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**МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ РОССИЙСКОЙ ФЕДЕРАЦИИ**

**Федеральное государственное бюджетное образовательное учреждение высшего образования**

**«Пермская государственная фармацевтическая академия»**

**Министерства здравоохранения Российской Федерации**

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Кафедра иностранных языков

*Полное наименование кафедры*

УТВЕРЖДЕНЫ

решением кафедры

Протокол от «27» мая 2016 г.

№ 9

**МЕТОДИЧЕСКИЕ МАТЕРИАЛЫ ПО ДИСЦИПЛИНЕ**

**Б1.Б1. Иностранный язык**

*Шифр и полное наименование дисциплины*

**Направление подготовки: 19.03.01 Биотехнология**

**Профиль программы: Фармацевтическая биотехнология**

**Год набора: 2017**

Пермь, 2016 г.

## **1. Рекомендации по подготовке к практическим занятиям.**

Обучающимся следует:

- приносить с собой рекомендованную преподавателем литературу к конкретному занятию;
- до очередного практического занятия по рекомендованным литературным источникам проработать теоретический материал соответствующей темы занятия и отработать задания, определённые для подготовки к лабораторному занятию;
- при подготовке к лабораторным занятиям следует использовать не только лекции, но и учебную литературу;
- в начале занятий задать преподавателю вопросы по материалу, вызвавшему затруднения в его понимании.

### **Вопросы для самопроверки**

#### **Раздел 1. Обучение в Фармацевтической академии.**

##### **Вопросы для самопроверки по теме 1.1. «Семья и друзья студента»**

1. What can you tell us about your family?
2. What term are you with your family in?
3. When and where did you finish school?
4. What was (were) your favorite subject(s) at school?
5. How many years did you study English at school?
6. When and why did you decide to choose a career of a pharmacist?
7. Who advise you to be a pharmacist?
8. Have you got brothers and sisters?
9. How many brothers and sisters have you got?
10. What are their names?
12. How old are they?
13. What term are you with your family in?
14. When and where did you finish school?

##### **Вопросы для самопроверки по теме 1.2. «Рабочий день студента»**

1. Do you plan your working day?
2. When do you get up?
3. What do you do in the morning?
4. What do you have for breakfast?
5. When does your working day begin?
6. How many pairs do you have a day?
7. How long does your working day last?
8. When do you leave academy?
9. How do you feel yourself after leaving academy?
10. Do you take part in out-of class activities?
11. What do you do in your spare time?
12. When is your working day over?
13. When do you go to bed?
14. What do you do in your spare time?

##### **Вопросы для самопроверки по теме 1.3. «История академии»**

1. What can you tell about the history of our academy?
2. How many departments does our academy have? What are they?
3. How long does the course of training run?
4. What subjects do the students study?

5. Where do the students have practice?
6. Where do the students live?
7. How do you plan your working day?
8. Do you take part in out-of class activities?
9. What do you do in your spare time?
10. What specialties do the students get after graduating from the academy?
11. Where may the students work after graduating from the academy?
12. What must pharmacist know?
13. What are the duties and the perspectives of a pharmacist?

#### **Вопросы для самопроверки по теме 1.4. «Академия сегодня»**

1. What academy do you study at?
2. What course are you in?
3. When was the pharmaceutical Institute founded?
4. When was the pharmaceutical Institute reorganized into academy?
5. How many departments does our academy have? What are they?
6. How long does the course of training run?
7. What subjects do the students study?
8. Where do the students have practice?
9. How do the students work with medicinal plants?
10. Where do the students live?
11. What specialties do the students get after graduating from the academy?
12. Where may the students work after graduating from the academy?

#### **Раздел 2. Химическая лаборатория.**

##### **Вопросы для самопроверки по теме 2.1. «Оборудование и описание химической лаборатории»**

1. Where is the chemical laboratory you make experiments situated?
2. What is a chemical laboratory?
3. How many rooms does the chemical laboratory consist of?
4. What are these rooms for? 43. What are they equipped with?
5. What branches of chemistry do the students of our academy study?
6. Where do the students carry out chemical experiments?
7. How many rooms does the chemical laboratory consist of?
8. What are these rooms for?
9. What are they equipped with?

##### **Вопросы для самопроверки по теме 2.2. «Правила работы в лаборатории»**

1. Do the students work in white gowns and hats in the laboratory?
2. What does the work in the chemical laboratory require?
3. What chemical processes will you deal with?
4. How do the students work with substances and reagents?
5. Why are the rules so important?
6. What are the rules for working at the lab?
7. Is it necessary to be accurate?

##### **Вопросы для самопроверки по теме 2.3. «Описание проведения экспериментов в химической лаборатории»**

1. What is the title of the experiment?
2. What are the objectives?
3. What equipment is used in the experiment?

4. What reagents are used in the experiment?
5. What is the result of the experiment?

### **Раздел 3. Великие ученые и их открытия.**

#### **Вопросы для самопроверки по теме 3.1. «Д. Менделеев»**

1. What discovery did D. I. Mendeleev make in 1869?
2. Why was it necessary to classify elements?
3. How were all the chemical elements classified before the discovery of the Periodic Law?
4. What became the basis for classification of the chemical elements by D. I. Mendeleev?
5. What did D. I. Mendeleev discover arranging all the known elements?
6. How is Mendeleev's Periodic Law formulated?
7. How many periods are there in the System?
8. What element in the System has the atomic weight of unity?
9. What does each period consist of?
10. How do the metallic properties change within periods?
11. What is indicated in each box of the System?
12. How did Mendeleev arrange periods?
13. How are vertical columns of elements called?
14. Elements of what subgroups possess stronger metallic properties?
15. What subgroups are called main and secondary ones?
16. How do properties of elements vary in the Periodic System?
17. Where were newly discovered elements placed in the Periodic System?
18. What is the practical importance of the Periodic Law?

#### **Вопросы для самопроверки по теме 3.2. «М. Ломоносов»**

1. When and where was M.V.Lomonosov born?
2. What did M.V.Lomonosov do at the age of 16<sup>th</sup>?
3. In what field of science were general discoveries of the scientist?
4. Why and where was M.V.Lomonosov sent?
5. What did M.V.Lomonosov predict?
6. Where did M.V.Lomonosov repeat R. Boyle's experiment?
7. What did M.V.Lomonosov think about the structure of matter?
8. What was M.V.Lomonosov the first to discover?
9. What may be said about M.V.Lomonosov as a linguist?
10. Did he work in the field of astronomy and other sciences?
11. What other fields of science interested M.V.Lomonosov?
12. Did M.V.Lomonosov take part in the foundation of Moscow University?

#### **Вопросы для самопроверки по теме 3.3. «Великий учёный (на выбор обучающегося)»**

1. When and where was the scientist born?
2. What family was he born in?
3. What did he get interested at his early school age?
4. What have you learnt about his education?
5. What University did he enter after finishing school?
6. What kind of student was he?
7. What field of science did he work in?
8. What problems did he study?
9. What field of science were general discoveries of the scientist in?
10. What is the main idea of the discovery?

11. What scientific degree did he get?
12. What was the practical importance of the discovery?
13. What was the attitude towards his discoveries abroad?
14. Was he awarded the Nobel Prize?
15. What significance had the scientific activity of the scientist for the world science?

#### **Вопросы для самопроверки по теме 4.1.. «Химия как наука»**

1. What is chemistry?
2. What is chemistry concerned with?
3. What physical and chemical properties do you know?
4. How many states of aggregation does matter have? What are they?
5. How does temperature influence the substance?
6. How are chemical products used in everyday life?
7. What main aspects does chemistry have?
8. What are the main divisions of chemistry?
9. What do organic and inorganic chemistries deal with?
10. What is the importance of chemistry?
11. What are the categories of chemistry?
12. How are the substances divided?
13. What kinds of chemistry are taught at our Academy?
14. What does organic chemistry study?
15. What does biochemistry study?

#### **Вопросы для самопроверки по теме 4.2. «Периодическая система Д.Менделеева»**

1. What discovery did D. I. Mendeleev make in 1869?
2. Why was it necessary to classify elements?
3. How were all the chemical elements classified before the discovery of the Periodic Law?
4. What became the basis for classification of the chemical elements by D. I. Mendeleev?
5. What did D. I. Mendeleev discover arranging all the known elements?
6. How is Mendeleev's Periodic Law formulated?
7. How many periods are there in the System?
8. What element in the System has the atomic weight of unity?
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12. How did Mendeleev arrange periods?
13. How are vertical columns of elements called?
14. Elements of what subgroups possess stronger metallic properties?
15. What subgroups are called main and secondary ones?
16. How do properties of elements vary in the Periodic System?
17. Where were newly discovered elements placed in the Periodic System?
18. What is the practical importance of the Periodic Law?

#### **Вопросы для самопроверки по теме 4.3. «Химический элемент»**

1. What are the most useful elements?
2. What is the history of the element's discovery?
3. Where has the element come from?
4. What is the symbol of the element?
5. What are the physical properties of the element?
6. What are the chemical properties of the element?
7. What are the typical chemical reactions of the element?
8. How can you distinguish the presence of that element?

9. Characterize the place of the element in the Periodic Table?
10. What is the practical importance of the element?
11. How is the element used in medicine?
12. What are the rarest elements?
13. Characterize the element according to the scheme?
14. What historical data about the discovery of Mendeleev's table do you know?
15. Is the element of vital importance? Prove.

### **Вопросы для самопроверки по теме 5.1. «Моя будущая профессия - биотехнолог»**

1. What is your future profession?
2. Why have you decided to become a biotechnologist?
3. What is your future specialization as a biotechnologist?
4. What are the possibilities of your future career path?
5. What are your priorities?
6. Where can you work after graduating from the Academy?
7. What functions does the work of a biotechnologist include?
8. Why are biotechnologist expected to become more integral with the health care system?
9. What can you say about working conditions of biotechnologist?
10. What the working place of a biotechnologist equipped with?

### **Вопросы для самопроверки по теме 5.3. «Возможности карьеры»**

1. What does the field of biotechnology focuses on?
2. Which areas does biotechnology include?
3. Which areas of specialization do people choose from if they vote for biotechnology careers?
4. What does working in the biotechnology field start with?
5. What should specialist do for staying on top of what is happening in the field?
6. Which specialist can you be in the biotechnology field?
7. Why are biomedical engineers needed?
8. Why will agricultural engineers be needed?
9. What do microbiologists do?
10. What do agricultural and food scientists do?

## **2. Рекомендации по подготовке презентации (Ролевая игра «Конференция»)**

Презентация — документ или комплект документов, предназначенный для представления чего-либо (организации, проекта, продукта и т. п.).

Компьютерную презентацию, сопровождающую выступление докладчика, удобнее всего подготовить в программе MS Power Point. Презентация как документ представляет собой последовательность сменяющих друг друга слайдов. Количество слайдов адекватно содержанию и продолжительности выступления (например, для 5-минутного выступления рекомендуется использовать не более 10 слайдов).

