proved so elusive.

The key issues: *a preliminary analysis*

Global climate change

The biophysical forcing and feedback mechanisms that control the energy budget of the Earth system include natural, external forcing mechanisms such as solar variability and volcanic activity, as well as forcing and feedback processes strongly impacted by human activities: for example, atmospheric greenhouse gases, dusts and aerosols. The need to characterise and quantify human impacts on these latter, and also on other chemical species that strongly influence the Earth system, leads to a consideration of industrialisation and land cover changes since both are key drivers of changes in atmospheric composition. The way in which this complex combination of natural and anthropogenic influences affects climate at any point on the Earth's surface is partly a function of the way in which the atmosphere and the oceans redistribute energy around the globe. The processes involved in this redistribution are not only strongly interactive, they are also influenced by feedback mechanisms that link them to the terrestrial biosphere. Thus, the whole Earth system is intimately involved. Moreover, all the human activities that come into play reflect cultural, economic, technological and political processes operating on a range of scales from personal to global. For example, future rates of increase in atmospheric greenhouse gases will depend not only on the biophysical processes by which CO_2, methane and the other gases are processed and ultimately transformed or sequestered in components of the Earth system; they will reflect economic and technologically based decisions about, for example, energy production and the reduction of emissions. Human priorities and

aspirations are just as crucial as trace-gas atmospheric residence times or the rate at which sediments in the deep ocean can provide long-term carbon storage.

Sea-level change

Our understanding of the climate system and its future behaviour is vital to any estimate of the way in which sea-level may change in the future. A recent, at least century-long rise in global mean sea-level is well documented and can be ascribed in part to the warming, hence expansion, of the surface layers of the ocean (the so-called steric effect) and partly to the melting of glaciers. In order to assess the likely future rate and amplitude of any further sea-level rise, we need to be able to quantify better the recent trends and ascribe them more precisely to the main processes involved. Complementary research on the influence of climate change on sea-level in the past is also necessary. The links between climate and sea-level are complex and even the simplest cause-effect relationships are subject to time-lags, hence the value of a longer time perspective. Beyond this, that essential look into the future will, as in the case of climate change, remain a matter of alternative scenarios, each dependent on a trajectory of climate change and a series of calculations designed to estimate the effects of the climate change on the main controls of sea-level – ocean surface temperature and the mass balance of both polar and temperate ice.

When we move on one step further and attempt to estimate the likely effect of a given rise in global sea-level on a specific site or region, we need to be able to develop realistic relationships between mean sea-level change and the changing magnitude-frequency relationships of extreme events such as storm surges.

Ecological and human implications of climate change

Projected future climatic variability, often expressed as changes in mean values, needs to be reframed as changes in the likely future incidence of extreme events, whether these be, for example, droughts, killing frosts, periods of prolonged heat stress, or storm damage. Future climate scenarios that incorporate both downscaling and articulation in terms of extremes, or other biologically relevant variables, can then be linked to models based on, for example, ecosystem responses, crop physiology and performance, or pest and disease prevalence and transmission, under changing conditions. Ultimately, the effects of human influences ranging from individual decision making to trans-national or global influences, must be integrated in the scenarios in a fully interactive way. In this example, the three components – climatic, eco-physiological and human – do not interact in simple cause-effect chains, in which climate controls eco-physiological function, which in turn determines what human populations can and cannot do. The three types of process interact to generate multiple feedbacks. Thus, in any attempt to develop realistic future scenarios, they must be coupled in ways that allow for these feedbacks.

Wider implications of human activities and global change

One of the most important aspects of global change has often been sidelined by the current preoccupation with climate and «global warming». In reality, the cumulative impact of human activities on the functioning of the biosphere over the last 200 years has been far greater than any resulting from climate change, despite the fact that the range of global temperature changes since the mid nineteenth century has been large in relation to the amplitude of variability recorded during the second half of the Holocene. These changes are deforestation, the expansion of agricultural and range lands, soil degradation through erosion and salinisation, loss of biodiversity through habitat fragmentation and overexploitation, pollution of water resources, dramatic changes in atmospheric composition in addition to those affecting the major greenhouse gases, as well as growing domination of some of the key biogeochemical cycles. It is important to note here that we cannot simply regard these changes, brought about by the combination of population growth, exploding technology and the urge for economic development at any cost as somehow separate and detached from climate change. Nor is the distinction between «cumulative» and «systemic» changes entirely straightforward, for some of the former now appear to be having systemic effects. There are, as ever, multiple interactions and feedbacks between the two types of process.

Implications for human vulnerability and sustainability

Clearly in order to create any plausible scenarios for the future, we need to integrate the processes and impacts outlined above into a fully holistic evaluation that embraces human as well as biophysical dimensions. One approach involves viewing the ecosystems of the world not as functioning entities in their own right, but rather from an anthropocentric standpoint, as providers of «goods» and «services». This is consistent with a realistic recognition that the perceived threat from global change is not the survival of the planet as a functioning system, but rather its capacity to deliver the security and the resources, both renewable and non-renewable, upon which human life depends. At the same time, it is important to recognise that any scheme of ecosystem goods and services is inevitably limited to the cultural system within which it is defined. Moreover, ecosystem qualities that defy simple economic valuation are not necessarily of no significance.

Any realistic appraisal of the future sustainability of the Earth system from a human perspective must rest not only on the responses to all the foregoing questions but on a parallel and interwoven consideration of the growing needs and impacts of future human populations. The issues of resilience, vulnerability, risk, sustainability and adaptive capacity arise at a variety of spatial and organisational scales, from local to global. Increasingly, at local, regional and national levels, they are being evaluated through the use of impact assessment models that seek to integrate all the processes and interactions, both biophysical and human, that are considered likely to affect significantly the future success of human populations and their endeavours.

X. Check your understanding of the essential details by answering the following questions:

1) What concept is central to any exploration of environmental change?

2) How does climate inreract with all the other components of the Earth system?

3) What are key Earth-system processes?

4) What forces are responsible for redistributing the energy received around the globe?

5) What will be the amplitude and the rate of global climate change over the next century and beyond?

6) What will be the likely response of sea-level to global climate change?

7) How will the changes in global mean climate be expressed in terms of extremes (droughts and floods, for example) at continental, national and regional level?

8) What are the future implications of other ongoing processes resulting from human activities as they proceed alongside climate change?

9) What is your understanding of the terms «resilience», «vulnerability», «risk», «sustainability» and «adaptive capacity». The information from the text will help you to do this task.

XI. Write a short summary of the text, covering only the principal information. No more than 200 words should be used.

Part B

I. The following words and word-combinations are essential for understanding the text. Learn their meaning and pronunciation:

1) to sustain – поддерживать, подкреплять;
2) abuse – плохое обращение, злоупотребление;
3) inevitable – неизбежный, неминуемый;
4) comprehensive – исчерпывающий, всесторонний;
5) relevant – уместный, относящийся к делу;
6) to treat – обращаться, трактовать;
7) wastewater – сточная вода;
8) sound – здоровый, надёжный;
9) to bring about – вызывать, приводить (к чему-то);
10) settling – осадка, осадок;
11) tank – резервуар, цистерна, бак;
12) precipitation – осаждение, выпадение осадков;
13) to survey – осматривать, обследовать;
14) linkage – сцепление, соединение;
15) acknowledgement – признание, подтверждение;
16) to imply – значить, заключать в себе, подразумевать;
17) recovery – выздоровление, восстановление;
18) disturbance – беспокойство, нарушение;

19) reclamation – исправление, мелиорация;
20) diffuse – разбросанный;
21) nutrient – питательный;
22) sludge – грязь, топь, отстой;
23) incineration – сжигание;
24) root – корень, корнеплоды;
25) sewage – сточные воды;
26) impoundment – загон (для скота);
27) sediment – осадок, гуща;
28) in the vicinity of – поблизости от;
29) prudent – осторожный, осмотрительный;
30) harvest – жатва, уборка урожая;
31) mill – мельница;
32) abatement – уменьшение, снижение.

***II*. *Quickly look through the text to know what it deals with and do the tasks that follow*.**

Text B

Ecological Engineering: **Overview**

1. The most used definition of ecological engineering employs the following formulation: ecological engineering is defined as the design of sustainable natural and artificial ecosystems that integrate human society with its natural environment for the benefit of both. It requires, on the one hand, that we understand nature and ensure a sustainable development of natural resources and ecosystems and, on the other hand, that we make use (but not abuse) of natural resources to the benefit of the human society. Thus, our inevitable interactions with nature must be made under the comprehensive consideration of the sustainability and balance of nature.

2. Ecological engineering is engineering, in the sense that it involves the design of man made or natural ecosystems or parts of ecosystems. Like all engineering disciplines, it is based on basic science, in this case ecology and systems ecology. The biological species are the components applied in ecological engineering. Thus, ecological engineering represents therefore a clear application of ecosystem theory.

3. Ecotechnic is another often applied word but one that also encompasses the development of all types of «soft» technology applied in society, in addition to ecotechnology or ecological engineering. These types of technology are often based on ecological principles (e. g., all types of cleaner technology), particularly if they are applied to solve an environmental problem. The use of ecological principles in the development of technology is denoted as industrial ecology.

4. Recently, UNEP and UNESCO have introduced two other terms relevant to this discussion:

a) *Phytoremediation*. The use of plants in ecological engineering (e. g., using wetlands to treat wastewater pollutants, or for removing toxic substance from

contaminated soil).

b) *Ecobydrology*. The use of a combination of ecological and hydrological principles to obtain ecologically sound environmental management.

5. Both phytoremidiation and ecohydrology are subdisciplines within the discipline ecological engineering or ecotechnology, which is an often used synonym for ecological engineering.

6. Further, ecological engineering should not be confused with bioengineering or biotechnology. Biotechnology involves the manipulation of the genetic structure of cells to produce new organisms capable of performing certain functions. Ecotechnology does not involve manipulation at the genetic level, but rather at several steps higher in the ecological hierarchy. The manipulation takes place on an assemblage of species and/or their abiotic environment, as a self designing system that can adapt to changes brought about by outside forces, whether controlled by humans or by natural forcing functions.

7. Ecological engineering is also not the same thing as environmental engineering, the latter is involved in cleaning processes to prevent pollution problems. It involves the use of settling tanks, filters, scrubbers, and man made components that have nothing to do with the biological and ecological components applied in ecological engineering, *even though* the use of environmental engineering is directed to reducing man made forcing functions on ecosystems. *As mentioned above*, the term ecotechnic may be considered to include a part of environmental technology, *namely* the part based on ecological principles such as recirculation. The tool boxes of ecological engineering and environmental engineering are completely different; where ecological engineering uses ecosystems, communities, organisms and their immediate abiotic environment, and environmental engineering uses chemical and biotechnological unit processes such as filtration, precipitation, and biological decomposition by aeration.

8. All applications of technologies are based on quantification. Because ecosystems are very complex systems, the quantification of their reactions to impacts or manipulations is also complex. Fortunately, ecological modeling represents a well developed tool to survey ecosystems, their reactions, and the linkage of their components. Ecological modeling is able to synthesize our knowledge about an ecosystem, making it possible to quantify, to a certain degree, any changes in ecosystems resulting from the use of both environmental engineering and ecological engineering. Ecological engineering may also be used directly to design constructed ecosystems. Consequently, ecological modeling and ecological engineering are two closely cooperating fields. Research in ecological engineering was originally addressed in the *Journal of Ecological Modelling* which was initially named *Ecological Modelling – International Journal on Ecological Modelling and Engineering and Systems Ecology* to emphasize the close relationship between the three fields of ecological modeling, ecological engineering, and systems ecology. *Ecological Engineering* was launched as an independent journal in 1992, with the name of *Ecological Modelling* being changed to *Ecological Modelling – An International Journal on Ecological Modelling and Systems Ecology*. At the same

time, the journal *Ecological Engineering* has successfully covered the field of ecological engineering, which has grown rapidly during the 1990s due to increasing acknowledgment of the need to use technologies other than environmental technology in efforts to solve pollution problems. This development does not imply that ecological modeling and ecological engineering are moving in different directions. On the contrary, ecological engineering has increasingly been using models to perform designs of constructed ecosystems, or to quantify the results of applying specific ecological engineering methods for comparison to alter native, applicable methods.

9. In addition, the relationship between ecological engineering and systems ecology is very clear. Ecological principles are used widely in practical application of ecological engineering methods. Mitsch and Jorgensen have provided 19 principles that can be used as a checklist to assess if an ecological engineering project follows ecological principles, that is, to determine if a project is ecologically sound.

III. Study the words on the left and guess their derivatives on the right. Translate them into Russian:

sustain – sustainable;
pollute – pollutant;
apply – application;
assemble – assemblage;
precipitate – precipitation;
acknowledge – acknowledgement;
decompose – decomposition;
contaminate – contamination;
incinerate – incineration;
renew – renewable.

IV. Study the words in the chart below and find their derivatives in the text.

Verb	Noun	Adjective
	denotation	
alternate		
	emphasis	
		removable
comprehend		
		preventive
	contamination	
		considerate
compare		
		sustainable
	description	

V. Match the words from the text (***on the left***) ***with their*** **a**) ***synonyms and*** **b**) ***antonyms*** (***on the right***):

A		**B**	
inevitable	average	recovery	separate
consideration	implementation	pollute	detriment
encompass	cautious, careful	comprehensive	deterioration
application	thought	obtain	former

survey	maintain, preserve, conserve	actual	purify
impact	cover, include	free	notional
sustain	observe	latter	preserve
supplementary	effect, influence	integrate	limited
denote	signify	benefit	busy
prudent	unavoidable	destroy	lose
moderate	additional		

VI. Translate the italicized parts of the sentences into English using the vocabulary of the text.

1. Our inevitable interactions with nature must be made under the (всестороннее) consideration of the sustainability and balance of nature.
2. The biological (виды) are the components applied in ecological engineering.
3. The manipulation takes place on (скопление) of species and/or their abiotic environment.
4. Ecological modeling represents a well-developed tool to survey ecosystems, their reactions and the (соединение) of their components.
5. Ecological modeling and ecological engineering are two (плотно) cooperating fields.
6. This development does not (подразумевает) that ecological modeling and ecological engineering are moving in different directions.

VII. Look through the text and find the words similar to the Russian ones that you can understand without a translation.

VIII. In passage 1 find the word with the suffix -ity. From what root is this word formed? Look for another word with the same root in this passage. What other words with the suffix -ity do you know?

IX. Find the connectors in passage 2. What are they used for? What is the function of a link word «thus»? Translate the last sentence of the passage.

X. In passage 3 find the sentence with Infinitive used to express purpose. Translate the sentence into Russian.

XI. In passage 4 find the sentence with a coordinating conjunction «both ... and». Translate the sentence into Russian.

XII. Read the last sentence of passage 6. Think of a possible variant of replacing the phrasal verb «bring about» without the change in meaning.

XIII. Read the first sentence of passage 7. Translate it paying attention to the word «the latter». Which word in the sentence does it replace? Why? Give your explanations.

XIV. Go back to passage 7. What is the role of these connectors in the passage? Translate the sentences into Russian.

XV. In passage 8 find the sentences with the Infinitives in different functions: as part of a compound verbal predicate, as an attribute, as an adverbial modifier of purpose. Translate these sentences into Russian.

XVI. In passage 8 you will also find proper names of different ecological journals. Read them aloud and give their Russian versions.

XVII. In passage 9 find the word with the suffix -ship. From what root is this word formed? What other words with the suffix -ship do you know?

***XVIII. Look through the whole text, find and read aloud the sentences illustrating the author's opinion on the fact that:* a) *our interactions with nature are indispensable*; b) *ecological engineering is based on basic science*; c) *UNEP and UNESCO have introduced two new terms*; d) *bioengineering or biotechnology should not be confused with ecological engineering*; e) *environmental engineering is involved in cleaning processes*; f) *all applications of technologies are based on quantification*.**

XIX. Look through the text once more and say if the author gave a complete and full coverage of the problems raised in the text.

XX. Answer the following questions:

1. What is ecological engineering?
2. What is ecological engineering based on?
3. What two other terms did UNEP and UNESCO introduce?
4. What does biotechnology involve?
5. What differentiates ecological engineering and environmental engineering?
6. What are all applications of technologies based on?
7. What are the four classes of ecotechnology?
8. What are the forms of the ecological engineering solution?

Part C

I. Study the words related to the text «Technology for Sustainability»:

1) to sustain – поддерживать, подкреплять, выносить, подтверждать;
2) to deplete – истощать, исчерпывать;
3) to encompass – окружать (заботой), заключать;
4) concern – забота, беспокойство;
5) enduring – длительный, продолжительный;
6) to strive – стараться, прилагать усилия;
7) plow – плуг;
8) innocuous – безвредный, безобидный;
9) exhaustion – изнеможение, истощение;

10) to stand for – символизировать, означать;
11) affluence – изобилие, богатство;
12) viable – жизнеспособный;
13) blade – лист, лопасть;
14) to spur – побуждать, подстрекать;
15) chip – щепка, стружка;
16) residue = residium (pl-dua) – остаток, осадок;
17) cane – камыш, тростник;
18) poplar – тополь;
19) feasible – выполнимый, осуществимый, возможный;
20) prematurely – преждевременно, поспешно;
21) straightforwardly – прямо, просто, открыто;
22) subtle – тонкий, неуловимый, искусный, трудный;
23) to reclaim – исправлять, восстанавливать;
24) to furbish – чистить, очищать, снабжать, предоставлять;
25) fusion – плавка, сплав;
26) to mature – созревать;
27) to leak out – просачиваться, вытекать;
28) apt to – склонный (к чему-то);
29) tough – прочный, крепкий;
30) affluence – изобилие, богатство;
31) reliance – доверие, уверенность, надежда.

II. Quickly scan the text «Technology for Sustainability» and find the words with the suffixes -hood and -er/or. Say what kind of nouns they usually form. Think of your own examples of the words formed with these suffixes.

Text C

Technology for Sustainability

1. There are numerous definitions of sustainability. Most address the ability of the planet to sustain current human behavior. For example, the «entropy principle» of sustainability states that life on Earth should not use more energy each day than is supplied by the Sun each day. Herman Daly proposed these three principles of sustainability: nonrenewable resources should not be depleted at rates higher than the development rate of renewable substitutes; renewable resources should not be exploited at a rate higher than their regeneration level; the absorption and regeneration capacity of the natural environment should not be exceeded. Thus, one central concern of sustainability is resource consumption, especially the consumption of nonrenewable resources.

2. Other definitions of sustainability also encompass ecological concerns. The Second World Conservation Strategy of the International Union for Conservation of Nature and Natural Resources, the United Nations Environment Programme, and the World Wildlife Fund state that society is ecologically stable when it conserves

ecological life-support systems and biodiversity; ensures that uses of renewable resources are sustainable and minimizes the depletion of nonrenewable resources; and keeps within the carrying capacity of supporting ecosystems.

Lastly, the most expansive definitions include references to population, economics, and social equity. For example, Donella Meadows stated that: «Our minds tell us that a sustainable world has to be one in which renewable resources are used no faster than they regenerate; in which pollution is emitted no faster than it can be recycled or rendered harmless; in which population is at least stable, maybe decreasing; in which prices internalize all real costs; in which there is no hunger or poverty; in which there is true, enduring democracy. But what else?»

3. One answer to this question could be an explicit reference to the future. The famous Bruntland Commission definition of sustainable development references the future thusly: development that would meet the needs of the present without compromising the ability of future generations to meet their own needs. In this definition, the planning horizon for sustainable development is left indefinite. Over what period of time must we strive to be sustainable? The answer is «a very long time». Just consider how long the planet Earth would need to sustain Earth-life until other suitable homes for Earth-life could be found and inhabited. Even the most optimistic space-farers would probably admit that Earth-life is thousands of years, if not tens or hundreds of thousands of years, from colonizing even our immediate galactic neighborhood.

Another answer to Meadow's question could be technology, because technology is intimately interrelated with sustainability concerns. In fact, technology can be seen as both a threat to sustainability and a contributor.

4. A prototype class of sustainable technologies that could be sustainable given certain levels of population and affluence and that could also reduce environmental impacts is renewable energy technologies. The primary renewable energy technologies are solar, wind, biomass, geothermal, and hydro.

5. Solar technologies are active and passive systems. Photo-voltaics (PV) is an example of active system technology. PV panels are designed to absorb sunlight and produce electric current. Most PV panels are silicon based. Passive solar technologies include solar water heaters and homes that are designed to cool well in the summer (e. g., through passive ventilation) and maintain heat in the winter.

6. Wind technology is currently the most economically competitive renewable energy resource. Larger wind turbines with more aerodynamically efficient blades built with lighter weight materials are spurring the growth of wind power around the world. One can now find wind turbines in the hills of California, off the coast of the Netherlands, and even in wind farms on real farms.

7. Modern biomass systems burn plant materials directly for energy or distill plant stocks to produce other fuels. Power plants have been built to burn wood chips and residue from sugar cane production. Fast-growing biomass crops, including switch grass and hybrid poplar, are also burned for energy. New, smaller-scale gasifiers are making this approach to biomass more economically feasible. With respect to the latter, corn and other plants are distilled to produce fuels such as

ethanol, which can be used in automobiles. An exciting prospect that is just recently emerging is the use of vegetable oil residues to power automobiles. Potential ecological downsides of biomass include the conversion of more undeveloped land into lands needed to grow biomass crops (e. g., the conversion of more tropical forest land for this purpose) and the pressures to prematurely use genetically modified plant species to improve the profitability of biomass production. Biomass is generally considered neutral with respect to greenhouse gas emissions.