На первом слайде обязательно представляется тема выступления и сведения об авторах. Следующие слайды можно подготовить, используя две различные стратегии их подготовки:

1 стратегия: на слайды выносятся опорный конспект выступления и ключевые слова с тем, чтобы пользоваться ими как планом для выступления. В этом случае к слайдам предъявляются следующие требования:

- объем текста на слайде – не больше 7 строк;
- маркированный/нумерованный список содержит не более 7 элементов;
- значимая информация выделяется с помощью цвета, кегля, эффектов анимации.

Особо внимательно необходимо проверить текст на отсутствие ошибок и опечаток. Основная ошибка при выборе данной стратегии состоит в том, что выступающие заменяют свою речь чтением текста со слайдов.

2 стратегия: на слайды помещается фактический материал (таблицы, графики, фотографии и пр.), который является уместным и достаточным средством наглядности, помогает в раскрытии стержневой идеи выступления. В этом случае к слайдам предъявляются следующие требования:

- выбранные средства визуализации информации (таблицы, схемы, графики и т.д.) соответствуют содержанию;

- использованы иллюстрации хорошего качества (высокого разрешения), с четким изображением;

Максимальное количество графической информации на одном слайде – 2 рисунка (фотографии, схемы и т.д.) с текстовыми комментариями (не более 2 строк к каждому). Наиболее важная информация должна располагаться в центре экрана.

### **Текстовые материалы к учебной конференции по теме 3.3. «Великие ученые»:**

1. The English physician Edward Jenner introduced vaccination against smallpox. His curiosity about natural phenomena and dedication to medicine earned him status as a pioneer of virology and immunology, as well as the founder of the preventive medicine.

In 1770 young Jenner went to London to study surgery and anatomy under the surgeon, anatomist and naturalist John Hunter. John Hunter was a noted experimentalist and a member of Royal Society. He recommended Jenner for the position of naturalist but Jenner chose the medical career. Hunter's experimental methods, insistence on exact observations resulted in Jenner's introduction of vaccination.

Practice inoculation reached England by the 18th century. Despite of the risk of inoculation people wanted to be vaccinated as quicker as possible. Although inoculation aided in the prevention of the disease it was dangerous. During Jenner's lifetime, smallpox was a common and often fatal disease. Due to observations young physician Jenner put forward theory about the prevention of smallpox. Dairy workers often from cowpox, a disease like smallpox only milder. Earlier cases of cowpox seemed Jenner immune to the most severe infection. The more Jenner was sure in his observations the quicker he wanted to obtain immunity to smallpox.

Jenner removed the fluid of cowpox from dairymaid and inoculated an eight-year old boy. Six weeks later he inoculated the boy with smallpox. The boy was healthy. Jenner proved his theory and called it vaccination. The demand for the vaccine increased and Jenner was honoured and respected throughout Europe and the United States. The Russian Queen Katherine the Great was the first to be vaccinated in Russia. Nearly two centuries after Jenner's experimental vaccination of young boy the World Health Organization (WHO) declared smallpox to be eradicated.

Notes: to eradicate –искоренять

2. Joseph Lister was an English surgeon and pioneer of antisepsis. Working at Edinburgh, he was also appointed a professor of clinical surgery at Glasgow, where he was one of the few to understand the implications of Louis Pasteur recent work on fermentation and the beginnings of the germ theory.

When Joseph Lister was a student at Edinburgh, he decided not only to practice medicine, but also to conduct research to improve medical knowledge.

Lister's research required considerable sacrifice and dedication, as it was undertaken at night after a full working day in the hospital. In Edinburgh Hospital where Lister worked, almost half of the surgery patients died from infections. Surgeons thought that it could nothing be done about these infections,

because they arose spontaneously inside the wound. In order to prevent infection Lister began to search the solution of the most actual problem of that time. He studied the work of European bacteriologists, notably that of Louis Pasteur. When he read Pasteur's work on germs he immediately applied Pasteur's thinking to the problem he investigated. He concluded that inflammation was the result of germs entering and developing in the wound. Since Pasteur's sterilization by heat could not be applied to the living organism, Lister was looking for a chemical substance to destroy the germs. He learned that carbolic acid was used as an effective disinfectant and could be safely used for human body. Facilities for washing hands or the patient's wounds did not exist and it was even considered unnecessary for the surgeon to wash his hands before he saw patient. Lister was of another opinion, he used carbolic acid to wash his hands, his instruments and the bandages used in the operation. The more he used these techniques the more sufficient data to show that his methods were a success Lister had. This led to the rise of sterile surgery. Some consider Lister "the father of modern antisepsis".

However, widespread acceptance of Lister's procedure was rather slow, as is often the case with revolutionary new ideas. Joseph Lister's behavior with his patients was quite a contrast to those surgeons who believed that such involvement would somehow lessen the respect of patients to their doctors. Over the next 12 years Lister continued to develop new surgical techniques by applying his antiseptic principle. In 1880 he introduced catgut for internal stitches. In later years, Joseph Lister was given the most prestigious positions by the scientific community in recognition of his contribution to medicine.

Notes: sacrifice – самопожертвование

3. Louis Pasteur was a French chemist and microbiologist best known as one of the founders of germ theory and bacteriology. He found a key to make medicine a science as well as an art.

For thousands of years before Pasteur, doctors were helpless in the face of disease. It was believed that only symptoms could be treated, not the cause of the disease and the diluted drug solution were used. This system was the main obstacle to the progress of medicinal chemistry. 6. Finally this theory was completely reversed by Louis Pasteur. 7. He thought that all diseases are caused by pathogenic parasites.

From that time Pasteur directed all his experimental work toward the problem of immunization and applied this principal to many diseases. 9. It is often said that English surgeon Edward Jenner discovered vaccination and that Louis Pasteur invented vaccines. These discoveries revolutionized work in infectious diseases. Pasteur focused on microbial origin of disease. His investigations of animals infected by pathogenic microbes and his studies of the microbial mechanisms that cause harmful physiological effects in animals made him a pioneer in the field of infectious pathology. In 1882

Louis Pasteur decided to attack the problem of rabies. The more mysterious origin of this horrible disease was the more it fascinated imagination of people for centuries. As the microbe that caused rabies was the smallest one that could be seen under Pasteur's microscope, experimentation with the disease demanded the development of new methodologies. Pasteur conducted his experiments using rabbits and transmitted the infectious agent from animal to animal until he obtained a stable preparation. In 1885 Pasteur vaccinated a nine-year-old boy who was bitten by a rabid dog. The vaccine was so successful that it brought immediate glory and fame to Louis Pasteur. Hundreds of other bite victims throughout the world were saved by Pasteur's vaccine, and the era of preventive medicine began.

Another thing Louis Pasteur did was the invention of method to stop milk and wine from causing sickness. The process of gentle heating was given the name pasteurization and it saved the French wine industry. Later it was also adapted to milk production, to juice preservation and to many other food preservation technologies. During Pasteur's career, he touched on many problems, throughout his life he was an effective observer and understood that future would belong to those who made much for suffering humanity.

4. The Scottish bacteriologist Alexander Fleming is the well known for his discovery of penicillin. It was the greatest contribution of medicinal science ever made to humanity.

Alexander Fleming was born in Scotland in August in 1881. Nature was considered by him as the first and the best teacher. Nature developed his power of observations and taught him to apply and to act according to observations.

Like many Scots Alexander Fleming left his native land for better career opportunities. In 1895 he went to London where he decided to dedicate his life to medicine. He chose a career in bacteriology. Alexander Fleming assisted Almroth Wright, the founder of vaccinotherapy. Almroth Wright was the first to use vaccines on human beings. Under the influence of Almroth Wright Fleming became interested in bacterial action and antibacterial drugs. The more knowledge Fleming obtained in the fields of anatomy, bacteriology the more he was sure in the right choice of his profession. The need for further research in these fields excited his mind.

After graduating from the London University Alexander Fleming was considered as outstanding as he was able to become a member of teaching and research staff of St. Mary's hospital.

After military service he returned to laboratory work and was engaged in developing antiseptics. Fleming conducted experiments that later focused his attention to the properties of penicillin. The leitmotiv of Fleming's career was his search for a chemical substance which would destroy infections bacteria without destroying tissues or weakening the body's defenses. Once Fleming noted that his experiment was ruined by an accident. Fleming noted that on a culture plate of staphylococci a mould which was introduced by accidental contamination had dissolved the colonies of staphylococci. He found that the bacterial substance produced by the mould was unstable and rapidly lost its activity. The blue mould was in fact the natural form of penicillin which Fleming realized was an effective way of killing bacteria. A few years later, penicillin was mass-produced. The accident led to one of the greatest medical discoveries of modern times.

Alexander Fleming's discovery of penicillin did more to help suffering people than anything else for centuries.

5. Henry Cavendish, (10 October 1731 - 24 February 1810) was a British scientist noted for his discovery of hydrogen or what he called "inflammable air". He described the density of inflammable air, which formed water on combustion, in his work "On Factitious Airs" in 1766. Antoine Lavoisier later reproduced Cavendish's experiment and gave the element its name. Cavendish is also known for the Cavendish experiment, his measurement of the Earth's density, and early research of electricity. The English physicist and chemist Henry Cavendish determined the value of the universal constant of gravitation, made noteworthy electrical studies, and is credited with the discovery of hydrogen and the composition of water.

Henry Cavendish was born in Nice, France, on October 10, 1731, the oldest son of Lord Charles Cavendish and Lady Anne Grey, who died a few years after Henry was born. As a youth he attended Dr. Newcomb's Academy in Hackney, England. Cavendish was silent, and solitary, viewed as somewhat eccentric, and formed no close personal relationships outside his family. He entered Peterhouse, Cambridge, in 1749, but left after three years without taking a degree.

Cavendish returned to London, England to live with his father. There, Cavendish built himself a laboratory and workshop. When his father died in 1783, Cavendish moved the laboratory to Clapham Common, where he also lived. He never married and was so reserved that there is little record of his having any social life except occasional meetings with scientific friends.

Contributions to chemistry. During his lifetime Cavendish made notable discoveries in chemistry, mainly between 1766 and 1788, and in electricity, between 1771 and 1788. In 1798 he published a single notable paper on the density of the earth. At the time Cavendish began his chemical work, chemists were just beginning to recognize that the “airs” that were evolved in many chemical reactions were clear parts and not just modifications of ordinary air.

Cavendish reported his own work in “Three Papers Containing Experiments on Factitious Air” in 1766. These papers added greatly to knowledge of the formation of “inflammable air” (hydrogen) by the action of dilute acids (acids that have been weakened) on metals.

Cavendish’s other great achievement in chemistry is his measuring of the density of hydrogen. Although his figure is only half what it should be, it is astonishing that he even found the right order. Not that his equipment was crude; where the techniques of his day allowed, his equipment was capable of precise results.