8. Geothermal technologies use the heat in the Earth as an energy resource. Future technologies may be able to tap heat stored deep in the Earth.

9. Hydro resources are renewable, as long as precipitation levels do not drop off. The damming of rivers produces most hydro energy. Recently, more efforts have been focusing on micro-hydro technologies. These technologies are built to use very small turbines that could be placed at the sides of streams or even in rain downspouts. Though small in scale, these systems could power a few electrical devices and have less environmental impacts than large dams.

10. Energy-efficiency technologies are not sustainable per se if their only impact is to slow the rate of the inevitable exhaustion of nonrenewable technologies. However, these technologies can contribute to sustainability by reducing emissions from the consumption of fossil fuels, which could help to slow the buildup of greenhouse gases in the atmosphere, and, consequently, help to slow global warming and climate change. For example, in homes, one can now find energy-efficient refrigerators, clothes washers and dryers, hot water heaters, consumer electronics, and lights, such as compact florescent bulbs.

11. In the commercial sector, a combination of energy-efficient and sustainable building practices is exemplified in green buildings. These buildings are designed to maximize passive solar potential. Windows may be specially designed to let more light in during the winter and block sunlight in the summer. Many green buildings are built with recycled materials. All have energy-efficient lighting. Where possible the buildings even use passive solar lighting through the use of light tunnels that bring sunlight into windowless parts of the buildings. These buildings have sophisticated energy management systems that allow occupants to heat and cool their own areas as they wish and that adapt to time-of-day and weather conditions. As a result, green buildings have much smaller heating, ventilation, and air conditioning (HVAC) systems. The buildings are supposed to have ecological benefits, too. Many have green roofs (i. e., have layers of Earth and surface plants growing on roofs to provide insulation) and have native landscaping.

12. Energy-efficient technologies are making in-roads into other sectors as well. Hybrid automobiles are rapidly increasing their market share. In addition, vehicles are becoming lighter as steel is being replaced by carbon fibers, aluminum, and magnesium. Major efforts are being made to save energy in industrial plants, from using more efficient variable speed drive motors to redesigning steam and process heat systems.

13. Water conservation and recycling technologies can also be considered sustainable. With respect to water, the goal is to ensure that enough water of high

enough quality is available to sustain our populations and preferred levels of affluence.

Recycling technologies help to reduce the need for new virgin materials and therefore help to reduce the footprint of human societies on the Earth. Most people are familiar with the recycling of newspapers, glass bottles, plastic bottles, and aluminum cans. In addition, industry recycles almost all steel from discarded automobiles and also reclaims almost all precious metals, such as platinum and palladium, from catalytic converters. Efforts are growing not only to recycle more materials but also refurbish products.

14. Now, let us address more advanced and speculative technologies that could improve the prospects for sustainability. With respect to energy production, researchers around the world are still working on fusion technology. The mainstream fusion technologies use magnetic fields or powerful lasers to exert great pressures on fusion targets, such as deuterium, to force atoms to fuse together and release energy. These technologies have matured greatly over the years. The promise is that any fusion technology, if successfully developed into a commercial energy resource, could greatly lessen the impacts of energy production on the environment.

15. In recent years, much has been written about the hydrogen economy. Briefly, the hydrogen economy is one where hydrogen and oxygen are used as inputs into fuel cells, which can power cars, buses, and even homes and businesses. Hydrogen and oxygen are plentiful on Earth and the only emissions from fuel cells are water. Thus, theoretically, the hydrogen economy could be highly sustainable. Huge new infrastructures of hydrogen stations, hydrogen vehicles, hydrogen fuel cells for homes, hydrogen pipelines, and hydrogen production plants must also be constructed to make the hydrogen economy a reality.

16. Nanotechnology can have major implications for sustainability. Nanotechnologists work on building substances, materials, and even machines atom-by-atom or molecule-by-molecule. Using this approach, nanomaterials and devices can be built that have extraordinary properties. For example, hydrogen gas tanks built out of carbon nanotubes could be leak proof. Nanotechnological processes are apt to produce much less waste, as only needed atoms or molecules will be used in the processes.

17. Indeed, this piece has only been able to mention a relative handful of technologies that could be used to promote sustainability (Table 1 contains a list of the technologies mentioned above and the status of their use in society). The opportunities for technological innovation with respect to sustainability are almost limitless. However, it is by no means certain that technological solutions will be sufficient to sustain life, as we know it, on planet Earth into the distant future. It can be argued that population and affluence, combined with a reliance on nonrenewable resources, presently leave us in a very unsustainable situation. New technologies could substantially improve this situation but context issues will remain. Therefore, technology for sustainability cannot be developed in a vacuum but needs to be developed synergistically with population and affluence considerations.

Table 1. Examples and current use of technologies that promote sustainability

General technology area	Specific technology	Current use
Renewable energy	Solar	Very limited but growing
	Wind	Limited but growing
	Biomass	Limited but growing
	Geothermal	Very limited but growing
	Hydro	Widespread and established
Energy efficiency	Hot water	Limited but growing
	Appliances	Common and growing
	Consumer electronics	Common and growing
	Lighting	Common and growing
	Heating, ventilation, and air conditioning (HVAC)	Very limited but growing
	Green buildings	Very limited but growing
	Windows	Limited but growing
	Automobiles	Limited but growing
	Variable speed drives	Limited but growing
	Other industrial measures	Limited but growing
Efficient production	Recycling	Widespread and established
	Refurbishing	Limited but growing
	Green chemistry	Very limited but growing
Water conservation	Low-flow shower heads	Limited but growing
	Composting toilets	Very limited but growing
	Drip irrigation	Limited but growing
	Advanced wastewater systems	Very limited but growing
Advanced energy technologies	Mainstream fusion	Still in the laboratory
	Cold fusion	Still in the laboratory
	Bubble fusion	Still in the laboratory
	Hydrogen economy	Still in the laboratory
Advanced enabling technologies	Nanotechnology	Very limited but growing

III. Read the title of the text. Translate it into Russian paying attention to the suffix -ity. Look through the text and find the words with the same suffix. Translate the words into Russian.

IV. Judging by the title say what the text might be about. What word helped you to form your opinion?

V. Now read passage 1 and find out what three principles of sustainability Herman Daly proposes. Enumerate them.

VI. In passage 2 find different definitions of sustainability. Reproduce them.

VII. Scan passage 3 and find two answers to Meadow's question.

VIII. What are the primary renewable energy technologies? Find the information in passage 4.

IX. In passage 5 find the information about passive and active sollar technologies. Enumerate them.

X. Look through passage 6. Find the sentence with the word «one». Translate this sentence into Russian. What other functions of the word «one» do you know?

XI. Scan passage 7 and speak in short about biomass and modern biomass systems. Translate the last sentence of this passage paying attention to the word combination «with respect to».

XII. What do geothermal technologies use? Look for the answer in passage 8.

XIII. Express the main idea of passage 9 using the following words and word-combinations: «hydro resources», «renewable», «precipitation level», «micro-hydro technologies».

XIV. How can energy-efficient technologies contribute to sustainability? Find the information in passage 10.

XV. What are green buildings? Look for the answer in passage 11.

XVI. Look through passage 12 and name the issues raised in it. Single-out key words which help you to form your opinion.

XVII. In passage 13 find the information about water conservation and recycling technologies. Discuss the information with your partner.

XVIII. What is fusion technology? Look for the answer in passage 14.

XIX. Scan passage 15 and speak about the hydrogen economy. What should be constructed to make the hydrogen economy a reality?

XX. Express the main idea of passage 16 using the following words and word-combinations: «nanotechnology», «sustainable technology», «nanomaterials», «nanotechnological processes».

XXI. Look through passage 17 and name the issues raised in it. Single-out key words which help you to form your opinion.

XXII. And, finally, generalize the issues raised in the text. Express your opinion, add the information you possess, give facts, examples in favour or against

the information given in the text. While speaking use the words of the active vocabulary.

XXIII. Say if the information of the text is new to you? Can it be applicable in your future professional activities?

Part D

I. Quickly look through the text below to get acquainted with its structural composition – subtitles, words in bold type, italics, etc. Do they tell you anything? Discuss it with your partner.

II. Quickly scan the text again for the words in italics. Make sure you know them. If you don't look them up in the dictionary or ask your teacher for help.

Text D

Applied Ecology

Applied Ecology

The science of ecology involves the study of interactions between organisms and their environment, both biotic and abiotic, with particular focus on those interactions that determine their distribution and abundance. Applied ecology is the science of the application of ecology to contemporary problems in managing our biological resources. It includes scientific study of the effects of humans on the interactions between organisms and their environment, but excludes human ecology.

Applied ecology has two broad themes. The utilitarian theme concerns the interests of humans in their food, shelter, welfare, and health, that is, the material services the natural environment provides. Such ecosystem services, once compromised, can be very expensive to replace despite our technological advances. How do we bring ecology to bear in maintaining and improving these ecosystem services where they currently exist, in restoring or replacing them if they have been lost, or in mitigating the impact if those services are under threat? A second theme concerns nonconsumptive values of the biota, for recreation, tourism, psychological well-being, or simply because humans have an ethical responsibility as custodians of the natural environment and the species it contains.

Some Iconic Examples

The scope of «applied ecology» is very broad indeed, possibly best illustrated by way of example. It is now widely accepted that the global climate is changing, that part of the cause is associated with industrial development, and that the impacts on human communities and the biota are potentially profound. Can we predict how natural ecosystems and the species they contain will respond, what have we done to constrain those responses (e. g., widespread fragmentation of habitat restricts range shifts), and what can we do to ameliorate the impacts of global climate change on the

biota? It is in answering these questions that «applied ecology» complements climate change studies by meteorologists, geographers, and geologists in other disciplines more focused on studying the direct impacts of climate change on human society.

Land clearing for forestry, pastoralism, and agriculture and aquatic habitat destruction through land reclamation and water resource development are arguably the most serious threats to biodiversity today. The long-term consequences of such activity is often not realized at the time it is undertaken, and there is no good appreciation of how far the system can be pushed in meeting production goals before both ecological and economic sustainability are compromised. When land use and water resource development have overshot sustainable levels for production and for other land-use values such as biodiversity, what can be done to restore those values (restoration) or bring about change leading to an acceptable and sustainable condition (rehabilitation)? Both restoration and rehabilitation are important components of «applied ecology».

Protected areas such as reserves and national parks make an important contribution to biodiversity conservation, but are they adequate to sustain biodiversity in the long term? The overall goals are to conserve species, their genetic variability and potential to respond to environmental change, and the natural ecosystem processes that provide the ecological context in which they have evolved and continue to evolve. Protected area management, the inventory of values and selection of reserves, their design, and the management of threats to their values such as feral animals and weeds, fire management, impacts of human visitation are all topics addressed in part by «applied ecology».

Globalized trade and associated movement of people and products leads inevitably to unwanted introduction of exotic species, some of which become established in the wild well outside their natural range. This is of major concern because feral populations can be reservoirs for disease that impacts on agricultural production. Can we predict which species are most likely to establish, which are likely to cause the greatest impact, model the spread of exotic species when they arrive, and control their spread, distribution, and abundance in order to manage their impacts once they are established?

These are examples of the broader societal context in which «applied ecology» does its work. The discipline is generally seen to add value to restoration ecology, habitat management and rehabilitation, management of invasive species (both native and exotic), conservation biology, wildlife utilization, protected area management, and agroecosystem management. The discipline also makes important contributions to environmental forensics, landscape architecture, ecotourism, and fisheries.

Foundation in the Fundamentals

The diversity of concepts drawn from ecology and applied in management of our natural resources is vast and stems from the multidisciplinary nature of natural resource management generally. In dealing with the impacts of climate change on the biota, for example, we need to know of the habitat requirements of species or «niche breadth»,

the extent of suitable habitat and connectivity that provides scope for «invasion» of new areas as the climate shifts. Coupled with this is the need to know of the limitations to their «physiological tolerances», their «dispersal capabilities» and the «demographic attributes» that will govern the speed of their response through range shifts. Many reptiles have temperature-dependent sex determination, and would appear appallingly vulnerable to climate change. What scope do they have to respond to climatic change, through «natural selection», which in part will depend on «genetic diversity» in the traits determining their «evolutionary responses» to changing climate? Will an evolutionary response be rapid enough? What scope do species have to respond through «phenotypic plasticity» rather than a direct evolutionary response. Table 2 provides a link between fundamental ecological concepts, principles, and ideas, and the broad areas of application in «applied ecology».

Table 2. Topics in «applied ecology» and concepts, ideas, and topics in ecology that are used in applied ecology

Topics in applied ecology	Relavant ecological concepts, ideas, and topics
Restoration ecology	Niche, succession, community dynamics, resilience
Habitat management and rehabilitation	Habitat selection, niche, community dynamics
Management of invasive species	Population dynamics, predator-prey relationships, competition, disease-host interactions, natural selection.
Conservation biology	Population dynamics, population genetics, population viability, biodiversity
Wildlife utilization	Population dynamics, sustained yield
Protected area management	Island biogeography, population viability, biodiversity, ecotones
Agroecosystem management	Competition, biodiversity, natural selection
Forensic sciences	Genetics, taxonomy
Landscape architecture	Connectivity, fragmentation, movements, metapopulations
Ecotourism	Population dynamics, thresholds, resilience
Fisheries	Population dynamics, sustained yield, food webs
Forestry	Population dynamics, sustained yield, demography
Urban development	Habitat, corridors
Ecosystem services	Nutrient cycling, biodiversity
Climate change	Niche, population dynamics
Pollution	Niche, assimilation, bioaccumulation, ecotoxicology
Energy generation and carbon management	Nutrient cycling, bioaccumulation
Water management	Niche, biodiversity assessment

What Do Applied Ecologists Do?

Applied ecologists engage in their profession at a broader level than commonly recognized. On the spectrum of esoteric research (of no identifiable immediate relevance), through strategic research (of broad relevance) to tactical research (of immediate relevance), applied ecologists vary in their level of engagement. Some are practitioners at the coalface of application undertaking research in the immediate context of management problems, and addressing the immediate concerns of management. Their work is typically funded directly by resource management agencies or industry.

Others address research questions of more fundamental strategic value, in areas where improved knowledge, understanding, and techniques are likely to be of service in addressing contemporary problems as well as problems of the future, many of which are currently unforeseen. Their work is typically funded by research and development (R&D) organizations or by government agencies such as the US National Science Foundation, the Australian Research Council, the UK Natural Environment Research Council, or the NZ Marsden Scheme.

Applied ecologists use one or more of the following approaches in conducting their science – observation, experimentation, and modeling. Experiments may be undertaken to explore causal relationships, perhaps involving exclosures and population manipulation to determine responses of vegetation, or to fine-tune survey and monitoring approaches. Modeling may be applied outside the scope of feasible experimentation to investigate the combined effects of environmental changes and human intervention on kangaroo populations as a tool to guide decision making. Some topics, such as large-scale climate change, can initially be studied by observation to quantify the changes that are or not occurring. Field experiments may be impossible, especially at large spatial scales, but small plot or laboratory experiments can provide useful information. Modeling provides a framework for integrating these observations and results of the limited experimentation that is possible to estimate likely changes in environmental conditions and responses by organisms to such changes. Future observations can be used to evaluate the accuracy of predictions of the modeling.

The mix of approaches that are used by applied ecologists is determined by their experience with each, the advantages and disadvantages of each including the costs, practicality, and the quality of data and hence the strength of conclusions obtained by each approach. For example, on the latter point, observations allow clear conclusions to be made about patterns in ecology. However experiments allow clearer conclusions about cause and effect in ecology; that is, about what causes changes in distribution and abundance of organisms compared with what changes have occurred. Modeling allows a great range of possible management actions or scenarios to be examined and a greater range than that can be examined by experiments. However the modeling results are hypothetical and require evaluation of their practical relevance.

III. Look for some specific information contained in the part entitled «Applied Ecology». What is applied ecology? What does it include? What two broad themes does applied ecology comprise?

IV. The part entitled «Some Iconic Examples» contains the information about the most serious threats to biodiversity today.* Enumerate them. *Find and read aloud the information about the overall goals of sustaining biodiversity.

V. Look through table 1 in the part «Foundation and Fundamentals» to find out topics, relevant ecological concepts and ideas in applied ecology. What topics, concepts, ideas are used in applied ecology.

VI. Turn your attention to the part «What Do Applied Ecologists Do?». What approaches do applied ecologists use? What are the advantages and disadvantages of these approaches?

VII. What conclusion is drawn in the final passage of the text? Do you agree with it? Express your opinion in short (preferably in one sentence).

VIII. Say whether the following statements are true (T) or false (F). Turn to the text to make your decision:

1. Applied ecology includes the design of sustainable natural and artificial ecosystems.
2. Applied ecology draws its strength from the commitment of ecologists to engage in the application of their science to natural resource management.
3. Agriculture and aquatic habitat destruction through land reclamation and water resource development contribute to biodiversity today.
4. Restoration and rehabilitation have nothing in common with applied ecology.
5. There is an evident link between the fundamental ecological concepts and the broad areas of use in applied ecology.
6. Applied ecologists make policy and make decisions about how to manage the environment.
7. Applied ecologists use different approaches in their research.
8. There are several advantages and disadvantages of different scientific approaches.

Unit IV
TELECOMMUNICATIONS

Part A

***I. Study the following words and word combinations. Make your predictions about the contents of the text*:**

1) e-learning – the use of electronic media and information and communication technologies in education;
2) to facilitate – to make easier;
3) eligible – suitable;
4) to bridge a difference – to make a difference between two groups smaller or less significant;
5) consequently – as a result;
6) like-minded – having similar tastes or opinions;
7) thereby – by that means, as a result of that;
8) to disperse – to distribute or spread over a wide area;
9) vocational training – training needed for a particular job or profession;
10) instruction – teaching, education;
11) lantern slide – a mounted photographic transparency for projection by a magic lantern (a lamp with a transparent case);
12) proprietary – (of a product) marketed under and protected by a registered trade name;
13) open – freely available or accessible, offered without restriction;
14) assignment – a task or piece of work that you are given to do, especially as part of your job or studies;
15) open learning – learning based on independent study or initiative rather than formal classroom instruction;
16) ISDN (Integrated Services Digital Network) – a telecommunications network through which sound, images, and data can be transmitted as digitized signals;
17) interoperability – connectivity;
18) whiteboard – a shiny white surface that can be wiped clean after being used for writing or drawing on; a large screen used to project computer images to a group of people;
19) furthermore – besides, also, moreover;
20) peer – a person who is an equal in social standing, rank, age, etc.;
21) party – a group of people associated in some activity;
22) MCU (Multipoint Control Unit) – a video-conferencing device that links two or more audiovisual workstations into one audiovisual conference call;
23) bottleneck – something that holds up progress;
24) ad-hoc – for a particular purpose only.

II. Translate the word in bold in the sentence below. Think of a word similar in meaning.

In the distance learning **setting**, such networking can enable students' connections with each other and thereby reduce their sense of isolation.

III. Translate the sentence below paying attention to the emphatic construction «it is (was) … that (which, who)…»:

It was the demand by industry, government, and the military for vocational training, however, that pushed distance learning to new levels.

IV. Read the sentence below, analyse and translate it paying attention to the meaning of the word «prove».

One of the first technological aides to education was the lantern slide, which was used in the 19th century in lyceum schools for adults and in travelling public-lecture tent shows throughout the world to project images on any convenient surface; such visual aides proved particularly useful in educating semiliterate audiences.

V. Go back to the sentence above, and locate the information that can be deleted. Read out your shortened version.

VI. Translate the sentence below paying attention to the Complex Subject.

The tutors and interactions among individual students are meant to compensate for the lack of face-to-face lectures in the Open University.

VII. Translate the underlined words in the sentence below. Think of the words similar in meaning.

To emphasize the tutorial and individualized-learning aspects of its method, the Open University prefers to describe it as «supported open learning» rather than distance learning.

VIII. Before reading the text give your answers to the following questions.

1. What is distance learning?
2. When did the first distance learning courses begin?
3. Who is distance learning most suitable for?
4. What communications technologies in your opinion enable learners and teachers to interact with each other?
5. What special hardware and software do you need for videoconferencing?

IX. Now read the text quickly and check your answers.

Text A

Distance Learning

A_____

1. Distance learning, also called distance education, e-learning, and online learning is a form of education in which the main elements include physical separation of teachers and students during instruction and the use of various

technologies to facilitate student-teacher and student-student communication. Distance learning often focuses on nontraditional students, such as full-time workers, military personnel, and nonresidents or individuals in remote regions who are unable to attend classroom lectures.

2. Four characteristics distinguish distance learning. First, distance learning is by definition carried out through institutions; it is not self-study or a nonacademic learning environment. The institutions may or may not offer traditional classroom-based instruction as well, but they are eligible for accreditation by the same agencies as those employing traditional methods. Second, geographic separation is inherent in distance learning, and time may also separate students and teachers. Accessibility and convenience are important advantages of this mode of education. Well-designed programs can also bridge intellectual, cultural, and social differences between students. Third, interactive telecommunications connect individuals within a learning group and with the teacher. Most often, electronic communications, such as e-mail, are used, but traditional forms of communication, such as the postal system, may also play a role. Whatever the medium, interaction is essential to distance education, as it is to any education. The connections of learners, teachers, and instructional resources become less dependent on physical proximity as communications systems become more sophisticated and widely available; consequently, the Internet, cell phones, and e-mail have contributed to the rapid growth in distance learning. Finally, distance education, like any education, establishes a learning group, sometimes called a learning community, which is composed of students, a teacher, and instructional resources – i. e., the books, audio, video, and graphic displays that allow the student to access the content of instruction. Social networking on the Internet promotes the idea of community building. On sites such as Facebook and YouTube, users construct profiles, identify members («friends») with whom they share a connection, and build new communities of like-minded persons. In the distance learning setting, such networking can enable students' connections with each other and thereby reduce their sense of isolation.