Cavendish also investigated the products of fermentation, a chemical reaction that splits complex organic compounds into simple substances. He showed that the gas from the fermentation of sugar is nearly the same as the “fixed air” characterized by the compound of chalk and magnesia (both are, in modern language, carbon dioxide).

Another example of Cavendish’s ability was “Experiments on Rathbone-Place Water” (1767), in which he set the highest possible standard of accuracy.

“Experiments” is regarded as a classic of analytical chemistry (the branch of chemistry that deals with separating substances into the different chemicals they are made from). In it Cavendish also examined the phenomenon (a fact that can be observed) of the retention of “calcareous earth” (chalk, calcium carbonate) in solution (a mixture dissolved in water). In doing so, he discovered the reversible reaction between calcium carbonate and carbon dioxide to form calcium bicarbonate, the cause of temporary hardness of water. He also found out how to soften such water by adding lime (calcium hydroxide).

One of Cavendish’s researches on the current problem of combustion (the process of burning) made an outstanding contribution to general theory. In 1784 Cavendish determined the composition (make up) of water, showing that it was a combination of oxygen and hydrogen. Joseph Priestley (1733–1804) had reported an experiment in which the explosion of the two gases had left moisture on the sides of a previously dry container. Cavendish studied this, prepared water in measurable amount, and got an approximate figure for its volume composition.

Because of his asocial and secretive behavior, Cavendish often avoided publishing his work, and much of his findings were not even told to his fellow scientists. It wasn’t until the late nineteenth century, long after his death, that James Clerk Maxwell looked through Cavendish’s papers and found things for which others had been given credit. Examples of what was included in Cavendish’s discoveries or anticipations were Richter’s Law of Reciprocal Proportions, Ohm’s Law, Dalton’s Law of Partial Pressures, principles of electrical conductivity (including Coulomb’s Law), and Charles’s Law of Gases.

Cavendish died in 1810 and was buried in the church that is now Derby Cathedral. Sir Humphry Davy was an English chemist best known for his contributions to the discoveries of chlorine and iodine. In 1798, he was appointed chemical superintendent of the Pneumatic Institution to study the therapeutic uses of various gases, after which he made several reports on the effects of inhaling nitrous oxide (laughing gas). In 1815, he invented the Davy lamp, which allowed miners to work safely in close contact with flammable gases. Davy was also a charismatic speaker and his scientific presentations at the Royal Institution of Great Britain were extremely popular among Londoners of the day.

6. Humphry Davy was born on December 17, 1778, in Penzance, Cornwall, to middle-class parents. He was well educated but he was also naturally intelligent and curious and those traits often manifested in the fiction and poetry he wrote at an early age. Davy was also deeply interested in nature, and he was a fisherman and collector of minerals and rocks. He was educated at the grammar school in nearby Penzance and, in 1793 at Truro. In 1795, a year after the death of his father, Robert, he was apprenticed to a surgeon and apothecary, and he hoped eventually to qualify in medicine.

He began the serious study of science in 1797, when his friend Davies Giddy offered him the use of his library in Tradea and took him to a chemical laboratory that was well equipped for that day. There Davy formed strongly independent views on the nature of heat, light, and electricity and the chemical and physical doctrines of A.-L. Lavoisier. In his small private laboratory, he prepared and inhaled nitrous oxide (laughing gas), in order to test if it caused diseases. In 1798 he was appointed the chemical superintendent of the Pneumatic Institution, founded at Clifton to inquire into the possible therapeutic uses of various gases.

Davy attacked the problem with characteristic enthusiasm, evincing an outstanding talent for experimental inquiry. He investigated the composition of the oxides and acids of nitrogen, nearly lost his own life inhaling water gas, a mixture of hydrogen and carbon monoxide sometimes used as fuel. The account of his work, published as *Researches, Chemical and Philosophical* (1800), immediately established his reputation, and he was invited to lecture at the newly founded Royal Institution of Great Britain in London. With that work Davy got recognition and became a professor of chemistry at the Royal Institution of

Great Britain two years later. Davy's personal charisma and charm made his scientific presentations to the public at the Royal Institution of Great Britain extremely popular among Londoners of the day.

Young Michael Faraday who later became one of the greatest scientists accompanied Davy in the European tour (1813–1815). By permission of Napoleon, he travelled through France, meeting many prominent scientists. With the aid of a small portable laboratory and of various institutions in France and Italy, he investigated the substance "X" (later called iodine), whose properties and similarity to chlorine he discovered. At that time Davy proved that diamond is a form of carbon.

Shortly after his return, he made investigations for the Society for Preventing Accidents in Coal Mines. This led to the invention of the miner's safety lamp and to subsequent researches on flame, for which he received the Rumford medals (gold and silver) from the Royal Society.

Davy's health was failing rapidly. After a last, short visit to England, he returned to Italy, settling at Rome. Though partly paralyzed through stroke, he spent his last months writing a series of dialogues, published after his death as "The Last Days of a Philosopher"

Davy was a pioneer in the field of electrolysis using the battery to split up common compounds and thus prepare many new elements. He went on to electrolyze molten salts and discovered several new metals, especially sodium and potassium, highly reactive elements known as the alkali metals. Potassium was discovered in 1807 by Davy, who derived it from caustic potash (KOH).

Before the 18th century, no distinction was made between potassium and sodium. Potassium was the first metal that was isolated by electrolysis. Sodium was first isolated by Davy in the same year by passing an electric current through molten sodium hydroxide. Sodium quickly oxidizes in air and is violently reactive with water, so it must be stored in an inert medium, such as kerosene. Sodium is present in great quantities in the earth's oceans as sodium chloride (common salt).

Davy went on to discover calcium in 1808 by electrolyzing a mixture of lime and mercuric oxide. Davy was trying to isolate calcium; when he heard that Berzelius and Pontin prepared calcium amalgam

by electrolyzing lime in mercury, he tried it himself. He worked with electrolysis throughout his life and also discovered magnesium, boron and barium.

7. Lomonosov's name belongs to the best names of the cultural history of the world. There was no problem in which he got interested.

Michael Vasiljevich Lomonosov was born in 1711 in the family of fisherman in village Denisovka not far from Archangelsk. When he was 10 years of age his father began to take him sea fishing. The dangerous life of a fisherman taught him to observe the natural phenomena more closely. During the long winter nights young Lomonosov studied grammar and mathematic.

At the age of 16th he came from his native village to Moscow to obtain an education. After studying in the Moscow Slavonic Greek Latin School he came to the newly organized academy university. 8. His ability and diligence attracted the attention of professors and as one of the best students in 1736 Lomonosov was sent to Germany to study and to work in the field of chemistry. He returned to Russia and in 1744 was appointed the professor and academician.

Lomonosov's contribution to Russian intellectual life was various and significant. 11. He has no equal in Russian science. General discovery of Lomonosov was in the field of natural science. The famous scientist predicted the electricity as the particular kind of molecule motion and underlined the great future of this natural power. He was the first to give the definition of the second Law of thermodynamics.

He paid much attention to the theoretical principles of chemistry by lecturing on physical chemistry and carrying out research on the nature and properties of salt solutions. In 1749 he organized, built and equipped a chemical laboratory for the academy where he repeated the experiments of R.Boyle on the changes of weight and made many important discoveries. The famous Russian scientist Michael Vasiljevich Lomonosov formulated for the first time the Law of conservation of matter and movement in 1748, which is now called the Lomonosov's Law.

M.V. Lomonosov considered that all phenomena of nature are the result of inner motion of the smallest particles of substance. All chemical processes are closely connected with heat, light, electric and capillary phenomena. This discovery was of great importance. Michael Vasiljevich was the first to discover the vegetable origin of coal. As a poet and scientist he played a great role in the formation of the Russian literary language. Lomonosov had a good knowledge of some foreign languages. He was engaged in the investigation of Russian language and has written Russian Grammar.

Michael Vasiljevich Lomonosov took part in the foundation of one of the most famous universities in our country, Moscow University, which has become one of the most important centre of science. In 1940 this university was named in honour of Lomonosov. Our literary language, grammar, literature and science are obliged to him very much. The more we read and learn about the biography of Lomonosov, the more we understand what a great contribution Lomonosov made into science.

### **Текстовые материалы к учебной конференции по теме 4.3. «Химический элемент»:**

#### **Iron**

1. Iron is the second most abundant metal in nature after aluminium. But native iron is extremely rare. Probably, the first iron used by our forefathers<sup>1</sup> was of a meteoritic origin.

2. Iron oxidizes readily in the presence of water and air and is found mainly in the form of oxides. Oxidation of iron is responsible for the fact that extant<sup>2</sup> articles made of iron in antiquity are extremely rare. Man discovered iron about five thousand years ago. At first iron was very expensive and was valued much higher than gold; very often iron jewelry was set in gold<sup>3</sup>.

3. Peoples of all continents became aware of gold, silver, and copper approximately at the same time; but in the case of iron the situation is different. Thus, in Egypt and Mesopotamia the process of extracting iron from ores was discovered two thousand years B.C.; in Trans-Caucasus, Asia Minor, and ancient Greece at the end of the second millenium; in India in the middle of the second millenium; and in China much later, only in the middle of the first millenium B.C. In the countries of the New World<sup>4</sup> Iron Age<sup>5</sup> began only with the arrival of Europeans, i.e. in the second millenium A.D.<sup>6</sup>; some African tribes<sup>7</sup> began to use iron skipping the Bronze Age<sup>8</sup> period in development. This is due to the difference in natural conditions. In countries where natural resources of copper and tin were small, a demand arose for replacing these metals. America had one of the largest deposits of native copper and, therefore, it was not necessary to search for new metals. Gradually, production of iron grew and iron began to pass from the category of precious metals into that of ordinary ones. By the beginning of the Christian era iron was already widely used.

4. Among all metals and alloys known by that time, iron was the hardest one. Therefore, as soon as iron grew relatively cheap, various tools and weapons were manufactured from it. At the beginning of the first millenium A.D. production of iron in Europe and Asia had made considerable progress; particularly great successes in smelting<sup>9</sup> and processing iron had been achieved by Indian metallurgists. It is interesting to have a look at the development of iron production methods. At first man used only meteoritic iron, which was very rare and therefore expensive. Then people learnt how to produce iron by intensively heating its ores with coal on windy sites. Iron thus obtained was spongy<sup>10</sup>, of low grade, and with large inclusions of slag<sup>11</sup>. An important step in iron production was made with the invention of a furnace open at the top and lined with a refractory material inside. Excavations of ancient towns in Syria indicate that iron of a rather good quality was produced in this way. Later, people noted that cast iron<sup>12</sup>, which had been considered to be a waste product, could be transformed into iron, the process requiring much less coal and yielding high-quality iron.

5. By the end of the 15<sup>th</sup> century first smelting furnaces<sup>13</sup> appeared producing exclusively cast iron. Iron and steel smelting processes were rapidly improving. In 1855 there appeared the converter process of steel making which is still used. The Martin process developed in 1865 yields steel almost free of slags.