B_____

3. Geographical isolation from schools and dispersed religious congregations spurred the development of religious correspondence education in the United States in the 19th century. From its religious origins, the program gradually expanded to include a nondenominational course of directed home reading and correspondence study. It was the demand by industry, government, and the military for vocational training, however, that pushed distance learning to new levels. In Europe, mail-order courses were established by the middle of the 19th century. Most correspondence courses emphasized instruction in spelling, grammar, composing business letters, and bookkeeping.

C_____

4. One of the first technological aides to education was the lantern slide, which was used in the 19th century in lyceum schools for adults and in travelling public-lecture tent shows throughout the world to project images on any convenient surface; such visual aides proved particularly useful in educating semiliterate audiences.

5. The first significant technological innovation was made by the American inventor Thomas Edison, who devised the tinfoil phonograph in 1877. This device made possible the first language laboratories. After World War I, university-owned radio stations became commonplace in the United States, with more than 200 such stations broadcasting recorded educational programs by 1936.

6. Edison was also one of the first to produce films for the classroom. Many colleges and universities experimented with educational film production before World War I, and training films were used extensively during the war to educate a diverse and often illiterate population of soldiers. Improvements in filmmaking, in particular the ability to produce «talkies», were put to use during World War II for technical training and propaganda purposes.

7. Instructional television courses began to be developed in the 1950s. By the 1970s community colleges all across the United States had created courses for broadcast on local television stations.

8. Various experiments in computer-based education also began in the 1950s, such as programmed or computer-assisted instruction, in which computers are used to present learning materials consisting of text, audio, and video and to evaluate students' progress.

D_____

9. The next major advancement in educational technology came with the linking of computers through the Internet. Modern distance learning courses employ Web-based course-management systems that incorporate digital reading materials, podcasts (recorded sessions for electronic listening or viewing at the student's leisure), e-mail, threaded (linked) discussion forums, chat rooms, and test-taking functionality in virtual (computer-simulated) classrooms. Both proprietary and open-source systems are common. Although most systems are generally asynchronous, allowing students access to most features whenever they wish, synchronous technologies, involving live video, sound, and shared access to electronic documents at scheduled times, are also used.

E_____

10. One of the most prominent types of educational institutions that makes use of distance learning is the open university, which is open in the sense that it admits nearly any adult. The Open University relies heavily on prepared materials and a tutor system. The printed text was originally the principal teaching medium in most Open University courses, but this changed somewhat with the advent of the Internet and computers, which enabled written assignments and materials to be distributed through the Web. For each course, the student is assigned a local tutor, who normally makes contact by telephone, mail, or e-mail to help with queries related to the academic materials. Students may also attend local face-to-face classes run by their tutor, and they may choose to form self-help groups with other students. Tutor-graded assignments and discussion sessions are the core aspects of this educational model. The tutors and interactions among individual students are meant to compensate for the lack of face-to-face lectures in the Open University. To emphasize the tutorial and

individualized-learning aspects of its method, the Open University prefers to describe it as «supported open learning» rather than distance learning.

F_____

11. Videoconferencing is the holding of a conference among people at remote locations by means of transmitted audio and video signals. During the late 1990s two new videophone solutions were developed: business videoconferencing and desktop videoconferencing. Business videoconferencing employs video cameras, video compression and decompression hardware and software, and interfaces to one or more ISDN lines or an Internet connection in order to provide capture, transmission, and display of synchronized voice and video to one or more locations. Typically, these systems are installed in conference rooms to permit meetings to be held without requiring travel by the participants. Several companies developed proprietary transmission protocols and voice and data compression techniques, but most make use of standards developed by the International Telecommunication Union (ITU) in order to permit interoperability of different systems. Desktop videophones usually consist of inexpensive cameras connected to a personal computer (PC), video-sharing software, and an Internet connection (either dial-up or broadband) between two PCs. Because of bandwidth limitations, desktop systems are usually of lower quality than business videoconferencing systems. Some desktop conferencing software includes application-sharing between two or more PCs, a shared clipboard, file-transfer capability, a «whiteboard» for sharing ideas, and chat service between users. Videoconferencing provides students with the opportunity to learn by participating in two-way communication forums. Furthermore, teachers and lecturers worldwide can be brought to remote or otherwise isolated educational facilities. Students from diverse communities and backgrounds can come together to learn about one another, although language barriers will continue to persist. Such students are able to explore, communicate, analyse and share information and ideas with one another. Through videoconferencing, students can visit other parts of the world to speak with their peers, and visit museums and educational facilities.

G_____

12. Simultaneous videoconferencing among three or more remote points is possible by means of a Multipoint Control Unit (MCU). This is a bridge that interconnects calls from several sources (in a similar way to the audio conference call). All parties call the MCU, or the MCU can also call the parties which are going to participate, in sequence. There are MCU bridges for IP and ISDN-based videoconferencing. There are MCUs which are pure software, and others which are a combination of hardware and software. An MCU is characterised according to the number of simultaneous calls it can handle, its ability to conduct transposing of data rates and protocols, and features such as Continuous Presence, in which multiple parties can be seen on-screen at once. MCUs can be stand-alone hardware devices, or they can be embedded into dedicated videoconferencing units.

13. Some systems are capable of multipoint conferencing with no MCU, stand-alone, embedded or otherwise. These use a standards-based H.323 technique known as «decentralized multipoint», where each station in a multipoint call exchanges

video and audio directly with the other stations with no central «manager» or other bottleneck. The advantages of this technique are that the video and audio will generally be of higher quality because they don't have to be relayed through a central point. Also, users can make ad-hoc multipoint calls without any concern for the availability or control of an MCU. This added convenience and quality comes at the expense of some increased network bandwidth, because every station must transmit to every other station directly.

H_____

14. Teleseminars are used to provide information and training to groups of people interested in a particular topic. The host of the teleseminar will schedule a specific time and date in advance to communicate with his/her audience. The audience can vary in size from a few callers to 1,000 participants depending on the capacity of the bridgeline used and the popularity of the topic being discussed. These conference calls are typically recorded. There is typically a fixed period of time devoted to the presentation of information followed by another fixed period of time for questions and answers. Teleseminars provide an opportunity for a host to provide information to a large number of people at one time. It allows a trainer to train many participants at once, one on many rather than one on one. It also eliminates the need for travel, expensive preparation and presentation material costs. These factors make teleseminars a very cost effective delivery method.

X. ***Go back to the text and match the heading with the gaps at the start of each paragraph***.

1. You need only a telephone connection.
2. Correspondence schools in the 19th century.
3. Web-based courses.
4. Multipoint videoconferencing.
5. Characteristic features of distance learning.
6. Real time videoconferencing.
7. Early educational technologies.
8. University of the Air.

XI. ***Read the sentences below and mark them as T*** (***true***) ***or F*** (***false***).

1. Various terms have been used to describe the phenomenon of distance learning.
2. Distance learning provides access to learning when the source of information and the learners are separated by time and distance, or both.
3. It was geographical isolation from schools that promoted the development of distance learning in the 19th century.
4. Instructional computers are basically used in one of two ways: either they provide a straightforward presentation of data or they play a tutorial role in which the student is tested on comprehension.
5. There are several entry requirements for most students in the Open University.

6. Videoconferencing is the conduct of a videoconference by a set of telecommunication technologies which allow two or more locations to communicate by simultaneous two-way video and audio transmissions.

7. Most countries avoid using standards developed by the ITU in order to improve telecommunication services.

8. Multipoint videoconferencing is impossible without a Multipoint Control Unit.

XII. Check your understanding of the essential details by answering the following questions.

1. What are the main characteristics of distance education?
2. How were some innovation products of the 19th–20th centuries used in education?
3. What opportunities for learning were offered by the Internet?
4. What teaching methods are used by the Open University?
5. What is the difference between business videoconferencing and desktop videoconferencing?
6. What are the advantages of teleseminars for students?

XIII. Summarize the ideas developed in each part of the text. Say what you think of the advantages and disadvantages of distance learning. What's new in distance learning?

Part B

I. The following words and word-combinations are essential for understanding the text. Learn their meaning and pronunciation:

1) to convey – передавать, проводить;
2) to distinguish – различать;
3) distortion – искажение;
4) pitch – высота звука;
5) to employ – применять, использовать;
6) retina – сетчатка, сетчатая оболочка;
7) disparity – неравенство; несоответствие;
8) flicker – мерцание;
9) to interpose – вставлять, помещать между;
10) shutter – задвижка, заслонка;
11) frame – кадр;
12) to confine – ограничивать;
13) aspect ratio – форматное соотношение, соотношение геометрических размеров;
14) scanning spot – сканирующее пятно, развертывающее пятно;
15) to dissect – разрезать, рассекать;
16) raster – растр;
17) fatigue – усталость;

18) piecemeal – по частям, постепенно;
19) persistence – сохранение эффекта после устранения причины, вызвавшей его; послесвечение.

II. Translate the words paying attention to the meaning of prefixes and suffixes:
1) to produce (производить) – reproduce, production, producer, reproduction;
2) to assemble (собирать) – reassemble, disassemble, assembly;
3) to move (двигать) – remove, movement;
4) to create (создавать) – recreate, creation, creator, creative;
5) to constitute (создавать) – reconstitute, constitution;
6) to ride (ехать) – override, rider;
7) to come (приходить) – overcome;
8) to aware (знающий) – unaware, awareness, unawareness;
9) to object (возражать) – objection, objectionable, unobjectionable;
10) to view (смотреть (телевизор)) – vision, viewer, visual, television, televise;
11) particular (особенный) – particularity, particularly;
12) reason (причина, здравомыслие) – reasonable, reasonably, unreasonable;
13) sequence (последовательность) – sequential, sequent, sequentially.

III. Arrange the words with similar meaning in pairs:

1) to convey	a) basic
2) to distinguish	b) to produce
3) to extend	c) for the same reason
4) to occur	d) measurement
5) feasible	e) a great difference
6) essential	f) possible
7) to employ	g) to make use of
8) simultaneously	h) to enlarge
9) dimension	i) at the same time
10) disparity	j) to conduct
11) by the same token	k) to happen
12) to induce	l) to differentiate

IV. Match the words with their definitions:

1) flicker	a) a particular order in which related things follow each other
2) pitch	b) the continued or prolonged existence of something
3) surface	c) extreme tiredness
4) sequence	d) fluctuations in the brightness of a film or television image such as occur when the number of frames per second is too small for persistence of vision
5) piecemeal	e) a plane figure with four straight sides and four right angles
6) ratio	f) a rectangular pattern of parallel scanning lines followed by the electron beam on a television screen or computer monitor

7) persistence	g) the quality of a sound governed by the rate of vibrations producing it; the degree of highness or lowness of a tone
8) raster	h) a relationship between two things when it is expressed in numbers or amounts
9) fatigue	i) it happens gradually, usually at irregular intervals, and is probably not satisfactory
10) rectangle	j) the outside part or uppermost layer of something

V. Find a word in each row the translation of each is given at the beginning:

1) исследовать	a) explore, b) distinguish, c) deal, d) embrace
2) фактически	a) orderly, b) virtually, c) particularly, d) originally
3) непрерывно	a) simultaneously, b) costly, c) briefly, d) continuously
4) требование	a) disparity, b) require, c) demand, d) persistence
5) сравнительно	a) approximately, b) comparatively, c) successively, d) comparison
6) протекать (о процессе)	a) proceed, b) embrace, c) incorporate, d) distribute
7) яркость	a) light, b) shadow, c) brightness, d) loudness
8) поэтому	a) therefore, b) however, c) whereby, d) thereby
9) для того, чтобы	a) since, b) in order to, c) hence, d) thus
10) высота (звука)	a) flicker, b) path, c) pitch, d) shutter
11) искажение	a) surface, b) distortion, c) persistence, d) disparity
12) посредством чего	a) beyond, b) hence, c) therefore, d) whereby

VI. Read the following sentences, examine the words in bold and give their Russian equivalents.

A – **that**

1. This sequential reproduction of visual images is feasible because the visual sense displays persistence; **that** is, the brain retains the impression of illumination for about one-tenth of a second.

2. The agent **that** disassembles the light values along each line is called the scanning spot.

3. Each line in the image is present only once during **that** time.

4. It will be possible to re-create more than 10 pictures per second and to simulate thereby the motion of the scene so **that** it appears to be continuous.

5. If the process of image synthesis takes less than one-tenth of a second, the eye will be unaware **that** the picture is being reassembled piecemeal.

B – **as**

1. This fundamental disparity is overcome in television practice by a process known **as** image analysis.

2. It will appear **as** if the whole surface of the viewing screen is continuously illuminated.

3. Flicker becomes more evident **as** the brightness of the picture increases.

4. A way around this difficulty has been found, in motion pictures **as** well **as** in television, by projecting each picture twice.

5. To avoid flicker twice **as** much channel space is needed **as** would suffice to depict motion.

C – **since**

1. Such fine detail would be a costly waste in television, **since** the television picture is viewed at comparatively long range.

2. The first requirement is that the reproduced picture shall not flicker, **since** flicker induces severe visual fatigue.

3. Improvements have been made continuously **since** that time, and today television technology is in the midst of considerable change.

D – **both**

1. In **both** SDTV and HDTV the width of the screen rectangle is greater than its height.

2. Since the late 1970s a special colour reference signal has been transmitted on line 19 of **both** scanning fields.

VII. ***Read the title of the text and decide on the most suitable definition to the word*** «**picture**»:

1) a painting or drawing;
2) a photograph;
3) an impression of something formed from an account or description;
4) an image on a screen;
5) a cinema film.

VIII. ***Quickly look through the text to know what it deals with and do the tasks that follow***.

Text B

The Television Picture

1. A television system involves equipment located at the source of production, equipment located in the home of the viewer, and equipment used to convey the television signal from the producer to the viewer. The purpose of all of this equipment is to extend the human senses of vision and hearing beyond ***their*** natural limits of physical extend. A television system must be designed, therefore, to embrace the essential capabilities of these senses, particularly the sense of vision. The aspects of vision ***that*** must be considered include the ability of the human eye to distinguish the brightness, colours, details, sizes, shapes, and positions of objects in a scene before ***it***. Aspects of hearing include the ability of the ear to distinguish the pitch, loudness, and distribution of sounds. To satisfy these capabilities, television systems must strike appropriate compromises between the quality of the desired image and the costs of reproducing ***it***. ***They*** must also be designed to override, within reasonable limits, the effects of interference and to minimize visual and audial distortions in the transmission and reproduction processes.

2. Television technology must deal with the fact that human vision employs hundreds of thousands of separate electrical circuits, located in the optic nerve

running from the retina to the brain, in order to convey simultaneously in two dimensions the whole content of a scene on ***which*** the eye is focused. In electrical communication, however, it is feasible to employ only one circuit (i. e., the broadcast channel) to connect a transmitter with a receiver. This fundamental disparity is overcome in television practice by a process known as image analysis, whereby the scene to be televised is broken up by the camera's image sensors into an orderly sequence of electrical waves and these waves are sent over the single channel, one after the other. At the receiver the waves are translated back into a corresponding sequence of lights and shadows, and ***these*** are reassembled in their correct positions on the viewing screen.

3. This sequential reproduction of visual images is feasible only because the visual sense displays persistence; that is, the brain retains the impression of illumination for about one-tenth of a second after the source of light is removed from the eye. If, therefore, the process of image synthesis takes less than one-tenth of a second, the eye will be unaware that the picture is being reassembled piecemeal, and ***it*** will appear as if the whole surface of the viewing screen is continuously illuminated. By the same token, it will then be possible to re-create more than 10 pictures per second and to simulate thereby the motion of the scene so that it appears to be continuous.

4. The first requirement to be met in image analysis is that the reproduced picture shall not flicker, since flicker induces severe visual fatigue. Flicker becomes more evident as the brightness of the picture increases. If flicker is to be unobjectionable at brightness suitable for home viewing during daylight as well as evening hours, the successive illuminations of the picture screen should occur no fewer than 50 times per second. This is approximately twice the rate of picture repetition needed for smooth reproduction of motion. To avoid flicker, therefore, twice as much channel space is needed as would suffice to depict motion.

5. The same disparity occurs in motion-picture practice, in which satisfactory performance with respect to flicker requires twice as much film as is necessary for smooth simulation of motion. A way around this difficulty has been found, in motion pictures as well as in television, by projecting each picture twice. In motion pictures, the projector interposes a shutter briefly between film and lens while a single frame of the film is being projected. In television, each image is analysed and synthesized in two sets of spaced lines, one of ***which*** fits successively within the spaces of ***the other***. Thus the picture area is illuminated twice during each complete picture transmission, although each line in the image is present only once during that time. This technique is feasible because the eye is comparatively insensitive to flicker when the variation of light is confined to a small part of the field of view. Hence, flicker of the individual lines is not evident. If the eye did not have this fortunate property, a television channel would have to occupy about twice as much spectrum space as it now does.

6. The second aspect of performance to be met in a television system is the detailed structure of the image. A printed engraving may possess several million halftone dots per square foot of area. However, engraving reproductions are intended

for minute inspection, and so the dot structure must not be apparent to the unaided eye even at close range. Such fine detail would be a costly waste in television, since the television picture is viewed at comparatively long range.

7. The third item to be selected in image analysis is the shape of the picture. For SDTV the universal picture is a rectangle that is one-third wider than it is high. This 4:3 ratio (or aspect ratio) was originally chosen in the 1950s to match the dimensions of standard 35-mm motion-picture film (prior to the advent of wide-screen cinema) in the interest of televising film without waste of frame area. HDTV sets, introduced in the 1980s, accommodate wide-screen pictures by offering an aspect ratio of 16:9. Regardless of the aspect ratio, in both SDTV and HDTV the width of the screen rectangle is greater than its height **in order** to incorporate the horizontal motion ***that*** predominates in virtually all televised events.

8. The fourth determination in image analysis is the path over which the image structure is explored at the camera and reconstituted on the receiver screen. In standard television, the pattern is a series of parallel straight lines, each progressing from left to right, the lines following in sequence from top to bottom of the picture frame. The exploration of the image structure proceeds at a constant speed along each line, since this provides uniform loading of the transmission channel under the demands of a given structural detail, no matter where in the frame the detail lies. The line-by-line, left-to-right, top-to-bottom dissection and reconstitution of television images is known as scanning, from its similarity to the progression of the line of vision in reading a page of printed matter. The agent that disassembles the light values along each line is called the scanning spot, in reference to the focused beam of electrons ***that*** scans the image in a camera tube and recreates the image in a picture tube. Tubes are no longer employed in most video cameras, but even in modern transistorized cameras the image is dissected into a series of «spots», and the path of dissection is called the scanning pattern, or raster.

IX. Look through the whole text and find the words similar to the Russian ones that you can understand without a dictionary. Read them aloud.

X. Look through the text and define the meaning of the words in italics.

XI. Read the second sentence of passage 1. What is the meaning of the verb «is»? Translate the sentence into Russian.

XII. Continue working with passage 1. Study it carefully and try to find the clause with the infinitive in the function of an adverbial modifier of purpose. Translate it into Russian.

XIII. Carefully study passage 1 and give answers to the following questions:

1. What types of equipment does a TV system consist of?
2. What is this equipment used for?
3. What aspects of vision and hearing should be taken into consideration developing TV systems?

4. Modern TV systems have reduced visual and audial distortions to the lowest possible level, haven't they?

XIV. The first sentence of passage 2 is a long one and consists of the main and additional clauses. Split the sentence according to formal indications into the main part and additional clauses. Translate the sentence into Russian. Bear in mind the functions of the Infinitive and the Participles.

XV. In passage 2 find the sentence with Passive Infinitive in the function of an attribute. Translate it into Russian.

XVI. In passage 2 you will find 2 words with the same root. Say to what part speech they belong. Translate them.

XVII. In passage 3 find the words with prefix re-. What is its meaning?

XVIII. Read carefully passages 2 and 3. Define if the following statements are true or false:

1. Human vision as well as electrical communication uses a great number of separate electrical circuits to carry an image.
2. Image analysis is a process that helps you successfully deal with the problem of a noticeable difference between human vision and television technology.
3. The camera's image sensors break up the scene into a systematic sequence of electrical waves that are sent over the single channel, following each other in quick succession.
4. Visual images can be reproduced sequentially due to the fact that the brain retains the impression of illumination for less than one-tenth of a second under certain circumstances.
5. The recreation of more than10 pictures per second will become possible due to the continuous motion of the scene.

XIX. Look through passage 4. Find the sentences with different types of comparison. Translate them into Russian.

XX. Find some connectors in passage 5. What role do they usually play? Give your comments. In passage 5 you will also find the sentence with the clause of condition. Translate the whole passage into Russian paying special attention to the sentence containing this clause.

XXI. Look through passages 6 and 7 and find English equivalents for the following Russian words and word combinations:

(рабочая) характеристика, растровая точка, гравирование, точечная структура, мельчайший, на расстоянии, первоначально, соответствовать размерам, до появления, формат изображения, независимо от, фактически.

XXII. In passage 8 find an Absolute Participial construction. Translate the sentence with this construction into Russian. In the same passage you will come across the words «in reference to». Think of the appropriate way of translating them.

XXIII. Look through the whole text, find the information about the aspects of image analysis. Enumerate them.

***XXIV. Look through the text once more, find and read aloud the sentences* a) *describing the method to avoid the flicker problem*; b) *explaining why the dot structure is sometimes impossible to perceive*; c) *explaining why HDTV sets choose the 16:9 ratio*; d) *describing what scanning is*.**

***XXIV. In pairs or small groups discuss what you have learnt about television picture parameters. While discussing use the following words and word combinations*: a) *flicker, to avoid, twice as much channel space, to project picture twice*; b) *detailed structure of the image, dot structure, apparent, at long range*; c) *the shape of the picture, to choose an aspect ratio, width, height, to incorporate the horizontal motion*; d) *path, to explore the image structure, scanning, line-by-line, left-to right, top-to-bottom dissection, reconstitution, the path of dissection, scanning pattern, raster*.**

Part C

***I. Study the words related to the text «Transmission media and the problem of signal degradation»*:**

1) distortion – искажение;
2) attenuation – затухание (сигнала), ослабление;
3) fidelity – (безукоризненная) точность воспроизведения;
4) boost – усиливать;
5) dissipation – диссипация, рассеяние;
6) dissipative loss – потери на расстоянии, диссипативные потери;
7) impedance matching – согласование полного сопротивления;
8) characteristic impedance – волновое сопротивление (линии передачи);
9) omnidirectional antenna – ненаправленная антенна;
10) point-to-point radio channel – двухточечный (двухпунктовый) радиоканал;
11) to constrain – накладывать ограничения;
12) deep-space communications –дальняя космическая связь;
13) waveguide – волновод;
14) diurnal – ежедневный, каждодневный;
15) beam divergence – расходимость пучка
16) stimulated emission – индуцированное излучение, вынужденное излучение; стимулированная эмиссия, индуцированная эмиссия;
17) to collimate – коллимировать;
18) feeder – питатель, фидер;
19) trunk – ствол (каналов); магистральная линия связи; внешняя линия; соединительная линия;
20) to offset – возмещать, компенсировать.

II. Read the title of the text. The word «medium» has several meanings. Read the dictionary definitions given below and choose the most appropriate one.

medium (pl. media)

1) an agency or means of doing something;

2) the intervening substance through which sensory impressions are conveyed or physical forces are transmitted;

3) a particular form of storage material for computer files, such as magnetic tape or discs;

4) the material or form used by an artist, composer, or writer.

III. Judging by the title say what the text might be about.

IV. Quickly scan the text and find the words similar to the Russian ones that you can understand without a dictionary. Read them aloud.

Text C

Transmission Media and the Problem of Signal Degradation

1. Every telecommunications system involves the transmission of an information-bearing electromagnetic signal through a physical medium that separates the transmitter from the receiver. All transmitted signals are to some extent degraded by the environment through which they propagate. Signal degradation can take many forms, but generally it falls into three types: noise, distortion, and attenuation. Noise is the presence of random, unpredictable, and undesirable electromagnetic emissions that can mask the intended information signal. Distortion is any undesired change in the amplitude or phase of any component of an information signal that causes a change in the overall waveform of the signal. Both noise and distortion are commonly introduced by all transmission media, and they both result in errors in reception. The relative impact of these factors on reliable communication depends on the rate of information transmission, on the desired fidelity upon reception, and on whether communication must occur in «real time» – i. e., as in telephone conversations and video teleconferencing.

2. Various modulating and encoding schemes have been devised to provide protection against the errors caused by channel distortion and channel noise. In addition to these signal-processing techniques, protection against reception errors can be provided by boosting the power of the transmitter, thus increasing the signal-to-noise ratio. However, even powerful signals suffer some degree of attenuation as they pass through the transmission medium. The principal cause of power loss is dissipation, the conversion of part of the electromagnetic energy to another form of energy such as heat.

3. Channel attenuation is an important factor in the use of each transmission medium. Along with noise and distortion, it can influence the choice of one medium over another. Modern telecommunications systems employ three main transmission media: wire, radio, and optical.

4. In wire transmission an information-bearing electromagnetic wave is guided along a wire conductor to a receiver. Propagation of the wave is always accompanied by a flow of electric current through the conductor. Since all practical conductor materials are characterized by some electrical resistance, part of the electric current is always lost by conversion to heat, which is radiated from the wire. This dissipative loss leads to attenuation of the electromagnetic signal, and the amount of attenuation increases linearly with increasing distance between the transmitter and the receiver.

5. Because of the high signal attenuation inherent in wire, transmission over distances greater than a few kilometres requires the use of regularly spaced repeaters to amplify, restore, and retransmit the signal. Transmission lines also require impedance matching at the transmitter or receiver in order to reduce echo-creating reflections. Impedance matching is accomplished in long-distance telephone cables by attaching a wire coil to each end of the line whose electrical impedance, measured in ohms, is equal to the characteristic impedance of the transmission line.

6. In radio transmission a radiating antenna is used to convert a time-varying electric current into an electromagnetic wave or field, which freely propagates through a nonconducting medium such as air or space. In a broadcast radio channel, an omnidirectional antenna radiates a transmitted signal over a wide service area. In a point-to-point radio channel, a directional transmitting antenna is used to focus the wave into a narrow beam, which is directed toward a single receiver site. In either case the transmitted electromagnetic wave is picked up by a remote receiving antenna and reconverted to an electric current.

7. Radio wave propagation is not constrained by any physical conductor or waveguide. This makes radio ideal for mobile communications, satellite and deep-space communications, broadcast communications, and other applications in which the laying of physical connections may be impossible or very costly. On the other hand, unlike guided channels such as wire or optical fibre, the medium through which radio waves propagate is highly variable, being subject to diurnal, annual, and solar changes in the ionosphere, variations in the density of water droplets in the troposphere, varying moisture gradients, and diverse sources of reflection and diffraction.

8. Optical communication employs a beam of modulated monochromatic light to carry information from transmitter to receiver. The light spectrum spans a tremendous range in the electromagnetic spectrum, extending from the region of 10 terahertz to 1 million terahertz. This frequency range essentially covers the spectrum from far infrared through all visible light to near ultraviolet. Propagating at such high frequencies, optical wavelengths are naturally suited for high-rate broadband telecommunication.

9. Practical exploitation of optical media for high-speed telecommunication over large distances requires a strong light beam that is nearly monochromatic, its power narrowly concentrated around a desired optical wavelength. Such a carrier would not have been possible without the invention of the ruby laser, first demonstrated in 1960, which produces intense light with very narrow spectral

linewidth by the process of coherent stimulated emission. Today, semiconductor injection-laser diodes are used for high-speed, long-distance optical communication.

10. Two kinds of optical channels exist: the unguided free-space channel, where light freely propagates through the atmosphere, and the guided optical fibre channel, where light propagates through an optical waveguide.

11. The loss mechanisms in a free-space optical channel are virtually identical to those in a line-of-sight microwave radio channel. Signals are degraded by beam divergence, atmospheric absorption, and atmospheric scattering. Beam divergence can be minimized by collimating (making parallel) the transmitted light into a coherent narrow beam by using a laser light source for a transmitter. Atmospheric absorption losses can be minimized by choosing transmission wavelengths that lie in one of the low-loss «windows» in the infrared, visible, or ultraviolet region. The atmosphere imposes high absorption losses as the optical wavelength approaches the resonant wavelengths of gaseous constituents such as oxygen, water vapour, carbon dioxide, and ozone. On a clear day the attenuation of visible light may be one decibel per kilometre or less, but significant scattering losses can be caused by any variability in atmospheric conditions, such as haze, fog, rain, or airborne dust. The high sensitivity of optical signals to atmospheric conditions has hindered development of free-space optical links for outdoor environments.

12. In contrast to wire transmission, in which an electric current flows through a copper conductor, in optical fibre transmission an electromagnetic (optical) field propagates through a fibre made of a nonconducting dielectric. Because of its high bandwidth, low attenuation, interference immunity, low cost, and light weight, optical fibre is becoming the medium of choice for fixed, high-speed digital telecommunications links. Optical fibre cables are supplanting copper wire cables in both long-distance applications, such as the feeder and trunk portions of telephone and cable television loops, and short-distance applications, such as local area networks (LANs) for computers and home distribution of telephone, television, and data services.

13. An optical fibre communications link consists of the following elements: an electro-optical transmitter, which converts analog or digital information into a modulated beam of light; a light-carrying fibre, which spans the transmission path; and an optoelectronic receiver, which converts detected light into an electric current. For long-distance links (greater than 30 km), regenerative repeaters are usually required to offset the attenuation of signal power. In the past, hybrid optical-electronic repeaters commonly were employed; these featured an optoelectronic receiver, electronic signal processing, and an electro-optical transmitter for regenerating the signal. Today, erbium-doped optical amplifiers are employed as efficient all-optical repeaters.

V. Look through passage 1 and name the issues raised in it. Single out key words which help you to form your opinion.

VI. Scan passage 2, find the topical sentence and read it aloud. Shorten it by deleting additional information. While scanning the passage pay attention to the function of the words «thus», «however». What information do you find about the measures to prevent reception errors?

VII. In passage 3 find the information about equipment and systems used in the transmission of electromagnetic signals. Name them.

VIII. Scan passage 4 and speak in short about drawbacks of wire transmission.

IX. Look through passage 5 to find out how to solve the problem of signal attenuation.

X. Look through passage 6 and find the sentence characterizing the principle of radio transmission. Reduce it by deleting secondary information.

XI. What is the main idea of passage 7? Read aloud the topical sentence and say if it covers the main idea of the passage. Go on looking through the passage and speak about the role of a word collocation «on the other hand».

XII. Scan passage 8 and say what transmission media are used in optical communication.

XIII. Express the main idea of passage 9 using the following words and word combinations: «practical exploitation», «require», «monochromatic», «concentrate narrowly», «wavelength».

XIV. What are the types of optical channels? Look for the answer in passage 10.

XV. In passage 11 the author mentions the causes of signal degradation in a free-space channel. Can we reduce them? In what way? Look through the passage and find the answer.

XVI. Compress the first sentence of passage 12 by deleting secondary information. Name the advantages of optical fibre.

XVII. Look through passage 13 to describe in short the parts of an optical fibre communications link and their functions.

XVIII. And, finally, generalize the issues raised in the text. Express your opinion, add the information you possess, give facts, examples in favour or against the information given in the text. While speaking use the words of the active vocabulary.

XIX. Say if the information of the text is new to you? Can it be used in your future professional activities?

Part D

I. Read the title of the text. What do you think the text will be about?

II. Choose the most suitable definition of the word «modulation» used in the text. Read passage 1 to check your answer:

a) technique for impressing information (voice, music, picture, or data) on a radio-frequency carrier wave by varying one or more characteristics of the wave in accordance with the intelligence signal;

b) simultaneous electronic transmission of two or more messages in one or both directions over a single transmission path, with signals separated in time or frequency;

c) the act of extracting the original information-bearing signal from a modulated carrier wave.

III. Look through the text «Modulation» to get acquainted with its structural composition – subtitles, words in bold, italics. Do they tell you anything?

IV. Quickly scan the text again for the words in italics. Make sure you know them. If you don't, look them up in the dictionary or ask your teacher for help.

Text D

Modulation

1. In many telecommunications systems, it is necessary to represent an *information-bearing signal* with a waveform that can pass accurately through a transmission *medium.* This assigning of a suitable waveform is accomplished by modulation, which is the process by which some characteristic of a carrier wave is varied in accordance with an information signal, or modulating wave. The modulated signal is then transmitted over a channel, after which the original information-bearing signal is recovered through a process of demodulation.

2. Modulation is applied to information signals for a number of reasons, some of which are outlined below.

– Many transmission channels are characterized by limited *passbands* – that is, they will pass only certain ranges of frequencies without seriously attenuating them (reducing their amplitude). Modulation methods must therefore be applied to the information signals in order to «frequency translate» the signals into the range of frequencies that are permitted by the channel. Examples of channels that exhibit passband characteristics include *alternating-current-coupled coaxial cables*, which pass signals only in the range of 60 kilohertz to several hundred megahertz, and fibre-optic cables, which pass light signals only within a given wavelength range without significant attenuation. In these instances frequency translation is used to «fit» the information signal to the communications channel.

– In many instances a communications channel is shared by multiple users. In order to prevent mutual interference, each user's information signal is modulated

onto an assigned *carrier* of a specific frequency. When the frequency assignment and subsequent combining is done at a central point, the resulting combination is a *frequency-division multiplexed signal*. Frequently there is no central combining point, and the communications channel itself acts as a distributed combine. An example of the latter situation is the broadcast radio bands (from 540 kilohertz to 600 megahertz), which permit simultaneous transmission of multiple AM-radio, FM-radio, and television signals without mutual interference as long as each signal is assigned to a different frequency band.

– Even when the communications channel can support direct transmission of the information-bearing signal, there are often practical reasons why this is undesirable. A simple example is the transmission of a three-kilohertz (i. e., voiceband) signal via radio wave. In free space the wavelength of a three-kilohertz signal is 100 kilometres (60 miles). Since an effective radio antenna is typically as large as half the wavelength of the signal, a three-kilohertz radio wave might require an antenna up to 50 kilometres in length. In this case translation of the voice frequency to a higher frequency would allow the use of a much smaller antenna.

Analog modulation

3. Voice signals, as well as audio and video signals, are inherently analog in form. In most modern systems these signals are digitized prior to transmission, but in some systems the analog signals are still transmitted directly without converting them to digital form. There are two commonly used methods of modulating analog signals. One technique, called amplitude modulation, varies the amplitude of a *fixed-frequency carrier wave* in proportion to the information signal. The other technique, called frequency modulation, varies the frequency of a fixed-amplitude carrier wave in proportion to the information signal.

Digital modulation

4. In order to transmit computer data and other digitized information over a communications channel, an analog carrier wave can be modulated to reflect the binary nature of the digital baseband signal. The parameters of the carrier that can be modified are the amplitude, the frequency, and the phase.

Amplitude-shift keying

5. If amplitude is the only parameter of the carrier wave to be altered by the information signal, the modulating method is called amplitude-shift keying (ASK). ASK can be considered a digital version of analog amplitude modulation. In its simplest form, a burst of radio frequency is transmitted only when a binary 1 appears and is stopped when a 0 appears. In another variation, the 0 and 1 are represented in the modulated signal by a shift between two preselected amplitudes.

Frequency-shift keying

6. If frequency is the parameter chosen to be a function of the information signal, the modulation method is called frequency-shift keying (FSK). In the simplest form of FSK signaling, digital data is transmitted using one of two frequencies, whereby one frequency is used to transmit a 1 and the other frequency to transmit a 0. Such a scheme was used in the Bell 103 voiceband modem, introduced in 1962, to transmit information at rates up to 300 bits per second over the public switched telephone network. In the Bell 103 modem, frequencies of 1080±100 hertz and 1750±100 hertz were used to send binary data in both directions.

Phase-shift keying

7. When phase is the parameter altered by the information signal, the method is called phase-shift keying (PSK). In the simplest form of PSK a single radio frequency carrier is sent with a fixed phase to represent a 0 and with a 180° phase shift – that is, with the opposite polarity – to represent a 1. PSK was employed in the Bell 212 modem, which was introduced about 1980 to transmit information at rates up to 1200 bits per second over the public switched telephone network.

Advanced methods

8. In addition to the elementary forms of digital modulation described above, there exist more advanced methods that result from a superposition of multiple modulating signals. An example of the latter form of modulation is quadrature amplitude modulation (QAM). QAM signals actually transmit two amplitude-modulated signals in phase quadrature (i. e., 90° apart), so that four or more bits are represented by each shift of the combined signal.

9. A form of modulation that combines convolutional codes with QAM is known as *trellis-coded modulation* (TCM). Trellis modulation is a modulation scheme which allows highly efficient transmission of information over band-limited channels such as telephone lines. Trellis modulation was invented by Gottfried Ungerboeck working for IBM in the 1970s, and first described in a conference paper in 1976; but it went largely unnoticed until he published a new detailed exposition in 1982 which achieved sudden widespread recognition.

10. The name *trellis* was coined because a state diagram of the technique, when drawn on paper, closely resembles the trellis lattice used in rose gardens. A flurry of research activity ensued, and by 1990 the International Telecommunication Union had published modem standards for the first trellis-modulated modem at 14,4 kilobits/s. Today, the most common trellis-modulated V.34 modems use a 4-dimensional set partition which is achieved by treating two 2-dimensional symbols as a single lattice. This set uses 8, 16 or 32 state convolutional codes to squeeze the equivalent of 6 to 10 bits into each symbol sent by the modem (for example, 2400 baud × 8 bits/symbol = 19200 bit/s). Once manufacturers introduced modems with trellis modulation, transmission rates increased to the point where interactive transfer of multimedia over the telephone became feasible (a 200 kilobyte image and

a 5 megabyte song could be downloaded in less than 1 minute and 30 minutes, respectively). Thus Ungerboeck's invention played a key role in the Information Age.

V. Look for some specific information contained in passage 2. What are reasons for using modulation. Discuss the reasons with your partner.

VI. What methods of modulating analog signals are mentioned in the text. Scan passage 3 to answer this question. Give a short characteristics of each method.

VII. In the part entitled «Digital modulation» find the information about the parameters of the carrier. Is this information important or it can be neglected?

VIII. What are other forms of digital modulation? Scan the part entitled «Advanced methods» to answer this question. Give a short characteristics of trellis modulation.

IX. Read the statements and mark them as T (true), F (false) or N (no information).

1. Demodulation is the act of extracting the original information-bearing signal from a modulated carrier wave.
2. The most commonly altered characteristics of the carrier wave include amplitude, frequency, phase, pulse sequence, and pulse duration.
3. One disadvantage of all amplitude modulation techniques is that the receiver amplifies and detects noise and electromagnetic interference in equal proportion to the signal.
4. In an ASK system the carrier signal will be transmitted only in case the signal value being 1; otherwise, a signal value of 0 will not be transmitted.
5. FSK uses a pair of discrete frequencies to transmit binary (0s and 1s) information.
6. Quadrature amplitude modulation (QAM) eliminates a superposition of multiple modulating signals.
7. QAM is used extensively as a modulation scheme for digital telecommunication systems.
8. Trellis-coded modulation forms an essential part of most of the modern voiceband modems.

UNIT V
SEMICONDUCTOR TECHNOLOGIES

Part A

I. Study the vocabulary that is essential for understanding the text:

1) fundamentals – основы;
2) to deserve – заслуживать;
3) outline – *существительное* набросок, *глагол* наметить в общих чертах;
4) performance – рабочие характеристики;
5) CMOS (Complementary Metal-Oxide-Semiconductor) – комплементарная структура металл-оксид-полупроводник (КМОП), технология изготовления микросхем;
6) nMOS (nchannel Metal-Oxide-Semiconductor) – МОП-структура с каналом n-типа, n-канальная МОП-структура, n-МОП-структура;
7) to accommodate – вмещать;
8) sequence – последовательность;
9) source – исток (в канальном транзисторе);
10) drain – сток (транзистора);
11) gate – затвор (транзистора);
12) impurity – примесь;
13) pattern – *существительное* шаблон, узор; *глагол* переносить узор;
14) (in)soluble – (не)растворимый;
15) to etch – вытравливать;
16) density – плотность;
17) solvent – растворитель;
18) to dope – вводить примеси, легировать полупроводник;
19) to diffuse – диффундировать (о газах и жидкостях);
20) deposition – отложение; осаждение; напыление, термовакуумное испарение;
21) to develop – проявлять (например пленку);
22) to penetrate – проникать;
23) to reduce – уменьшать;
24) precise – точный;
25) to align – выравнивать, ориентировать;
26) junction – переход (в полупроводниковом приборе);
27) vapor – пар.

II. Read the following words and word combinations and say what topic they can refer to.

Semiconductors, integrated circuit, basic elements, multistep fabrication process, photolithography, masking, exposition, patterning, etching, doping, diffusion, ion implantation, deposition , layering, cutting, packing, testing, packaging.

III. Read the following text and say what words are used to indicate the succession of operations.

The process starts with the creation of the n-well regions for pMOS transistors, by impurity implantation into the substrate. Then, a thick oxide is grown in the regions surrounding the nMOS and pMOS active regions. The thin gate oxide is subsequently grown on the surface through thermal oxidation. These steps are followed by the creation of n- and p-regions (source, drain and channel-stop implants) and by final metallization (creation of metal interconnects).

IV. There is an odd word in the list of text connectors given below. Which one?

Hence, so, consequently, usually, however, thus, besides, concluding.

V. Find connecting words showing logical relations between the sentences (opposition, conclusion, contradiction, concession).

The type of photoresist which is initially insoluble and becomes soluble after exposure to UV light is called positive photoresist. Yet, there is another type of photoresist which is initially soluble and becomes insoluble (hardened) after exposure to UV light, called negative photoresist. Negative photoresists are more sensitive to light, but their photolithographic resolution is not as high as that of the positive photoresists. Therefore, negative photoresists are used less commonly in the manufacturing of high-density integrated circuits.

VI. Before reading the text study the following diagram (Fig. 9) and discuss in pairs or in small groups the following questions:

a) What does the diagram describe?

b) What major stages does the process of IC manufacturing include?

c) What operation does each stage include?