6. A chemical symbol Fe originates from the Latin *ferrum*, which means “iron”.

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#### **Notes:**

1. forefathers – предки, праотцы
2. extant – сохранившийся, дошедший до нас
3. iron jewelry was set in gold – украшения из железа помещались (вставлялись) в золотую оправу
4. in the countries of New World – в странах Нового Света
5. Iron age – «железный» век
6. in the second millennium A. D. – во втором тысячелетии нашей эры
7. tribe – племя
8. skipping the Bronze Age – минуя «бронзовый» век
9. smelting – плавка (металлов)
10. spongy – пористый
11. slag – шлак, окалина
12. cast iron - чугуун
13. smelting furnace – плавильная печь

### **Sodium and Potassium**

1. Man had known sodium and potassium compounds for a very long time. Carbonates of these metals were used in Egypt for laundry. Common salt, one of the most widespread sodium compounds, was used in foods from time immemorial; in some countries it was very expensive and sometimes wars were waged for the right to possess salt mines. Sodium carbonate was usually obtained from salt lakes whereas potassium carbonate by leaching plant ash<sup>1</sup>; for this reason the former was named mineral alkali

and the latter vegetable alkali. The word “alkali” was introduced by Geber, a medieval alchemist, although he made no distinction between the two carbonates. The differences in their nature were first mentioned in 1683. The Dutch scientist I. Bon noted that when soda and potash were used in the similar process, the shapes of the precipitated crystals were different depending on the initial product.

2. In 1702 G. Stahl noted the difference in crystals of some sodium and potassium compounds. This was an important step in distinguishing between soda and potash. In 1736 the French chemist A. Monsean proved that soda was always present in common salt, Glauber's salt, and in borax. Since an acidic constituent of soda was known, the nature of the basic constituent was of great interest. According to Monsean, soda formed Glauber's salt with sulphuric acid, cubic saltpeter (sodium nitrate) with nitric acid, and a variety of sea salt with hydrochloric acid: isn't this reason enough to deduce that soda is the basis of sea salt?

3. Although chemists had suspected for a long time that alkali earths were oxides of metals, the nature of soda and potash had not been studied up to the early 19<sup>th</sup> century. Even Lavoisier had no definite idea on this subject. He did not know what the basic constituents of soda and potash were and assumed that nitrogen could be a constituent. This confusion seems to stem from the similarity between the properties of sodium, potassium, and ammonium salts.

4. Credit<sup>2</sup> for determining these constituents belongs to H. Davy. At first he was dogged by failures<sup>3</sup>: he could not separate metals from soda and potash with the aid of a galvanic battery. However, soon the scientist understood his error – he used saturated aqueous solutions but the presence of water hinders<sup>4</sup> decomposition. In October, 1807, Davy decided to melt anhydrous potash, and as soon as he started electrolysis of the alkali hydroxide melt<sup>5</sup>, small balls resembling mercury with bright metallic lustre appeared on the negative electrode immersed into the melt. Some of the balls burnt up immediately with an explosion forming bright flame while the others did not burn, but just dimmed<sup>6</sup> and became covered with a white film. Davy concluded that numerous experiments had shown that the balls were the substance which he had been looking for and this substance was highly inflammable potassium hydroxide.

5. Davy studied this metal thoroughly and found that when it reacted with water the resulting flame was due to burning of the hydrogen liberated from water. Having studied the metal obtained from potassium hydroxide, H. Davy began to search for sodium hydroxide using the same method and he succeeded in separating another alkali metal. The scientist noted that for its preparation a much more powerful battery was required than in the experiments with potash. Nevertheless, the properties of both metals turned out to be similar. For a short time the scientist carefully studied the properties of potassium and sodium. Some chemists doubted the elemental nature of sodium and potassium believing that they were compounds of alkalis with hydrogen. However, Gay Lussac and Thenard proved convincingly<sup>7</sup> that Davy had, indeed, obtained simple substances.

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**Notes:**

1. be leaching plant ash – выщелачиванием растительной золы
2. credit – заслуга, честь
3. at first he was dogged by failures – сначала его преследовали неудачи
4. to hinder – мешать, затруднять, препятствовать
5. melt – расплав
6. dimmed - потускнел
7. proved convincingly – убедительно доказали

### **Resembling Barium**

1. When the Curies and G. Bemont analysed pitchblende<sup>1</sup> they noticed a higher radioactivity of one more fraction apart from the bismuth fraction. After they had succeeded in extracting polonium they started to analyse the second fraction thinking that they could find yet another unknown radioactive element. The new element was named radium from the Latin *radius* meaning ray. The birthday of radium was December 26, 1898 when the members of the Paris Academy of Sciences heard a report entitled “On a new highly radioactive substance contained in pitchblende”. The authors reported that they had

managed to extract from the uranium ore tailings<sup>2</sup> a substance containing a new element whose properties are very similar to those of barium. The amount of radium contained in barium chloride proved to be sufficient for recording its spectrum. This was done by the well-known French spectral analyst E. Demarcay who found a new line in the spectrum of the extracted substance. Thus, two methods – radiometry and spectroscopy – almost simultaneously substantiated<sup>3</sup> the existence of a new radioactive element.

2. The position of radium among the natural radioactive elements (of course, excluding thorium and uranium) almost immediately proved to be the most favourable one owing to many reasons. The half-life<sup>4</sup> of radium was soon found to be fairly long, namely, 1600 years. The content of radium in the uranium ores was much higher than that of polonium (4300 times higher); this contributed to natural accumulation of radium. Furthermore, the intensity of alpha radiation of radium was sufficiently high to allow an easy monitoring of its behaviour in various chemical procedures. Finally, a distinguishing feature of radium was that it evolved a radioactive gas. Radium was a convenient subject for studies owing to a favourable combination of its properties and therefore it became the first radioactive element (again, with the exception of uranium and thorium) to find its permanent place in the periodic system without long delay. Firstly, chemical and spectral studies of radium demonstrated that in all respects<sup>5</sup> it belongs to the subgroup of alkaline earth metals; secondly, its relative atomic mass could be determined accurately enough. To do this sufficient amounts of a radium preparation had to be obtained. The Curies worked ceaselessly for 45 months in their ill-equipped<sup>6</sup> laboratory processing uranium ore tailings from Bohemian mines. They performed fractional crystallization about 10000 times and finally obtained a priceless prize - 0.1g of radium chloride. The history of science knows no more noble example of enthusiastic work. This amount was sufficient for measurements and on March 28, 1902, Marie Curie reported that the relative atomic mass of radium was 225.9 (which does not differ much from the current figure of 226.02). This value just suited the suggested position of radium in the periodic system.

3. The discovery of radium was the best substantiated one among the many alleged discoveries<sup>7</sup> of radioactive elements, which soon followed. Every year more new discoveries were reported. Radium was also the first radioactive element obtained in the metallic form.

4. Marie Curie and her collaborator A. Debierne electrolyzed a solution containing 0.106 g of radium chloride. Metallic radium deposited on the mercury cathode forming amalgam. The amalgam was put into an iron vessel and heated under a hydrogen flow to remove mercury. Then grains of silvery whitish<sup>8</sup> metal glistened at the bottom of the vessel.

5. The discovery of radium was one of the major triumphs of science. The studies of radium contributed to fundamental changes in our knowledge of the properties and structure of matter and gave rise to the concept of atomic energy. Finally, radium was also the first radioactive element to be practically used (for instance, in medicine).

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**Notes:**

1. pitchblende – уранит, урановая смолка (минерал)
2. tailing – отходы, пустая порода
3. substantiated – подкрепили доказательствами
4. half-life – период полураспада
5. in all respects – во всех отношениях
6. ill-equipped – плохо оборудованная
7. alleged discoveries – сомнительные открытия
8. whitish – бледный, светлый

## **Radium**

1. At the end of the 19<sup>th</sup> century uranium compounds were investigated and were found to emit penetrating rays<sup>1</sup>. These rays were discovered to affect a protected photographic plate in much the same manner<sup>2</sup> as X - rays. Besides, these rays were observed to cause the air through which they pass to become a conductor of electricity. The rays from uranium compounds were found to differ from X- rays, however, in that they were not produced by any artificial means. Instead, they appeared to be emitted by

certain materials quite spontaneously. The production of these rays, therefore, proved to be a perfectly natural process. Further work showed that a uranium mineral called pitchblende<sup>3</sup> was much more strongly radioactive than could be accounted for<sup>4</sup> by its content of uranium alone. Pitchblende was therefore suspected of containing some undiscovered element of greater radioactive power than uranium itself.

2. The research of the unknown element was undertaken by a Polish woman, living in France, Mary Curie, who together with her husband, Pierre Curie, discovered the element she was searching for. The element was given the name radium and was stated by M. Curie to resemble barium in being precipitable as an insoluble sulphate. The atomic weight of the radium was found by M. Curie by the analysis of radium chloride to be approximately 225, and later she obtained the more accurate value<sup>5</sup>, 226.2, by the analysis of a relatively large quantity (0.1 gr.) of pure radium bromide.

3. Radium is interesting particularly because it emits rays which are similar to those first discovered in the case of uranium. This property has been named radioactivity and the substances that emit penetrating radiations are said to be radioactive. The rays emitted possess energy as shown by their ability to affect the photographic plate, to cause zinc sulphide to emit light, and to render<sup>6</sup> air a conductor of electricity. In addition, the emission of rays may be shown to be attended by a liberation of heat; one gram of radium has been estimated to evolve as much as 133 calories<sup>7</sup> of heat per hour. The evolution of heat does not depend on whether the radium is present as a chloride, a bromide, or in metallic form. This seems evidence that the emission of heat is a property of the radium atom. Thus, radium atom may be seen to be a source of energy that is released, in part<sup>8</sup>, during the radioactive disintegration<sup>9</sup>.

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**Notes:**

1. to emit penetrating rays – излучать проникающие лучи
2. in much the same manner – таким же образом, как
3. pitchblende – уранит, урановая смолка
4. than could be accounted for – чем можно было бы объяснить
5. the more accurate value – более точная цифра
6. to render – делать
7. as much as 133 calories – 133 калории
8. in part – частично
9. radioactive disintegration – радиоактивный распад

### **Silicon (1)**

1. Silicon is the second most abundant element on Earth after oxygen. Although it constitutes 28 per cent of the earth's crust<sup>1</sup>, its abundance did not make for its early discovery. The reason for this lies in the difficulty of reducing silicon from its oxide.

2. Generally speaking, there is every ground to classify silicon as an element of antiquity<sup>2</sup>. Its compounds were known and used from time immemorial<sup>3</sup> (suffice it to mention<sup>4</sup> silicon tools of primitive man). We classified carbon as an element of antiquity since it was known in a free state from very remote times<sup>5</sup>. However, that carbon is a chemical element became clear only two hundred years ago. Glass, in the long run<sup>6</sup>, is also a silicon material. However, the date of silicon discovery is the date of its preparation in a free state since such is the established practice in the history of science.