VII. Read the title of the text and look through the figures contained in it and say what the text may be concerned with.

VIII. Read the text quickly paying attention to the principal information. After reading do the tasks that follow.

CMOS fabrication Technology and design rules

Introduction

In this chapter, the fundamentals of MOS chip fabrication will be discussed and the major steps of the process flow will be examined. It is not the aim of this chapter to present a detailed discussion of silicon fabrication technology, which deserves separate treatment in a dedicated course. Rather, the emphasis will be on the general outline of the process flow and on the interaction of various processing steps, which ultimately determine the device and the circuit performance characteristics. The following chapters show that there are very strong links between the fabrication process, the circuit design process and the performance of the resulting chip. Hence, circuit designers must have a working knowledge of chip fabrication to create

effective designs and in order to optimize the circuits with respect to various manufacturing parameters. Also, the circuit designer must have a clear understanding of the roles of various masks used in the fabrication process, and how the masks are used to define various features of the devices on-chip.

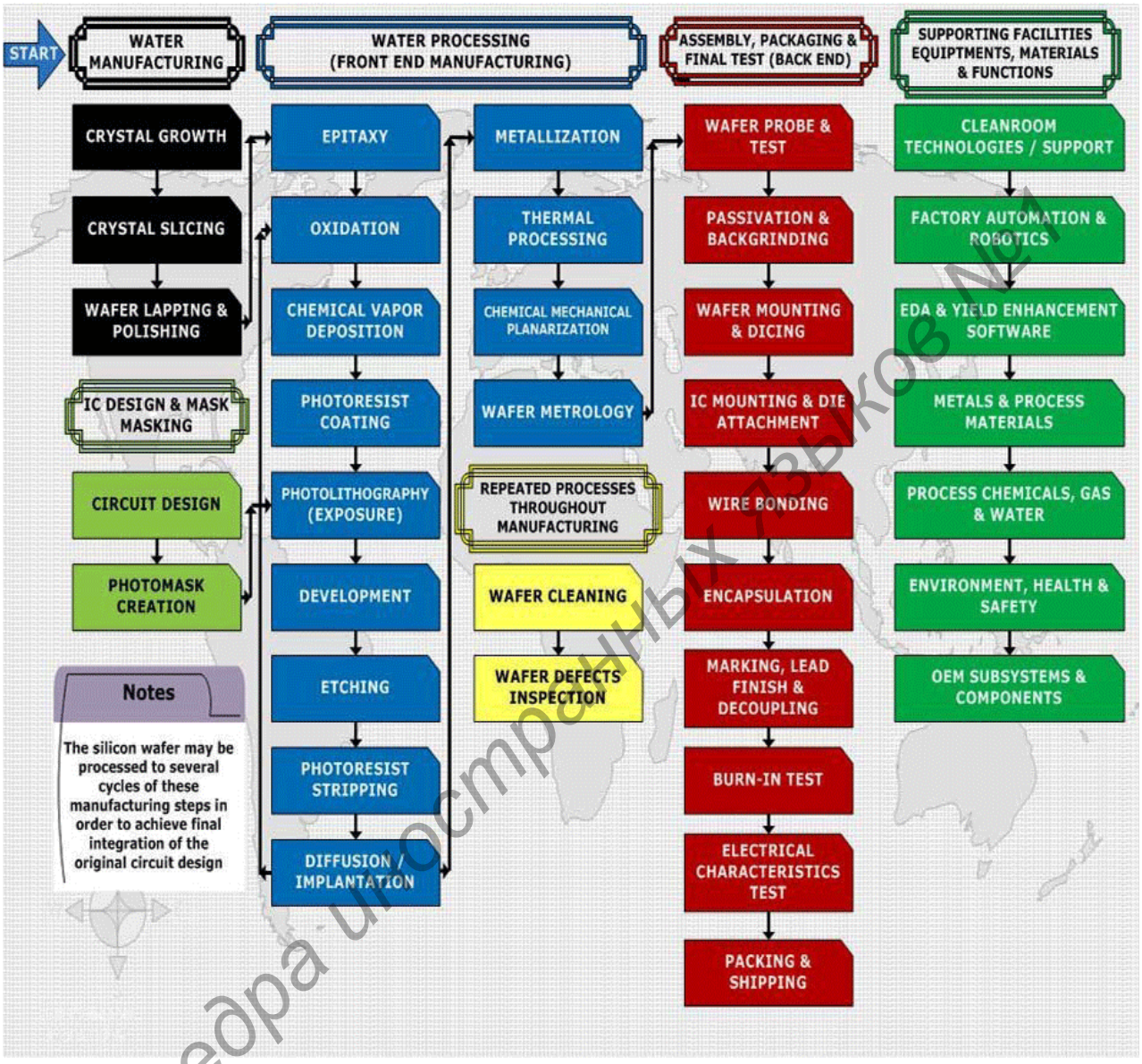


Figure 9. General process of IC fabrication

The following discussion will concentrate on the well-established CMOS fabrication technology, which requires that both n-channel (nMOS) and p-channel (pMOS) transistors be built on the same chip substrate. To accommodate both nMOS and pMOS devices, special regions must be created in which the semiconductor type is opposite to the substrate type. These regions are called wells or tubs. A p-well is created in an n-type substrate or, alternatively, an n- well is created in a p-type substrate. In the simple n-well CMOS fabrication technology presented, the nMOS transistor is created in the p-type substrate, and the pMOS transistor is created in the n-well, which is built-in into the p-type substrate. In the twin-tub CMOS technology,

additional tubs of the same type as the substrate can also be created for device optimization.

The simplified process sequence for the fabrication of CMOS integrated circuits on a p-type silicon substrate is shown in Fig. 10. The process starts with the creation of the n-well regions for pMOS transistors, by impurity implantation into the substrate. Then, a thick oxide is grown in the regions surrounding the nMOS and pMOS active regions. The thin gate oxide is subsequently grown on the surface through thermal oxidation. These steps are followed by the creation of n+ and p+ regions (source, drain and channel-stop implants) and by final metallization (creation of metal interconnects).

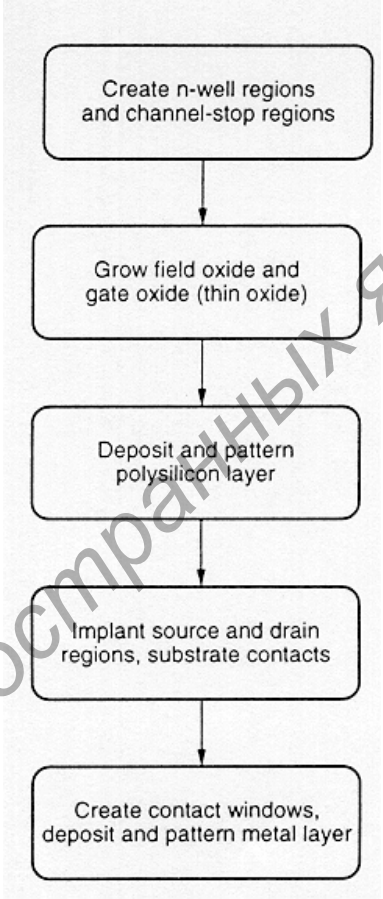


Figure 10. Simplified process sequence for fabrication of the n-well CMOS integrated circuit with a single polysilicon layer, showing only major fabrication steps

The process flow sequence pictured in Fig. 10 may at first seem to be too abstract, since detailed fabrication steps are not shown. To obtain a better understanding of the issues involved in the semiconductor fabrication process, we first have to consider some of the basic steps in more detail.

Fabrication Process Flow – Basic Steps

Note that each processing step requires that certain areas are defined on chip by appropriate masks. Consequently, the integrated circuit may be viewed as a set of patterned layers of doped silicon, polysilicon, metal and insulating silicon dioxide. In

general, a layer must be patterned before the next layer of material is applied on chip. The process used to transfer a pattern to a layer on the chip is called lithography. Since each layer has its own distinct patterning requirements, the lithographic sequence must be repeated for every layer, using a different mask.

To illustrate the fabrication steps involved in patterning silicon dioxide through optical lithography, let us first examine the process flow shown in Fig. 11 The sequence starts with the thermal oxidation of the silicon surface, by which an oxide layer of about 1 micrometer thickness, for example, is created on the substrate (Fig. 11(b)). The entire oxide surface is then covered with a layer of photoresist, which is essentially a light-sensitive, acid-resistant organic polymer, initially insoluble in the developing solution (Fig. 11(c)). If the photoresist material is exposed to ultraviolet (UV) light, the exposed areas become soluble so that they are no longer resistant to etching solvents. To selectively expose the photoresist, we have to cover some of the areas on the surface with a mask during exposure. Thus, when the structure with the mask on top is exposed to UV light, areas which are covered by the opaque features on the mask are shielded. In the areas where the UV light can pass through, on the other hand, the photoresist is exposed and becomes soluble (Fig. 11(d)).

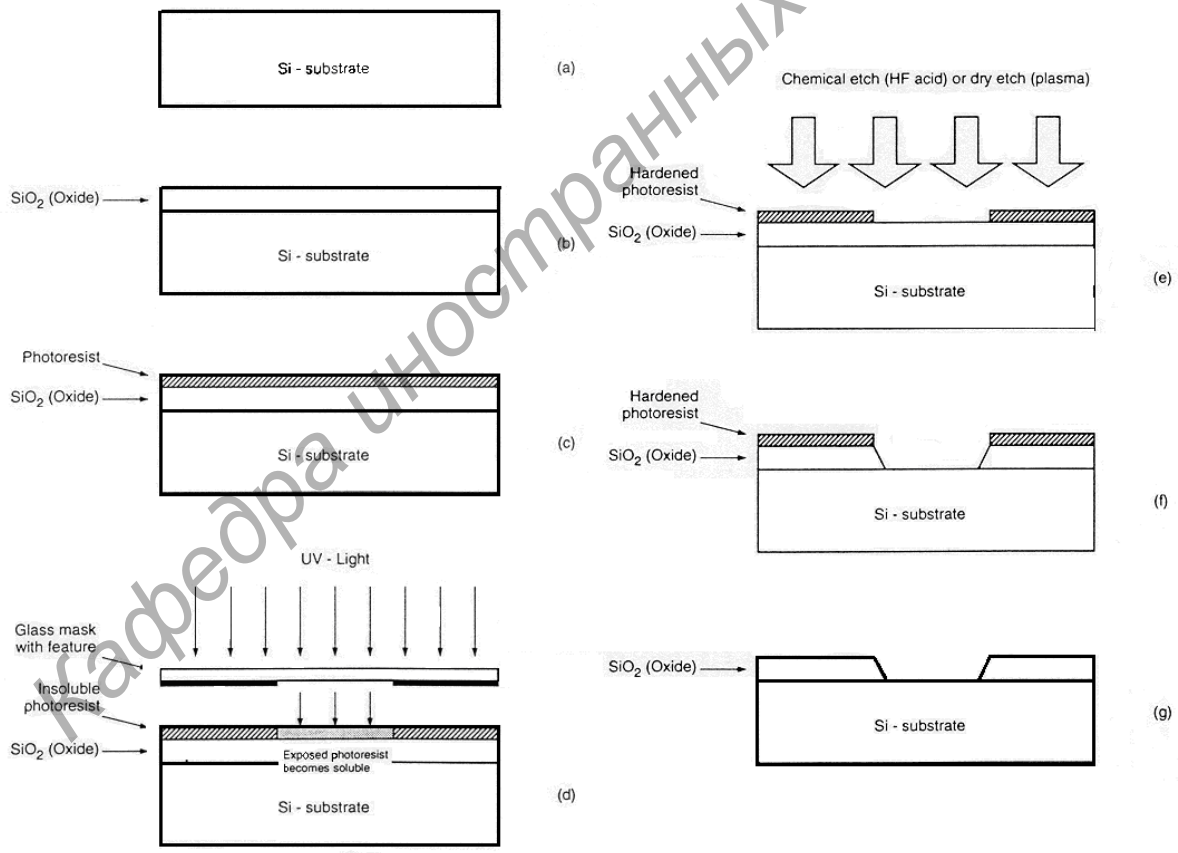


Figure 11. Process steps required for patterning of silicon dioxide

The type of photoresist which is initially insoluble and becomes soluble after exposure to UV light is called positive photoresist. The process sequence shown in

Fig. 11 uses positive photoresist. There is another type of photoresist which is initially soluble and becomes insoluble (hardened) after exposure to UV light, called negative photoresist. If negative photoresist is used in the photolithography process, the areas which are not shielded from the UV light by the opaque mask features become insoluble, whereas the shielded areas can subsequently be etched away by a developing solution. Negative photoresists are more sensitive to light, but their photolithographic resolution is not as high as that of the positive photoresists. Therefore, negative photoresists are used less commonly in the manufacturing of high-density integrated circuits.

Following the UV exposure step, the unexposed portions of the photoresist can be removed by a solvent. Now, the silicon dioxide regions which are not covered by hardened photoresist can be etched away either by using a chemical solvent (HF acid) or by using a dry etch (plasma etch) process (Fig. 11(e)). Note that at the end of this step, we obtain an oxide window that reaches down to the silicon surface (Fig. 11(f)). The remaining photoresist can now be stripped from the silicon dioxide surface by using another solvent, leaving the patterned silicon dioxide feature on the surface as shown in Fig. 11(g).

The sequence of process steps illustrated in detail in Fig. 11 actually accomplishes a single pattern transfer onto the silicon dioxide surface, as shown in Fig. 12. The fabrication of semiconductor devices requires several such pattern transfers to be performed on silicon dioxide, polysilicon, and metal. The basic patterning process used in all fabrication steps, however, is quite similar to the one shown in Fig. 11. Also note that for accurate generation of high-density patterns required in sub-micron devices, electron beam (E-beam) lithography is used instead of optical lithography. In the following, the main processing steps involved in the fabrication of an n-channel MOS transistor on p-type silicon substrate will be examined.

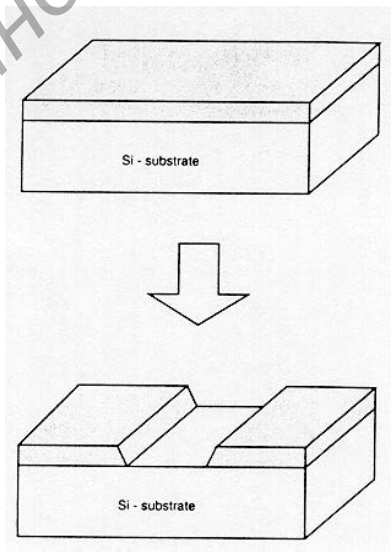


Figure 12. The result of a single lithographic patterning sequence on silicon dioxide, without showing the intermediate steps. Compare the unpatterned structure (top) and the patterned structure (bottom) with Fig. 11 (b) and Fig. 11 (g), respectively

The process starts with the oxidation of the silicon substrate (Fig. 13(a)), in which a relatively thick silicon dioxide layer, also called field oxide, is created on the surface (Fig. 13(b)). Then, the field oxide is selectively etched to expose the silicon surface on which the MOS transistor will be created (Fig. 13(c)). Following this step, the surface is covered with a thin, high-quality oxide layer, which will eventually form the gate oxide of the MOS transistor (Fig. 13(d)). On top of the thin oxide, a layer of polysilicon (polycrystalline silicon) is deposited (Fig. 13(e)). Polysilicon is used both as gate electrode material for MOS transistors and also as an interconnect medium in silicon integrated circuits. Undoped polysilicon has relatively high resistivity. The resistivity of polysilicon can be reduced, however, by doping it with impurity atoms.

After deposition, the polysilicon layer is patterned and etched to form the interconnects and the MOS transistor gates (Fig. 13(f)). The thin gate oxide not covered by polysilicon is also etched away, which exposes the bare silicon surface on which the source and drain junctions are to be formed (Fig. 13(g)). The entire silicon surface is then doped with a high concentration of impurities, either through diffusion or ion implantation (in this case with donor atoms to produce n-type doping). Figure 13(h) shows that the doping penetrates the exposed areas on the silicon surface, ultimately creating two n-type regions (source and drain junctions) in the p-type substrate. The impurity doping also penetrates the polysilicon on the surface, reducing its resistivity. Note that the polysilicon gate, which is patterned before doping actually defines the precise location of the channel region and, hence, the location of the source and the drain regions. Since this procedure allows very precise positioning of the two regions relative to the gate, it is also called the self-aligned process.

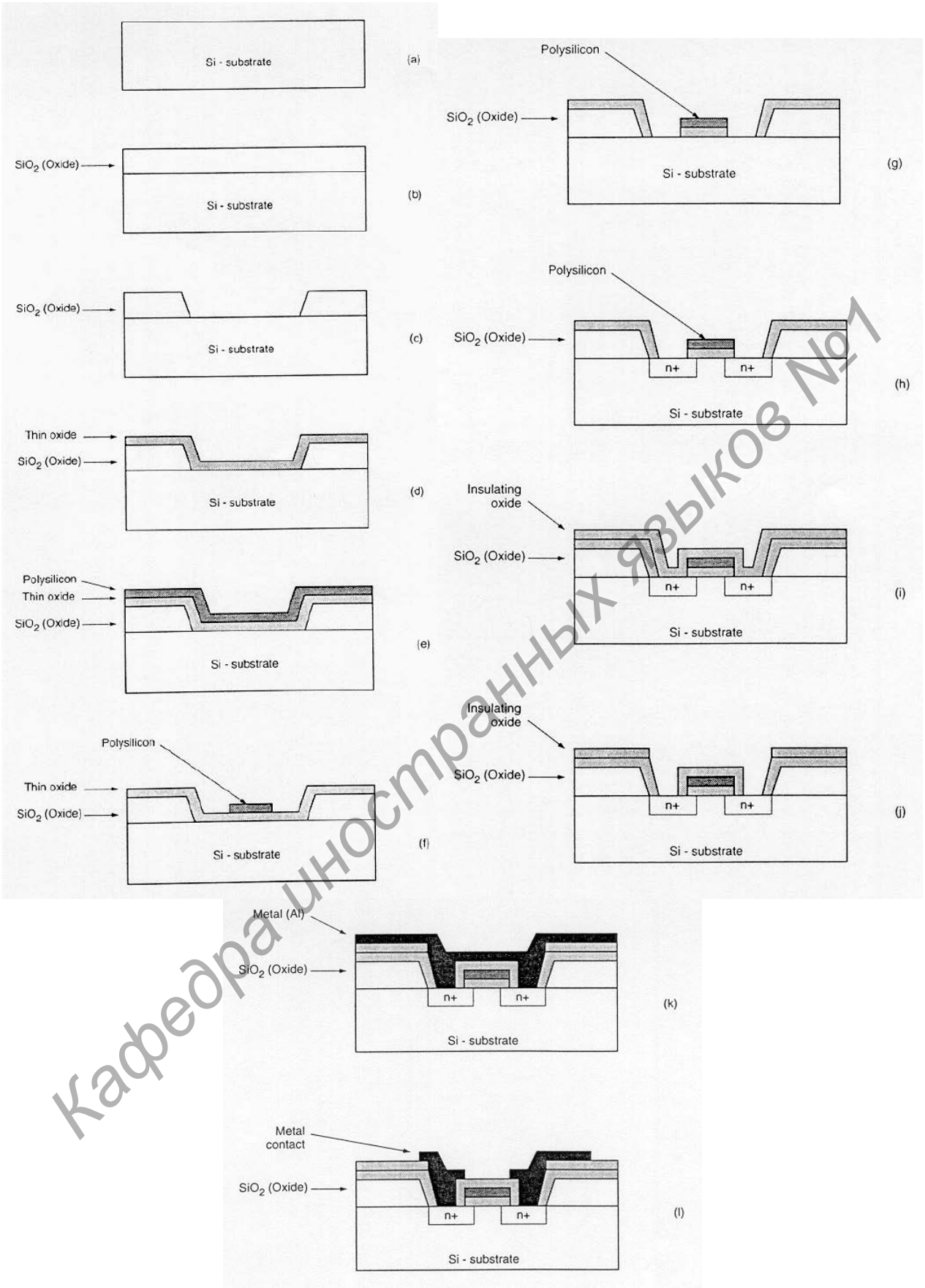


Figure 13. Process flow for the fabrication of an n-type MOSFET on p-type silicon

Once the source and drain regions are completed, the entire surface is again covered with an insulating layer of silicon dioxide (Fig. 13(i)). The insulating oxide layer is then patterned in order to provide contact windows for the drain and source junctions (Fig. 13(j)). The surface is covered with evaporated aluminum which will form the interconnects (Fig. 13(k)). Finally, the metal layer is patterned and etched, completing the interconnection of the MOS transistors on the surface (Fig. 13(l)). Usually, a second (and third) layer of metallic interconnect can also be added on top of this structure by creating another insulating oxide layer, cutting contact (via) holes, depositing, and patterning the metal.

IX. ***Check your understanding of the essential details by answering the following questions***:

1. What type of ICs fabrication process is described in the text?
2. What is:
   a) an integrated circuit;
   b) lithography;
   c) photoresist;
   d) a well or a tub.
3. What IC fabrication operations are described in the text ?
4. What is the difference between positive and negative photoresist and their use?