3. At the turn of the 18<sup>th</sup> century<sup>7</sup> many scientists believed that silica, or silica earth<sup>8</sup>, contained an unknown chemical element and tried to isolate it in a free state. H. Davy attempted to decompose silica with an electric current – the method by which a number of alkali metals had already been prepared – but without success. The scientist's attempt to prepare free silicon by passing metallic potassium vapour over red-hot silicon oxide<sup>9</sup> also failed. In 1811 L. J. Gay Lussac and L. Thenard applied themselves to the problem. They observed a vigorous reaction between silicon tetra-fluoride and metallic potassium; a reddish brown compound was formed in the reaction. The scientists could not reveal the nature of the product; most likely, it was contaminated amorphous silicon<sup>10</sup>.

4. At last, in 1823, J. Berzelius had a stroke of good luck. The Swedish chemist heated a ground mixture<sup>11</sup> of silicon oxide, iron, and charcoal to a high temperature and obtained an alloy of silicon and iron (ferrosilicium), the composition of which he was able to prove. To separate free silicon, J. Berzelius

repeated L. Thenard and L.J. Gay Lussac's experiments and also obtained a brown mass. Under the action of water, hydrogen was liberated and free amorphous silicon was formed as a dark brown insoluble powder which contained potassium silicofluoride as an impurity. Berzelius removed the impurity by washing the precipitate for a very long time.

5. Another method proposed by J. Berzelius – calcination of potassium fluorosilicate with an excess of potassium – proved to be more successful and straightforward<sup>12</sup>. The sintered<sup>13</sup> mass was decomposed with water and, as a result, pure amorphous silicon was obtained. J. Berzelius showed that upon calcination silicon was transformed into silica; this makes Berzelius the discoverer of silicon. Crystalline silicon was obtained in 1854 by A. Saint Claire Deville during separation of metallic aluminium. The Latin name “silicium” originates from *silex* meaning “a hard stone”.

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**Notes:**

1. earth's crust – земная кора
2. antiquity – древность, античность
3. from the time immemorial - с незапамятных времен
4. suffice it to mention – стоит упомянуть
5. from very remote time – с древних времен
6. in the long run – в конечном счете
7. at the turn of the 18th century – в начале 19 века
8. silica = silica earth – кремнезем, диоксид кремния SiO<sub>2</sub>
9. red-hot silicon oxide – раскаленный оксид кремния
10. contaminated amorphous silicon – неочищенный аморфный кремнезем
11. ground mixture – измельченная смесь
12. straightforward – простой, прямой
13. sintered – металлокерамический

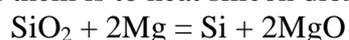
## Silicon (2)

1. Silicon does not occur free in nature. Compounds of silicon make up<sup>1</sup> about 27.6 per cent of the matter in the crust of the earth, and the element ranks next after oxygen in abundance.

2. It follows carbon in Column IVB of the Periodic Table and its chemistry like that of carbon is complex. Silicon plays an important part in the inorganic world. The importance of carbon in organic chemistry results from its possessing the ability to form carbon-carbon bonds, which permits complex molecules, with the most varied properties to exist<sup>2</sup>. The importance of silicon in inorganic world results from a different property of the element. Silicon molecules exist in chains and more complex structure, in which the silicon atoms are characterized by being connected by oxygen atoms.

3. The important compounds of silicon and carbon are not at all similar. These differences are due to the silicon atom having a much larger radius than the carbon atom. The attraction of the nucleus for electrons is less in the silicon atom than in the carbon atom.

4. Although the compounds of silicon have been used for many centuries the element was not prepared until after the beginning of the 19<sup>th</sup> century. Many methods are now in use for preparing silicon. One of them is to heat silicon dioxide with magnesium:



5. One way of preparing silicon industrially is by reducing the dioxide (SiO<sub>2</sub>) with carbon in an electric furnace<sup>3</sup>. Some difficulty is encountered in preventing silicon and carbon from reacting to form a carbide, but a product containing up to 98 per cent of silicon is made by this reaction.

6. Silicon resembles carbon in having crystalline as well as amorphous form. The latter<sup>4</sup> is a brown powder that really consists of very small crystals. Crystalline silicon has a structure resembling that of diamond. They are alike in being very hard. Crystalline silicon is hard enough to scratch glass. Crystalline silicon is less active in chemical reactions than amorphous form.

7. Besides being employed in the steel industry free silicon has few uses. But the compounds of silicon have a wide application.

### **Notes:**

1. make up – составляют
2. the ability to form carbon-carbon bonds, which permits complex molecules, with the most varied properties to exist - ... способностью к образованию углерод-углеродной связи, которая допускает существование сложных молекул с самыми разнообразными свойствами
3. electric furnace – электрическая печь
4. the latter – последняя (из 2-х упомянутых)

### **3. Рекомендации по подготовке сообщения**

Сообщение – это небольшой по объёму устный доклад, в краткой форме передающий ясную и четкую суть информации. Пишется в краткой форме и не имеет излишних художественных оборотов и словосочетаний. Основная задача сообщения донести определенную информацию не выходя из рамок заданной темы. Сообщаемая информация носит характер уточнения или обобщения, несёт новизну, отражает современный взгляд по определённым проблемам. Сообщение отличается от доклада не только объёмом информации, но и её характером – сообщения дополняют изучаемый вопрос фактическими или статистическими достоверными материалами. Основные способы изложения - повествование, рассуждение. Регламент времени на озвучивание сообщения – до 5 мин.

В сообщении выделяются три части: вступление - выступающий называет тему сообщения; основная часть - сообщаются факты, данные, указывается точное время действия и т. п.; заключение - обобщается все сказанное, делаются выводы.

Этапы подготовки сообщения:

1. Изучение темы, подбор литературы;
2. Тщательное изучение материалов;
3. Выделение самого главного, что относится к заданной тематике;
4. Составление подробного поэтапного плана сообщения;
5. Написание по пунктам плана текста;
6. Озвучивание сообщения в установленный срок согласно регламента;
7. Оценивание сообщения.

### **4. Рекомендации по переводу литературы**

При переводе научной литературы рекомендуется следующая последовательность работы над текстом:

1. Прочсть весь текст или абзац и постараться уяснить его общее содержание.
2. Каждое сложное предложение разбить на отдельные предложения: сложноподчиненные на главное и придаточное, а сложносочиненные – на простые.
3. При анализе сложных по своей структуре предложений, в которых не сразу можно определить составляющие их элементы, рекомендуется, прежде всего, найти сказуемое главного и придаточных предложений.
4. В каждом предложении определить группу сказуемого (по личной форме глагола), затем найти группу подлежащего и группу дополнения.
5. Перевод предложения начинать с группы подлежащего, затем переводить группу сказуемого, дополнения и обстоятельства.
6. Отыскать незнакомые слова в словаре, уяснив предварительно, какой частью речи они являются в данном предложении. При этом не брать первое значение слова, а прочсть все значения, дающиеся для данной части речи, и выбрать наиболее подходящее по содержанию

переводимого текста. Выписать незнакомые слова в терминологический словарь, указать перевод на русский язык.

**Тексты для перевода по темам 4.3, 4.4. «Химический элемент», «История открытия химических элементов»:**

#### **Named after the Moon**

Selenium is still another element that chemists had met long before its discovery, but failed to identify owing to its having been masked<sup>1</sup> by the presence of other similar elements. Thus, selenium remained undiscovered, “hiding” behind sulphur and tellurium. Only in 1817 did it surrender to the Swedish chemists – the famous J. Berzelius and his assistant G. Gahn. Inspecting a sulphuric acid factory in Gripsholm on September 23, they found a small amount of a precipitate, partially red and partially light brown, in sulphuric acid. On heating in the flame of a blowpipe<sup>2</sup>, the precipitate emitted a weak smell of radish<sup>3</sup> and transformed into a regulus<sup>4</sup> with a leaden lustre. In Klaproth's opinion the smell of radish pointed to the presence of tellurium. Similar smell was noticed in the Falun<sup>5</sup> mine where pyrite required for the acid production was extracted. Curiosity and hope to find this rare metal in the brown precipitate forced Berzelius to investigate it. However, he did not discover tellurium. Then he collected the deposits formed after several months of sulphur combustion for sulphuric acid production in the Falun factory and obtained a large amount of precipitate. Thoroughly analysing the precipitate, Berzelius came to the conclusion that it contained an unknown metal whose properties were similar to those of tellurium. By analogy, the new metal was named "selenium" from the Greek selenus for the Moon (as tellurium is named after our planet). Berzelius studied many properties of selenium and described them in an article "The Study of a New Mineral Body Found in Sulphur Extracted in Falun" published in 1818 in the journal *Annales de chimie et de physique*.

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#### **Notes:**

1. owing to its having been masked – из-за того, что он был скрыт
2. blowpipe – паяльная трубка
3. radish – редис
4. regulus – король металл (*фракция металлических включений, содержащая драгоценные металлы*)
5. Falun – город в Швеции

#### **Named after the Earth**

1. In the second half of the 18th century a strange bluish-white ore was discovered in Austria or, to be more exact<sup>1</sup>, in the part of it that was called Siebengebirge (Seven Mountains). It was strange because there was no common opinion about its composition. The debates mainly revolved around the question whether it contained gold or not. Its names were also unusual: paradoxical gold, white gold, and, finally, problematic gold. Some scientists believed that there was no problem at all, and the ore, most likely, contained antimony<sup>2</sup> or bismuth, or both. In 1782 the mining engineer I. Muller (later Baron von Reichenstein) subjected the ore to a thorough chemical analysis and extracted metal reguluses from it which, as it seemed to him, closely resembled antimony. But in the following year he decided that in spite of<sup>3</sup> the resemblance, he was dealing with<sup>4</sup> a new, previously unknown metal. Not relying upon his own opinion, the scientist consulted T. Bergman. But the sample of the ore sent to Bergman was too small to come to a definite conclusion. It was only possible to establish that Muller's metal was not antimony, and that was the end of the matter. During the next fifteen years nobody recalled the discovery of the Austrian mining engineer. Tellurium's real birth was still ahead.

2. Its second birth was promoted by the German chemist M. Klaproth. At the Berlin Academy of Sciences session on January 25, 1798, he reported about the gold-bearing ore from "Seven Mountains". Klaproth repeated what Muller had done in his time. But if the latter was in doubt there was no doubt for

M. Klaproth. He named the new element "tellurium" (from the Latin *tellus* for "Earth"). Although Klaproth had received the reo sample from Muller, he did not want to share the glory of the discoverer of tellurium with him. We, for our part<sup>5</sup>, think that the role of the German chemist was no less important. At any rate he revived the forgotten element.

3. There is reason to believe that the third person was also involved in the discovery of tellurium. He was P. Kiteibel, a Professor of the Pest<sup>6</sup> University in Hungary, a chemist and botanist. In 1789 he received a mineral which was assumed to be molybdenite containing silver from a colleague. P. Kiteibel extracted a new element from it. Then he established that the same element was present in problematic gold. Thus, P. Kiteibel discovered tellurium independently of other scientists. It is a pity<sup>7</sup> that he did not publish at once<sup>8</sup> his findings but instead sent a description of his investigation to some of his colleagues and, in particular, to the Viennese<sup>9</sup> mineralogist F. Estner. M. Klaproth learned about Kiteibel's results through F. Estner and spoke favourably of them without actually corroborating them. I. Muller wrote to M. Klaproth several years later and the latter found time to reproduce the results of his correspondent. After that Klaproth considered him to be the only author of the discovery, and he underlined this in his report.

4. For a long time tellurium was regarded as metal. In 1832 Berzelius showed its great similarity with selenium and sulphur, and tellurium was once and forever<sup>10</sup> classified as a non-metal.

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**Notes:**

1. to be more exact – точнее говоря
2. antimony – сурьма
3. in spite of – несмотря на
4. he was dealing with – он имел дело с
5. for our part – со своей стороны
6. Pest – Пешт (*город в Венгрии*)
7. it is a pity that – жаль, что
8. at once – сразу
9. Viennese – венский
10. once and forever – раз и навсегда

### **Beryllium (1)**

1. Academician A.E. Fersman, the outstanding Russian geo-chemist, called beryllium one of the most remarkable elements having tremendous theoretical and practical importance. However, beryllium is not outstanding in any one of its qualities; it has typical properties of metals. What is really remarkable, is the extremely fortunate combination (as if purposely invented by nature) of different properties. Beryllium clearly illustrates how the history of a chemical element is affected by its properties. As regards<sup>1</sup> its chemical behaviour, beryllium has much more in common<sup>2</sup> with aluminium (its diagonally neighbouring element in the periodic table) than with magnesium, its direct analogue in the same group. That is why aluminium was masking the presence of beryllium (as well as of zirconium) in natural minerals for such a long time.

2. Because of a pronounced amphoteric nature of beryllium, all attempts to obtain beryllium compounds in a sufficiently pure form were unsuccessful for a long time. As a result, many properties of the element and especially its valence and atomic mass were determined incorrectly. Consequently, the place of beryllium in the periodic table was not definitely found for a very long time. Only after it had been firmly established that beryllium is bivalent, that the formula of its oxide is BeO, and atomic mass is 9.01, was it once and for all<sup>3</sup> placed in the upper box of the second group. A great contribution to that was made by the Russian scientist I.V. Avdeev.

3. The history of beryllium minerals goes far back into the past when such precious stones as beryls and emeralds were already known.

4. One of the first scientists to begin the study of beryls in 1779 was F. Achard, Professor of Chemistry at the Berlin Academy of Sciences. Before that time he had become famous for developing an industrial method of making sugar from sugar beet. The German chemist performed six analyses. His

results recalculated in modern terms show that beryls contain 21.7% silicon oxide, 60.05% aluminium oxide, 5.02% iron oxide, and 8.3% calcium oxide. The total was only 95.07% (five per cent was missing!) but F. Achard had no comment on this.

5. Similar figures were obtained in 1785 by J. Bindheim: in his case the “calculations” yielded the sum of the components of 101 per cent. So, nothing particular was found about beryls.

6. In 1797 M. Klaproth, who by that time had already discovered uranium, titanium, and zirconium proving himself an outstanding analyst, received from the Russian diplomat and author D. Golitsyn samples of Peruvian emeralds and analysed them. But M. Klaproth did not wind up with<sup>4</sup> 100 per cent either (66.25% silica, 31.25% alumina, 0.5% iron oxide, total 98%). The scientist did not know where 2 per cent had disappeared and did not try to explain. So he was not fated to add the discovery of the fourth element to his record.

7. At the same time, in France, another analyst L. Vauquelin, no less skillful than M. Klaproth, was at work. Beginning with 1793 he continued to study beryls and emeralds. But Vauquelin found nothing except ordinary components (silica, alumina, lime, iron oxide). Later Vauquelin recalled how difficult it had been to recognize a new substance when its properties were so similar to those of already known ones, the scientist meant a close similarity between oxides of aluminium and unknown beryllium. Anticipating the events a little, we shall call Vauquelin the real discoverer of beryllium. The logic discovery was not simple and it, undoubtedly, does justice to the scientist. He reasoned in the following way: beryl and emerald are very much alike as regards their composition and the shape of crystals. The crystal shape is absolutely the same but what about composition? Vauquelin's predecessors found the same components (alumina, silica, lime) in both minerals but their content varied.

8. After the first unsuccessful experiments L. Vauquelin decided to see why the components content varied so widely. Could it be that<sup>5</sup> the minerals contained “something” else which was either lost in the course of the reaction or, figuratively speaking<sup>6</sup>, was “hiding behind the backs”<sup>7</sup> of one of the components (for instance, alumina).

9. L. Vauquelin had a certain psychological advantage. In 1797 he discovered chromium, which imparts a greenish colour to emerald and is absent in beryl. Hence, the difference between beryl and emerald is an established fact. But not only chromium could be responsible for the difference. February 14, 1798, should be considered as the birthday of beryllium. On that day Vauquelin made a report to the Paris Academy of Sciences, “About Aquamarine, or Beryl, and the Discovery of a New Earth in this Mineral”. He told the audience how he had performed five analyses and how he had become more and more convinced of the existence of the new earth. The first results were as follows:

**Beryl:** 69 parts of silica, 21 parts of alumina, 8-9 parts of lime, and 1.5 parts of iron oxide. Emerald: 64 parts of silica, 29 parts of alumina, 2 parts of lime, 3-4 parts of chromium oxide, and 1-2 parts of water. Whether it was intuition or something else, but Vauquelin suspected that in both cases alumina contained an impurity. It resembled alumina very much and, therefore, it was rather difficult to detect it. The brilliant intuition of an analyst helped the scientist to discover that the impurity (the new earth), unlike alumina, did not form alum. Later he found other differences. But similarity prevailed over difference enabling beryllium to hide for so long behind aluminium. If beryllium earth is not alumina, L. Vauquelin thought, it is none of the known earths since it differs from them much more than alumina. The scientist proposed to name the new element “glucinium” (symbol Gl) from the Greek *glykys* which means “sweet”. The present name “beryllium” was proposed by M. Klaproth who justly noted that some compounds of other elements are also sweet.

10. As an interesting historical detail we should like to mention that Vauquelin analysed Altaian beryls presented to him by French mineralogist and traveller E. Patren.

11. The discovery of L. Vauquelin was confirmed by I. Gmelin, the German chemist, a professor of chemistry in Gottingen. He analysed Siberian beryls from Nerchinsk and made the same conclusions as Vauquelin. Metallic beryllium was isolated in 1828 by F. Wohler and E. Bussy who treated beryllium chloride with potassium metal. It was thirty years after the discovery of beryllium.

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**Notes:**

1. as regards – что касается

2. has much more in common – имеет гораздо больше общего
3. once and for all – раз и навсегда
4. did not wind up with – не завершил
5. Could it be that – Если бы это могло быть так
6. figuratively speaking – образно говоря
7. was “hiding behind the backs” – «прятался за спиной»

### **Beryllium (2)**

1. Beryllium oxide, BeO, is made by heating the hydroxide to 440°C, or better the basic carbonate to 1,100°C. It has a wurtzite (4:1) lattice<sup>1</sup>, showing that it is covalent in the solid state; herein<sup>2</sup> it differs from the oxides of the alkaline earths<sup>3</sup> (including magnesium), which all have the ionized sodium chloride (6:1) structure, the differences being due to<sup>4</sup> the smaller size and hence<sup>5</sup> the greater deforming power of the beryllium ion. BeO melts at 2,570°C. It dissolves in acids, but the more slowly the higher it has been heated. It has been shown (from the heat of the solution in hydrofluoric acid) that the energy content of the solid is the greater the lower the temperature of preparation.

2. This may be due to a more colloidal state of the low temperature specimens<sup>6</sup>, with the lattice becoming more complete after exposure to<sup>7</sup> a high temperature; this view is supported<sup>8</sup> by X-ray examination. Beryllium hydroxide, Be(OH)<sub>2</sub> is precipitated from the solution of beryllium salts by hydroxyl ion, with the precipitate readily dissolving in the excess of alkali. Other conditions being equal, beryllium hydroxide crystallizes out from the solution slowly only on standing<sup>9</sup>.

3. This implies<sup>10</sup> that there are two forms of hydroxide, one being more soluble and less stable than the other. The conclusion has been confirmed by direct measurement of solubility. The precipitate first formed is gelatinous, this being changed into an unstable crystalline α-form, and that on standing into a stable β-form, which is only about 1/25 as soluble. Contrary to<sup>11</sup> earlier statements, neither the α-form nor the β-form absorbs carbon dioxide. Even the β-form will dissolve in highly concentrated (10N) sodium hydroxide, there being formed the beryllates NaHB<sub>2</sub>O<sub>2</sub>, or Na<sub>2</sub>BeO<sub>2</sub>. Beryllium hydroxide dissolves readily in solutions of beryllium salts. It does not dissolve in solutions of ammonium salts, or of most amines, but it does in a solution of ethylene diamine. Beryllium, unlike all other elements of Group II, will not form peroxide.

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#### **Notes:**

1. wurtzite lattice – кристаллическая решетка вюрцита
2. herein – в этом
3. alkaline earths – щелочноземельные элементы
4. being due to – обусловлены
5. hence – следовательно, в результате
6. specimens – экземпляры
7. after exposure to – после воздействия
8. is supported by – подтверждается
9. on standing – при отстаивании
10. this implies – это означает
11. contrary to – вопреки

### **“Inflammable Air”**

1. Hydrogen is one of the most striking elements of the periodic system, its number is one, and it is the lightest of all the existing gases. It is the element whose discovery was indispensable for the solution of many problems of chemical theory. It is an element whose atom, losing its only valence electron, becomes a “bare” proton. And, therefore, chemistry of hydrogen is, in a way<sup>1</sup>, unique; it is the chemistry of an elementary particle.

2. Once D.I. Mendeleev called hydrogen the most typical of typical elements (meaning the elements of the short periods in the System), because it begins the natural series of chemical elements.

And such a fascinating element is readily available: it can be obtained without difficulty in any school laboratory, for instance, by pouring hydrochloric acid on zinc shavings.