X. ***Make appropriate corrections in the succession of an n-channel MOS transistor fabrication operation steps in accordance with the text***:

a) oxidation of the silicon substrate;

b) covering the surface with evaporated aluminum which will form the interconnects;

c) covering the surface with a thin, high-quality oxide layer which will eventually form the gate oxide of the MOS transistor gates;

d) doping of silicon surface with a high concentration of impurities, either through diffusion or ion implantation;

e) subsequent covering of the entire surface with an insulating layer of silicon dioxide after completing the source and drain regions;

f) etching away thin gate oxide that remained uncovered with polysilicon;

g) deposition of a layer of polysilicon (polycrystalline silicon);

h) patterning and etching of the polysilicon layer to form the interconnects and the MOS transistor gates;

i) selective etching of field oxide to expose the silicon surface on which the MOS transistor will be created;

j) patterning and etching of the metal layer to complete the interconnection of the MOS transistors on the surface.

XI. ***Make your comments on the figures provided in the text.***

XII. ***Write a 200 words summary of the text.***

Part B

I. Study the vocabulary which is essential to for understanding the text:

1) tub – карман (в структуре ИС);
2) conventional – обычный, стандартный;
3) threshold voltage – порговое напряжение;
4) twin-tub CMOS process – производство схем на КМОП-транзисторах со спаренными каналами;
5) n(p)-well – n(p)-карман (канал) (в структуре ИС);
6) layer – слой;
7) substrate – подложка;
8) SOI (silicon-on-insulator) – технология «кремний на изоляторе» (КНИ), т. е. технология изготовления микросхем, при которой транзисторы изолируются от подложки слоем диоксида кремния;
9) to avoid – избегать;
10) conductance – электропроводимость;
11) capacitance – ёмкость; ёмкостное сопротивление;
12) latch – защёлка; защёлкивать, фиксировать;
13) to justify – оправдывать;
14) to conform (to, with) – соответствовать чему-либо;
15) feature size – размер элемента (ИС); ширина линии (в структуре ИС);
16) dimensions – размеры;
17) layout – разметка, компоновка;
18) yield – отдача, производительность;
19) to specify – точно определять, устанавливать, предписывать; детально излагать;
20) constraint – ограничение;
21) to devise – изобретать;
22) to scale – масштабировать;
23) boundary – граница;
24) reliable – надёжный.

II. Quickly look through the text to learn what it deals with and do the tasks that follow.

Text B

1. Advanced CMOS Fabrication Technologies

In this section, two examples will be given for advanced CMOS processes which offer additional benefits in terms of device performance and integration density. These processes, namely, the twin-tub CMOS process and the silicon-on-insulator (SOI) process, are becoming especially more popular for sub-micron geometries where device performance and density must be pushed beyond the limits of the conventional n-well CMOS process.

2. **Twin-Tub (Twin-Well) CMOS Process**

This technology provides the basis for separate optimization of the nMOS and pMOS transistors, thus making it possible for threshold voltage, body effect and the channel transconductance of both types of transistors to be tuned independently. Generally, the starting material is a n+ or p+ substrate, with a lightly doped epitaxial layer on top. This epitaxial layer provides the actual substrate on which the n-well and the p-well are formed. Since two independent doping steps are performed for the creation of the well regions, the dopant concentrations can be carefully optimized to produce the desired device characteristics.

3. In the conventional n-well CMOS process, the doping density of the well region is typically about one order of magnitude higher than the substrate, which, among other effects, results in unbalanced drain parasitics. The twin-tub process (Fig. 14) also avoids this problem.

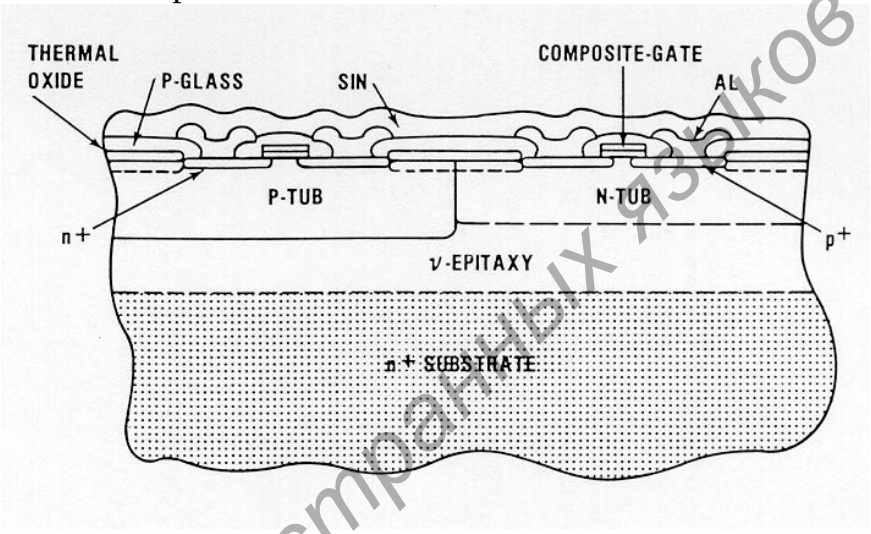


Figure 14. Cross-section of nMOS and pMOS transistors in twin-tub CMOS process

Silicon-on-Insulator (SOI) CMOS Process

4. Rather than using silicon as the substrate material, technologists have sought to use an insulating substrate to improve process characteristics such as speed and latch-up susceptibility. The SOI CMOS technology allows the creation of independent, completely isolated nMOS and pMOS transistors virtually side-by-side on an insulating substrate (for example: sapphire). The main advantages of this technology are the higher integration density (because of the absence of well regions), complete avoidance of the latch-up problem, and lower parasitic capacitances compared to the conventional n-well or twin-tub CMOS processes. A cross-section of nMOS and pMOS devices in created using SOI process is shown in Fig. 15.

5. The SOI CMOS process is considerably more costly than the standard n-well CMOS process. Yet the improvements of device performance and the absence of latch-up problems can justify its use, especially for deep-sub-micron devices.

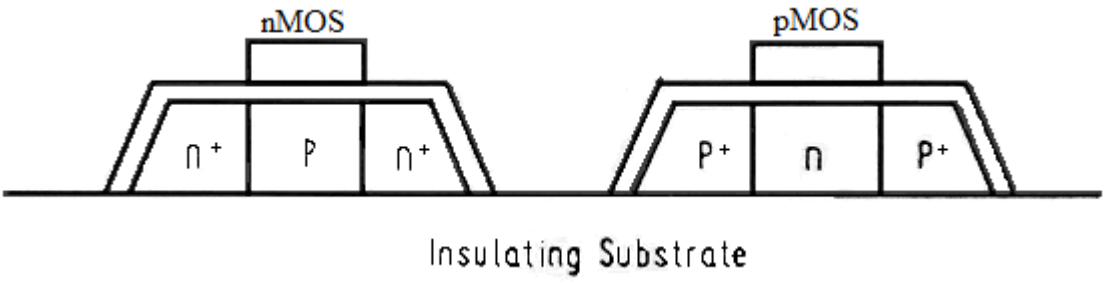


Figure 15. Cross-section of nMOS and pMOS transistors in SOI CMOS process

6. **Layout Design Rules**

The physical mask layout of any circuit to be manufactured using a particular process must conform to a set of geometric constraints or rules, which are generally called layout design rules. These rules usually specify the minimum allowable line widths for physical objects on-chip such as metal and polysilicon interconnects or diffusion areas, minimum feature dimensions, and minimum allowable separations between two such features. If a metal line width is made too small, for example, it is possible for the line to break during the fabrication process or afterwards, resulting in an open circuit. If two lines are placed too close to each other in the layout, they may form an unwanted short circuit by merging during or after the fabrication process. The main objective of design rules is to achieve a high overall yield and reliability while using the smallest possible silicon area, for any circuit to be manufactured with a particular process.

7. Note that there is usually a trade-off between higher yield which is obtained through conservative geometries, and better area efficiency, which is obtained through aggressive, high-density placement of various features on the chip. The layout design rules which are specified for a particular fabrication process normally represent a reasonable optimum point in terms of yield and density. It must be emphasized, however, that the design rules do not represent strict boundaries which separate «correct» designs from «incorrect» ones. A layout which violates some of the specified design rules may still result in an operational circuit with reasonable yield, whereas another layout observing all specified design rules may result in a circuit which is not functional and/or has very low yield. To summarize, we can say, in general, that observing the layout design rules significantly increases the probability of fabricating a successful product with high yield.

8. The design rules are usually described in two ways:

– micron rules, in which the layout constraints such as minimum feature sizes and minimum allowable feature separations, are stated in terms of absolute dimensions in micrometers;

– lambda rules, which specify the layout constraints in terms of a single parameter (?) and, thus, allow linear, proportional scaling of all geometrical constraints.

Lambda-based layout design rules were originally devised to simplify the industry-standard micron-based design rules and to allow scaling capability for various processes. It must be emphasized, however, that most of the submicron CMOS process design rules do not lend themselves to straightforward linear scaling. The use of lambda-based design rules must therefore be handled with caution in sub-micron geometries. In the following, we present a sample set of the lambda-based layout design rules devised for the MOSIS CMOS process and illustrate the implications of these rules on the example of a simple layout which includes two transistors.

III. Read the words with one and the same affix. Define the root from which they are derived. Pay attention to the meaning attributed to the words by this affix:

a) integration, optimization, creation, separation, fabrication, implication, application, separation, penetration, specification;

b) additional, conventional, operational, functional, typical;

c) allowable, reasonable, favorable, permissible, acceptable, reliable, changeable;

d) optimize, summarize, devise, emphasize;

e) specify, justify, identify;

f) completely, virtually, considerably, successfully, slightly, normally, significantly, usually.

IV. Think of a word that is associated with the given words:

fabrication, epitaxial, advantage, integration density, circuit, rules, layout.

V. Find equivalents of the following words in passages 1, 2, 3, 4, 5, 6, 7, 8:

modern, advantage, twin-well, special, commonly used, n-well, improvement, slightly, stratum, wafer, impurity, particularly, correspond to, goal, limits, established rules, admissible, production process, to be placed, goal, to sum up, greatly, to work out, to make simpler.

VI. Look through the text and find the words similar to the Russian ones that you can understand without translation. Read them aloud.

VII. Find as many Stone wall constructions in the text as you can and translate them into Russian, **e.g. multistep process process flow, CMOS fabrication process etc**.

VIII. Read the first sentence of passage 1 and think of the possible way of substituting the word combination «**in terms of**» ***without the change in the meaning. The same word combination is used in passage 7 and 8. Find those sentences and translate them into Russian.***

IX. In passage 2 you will come across the conjunction **since** ***used to introduce an adverbial clause. Translate the sentence into Russian. Think of the other functions of the word and its translation.***

X. In passage 6 the word combination* any circuit to be manufactured *with the infinitive in the attributive function is used two times. Find these sentences and translate them into Russian.

XI. Read passage 8 very attentively paying attention to the use of infinitive in various functions. Translate the passage into Russian.

XII. Answer the following questions:

1) Why is the twin-tub CMOS process and the silicon-on-insulator (SOI) process taken for illustrating advanced CMOS Fabrication Technology?

2) What are the factors that make twin-tub CMOS process advantageous?

3) What are the advantages and disadvantages of Silicon-on-Insulator (SOI) CMOS Process?

4) What do the Layout Design Rules specify?

5) What is the purpose of introducing Layout Design Rules?

6) What kind of remarks does the author make concerning the two Layout Design Rules mentioned in the text?

Part C

I. Study the words related to the text:

1) valence – валентность;
2) to wander – отклоняться, смещаться, дрейфовать;
3) to swap – обменивать(ся), менять;
4) indistinguishable – неразличимый, невидимый, незаметный; неотличимый;
5) conduction – проводимость;
6) forbidden – запрещённый;
7) valence band – валентная зона;
8) property – свойство;
9) conduction band – зона проводимости;
10) alloy – сплав;
11) quaternary – относящийся к четвёртой группе;
12) quinternary – относящийся к пятой группе;
13) intrinsic – действительный, собственный (полупроводник);
14) extrinsic – примесный (полупроводник);
15) density – плотность;
16) energy gap – запрещённая зона;
17) crystal lattice – кристаллическая решётка;
18) hole – дырка;
19) compound semiconductors – сложные полупроводники;
20) hydrogenic – водородоподобный.

II. Quickly scan the text and say more exactly what questions of semiconductor physics are touched in it.

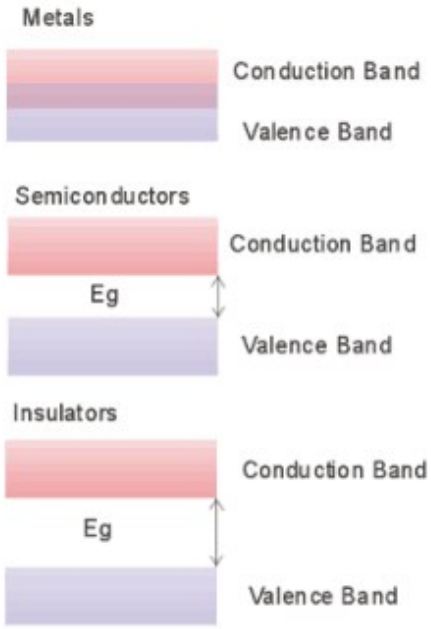
Text C

Basic Semiconductor Physics

1. Materials can be classified into *conductors*, *semiconductors* or *insulators* by their ability to conduct electricity.

It is a popular belief that insulators do not conduct electricity because their valence electrons are not free to wander throughout the material. In fact they are free to move around, however, in an insulator there are as many electrons as there are energy levels for them to occupy. If an electron swaps place with another electron no change is made since electrons are indistinguishable. There are higher energy levels, but to promote the electrons to these energy levels requires more energy than is usually practical.

Metals conduct electricity easily because the energy levels between the conduction and valence band are closely spaced, or there are more energy levels available than there are electrons to fill them, so very little energy is required to find new energies for electrons to occupy. The resistivity of a material is a measure of how difficult it is for a current to flow. Semiconductors have a resistivity between $10^{-4}<\rho<10^{8}\ \Omega$ m although these are rough limits. The band theory of materials explains qualitatively the difference between these types of materials. Electrons occupy energy levels from the lowest energies upwards. However, some energy levels are forbidden because of the wave like properties of atoms in the material. The allowed energy levels tend to form bands. The highest filled level at T = 0 K is known as the *valence band*. Electrons in the valence band do not participate in the conduction process. The first unfilled level above the valence band is known as the *conduction band*. In metals, there is no forbidden gap; the conduction band and the valence band overlap, allowing free electrons to participate in the conduction process. Insulators have an energy gap that is far greater than the thermal energy of the electron, while in semiconductor materials the energy gap is typically around 1eV. The diagram below shows the differences in metals, semiconductors and insulators in terms of the how the energy bands are separated.



2. *Elemental semiconductors* are semiconductors where each atom is of the same type such as Ge, Si. These atoms are bound together by covalent bonds, so that each atom shares an electron with its nearest neighbour, forming strong bonds.

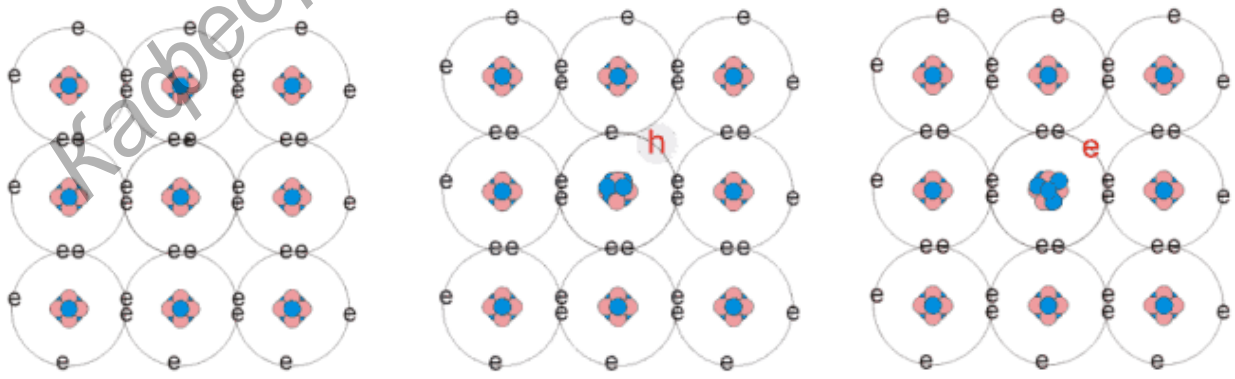
3. *Compound semiconductors* are made of two or more elements. Common examples are GaAs or InP. These compound semiconductors belong to the III-V semiconductors so called because first and second elements can be found in group III and group V of the periodic table respectively. In compound semiconductors, the difference in electro-negativity leads to a combination of covalent and ionic bonding. Ternary semiconductors are formed by the addition of a small quantity of a third element to the mixture, for example Al x Ga 1-x As. The subscript x refers to the alloy content of the material, what proportion of the material is added and what proportion is replaced by the alloy material. The addition of alloys to semiconductors can be extended to include quaternary materials such as Ga x In (1-x) As y P (1-y) or GaInNAs and even quinternary materials such as GaInNAsSb. Once again, the subscripts denote the proportion elements that constitute the mixture of elements. Alloying semiconductors in this way allows the energy gap and lattice spacing of the crystal to be chosen to suit the application.

4. *Intrinsic semiconductors* are essentially pure semiconductor material. The semiconductor material structure should contain no impurity atoms. Elemental and compound semiconductors can be intrinsic semiconductors. At room temperature, the thermal energy of the atoms may allow a small number of the electrons to participate in the conduction process. Unlike metals, where the resistance of the material decreases with temperature, for semiconductors, as the temperature increases, the thermal energy of the valence electrons increases, allowing more of them to breach the energy gap into the conduction band. When an electron gains enough energy to escape the electrostatic attraction of its parent atom, it leaves behind a vacancy which may be filled by another electron. The vacancy produced can be thought of as a second carrier of positive charge. It is known as a *hole*. As electrons flow through the

semiconductor, holes flow in the opposite direction. If there are n free electrons in an intrinsic semiconductor, then there must also be n holes. Holes and electrons created in this way are known as intrinsic charge carriers. The carrier concentration, or charge density, defines the number of charge carriers per unit volume. This relationship can be expressed as n = p where n is the number of electrons and p the number of holes per unit volume. The variation in the energy gap between different semiconductor materials means that the intrinsic carrier concentration at a given temperature also varies.

5. An extrinsic semiconductor can be formed from an intrinsic semiconductor by adding impurity atoms to the crystal in a process known as *doping*. To take the most simple example, consider silicon. Since silicon belongs to group IV of the periodic table, it has four valence electrons. In the crystal form, each atom shares an electron with a neighbouring atom. In this state it is an intrinsic semiconductor. B, Al, In, Ga all have three electrons in the valence band. When a small proportion of these atoms, (less than 1 in 10^6), is incorporated into the crystal the dopant atom has an insufficient number of bonds to share bonds with the surrounding silicon atoms. One of the silicon atoms has a vacancy for an electron. It creates a hole that contributes to the conduction process at all temperatures. Dopants that create holes in this manner are known as acceptors. This type of extrinsic semiconductor is known as *p-type* as it creates positive charge carriers. Elements that belong to group V of the periodic table such as As, P, Sb have an extra electron in the valence band. When added as a dopant to intrinsic silicon, the dopant atom contributes an additional electron to the crystal. Dopants that add electrons to the crystal are known as donors and the semiconductor material is said to be *n-type*.

6. Doping of compound semiconductors is slightly more complicated. The effect of the dopant atom depends on the site occupied by the atom in the *lattice*. In III-V semiconductors, atoms from group II act as acceptors when occupying the site of a group III atom, while atoms in group VI act as donors when they replace atoms from group V. Dopant atoms from group IV have the property that they can act as acceptors or donors depending on whether they occupy the site of group III or group V atoms respectively. Such impurities are known as *amphoteric impurities*.



Intrinsic p-type n-type

Figure 16. Schematic diagram showing the only the valence electron shell to illustrate intrinsic, p-type and n-type semiconductors

III. Read the first passage and say what factors determine the conductance of the material.

IV. In passage 2 find the chemical elements chosen by the author to illustrate the specific character of covalent bonds in semiconductors.

V. Look through passage 3 which gives you some information about compound semiconductors. What is said about their specific features?

VI. Scan passage 4 and speak in short about intrinsic semiconductors.

VII. Look through passage 5 and entitle it. Which word is most frequently used in this passage. Explain the difference between p-type and n-type semiconductors.

VIII. Look through passage 6 and say how we name the dopants that can act as donors and acceptors.

IX. Write out topical notions and their definitions from the text. They will help you make a block diagram of the text.

X. Make a block diagram of the text.

Part D

I. Look through the text. Pay attention to the subtitles. Do they tell you anything? Discuss it with your partner.

Text D

Graphene – the perfect atomic lattice

A thin flake of ordinary carbon, just one atom thick, lies behind this year's Nobel Prize in Physics.

Andrey Geim and Konstantin Novoselov have shown that carbon in such a flat form has exceptional properties that originate from the remarkable world of quantum physics.

1. Graphene is a form of carbon.

As a material it is completely new – not only the thinnest ever but also the strongest. As a conductor of electricity it performs as well as copper. As a conductor of heat it outperforms all other known materials. It is almost completely transparent, yet so dense that not even helium, the smallest gas atom, can pass through it.

Carbon, the basis of all known life on earth, has surprised us once again.