3. Even in those bygone times<sup>2</sup>, when chemistry was not a science yet and when alchemists were still searching for the “philosophers’ stone”, hydrochloric, sulphuric, and nitric acids as well as iron and zinc were already known. In other words, man had in his possession<sup>3</sup> all components whose reaction could give rise<sup>4</sup> to hydrogen. Only a chance was needed and chemical literature of the 16-18<sup>th</sup> centuries reported that many times chemists observed how the pouring of, for instance, sulphuric acid on iron shavings produced bubbles of a gas which they believed to be an inflammable variety of air. One of those who observed this mysterious variety of air was the famous Russian scientist M. V. Lomonosov. In 1745 he wrote a thesis, *On Metallic Lustre*, which said, among other things: “On dissolution of some base metal, especially iron, in acidic alcohols, inflammable vapour shots out from the opening of the flask ... . « (According to the terminology of those times, acidic alcohols meant acids). Thus, M.V. Lomonosov observed none other than hydrogen. But the sentence went on to read: “... which is phlogiston<sup>5</sup>.” Since metal dissolved in the acid liberating *materia ignea* or “inflammable vapour”, it was very convenient to assume that dissolving metal releases phlogiston: everything fits nicely into the theory of phlogiston.

4. And now is the time to meet the outstanding English scientist H. Cavendish, a man fanatically devoted to science and an excellent experimenter. He never hurried with making public his experimental results and sometimes several years had to pass before his articles appeared. Therefore, it is difficult to pinpoint<sup>6</sup> the date when the scientist observed and described the liberation of “inflammable air”. What is known is that this work published in 1766 and entitled “*Experiments with Artificial Air*” was done as a part of pneumatic chemistry research. It is also likely that the work was performed under the influence of J. Black. H. Cavendish had become interested in fixed air and decided to see whether there existed other types of artificial air. In this manner<sup>7</sup> the scientist referred to the variety of air which is contained in compounds in a bound state and which can be separated from them artificially. H. Cavendish knew that inflammable air had been observed many times. He himself obtained it by the same technique: the action of sulphuric and hydrochloric acids on iron, zinc, and tin, but he was the first to obtain definite proof that the same type of air was formed in all cases - inflammable air. And he was the first to notice the unusual properties of inflammable air. As a follower of the phlogistic theory, H. Cavendish could give only one interpretation of the substance's nature. Like M.V. Lomonosov, he identified it as phlogiston. Studying the properties of inflammable air, he was sure that he was studying the properties of phlogiston. H. Cavendish believed that different metals contain different proportions of inflammable air. Thus, to the fixed air of J. Black, the inflammable air of H. Cavendish was added. Strictly speaking, the two scientists discovered nothing new: each of them only summarized the data of previous observations. But this summing up represented considerable progress in the history of human knowledge.

5. Fixed air and inflammable air differed both from ordinary air and from each other. Inflammable air was surprisingly light. H. Cavendish found that phlogiston, which he had separated, had a mass. He was the first to introduce a quantity to characterize gases, that of density. Having assumed the density of air to be unity, Cavendish obtained the density of 0.09 for inflammable air and 1.57 for fixed air. But here a contradiction arose between Cavendish the experimenter and Cavendish the adherent of the phlogistic theory. Since inflammable air had a positive mass, it could by no means<sup>8</sup> be considered to be pure phlogiston. Otherwise, metals losing inflammable air would have to lose mass as well. To avoid the contradiction, Cavendish proposed an original hypothesis: inflammable air is a combination of phlogiston and water. The essence of the hypothesis was that at last hydrogen appeared in the composition of inflammable air.

6. The evident conclusion is that Cavendish, like his predecessors, did not understand the nature of inflammable air, although he had weighed it, described its properties, and considered it to be independent kind of artificial air. In a word<sup>9</sup>, Cavendish, unaware of the fact, studied “phlogiston” obtained by him as he would have studied a new chemical element. But Cavendish could not perceive that inflammable air was a gaseous chemical element – so strong were the chains of the phlogistic theory. And having found that the real properties of inflammable air contradicted this theory, he came up with a new hypothesis, as erroneous as the theory itself.

7. Therefore, strictly speaking, the phrase “hydrogen was discovered in 1766 by the English scientist H. Cavendish” is meaningless. Cavendish described the processes of preparation and the properties of inflammable air in greater detail than his predecessors. However, he “knew nor what he was doing”. The elementary nature of inflammable air remained beyond his grasp<sup>10</sup>. It was not scientist’s fault, however, chemistry had not yet matured enough for such an insight. Many years have passed before hydrogen became, at last, hydrogen and occupied its proper place in chemistry.

8. Its Latin name *hydrogenium* stems from the Greek words *hydr* and *gennao* which mean “producing water”. The name was proposed in 1779 by A. Lavoisier after the composition of water had been established. The symbol *H* was proposed by J. Berzelius.

9. Hydrogen is a unique element in the sense<sup>11</sup> that its isotopes differ in their physical and chemical properties. At one time<sup>12</sup> this difference prompted some scientists to consider hydrogen isotopes as independent elements and to find for them special boxes in the periodic table. Therefore, the history of the discovery of hydrogen isotopes is of special interest, as a continuation of the history of hydrogen itself. The search for hydrogen isotopes began in the twenties of the 20<sup>th</sup> century but all attempts were unsuccessful, resulting in the belief<sup>13</sup> that hydrogen had no isotopes. In 1931 it was suggested that hydrogen, nevertheless, contains a heavy isotope with a mass number of 2. Since this isotope had to be twice as heavy as hydrogen, the scientists tried to isolate heavy hydrogen by physical methods. In 1932 the American scientists Urey, Brickwedde, and Murphy evaporated liquid hydrogen and, studying the residue by spectroscopy, found a heavy isotope in it. In the atmosphere it was discovered only in 1941. The name "deuterium" originates from the Greek word *deateros* which means "second, another one". The next isotope with a mass number of 3, tritium (from the Greek *tritros*—the third), is radioactive and was discovered in 1934 by English scientists M. Oliphant, P. Hartec, and E. Rutherford. The name "protium" was assigned to the main hydrogen isotope. This is the only case when isotopes of the same element have different names and symbols (H, D<sub>t</sub> and T). 99.99 per cent of all hydrogen is protium; the rest is deuterium with only traces of tritium.

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#### Notes:

1. in a way – в некотором смысле; можно сказать; отчасти
2. Even in those bygone times ... – Даже в далеком прошлом ...
3. in his possession – в своем распоряжении
4. give rise – быть источником; дать начало
5. phlogiston – флогистон (от греч. *phlogistos* – воспламеняемый, горючий)
6. to pinpoint – точно определить; указать
7. in this manner – таким образом
8. by no means – никоим образом
9. in a word – одним словом; короче говоря
10. beyond his grasp – выше его понимания
11. in the since – в том смысле
12. at one time – одно время (разом, сразу, одновременно)
13. resulting in the belief – что привело к убеждению (мнению)

#### Yellow – Green Halogen

1. In ancient times man knew of such chlorine-containing compounds as sodium chloride NaCl and ammonium chloride NH<sub>4</sub>Cl. Later hydrochloric acid (HCl) became known and widely used. Numerous chlorine compounds were subjected to the scrutiny<sup>1</sup> of researchers and there is no doubt that during manipulations with them free chlorine was repeatedly obtained. Among those who observed free chlorine were such outstanding scientists as J. Glauber (of the Glauber's salt fame), J. Van Helmont, and R. Boyle. But even if this strange yellow-green gas had caught their attention, they would have hardly understood its nature.

2. The Swedish chemist C. Scheele was also mistaken. He prepared chlorine by the same method that is described in modern school textbook: by the reaction of hydrochloric acid with manganese oxide (Scheele made use of ground pyrolusite, that is natural MnO<sub>2</sub>). It would be wrong to say that the scientist

chose this method by chance<sup>2</sup>. Scheele knew that the reaction of HCl with pyrolusite had to give rise<sup>3</sup> as usual to inflammable air (known subsequently as hydrogen). Some gas was, indeed, liberated but it did not bore even remote likeness to inflammable air. It had a very unpleasant smell and an unpleasant yellow-green colour. The gas corroded corks and bleached flowers and plant leaves. The new gas proved to be a highly active chemical reagent. It reacted with many metals and, when with ammonia, formed a dense smoke (ammonium chloride NH<sub>4</sub>Cl). Its solubility in water was poor. Scheele did not utter the words "a new chemical element", although he had the discovery within his grasp<sup>4</sup> and could follow the logical chain of arguments about its elementary nature. A zealous follower of the phlogistic theory, the Swedish chemist identified the gas discovered by him with hydrochloric acid that had lost phlogiston<sup>5</sup>. He named it "dephlogisticated hydrochloric acid or dephlogisticated muric acid" (HCl was named muric acid after the Latin *muria*, "brine, salt water"). At that time Scheele shared the opinion of H. Cavendish and other scientists that inflammable air (hydrogen) was actually phlogiston. It followed that the new gas had to be a simple substance (hydrochloric acid minus phlogiston) but Scheele did not make such seemingly obvious conclusion. Although 1774 is considered to be the new gas's date of discovery, much time was to pass before its nature was properly understood.

3. A. Lavoisier overturned the phlogistic theory. Even the name "dephlogisticated muric acid" evoked a strong protest in him. In his opinion, the acid obtained by Scheele was a compound of muric (hydrochloric) acid and oxygen. Oxidized muric acid—that is how Lavoisier named what we know as elemental chlorine now. The French chemist believed that all acids must contain oxygen combined with some element. Lavoisier called this element "murium" in the case of muric acid and included it into his "Table of Simple Bodies".

4. The result was paradoxical; trying to elucidate the nature of the gas discovered by Scheele, Lavoisier only complicated the issue. Probably, this development in the history of chlorine was simply inevitable in the light of new theoretical conceptions. Some chemists attempted to prepare free murium but the attempts were fruitless and the nature of the new gas did not become clearer.

5. In 1807 H. Davy tried to solve the problem, subjecting the notorious muric acid to various manipulations. He attempted to decompose it electrolytically, but no decomposition was observed. No matter<sup>6</sup> how ingeniously he treated oxymuric acid, he could not succeed in preparing water or liberating oxygen. In a word<sup>7</sup>, the acid behaved as if it were<sup>8</sup> a simple substance. Moreover, its action on metals or their oxides yielded typical salts. Nothing else was left to Davy but to recognize that oxymuric acid consisted of only one simple substance, i.e. to recognize the elemental nature of the gas discovered more than 30 years earlier by Scheele. He reported on this to the Royal Society on November 19, 1810. Davy proposed to name the element "chlorine" from the Greek *chloros* meaning "yellow-green". Two years later, in 1812, the French chemist Gay Lussac proposed to change the name for "chlor" (which became generally accepted except in English-speaking countries).

6. Gay Lussac in cooperation with Thenard began to study oxymuric acid almost simultaneously with Davy; at first, they wanted to prove that it was oxygen-free. The two scientists passed the acid through a red-hot porcelain tube over charcoal. If there had been oxygen in the gas discovered by Scheele, it would have been absorbed by the charcoal. Although the composition of the gas at the inlet and outlet of the tube remained unchanged, this experiment did not shake the belief of the firm followers of A. Lavoisier about the composition of oxymuric acid.

7. Nevertheless, Davy's experiments strongly impressed the contemporary scientific community which gradually came to the conclusion that murium was in fact chlorine. In 1813 Gay Lussac and Thenard agreed with Davy. Only Berzelius for a long time continued to doubt the elemental nature of chlorine but in the end he also had to accept the truth. The elemental nature of chlorine became an irrefutable fact only after the discovery and study of iodine and bromine.