2. Pencil, paper and sticky tape.

It could not have been easier to obtain graphene, the miraculous material that comes from ordinary graphite such as is found in pencils. However, the most simple and obvious things are often hidden from our view.

Graphene consists of carbon atoms joined together in a flat lattice – similar to a honeycomb structure but just one atom thick. One millimeter of graphite actually consists of three million layers of graphene stacked on top of one another. The layers are weakly held together and are therefore fairly simple to tear off and separate. Anyone who has written something with an ordinary pencil has experienced this, and it is possible, when they did, that only a single layer of atoms, graphene, happened to end up on the paper.

This is what happened when Andrey Geim and Konstantin Novoselov used adhesive tape to rip off thin flakes from a larger piece of graphite in a more methodical manner. In the beginning they got flakes consisting of many layers of graphene, but when they repeated the tape-trick ten to twenty times the flakes got thinner and thinner. The next step was to find the miniscule fragments of graphene among the thicker layers of graphite and other carbon scraps. This is when they got their second brilliant idea: in order to be able to see the results of their meticulous work, the scientists from Manchester decided to attach the flakes to a plate of oxidized silicon, the standard working material in the semiconductor industry.

When the plate is placed in a standard microscope one can see a rainbow of colours, similar to what is seen when oil is spilled onto water, and thus determine the number of graphene layers in the flakes. The thickness of the underlying layer of silicon dioxide, was in turn, crucial for revealing the graphene. Under the microscope graphene now came into view – a truly two-dimensional crystalline material that exists at room temperature. Graphene is a perfectly regular network of carbon with only two dimensions, width and length. The basic unit of this pattern consists of six carbon atoms joined together chemically. Graphene, as well as some other forms of carbon that we know of, consists of billions of carbon atoms joined together in a hexagonal pattern.

Graphene has of course always existed; the crucial thing was to be able to spot it. Similarly, other naturally occurring forms of carbon have appeared before scientists when they viewed them in the right way: first nanotubes and then hollow balls of carbon, fullerenes (Nobel Prize in Chemistry 1996). Trapped inside graphite, graphene was waiting to be released. No-one really thought that it was possible.

3. **Graphene from graphite**.

Graphite is a basic material found in nature. When taken apart graphite sheets become graphene. A rolled up layer of graphene forms a carbon nanotube, folded up it becomes a small ball, fullerene. Hidden inside graphite, graphene was waiting to be discovered.

Many scientists thought that it would be impossible to isolate such thin materials: they would become crinkled or roll up at room temperature, or even simply completely vanish. In spite of this, some people still tried even though previous attempts to obtain graphene had failed. Formerly, it had been possible to obtain films with a thickness of less than 100 atoms – indeed, some had even been so thin that they were transparent.

One way of obtaining graphene from graphite is to introduce chemical substances between the layers of atoms in order to weaken the bond between them

and then subsequently separate the layers. Another method is to simply scratch away the layers of graphite. It was also tried, successfully, to «burn off» the silicon from silicon carbide crystals. At very high temperatures thin layers of carbon were left behind. Different techniques of epitaxial growth, used to create various semiconductor materials, are the most promising as regards producing graphene for use in the electronics industry. Rolls of 70 centimeter wide sheets of graphene are the largest produced so far.

4. **In a world of paradoxes**.

Andrey Geim and Konstantin Novoselov could only obtain micro flakes of the new material. Despite the miniscule size they could now begin to investigate the two most remarkable traits of graphene, which both influence its electrical properties.

The first is the nearly perfect composition of graphene. The error-free ordering is due to the strong bonding of the carbon atoms. At the same time, the bonds are flexible enough to allow the web to stretch by up to 20 % of its original size. The lattice also enables electrons to travel long distances in graphene without disturbance. In normal conductors, electrons often bounce like a ball in a pinball machine. This bouncing weakens the performance of the conductor.

The other unique trait of graphene is that its electrons behave like particles of light, the massless photons, that in a vacuum relentlessly move ahead at a speed of 300 million meters per second. Similarly, electrons travelling in graphene behave as if they did not have any mass and move ahead at a constant speed of one million meters per second. This opens up the possibility of studying certain phenomena more easily on a smaller scale, i.e. without the use of a large particle accelerator.

Graphene also allows scientists to test for some of the more ghost-like quantum effects that so far only have been discussed theoretically. One such phenomenon is a variant of Klein tunelling, which was formulated by the Swedish physicist Oskar Klein in 1929. The tunnel effect in quantum physics describes how particles can sometimes pass through a barrier that would normally block them. The larger the barrier the smaller the chance of quantum particles passing through. However, this does not apply to electrons travelling in graphene – in some circumstances they move ahead as if the barrier did not even exist.

5. **Dream worlds**.

The possible practical applications for graphene have received much attention. So far, most of them exist only in our fantasies, but many are already being tested, also by Geim and Novoselov themselves.

Graphene’s conducting ability has spurred a great deal of interest. Graphene transistors are predicted to be substantially faster than those made out of silicon today. In order for computer chips to become faster and more energy efficient they have to be smaller. Silicon hits a size boundary where the material ceases to function. The limit for graphene is even lower, so graphene components could be packed on a chip more tightly than today.

One milestone was passed a few years ago when its key component, graphene transistor, was presented that was as fast as its silicon counterpart. Maybe we are on the verge of yet another miniaturization of electronics that will lead to computers

becoming even more efficient in the future. So far, graphene computers are nothing but a distant dream, although paper-thin transparent computer monitors that can be rolled up and carried in a hand bag have already appeared in commercials for tomorrow's consumer electronics.

In the meantime we can only speculate about some of the more and some of the less realistic applications, all still requiring significant initiatives with their outcomes still being uncertain.

Since graphene is practically transparent (up to nearly 98 %) while simultaneously being able to conduct electricity, it would be suitable for the production of transparent touch screens, light panels and maybe even solar cells. Also plastics could be made into electronic conductors if only 1 % of graphene were mixed into them. Likewise by mixing in just a fraction of a per mille of graphene, the heat resistance of plastics would increase by 30 ˚C while at the same time making them more mechanically robust. This resilience could be utilised in new super strong materials, which are also thin, elastic and lightweight. In the future, satellites, airplanes, and cars could be manufactured out of the new composite materials.

The perfect structure of graphene also makes it suitable for the production of extremely sensitive sensors that could register even the smallest levels of pollution. Even a single molecule adsorbed to the graphene surface would be discovered.

II. Look through passage 1 and define its main idea.

III. Look through the second passage and say in what way Andrey Geim and Konstantin Novoselov got graphine spotted.

IV. Look through passage 3 and say why it has been impossible to isolate graphene in the graphite. What is said about various methods of its obtaining?

V. What unique traits of graphene did the two scientists discover? What is the benefit of their discovery for the science? You will find the answers to these questions in passage 4.

VI. Look through passage 5. Find the sentences emphasizing perspective opportunities of graphene application.

VII. Say whether the following statements are true (T) or false (F). Turn to the text to make your decision.

1. Graphene is a good insulator.
2. Graphene is very strong and difficult to separate.
3. First nanotubes and fullerenes were discovered thanks to the new methods of viewing the materials.
4. The obtaining of graphene was preceded by numerous attempts that had been a failure.
5. Graphene can be obtained only in two ways.
6. The investigation of grapheme enabled scientists to show some quantum effects that so far had been discussed only theoretically.

7. Geim and Novoselov’s investigation remains unnoticed in the world’s scientific community.

8. The estimation of the already obtained results shows that graphene computers are a matter of the nearest future.

9. For the time being, the application of graphene is very scarce and the perspectives are very uncertain.

VIII. ***Did you find the information presented in the text interesting***? ***Share your opinion on the information with your friends***.

UNIT VI
NANOTECHNOLOGY

Part A

I. Study the vocabulary that is essential for understanding the text:

1) molecular – молекулярный;
2) uncertainty – неопределённость;
3) quantum – квантовый;
4) particle – частица;
5) fuzziness – неясность, неопределённость;
6) unworkable – неработоспособный, неприемлемый, не пригодный для работы;
7) reliable – надёжный;
8) enzyme – энзим;
9) to proofread – читать корректуру;
10) bond – связь; соединение;
11) assembler – ассемблер, устройство преобразования языков программирования;
12) cell – клетка;
13) cluster – кластер; группа; скопление;
14) protein – протеин;
15) dimension – размер;
16) feasibility – применимость, осуществимость;
17) precision – точность, прецизионность;
18) to pry – поднимать, передвигать;
19) genetic engineering – генная инженерия;
20) to bar –препятствовать; прекращать;
21) breakthrough – прорыв, выдающееся научное или техническое достижение;
22) upheaval – переворот, подъём.

II. Read the sentence below and locate the information that can be deleted. Read out your shortened version.

Nonetheless, calculations show that the uncertainty principle places few important limits on how well atoms can be held in place, at least for the purposes outlined here.

III. Read the following sentence and name the key words reflecting the principal information:

The idea that new kinds of nanomachinery will bring new, useful abilities may seem startling: in all its billions of years of evolution, life has never abandoned its basic reliance on protein machines

IV. Translate the sentence below paying attention to the function of the words «like» and «unlike». Think of a possible substitute to this word.

Like an industrial robot arm – but unlike anything in a living cell – they will be able to rotate and move molecules in three dimensions under programmed control, making possible the precise assembly of complex objects.

V. Go back to the sentence above, analyse it and single out the information that can be deleted.

VI. Translate the underlined word in the sentence below. Think of a word similar in meaning:

Any production manager can well appreciate the reasons; even more than a factory, life cannot afford to shut down to replace its old systems.

VII. Translate the sentence below paying attention to the use of the word «one».

One might doubt that artificial nanomachines could even equal the abilities of nanomachines in the cell, if there were reasons to think that cells contained some special magic that makes them work.

VIII. Before reading the text below discuss in pairs or in small groups the following issues:

a) The problems that prevent the development of workable, reliable and usable molecular machines;

b) The creation of new kinds of nanomachinery with new startling abilities: assemblers, robots, etc.;

c) Artificial nanomachines versus natural nanomachines in the cell;

d) Challenges of nanotechnology;

e) The comparison of electronic microcomputers and electronic nanocomputers, the notion of assemblers and disassemblers;

f) Changes to be brought about by nanotechnology.

IX. Now read the text quickly paying attention to the principal information. After reading do the tasks that follow.

Text A

Nanotechnologies

Nailing Down Conclusions

In everything I have been describing, I have stuck closely to the demonstrated facts of chemistry and molecular biology. Still, people regularly raise certain questions rooted in physics and biology. These deserve more direct answers.

– *Will the uncertainty principle of quantum physics make molecular machines unworkable*?

This principle states (among other things) that particles can't be pinned down in an exact location for any length of time. It limits what molecular machines can do, just as it limits what anything else can do. The uncertainty principle makes *electron* positions quite fuzzy, and in fact this fuzziness determines the very size and structure

of atoms. An atom as a whole, however, has a comparatively definite position set by its comparatively massive nucleus. If atoms didn't stay put fairly well, molecules would not exist. One needn't study quantum mechanics to trust these conclusions, because molecular machines in the cell demonstrate that molecular machines work.

– *Will the molecular vibrations of heat make molecular machines unworkable or too unreliable for use*?

Thermal vibrations will cause greater problems than will the uncertainty principle, yet here again existing molecular machines directly demonstrate that molecular machines can work at ordinary temperatures. Despite thermal vibrations, the DNA-copying machinery in some cells makes less than one error in 100,000,000,000 operations. To achieve this accuracy, however, cells use machines (such as the enzyme DNA polymerase I) that proofread the copy and correct errors. Assemblers may well need similar error-checking and error-correcting abilities, if they are to produce reliable results.

– *Will radiation disrupt molecular machines and render them unusable*?

High-energy radiation can break chemical bonds and disrupt molecular machines. Living cells once again show that solutions exist: they operate for years by repairing and replacing radiation-damaged parts. Because individual machines are so tiny, however, they present small targets for radiation and are seldom hit. Still, if a system of nanomachines must be reliable, then it will have to tolerate a certain amount of damage, and damaged parts must regularly be repaired or replaced. This approach to reliability is well known to designers of aircraft and spacecraft.

– *Since evolution has failed to produce assemblers, does this show that they are either impossible or useless*?

The earlier questions were answered in part by pointing to the working molecular machinery of cells. This makes a simple and powerful case that natural law permits small clusters of atoms to behave as controlled machines, able to build other nanomachines. Yet despite their basic resemblance to ribosomes, assemblers will differ from anything found in cells; the things they do – while consisting of ordinary molecular motions and reactions – will have novel results. No cell, for example, makes diamond fiber.

Does this suggest that improvements are impossible, though? Evolution progresses through small changes, and evolution *of* DNA cannot easily *replace* DNA. Since the DNA/RNA/ribosome system is specialized to make proteins, life has had no real opportunity to evolve an alternative.

Improved molecular machinery should no more surprise us than alloy steel being ten times stronger than bone, or copper wires transmitting signals a million times faster than nerves. Cars outspeed cheetahs, jets outfly falcons, and computers already outcalculate head-scratching humans. The future will bring further examples of improvements on biological evolution, of which second-generation nanomachines will be but one.

In physical terms, it is clear enough why advanced assemblers will be able to do more than existing protein machines. They will be programmable like ribosomes, but they will be able to use a wider range of tools than all the enzymes in a cell put

together. Because they will be made of materials far more strong, stiff, and stable than proteins, they will be able to exert greater forces, move with greater precision, and endure harsher conditions. These advantages will enable them to assemble a far wider range of molecular structures than living cells have done.

– Is there some special magic about life, essential to making molecular machinery work?

This idea is called «vitalism». Biologists have abandoned it because they have found chemical and physical explanations for every aspect of living cells yet studied, including their motion, growth, and reproduction. Indeed, this knowledge is the very foundation of biotechnology.

– The case for the feasibility of assemblers and other nanomachines may sound firm, but why not just wait and see whether they can be developed?

Sheer curiosity seems reason enough to examine the possibilities opened by nanotechnology, but there are stronger reasons. These developments will sweep the world within ten to fifty years – that is, within the expected lifetimes of ourselves or our families. What is more, the conclusions of the following chapters suggest that a wait-and-see policy would be very expensive – that it would cost many millions of lives, and perhaps end life on Earth.

Is the case for the feasibility of nanotechnology and assemblers firm enough that they should be taken seriously? It seems so, because the heart of the case rests on two well-established facts of science and engineering. These are (1) that existing molecular machines serve a range of basic functions, and (2) that parts serving these basic functions can be combined to build complex machines. Since chemical reactions can bond atoms together in diverse ways, and since molecular machines can direct chemical reactions according to programmed instructions, assemblers definitely are feasible.

Nanocomputers

Assemblers will bring one breakthrough of obvious and basic importance: engineers will use them to shrink the size and cost of computer circuits and speed their operation by enormous factors.

The idea of a purely mechanical computer is scarcely new. In England during the mid-1800s, Charles Babbage invented a mechanical computer built of brass gears; his co-worker Augusta Ada, the Countess of Lovelace, invented computer programming. Babbage's endless redesigning of the machine, problems with accurate manufacturing, and opposition from budget-watching critics (some doubting the usefulness of computers!), combined to prevent its completion.

In this tradition, Danny Hillis and Brian Silverman of the MIT Artificial Intelligence Laboratory built a special-purpose mechanical computer able to play tic-tac-toe. Yards on a side, full of rotating shafts and movable frames that represent the state of the board and the strategy of the game, it now stands in the Computer Museum in Boston. It looks much like a large ball-and-stick molecular model, for it is built of Tinkertoys.

Brass gears and Tinkertoys make for big, slow computers. With components a few atoms wide, though, a simple mechanical computer would fit within 1/100 of a cubic micron, many billions of times more compact than today's so-called microelectronics. Even with a billion bytes of storage, a nanomechanical computer could fit in a box a micron wide, about the size of a bacterium. And it would be fast. Although mechanical signals move about 100,000 times slower than the electrical signals in today's machines, they will need to travel only 1/1,000,000 as far, and thus will face less delay. So a mere mechanical computer will work faster than the electronic whirl-winds of today.

Electronic nanocomputers will likely be thousands of times faster than electronic microcomputers – perhaps hundreds of thousands of times faster, if a scheme proposed by Nobel Prize-winning physicist Richard Feynman works out. Increased speed through decreased size is an old story in electronics.

Disassemblers

Molecular computers will control molecular assemblers, providing the swift flow of instructions needed to direct the placement of vast numbers of atoms. Nanocomputers with molecular memory devices will also store data generated by a process that is the opposite of assembly.

Assemblers will help engineers synthesize things; their relatives, disassemblers, will help scientists and engineers analyze things. The case for assemblers rests on the ability of enzymes and chemical reactions to form bonds, and of machines to control the process. The case for disassemblers rests on the ability of enzymes and chemical reactions to break bonds, and of machines to control the process. Enzymes, acids, oxidizers, alkali metals, ions, and reactive groups of atoms called free radicals – all can break bonds and remove groups of atoms. Because nothing is absolutely immune to corrosion, it seems that molecular tools will be able to take anything apart, a few atoms at a time. What is more, a nanomachine could (at need or convenience) apply mechanical force as well, in effect prying groups of atoms free.

A nanomachine able to do this, while recording what it removes layer by layer, is a *disassembler*. Assemblers, disassemblers, and nanocomputers will work together. For example, a nanocomputer system will be able to direct the disassembly of an object, record its structure, and then direct the assembly of perfect copies. And this gives some hint of the power of nanotechnology.

The World Made New

Assemblers will take years to emerge, but their emergence seems almost inevitable: Though the path to assemblers has many steps, each step will bring the next in each and each will bring immediate rewards. The first steps have already been taken, under the names of «genetic engineering» and «biotechnology». Other paths to assemblers seem possible. Barring worldwide destruction or worldwide controls, the technology race will continue whether we wish it or not. And as advances in

computer-aided design speed the development of molecular tools, the advance toward assemblers will quicken.

To have any hope of understanding our future, we must understand the consequences of assemblers, disassemblers, and nanocomputers. They promise to bring changes as profound as the industrial revolution, antibiotics, and nuclear weapons all rolled up in one massive breakthrough. To understand a future of such profound change, it makes sense to seek principles of change that have survived the greatest upheavals of the past. They will prove a useful guide.

X. Check your understanding of the essential details by answering the following questions:

1) Will the uncertainty principle of quantum physics, the molecular vibrations of heat, radiation make molecular machines unworkable or unusable?

2) Why will advanced assemblers be able to do more than existing protein machines?

3) Why have biologists rejected the idea which is known as «vitalism»?

4) What is the author's opinion about the feasibility of nanotechnology and assemblers?

5) Who was the idea of a mechanical computer, computer programming, special-purpose mechanical computer, electronic nanocomputers suggested by?

6) What is your understanding of the words assembler, disassembler, inevitable, feasibility, a wait-and-see policy?

7) What changes may assemblers, disassembles and nanocomputers bring in to our life?

XI. Write a short summary of the text, covering only the principal information. No more than 200 words should be used.

Part B

I. The following words and word-combinations are essential for understanding the text. Learn their meaning and pronunciation:

1) patrol – патрулировать, охранять;
2) deflect – отклонять(ся);
3) speck – пятно, точка;
4) probe – щуп, зонд, пробник;
5) controversy – полемика, дискуссия, спор, разногласие;
6) operate – работать, функционировать;
7) grip – схватывание; сжатие, зажатие;
8) weird – потусторонний, сверхъестественный, таинственный;
9) strand – цепь, нить;
10) unwittingly – невольно, непреднамеренно, нечаянно, случайно;
11) stained glass – цветное стекло, витражное стекло;
12) range – простираться, измерять;

13) explore – исследовать;
14) scan – пристально разглядывать, изучать;
15) capture – захватывать, улавливать, фиксировать (изображение);
16) modify – модифицировать, изменять;
17) buckminsterfullerene – бакминстерфуллерен;
18) roll – ролик, рулон;
19) novel – неизвестный, новый;
20) harness – использовать;
21) multitude – множество, большое число, масса;
22) piston – поршень;
23) tweezer – выщипывать пинцетом, щипчиками;
24) capacitor – конденсатор;
25) nano train set – нано состав;
26) velcro; velours croché – «бархат с крючками»; застёжка «липучка»;
27) abacus – счёты; абак(а);
28) soldering iron – паяльник.

II. Match the words with their definitions.

1. ailment	to turn or cause to turn aside from a course
2. deflect	small or tiny piece of something
3. speck	a slight ailment but often persistent illness
4. controversy	the act or an instance of grasping and holding firmly
5. grip	suggestive of or relating to the supernatural
6. weird	dispute, argument, or debate
7. stained glass	a form of carbon that contains molecules having 60 carbon atoms arranged at the vertices of a polyhedron with hexagonal and pentagonal faces. Etymology: named after (Richard) Buckminster Fuller (1895–1983), US architect and engineer
8. buckminsterfullerene	glass that has been coloured in any of various ways
9. nano-Velcro	hook-and-loop fastener
10. abacus	a counting device that consists of a frame holding rods on which a specific number of beads are free to move

III. Arrange the words of the two groups in pairs with:
a) *similar meaning*

1. operate	a. atom
2. particle	b. work
3. stretch	c. filament
4. strand	d. extend
5. unwittingly	e. involuntarily
6. explore	f. very small
7. tiny	g. find

8. discover	h. investigate
9. scan	i. use
10. application	j. examine

b) *opposite meaning*

1. unusual	a. same
2. light	b. decrease
3. different	c. disappear
4. increase	d. ordinary
5. roughly	e. heavy
6.appear	f. exactly
7.capture	g. lose
8. tough	h. soft
9. novel	i. widespread
10. unique	j. known

IV. ***Choose from the given words***: **a**) ***nouns***; **b**) ***verbs***; **c**) ***adjectives***; **d**) ***adverbs***.

a) nouns

probe; probeable; prober;
controversy; controversial; controversialism; controversialist; controversially
scale; scalelike, scaler, scaling;

b) verbs

operate; operatorless; operator, operation;
image; imagination; imaginal; imagineable; imaginary; imager; imagine;
inspiration; inspiratory; inspirator; inspirational; inspire;

c) adjectives

differ; difference; differencial; different; differentiate;
thickness; thicken; thickener; thickly; thick;
lighten; lighter; light; lightly;

d) adverbs

wit; witting; wittingly; unwittingly;
colour; colourfully; colourful; colouration; colourant; colourless;
roughly; rough; roughness; roughing.

V. Study the title and subtitles of the text and make your predictions about its contents.

Text B

Instant Expert: **Nanotechnology**

1. Imagine a world where microscopic medical implants patrol our arteries, diagnosing ailments and fighting disease; where military battle-suits deflect

explosions; where computer chips are no bigger than specks of dust; and where clouds of miniature space probes transmit data from the atmospheres of Mars or Titan.

2. Many incredible claims have been made about the future's nanotechnological applications, but what exactly does nano mean, and why has controversy plagued this emerging technology?

3. Nanotechnology is science and engineering at the scale of atoms and molecules. It is the manipulation and use of materials and devices so tiny that nothing can be built any smaller.

How small is small?

4. Nanomaterials are typically between 0.1 and 100 nanometres (nm) in size – with 1 nm being equivalent to one billionth of a metre (10-9 m).

5. This is the scale at which the basic functions of the biological world operate – and materials of this size display unusual physical and chemical properties. These profoundly different properties are due to an increase in surface area compared to volume as particles get smaller – and also the grip of weird quantum effects at the atomic scale.

6. If 1 nanometre was roughly the width of a pinhead, then 1 metre on this scale would stretch the entire distance from Washington, DC to Atlanta – around 1000 kilometres. But a pinhead is actually one million nanometres wide. Most atoms are 0.1 to 0.2 nm wide, strands of DNA around 2 nm wide, red blood cells are around 7000 nm in diameter, while human hairs are typically 80,000 nm across.

7. Unwittingly, people have made use of some unusual properties of materials at the nanoscale for centuries. Tiny particles of gold for example, can appear red or green – a property that has been used to colour stained glass windows for over 1000 years.

8. Nanotechnology is found elsewhere today in products ranging from nanometre-thick films on «self-cleaning» windows to pigments in sunscreens and lipsticks.

Nano is born

9. The idea of nanotechnology was born in 1959 when physicist Richard Feynman gave a lecture exploring the idea of building things at the atomic and molecular scale. He imagined the entire Encyclopaedia Britannica written on the head of a pin.

10. However, experimental nanotechnology did not come into its own until 1981, when IBM scientists in Zurich, Switzerland, built the first scanning tunnelling microscope (STM). This allows us to see single atoms by scanning a tiny probe over the surface of a silicon crystal. In 1990, IBM scientists discovered how to use an STM to move single xenon atoms around on a nickel surface – in an iconic experiment, with an inspired eye for marketing, they moved 35 atoms to spell out «IBM».

11. Further techniques have since been developed to capture images at the atomic scale, these include the atomic force microscope (AFM), magnetic resonance imaging (MRI) and the even a kind of modified light microscope.

12. Other significant advances were made in 1985, when chemists discovered how to create a soccer-ball-shaped molecule of 60 carbon atoms, which they called buckminsterfullerene (also known as C60 or buckyballs). And in 1991, tiny, super-strong rolls of carbon atoms known as carbon nanotubes were created. These are six times lighter, yet 100 times stronger than steel.

13. Both materials have important applications as nanoscale building blocks. Nanotubes have been made into fibres, long threads and fabrics, and used to create tough plastics, computer chips, toxic gas detectors, and numerous other novel materials. The far future might even see the unique properties of nanotubes harnessed to build a space elevator.

14. More recently, scientists working on the nanoscale have created a multitude of other nanoscale components and devices, including: tiny transistors, superconducting quantum dots, nanodiodes, nanosensors, molecular pistons, supercapacitors, «biomolecular» motors, chemical motors, a nano train set, nanoscale elevators, a DNA nanowalking robot, nanothermometers, nano containers, the beginnings of a miniature chemistry set, nano-Velcro, nanotweezers, nano weighing scales, a nano abacus, a nano guitar, a nanoscale fountain pen, and even a nanosized soldering iron.

VI. Look through the text and find the derivatives of the following words:

a) *verbs*: explode, apply, manipulate, signify; detect; elevate, tweeze;

b) *nouns*: base, atom, width, biology, experiment, magnet;

c) *adjectives*: typical, profound, witting, multiple.

What other derivatives of the listed words do you know?

VII. In passage 10 you will find the information on the breakthrough made by IBM scientists. What is it? Translate the part of the sentence «did not come into its own until».

VIII. Look through the whole text and find the international words. Read them aloud. Give their meaning without the use of a dictionary.

IX. In passage 1 single out topical rows. Name them.

X. Look through passages 2 and 3 and give the definition of this emerging technology.

XI. In passage 4 find an Absolute Participial Construction. Say what formal signs helped you to single it out. Translate the sentence into Russian.

XII. Answer the following questions on passages 4 and 5.

1. What is the scale of nanomaterials?
2. What are the peculiarities of the nanomaterial qualities?
3. What are the reasons of the unusual nanomaterial properties?

XIII. Read passage 6 carefully and fill in the table. Translate the passage into Russian.

A pinhead	
	0.1 to 0.2 nm
Strands of DNA	
	7000 nm in diameter
	80,000 nm across

XIV. Read passage 7. Think of the appropriate way of translating the word «unwittingly». What other words could be used instead of it? Translate the whole passage into Russian.

XV. Read passage 8, paying attention to the meaning of the word combination «self-cleaning». Translate the sentence into Russian.

XVI. In passage 9 find the sentences with participles I and II in the function of an attribute. Translate the sentences into Russian.

XVII. In passage 10 find the sentences describing the consequences of inventing a scanning tunneling microscope. Suggest a possible variant of translating the following fragment «… with an inspired eye for marketing» in the last sentence of the passage.

XVIII. Read passages 11 and 12. What is the function of the word «these» used in both passages? Give explanations and translate the sentences into Russian.

XIX. Go back to passage 12 and look for the answer to the following questions. What did chemists discover and what is another name for buckminsterfullerene?

XX. Read passage 13. What does the word «both» refer to? What can both materials be used for?

XXI. Study passage 14. Think of the appropriate way of translating the word «multitude». What other words could be used instead of it?

XXII. In passage 14 find the words similar to the Russian ones that you can understand without a transition. Translate the whole passage into Russian.

***XXIII. Look through the whole text again, find the sentences illustrating the author's opinion on the fact that*: a) *nanomaterials demonstrate extraordinary properties*; b) *there are some reasons for a sharp distinction in characteristics of nanomaterials*; c) *people unintentionally used some qualities of materials at the nanoscale*; d) *two kinds of nanomaterial were discovered*.**

***XXIV. Answer the following questions*:**

1) When was the idea of nanotechnology introduced for the first time?

2) What discoveries favoured the development of experimental nanotechnology?

3) Where are buckyballs and carbon nanotubes applied?

4) What are the possible future applications of nanotechnology?

Part C

I. Study the words related to the text «Definition of nanotechnology»:

1) confusion – путаница, неразбериха;
2) network – схема, сеть, цепь;
3) carbon – углерод;
4) nanotube – нанотруба, нанотрубка;
5) inaugural – вступительный, знаменующий начало;
6) biomolecule – биомолекула;
7) constrain – накладывать ограничения;
8) arbitrary – произвольный, произвольно выбранный, условный;
9) novel – неизвестный, новый;
10) relevance – релевантность, значимость;
11) dimension – размер, величина;
12) bulk – масса, объём;
13) inert – инертный;
14) tiny – очень маленький, крошечный;
15) render – переводить, представлять, приводить в состояние;
16) quantum effect – квантовый эффект;
17) matter – вещество, материя;
18) nanoparticle – наночастица;
19) dot – точка;
20) counterpart – эквивалент, аналог, дубликат, копия;
21) stem from – происходить от (чего-либо), являться результатом (чего-либо);
22) weird – сверхъестественный, причудливый;
23) aggregate – объединять, соединять;
24) envision – воображать (что-либо), представлять себе, предвидеть;
25) building block – конструктивный блок, стандартный блок;
26) heterogeneous – гетерогенный, неоднородный, разнородный;
27) anticipate – ожидать, предвосхищать;
28) dispersion – дисперсия, рассеяние;
29) incremental – инкрементный, поэтапный, увеличивающийся постепенно;
30) actuator – привод, исполнительный механизм;
31) bio-assembly – сборка, компоновка; монтаж;
32) architecture – архитектура, структура;
33) networking – создание сети, построение сети.

II. Quickly scan the text «Definition of nanotechnology» and find the words with suffixes -ure and -er/or. Translate them into Russian. Say what kind of nouns

they usually form. ***Think of your own examples of words formed with these suffixes***.

Text C

Definition of nanotechnology

1. One of the problems facing nanotechnology is the confusion about its definition. Most definitions revolve around the study and control of phenomena and materials at length scales below 100 nanometers (nm) and the most overused comparison you read about all the time is that with a human hair, which is about 80,000 nm wide.

2. Some definitions include a reference to molecular systems and devices and nanotechnology «purists» argue that any definition of nanotechnology needs to include a reference to «functional systems». The inaugural issue of Nature Nanotechnology in 2006 asked 13 researchers from different areas what nanotechnology means to them and the responses, from enthusiastic to skeptical, reflect a variety of perspectives.

3. Another important criteria for the definition is the requirement that the nanostructure is man-made. Otherwise you would have to include every naturally formed biomolecule and material particle, in effect redefining much of chemistry and molecular biology as «nanotechnology».

4. The most important requirement for the nanotechnology definition is that the nano-structure has special properties that are exclusively due to its nanoscale proportions.

5. We found a good definition that is practical and unconstrained by any arbitrary size limitations: the design, characterization, production, and application of structures, devices, and systems by controlled manipulation of size and shape at the nanometer scale (atomic, molecular, and macromolecular scale) that produces structures, devices, and systems with at least one novel/superior characteristic or property.

The relevance of the nanoscale

6. The bulk properties of materials often change dramatically when reduced to nanoscale dimensions. This has to do with two main reasons:

7. Firstly, nanomaterials have a relatively larger surface area when compared to the same mass of material in bulk form. This can make materials more chemically reactive (in some cases materials that are inert in their larger form are reactive when produced in their nanoscale form), and affect their strength or electrical properties.

8. To understand the effect of particle size on surface area, consider a U.S. silver dollar. The silver dollar contains 26,96 grams of coin silver, has a diameter of about 4 centimeters, and has a total surface area of approximately 27,70 square centimeters. If the same amount of coin silver were divided into tiny particles – say 1 nanometer in diameter – the total surface area of those particles would be 11400 square meters. In other words: when the amount of coin silver contained in a silver

dollar is rendered into 1 nm particles, the surface area of those particles is over 4 million times greater than the surface area of the silver dollar!

9. Secondly, quantum effects can begin to dominate the behavior of matter at the nanoscale – particularly at the lower end – affecting the optical, electrical and magnetic behavior of materials. Materials can be produced that are nanoscale in one dimension (for example, very thin surface coatings), in two dimensions (for example, nanowires and nanotubes) or in all three dimensions (for example, nanoparticles and quantum dots).

10. Composites made from particles of nano-size ceramics or metals smaller than 100 nanometers can suddenly become much stronger than predicted by existing materials-science models. For example, metals with a so-called grain size of around 10 nanometers are as much as seven times harder and tougher than their ordinary counterparts with grain sizes in the hundreds of nanometers.

11. The causes of these drastic changes stem from the weird world of quantum physics. The bulk properties of any material are merely the average of all the quantum forces affecting all the atoms. As you make things smaller and smaller, you eventually reach a point where the averaging no longer works and you have to deal with the specific behavior of individual atoms or molecules – behavior that can be very different to when these atoms are aggregated into a bulk material.

Nanotechnology will develop in generations

12. As we reported previously (Nanotechnology manufacturing key to industrialized countries' future competitiveness), systematic control and manufacture at the nanoscale are envisioned to evolve in four overlapping generations of new nanotechnology product types that start with nanoscale building blocks and evolve over time into complex heterogeneous systems. Each anticipated generation of products will provide a nanotechnology base for further innovation, leading to succeeding generations of products of increasing complexity and functionality:

13. First Generation (beginning 2000): passive nanostructures, illustrated by nanostructured coatings, nanoparticles, dispersion of nanoparticles, nanocomposites, and bulk nanostructured materials – nanostructures made of metals, polymers, ceramics; bio-building blocks. The nanotech sunscreens and golf balls that you read about are only incremental improvements of previous products where thanks to the use of such passive nanostructures – in the case of sunscreen zinc oxide or titanium dioxide; and carbon nanotubes in the case of golf balls – better performance characteristics could be achieved.

14. Second Generation (beginning 2005): active nanostructures, illustrated by transistors, amplifiers, targeted drugs and chemicals, biological and non-biological sensors, actuators, and adaptive structures.

15. Third Generation (beginning 2010): three-dimensional nanosystems and systems of nanosystems using various synthesis and assembly techniques such as bio-assembly, networking at the nanoscale, and multiscale architectures.

16. Fourth Generation (beginning 2015): materials by design and heterogeneous molecular nanosystems, where each molecule in the nanosystem has a specific structure and plays a different role. Molecules will be used as devices, and from their engineered structures and architectures will emerge fundamentally new functions.

III. Read the title of the text. Translate it into Russian paying attention to the suffix -tion. Look through the text and find the words with some other noun forming suffixes. Translate the words into Russian.

IV. Judging by the title say what the text might be about. What word helped you to form your opinion?

V. Now in passage 1 find the information about the notions most definitions of nanotechnology revolve around.

VI. Read passage 2 to find out what references the definition needs to include.

VII. Scan passage 3 and speak in short about another important criterium for the definition.

VIII. Look through passage 4 and name the most important requirement for the nanotechnology definition.

IX. Read passage 5 and say what items are raised in it. Single-out key words which help you to form your opinion.

X. Scan passages 6, 7, 8 and explain what the first reason for the dramatic change of the properties of nanoscale materials is.

XI. What do «quantum affects at the nanoscale» mean? Look for the answer in passage 9.

XII. What properties do the nanomaterials acquire? Look for the information in passage 10. Pay attention to the comparative degrees of adjectives. Translate them into Russian.

XIII. Express the main idea of passage 11 using the following words and word-combinations: drastic changes; the weird world of quantum physics; atoms; specific behavior of individual atoms or molecules.

XIV. Compress the first sentence of passage 12 by deleting secondary information. Say what qualities new nanotechnology products will possess?

XV. Scan passage 13 and describe in short passive nanostructures and bulk nanostructured materials of the first generation.

XVI. What active nanostructures will represent the second generation? Look for the information in passage 14.

***XVII. What systems and techniques will characterize the third generation*? *Find the information in passage 15*.**

***XVIII. Describe the peculiarities of the materials of the fourth generation. Answer the question: What will emerge from the engineered structures of molecules used as devices*?**

***XIX. And, finally, generalize the issues raised in the text. Express your opinion, add the information you possess, give facts, examples in favour or against the information given in the text. While speaking use the words of the active vocabulary*.**

***XX. Say if the information of the text is new to you*? *Can it be used in your future professional activities*?**

Part D

***I. Quickly look through the text below to get acquainted with its structural composition – subtitles, words in bold type, italics, etc. Do they tell you anything*? *Discuss it with your partner*.**

***II. Quickly scan the text again for the words in italics. Make sure you know them. If don't look them up in the dictionary or ask your teacher for help*.**

Text D

Nanotechnology

Engineering Wonder

Engineering at the nanoscale is no simple feat, and scientists are having to come up with completely different solutions to build from the «*bottom-up*» rather than using traditional «*top-down*» manufacturing techniques.

Some nanomaterials, such as *nanowires* and other simple devices have been shown *to assemble themselves* given the right conditions, and *other experiments at larger scales* are striving to demonstrate the principles of self-assembly. Microelectronic devices might be persuaded to grow from the ground-up, *rather like trees*.

Researchers are also finding ways to put proteins, DNA, viruses and *bacteria* and *other micro-organisms* to work in building nanomaterials, and also taking *other inspiration* from the natural world.

Some problems have arisen due to a lack of *consistency* in measuring distances at the nanoscale, but an atomic *lattice nanoruler* could improve accuracy.

Great potential

In the short term, the greatest advances through nanotechnology will come in the form of novel medical devices and processes, new catalysts for industry and smaller components for computers.

In medicine, we are already seeing research on: New ways to deliver drugs with contact *lenses*; the directing of drugs to tumours with tiny «*smart bombs*»; gold «*nano-bullets*» that seek-and-destroy tumours; starving cancer with nanoparticles; *diagnosing diseases* such as *Alzheimer's*, monitoring health and fighting sickness with tiny probes; and *growing new organs* from scratch.

And biochemists are hoping to *deploy viruses* as «nanocameras» to get a clearer picture of what is going on inside cells.

In computing nanoscience may lead to smaller or more powerful microchips with *increased capacity* and dramatic *reductions in the size* of hard discs. Some experiments have even shown that it might be possible to manufacture tiny parts for computers *inside bacteria*. *Quantum computing* and *quantum cryptography* also rely on advances in nanotechnology. In fact, existing computer chips are already manufactured taking advantage of techniques at the nanoscale.

In environmental science nanotechnology is providing ways to *detect* and filter bacteria and toxins out of water supplies and clear up *heavy metal* and *organic chemical* pollution.

Nanoscience has already benefited the environment with the development of the catalytic converter – which detoxifies engine fumes the world over. Further innovations are leading to smaller, more efficient batteries, advanced *solar powe*r and fuel cells and *catalytic diesel additives* that improve fuel efficiency.

In addition, new and powerful *light-emitting diodes* (LEDs) may soon replace conventional light bulbs, offering huge energy savings. LEDs are built with semiconductors, increasingly developed at the nanoscale.

In military technology governments are splashing cash on developing new, lightweight equipment and weapons, bullet-proof battle-suits that can morph to provide camouflage or even stiffen to provide splints for broken limbs, and nanosensors that might detect chemical or biological perils.

Nanoparticles are currently in use in 120 millimetre tank rounds and may soon be used in other types of munitions – their larger surface area to volume ratio makes them especially reactive.

Diminutive debate

Despite the fact that it still has relatively few commercial applications, nanotechnology has generated criticism from environmental groups and others – such as the UK's *Prince Charles* – who fear as-yet-unknown risks to human health and the environment.

Critics have called for a *moratorium* on research, arguing that we know little about the toxicological effects of nanoparticles, and that there are no regulations to

control them – nanotechnology advocates simply call this scaremongering, and fail to understand what all the fuss is about.

Futurist K Eric Drexler – credited with coining the term nanotechnology – dreamed up one possible nightmare scenario in his1986 book *Engines of Creation*. Though he now deems it an unlikely scenario, Drexler stirred fears about nanotechnology by painting a future where tiny, self-replicating *nanobots* run amok, digesting life on earth and reducing everything to a «*grey goo*».

The few experimental studies to date into the health impact of nanoparticles reveal that high concentrations of nanotubes could damage the lungs of rats and mice. One 2004 study hinted that *buckyballs* can accumulate and cause brain damage in fish.

A report, independently commissioned in 2003 by the environmental group Greenpeace, acknowledged that – while there could be *risks from nanotechnology* – the field could generate significant innovations to benefit the environment. A 2004 report, commissioned by the UK government, argued that most nanotechnology presents few *novel risks*, but recommended more research, along with new regulations to control the technology.

An *open public debate* on the development and future of nanotechnology may be the best way to stop it becoming embroiled in the same kind of *furore* that has surrounded GM organisms.

III. Now turn your attention to the first sentence in the text and using key words give its main idea.

IV. Look for some specific information contained in the part entitled «Engineering wonder». What is meant by «completely different solutions»? Is this information of vital importance or it can be neglected?

V. What are the reasons for some problems of engineering at the nanoscale?

VI. In the part entitled «Great potential» study the first sentence and name the greatest advances through nanotechnology that might be expected.

VII. What are the nanotechnology developments in medicine, biochemistry, computing nanoscience, environmental science, radioengineering and military technology?

VIII. Why has nanotechnology generated criticism and what risks does it present? What conclusion is drawn in the final passage of the text? Do you agree with it?

IX. Say whether the following statements are true (T) or false (F). Turn to the text to make your decision.

1. One of the peculiarities of nanotechnology is the approach «upwards».
2. One of the characteristic features of nanoengineering devices is the ability to self-destruction.
3. The problem preventing nanoscale engineering from fast developing is characterized by inconsistence in measuring distances.

4. Special regulations have been adopted to protect human health against harmful effects of nanotechnology.

5. Drexler’s book stirred positive emotions in respect to painting a bright future of nanotechnology.

6. The group Greenpeace denied the fact of risks from nanotechnology.

7. The report of the UK government states that most nanotechnology is characterized by a sufficient level of health hazard which was proved by recent research.

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