8. In 1811 the German chemist I. Schweiger proposed to name chlorine a "halogen" (from the Greek for "salt" and "produce", i.e. "salt-producing") because of its ability to combine readily with alkaline metals. At that time the name was not accepted but later it became common for the group of similar elements: fluorine, chlorine, bromine, and iodine. Chlorine was obtained for the first time in a liquid form in 1823 by M. Faraday.

**Notes:**

1. scrutiny – внимательное изучение
2. by chance – случайно
3. to give rise to – вызывать, давать в результате
4. within his grasp – так близко, что можно рукой достать; в пределах его возможностей
5. phlogiston – от греч. “phlogistos” воспламеняемый, горючий
6. no matter – не имеет значения
7. in a word – одним словом
8. as if it were – как если бы это было

**“Violet Colour”**

1. Iodine was the second halogen to be obtained in a free state. Both the appearance and chemical properties of iodine are rather peculiar. Were it the only halogen in existence<sup>1</sup>, chemists would have to think hard about its nature, but the elemental chlorine had already been known and this fact helped to understand the nature of iodine.

2. B. Courtois, an entrepreneur from the French town of Dijon<sup>2</sup>, was engaged, among other things, in the production of potash and saltpeter. He used ash of sea algae as the initial raw material. A mother solution of sea algae was formed under the action of water on the ash. Today we know that the ash contains chlorides, bromides, iodides, carbonates, and sulphates of some alkali and alkaline-earth metals. However, when Courtois performed his experiments it was only known that the ash contained potassium and sodium compounds (chlorides, carbonates, and sulphates). Upon evaporation, first, sodium chloride precipitated and then potassium chloride and sulphate. The residual mother solution contained a complex mixture of various salts, including sulphur-containing ones.

3. To decompose these sulphur compounds, Courtois added sulphuric acid to the solution. One day it so happened that he added a greater amount of acid than was necessary. Suddenly something unexpected happened: amazingly beautiful clouds of violet vapour appeared whose magnificence was marred<sup>3</sup> only by their unpleasant, even lachrymose smell<sup>4</sup>. Then followed something even more surprising: on the surface of cold objects the vapour did not condense forming heavy drops of a violet liquid but precipitated at once as dark crystals with metallic lustre. Courtois discovered many other interesting and unusual properties of the new substance. He had every reason to announce the discovery of a new chemical element but, evidently, the researcher was not confident enough and his laboratory was too poorly equipped to perform further investigations. He, therefore, turned for help to his friends, Ch. Desormes and N. Clement, asking them for a permission to continue his experiments in their laboratory. He also asked them to report his discovery in a scientific journal.

4. Consequently, the report about “The Discovery of a New Substance Obtained from an Alkali Salt by Mr. Courtois” signed by N. Clement and Ch. Desormes appeared only in 1813 in the “Annales de chimie et de physique”<sup>5</sup>, i.e. two years after the discovery of the element. To enable other chemists to investigate the substance, B. Courtois gave a very small amount of it to a pharmaceutical firm in Dijon. Clement himself prepared a certain amount of iodine, studied its properties and was, probably, the first to advance an opinion that iodine resembled chlorine. In 1813 J. Gay Lussac and H. Davy independently of each other proved the elemental nature of iodine. The French chemist suggested the name “iode” for the new element (from the Greek *iodes* meaning “violet colour”) and the English scientist suggested the name “iodine”. The first name found acceptance in the Russian language.

5. Iodine is a rare example of a chemical element whose properties were studied thoroughly during a short period of time after its discovery. Here a great contribution was made by Gay Lussac who even wrote a book on iodine which was in effect the first monograph in the history of science completely devoted to one element.

6. But the subsequent generations did not forget B. Courtois's contribution. A street in Dijon is named after him; this honour was bestowed on<sup>6</sup> very few discoverers of chemical elements.

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**Notes:**

1. Were it the only halogen in existence – Даже если бы существовал (был) один единственный галоген
2. Dijon – Дижон (.город во Франции)
3. was marred – был испорчен
4. lachrymose smell – запах, вызывающий слезотечение
5. “Annales de chimie et de physique” – «Основы химии и физики»
6. was bestowed on – была дарована

### “Muride”

1. This element, unusual in many respects, was the last of the natural halogens to be discovered (if, of course, we accept the discovery of fluorine by Scheele in 1771).

2. On an autumn day in 1825, the following event took place in the laboratory of L. Gmelin, a professor of medicine and chemistry at Heidelberg University. A student by the name of C. Lowig brought to his teacher a thick-walled flask with an evil-smelling reddish brown liquid. Lowig told Gmelin that in his native town of Kreiznach he had studied the composition of water from a mineral spring. Gaseous chlorine turned the mother solution red. Lowig extracted with ether the substance that caused the colouring of the solution. It was a reddish brown liquid known subsequently as bromine. Gmelin showed great interest in his student's work and advised him to prepare the new substance in greater amounts and to study its properties in detail. It was a reasonable piece of advice since Lowig had little experience as an experimenter; but the work required time and the time factor turned against the student.

3. While he was assiduously preparing new portions of bad-smelling reddish brown liquid, a large article appeared in the *Annales de chimie et de physique*. The article was entitled "Memoir on a Specific Substance Contained in Sea Water" and was written by A. Balard. He was a laboratory assistant at a pharmaceutical school in the French town of Montpellier. The properties of his "specific substance" turned out to be quite similar to those of the reddish brown liquid obtained by Lowig. A. Balard wrote that in 1824 he began to study vegetation of salt marshes<sup>1</sup>. He subjected marsh grasses to the action of various chemical reagents trying to extract useful compounds from them. He prepared a mother solution which turned brown under the action of some reagents, such as chlorine. Then A. Balard studied an alkaline solution obtained after the treatment of sea algae ash<sup>2</sup>. As soon as chlorine water and starch were added to the solution, it separated into two layers. The lower part was blue and the upper one, reddish brown. A. Balard decided that the lower layer contained iodine which coloured starch blue. And what about the upper layer? Balard assumed that it contained a compound of chlorine with iodine. He tried to extract it but in vain<sup>3</sup>. Only after that did the laboratory assistant from Montpellier dare to think that reddish brown colouring was caused by a new chemical element. Balard separated the reddish brown liquid, which was similar to that separated several months before by the unknown student Lowig who later became an Academician and Professor at Sorbonne.

4. Balard gave the new element a prosaic name “muride” from the Latin *muria* for “brine”<sup>4</sup>. He had an equally prosaic view of the nature of the element believing it to be the only non-metal liquid at room temperature like metallic mercury, which is liquid under the same conditions.

5. Balard's article did not remain unnoticed but, nevertheless, his friends advised him to send a report to the Paris Academy of Sciences. Balard followed the advice and on November 30, 1825, he sent a communication<sup>5</sup> “Memoir on a Specific Substance Contained in Sea Water”. The most important thing in the communication was the observation on similarity of muride with chlorine and iodine. The members of the Academy did not take such reports on trust<sup>6</sup> and a special committee was set up to check Balard's experimental results. The committee, consisting of Gay Lussac, Vauquelin, and Thenard, confirmed all the results obtained by Balard and only the name of the new element caused objections. The committee named it “bromine” from the Greek *bromos* which means "stinking". The committee made its ruling<sup>7</sup> on August 14, 1826; the discovery of bromine was extremely important for chemistry.

6. And only one scientist met the news of the discovery with irritation. He was J. Liebig. Several years earlier he had received a bottle with a liquid from a German firm that asked Liebig to identify the liquid. The scientist did not analyse it thoroughly and made a hasty conclusion that the liquid was a compound of iodine with chlorine. When Liebig learnt about Balard's discovery he analysed the liquid

remaining in the bottle and established that it was bromine. His contemporaries reported that Liebig said in temper<sup>8</sup>: “It is not Balard who discovered bromine but bromine that discovered Balard.”

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**Notes:**

1. salt marshes – солевые болота
2. sea algae ash – зола морских водорослей
3. in vain – напрасно, тщетно
4. brine – соляной раствор, морская вода, рассол
5. communication – сообщение, информация
6. did not take ... on trust – не приняла ... на веру
7. ruling – решение
8. in temper – раздраженно

### **The Element with Unjust History**

1. Aluminium is a chemical element to which history unjust. The third most abundant metal on Earth after oxygen and silicon, and found practically everywhere in the earth's crust (in 250 minerals, at least) aluminium was discovered only in 1825. And still, this later discovery of aluminium is not accidental. It was due to the extreme stability of aluminium oxide. To separate metallic aluminium from it is a tall order<sup>1</sup> even in our times, to say nothing of<sup>2</sup> the last century. Such reducing agents as charcoal and hydrogen could not separate the metal from the oxide. Only alkali metals, first of all potassium made it possible “to capture the fortress”. This shows how the discovery of some elements created prerequisites for the discovery of others: free aluminium was first prepared with the help of potassium. Man knew of various aluminium compounds in very remote times. Clay and brick are nothing but<sup>3</sup> usual aluminosilicates. Alumina (aluminium oxide) was a constant companion of man but many centuries were required to prove the presence of new metal in it.

2. Aluminium is one of the main components in such precious stone known from time immemorial as ruby and garnet, sapphire and turquoise. Alums were known for a long time. In Latin they were named *alumen* – the word which contained the root of the future “aluminium”. However, the composition of alums remained undetermined for a long time and they were often confused with other compounds.

3. In 1754 the German chemist Marggraf tried to shed light<sup>4</sup> on the problem. Having added pure alkali to the alum solution, he obtained a dense white precipitate which is named “alum earth”. Then Marggraf observed that the addition of sulphuric acid to the “earth” yielded alum; thus, the composition of alum was established. And, finally, Marggraf demonstrated the presence of the “alum earth” in clays. Had history so willed it<sup>5</sup>, Marggraf would have been acclaimed as the discoverer of this element, but history waited for somebody else to prepare pure aluminium. Only 30 years after Marggraf's experiment did it became clear that alumina was an oxide of an unknown element. This was suggested by A.Lavoisier who placed “alum earth” into his “Table of Simple Bodies”. But no attempts were made for some time to separate the element in a free state.

4. The first attempt was made by H. Davy and J. Berzelius, who tried to decompose alumina with the aid of electric current, but in vain<sup>6</sup>, it was only H. Davy's proposal (1807) to name the element “aluminium” that had any practical importance. This name became internationally accepted although in Russia the name “glinium” (from the Russian word for “clay”) was used for a long time.

5. The first who managed<sup>7</sup> to obtain metallic aluminium was the Danish scientist H. Oersted known in history as a physicist rather than as a chemist. He discovered the induction of magnetic field of an electric current, but preparation of pure aluminium showed him to be also a skillful chemist. Having red-heated a mixture of alumina with charcoal, Oersted passed chlorine through it; as a result anhydrous aluminium chloride was obtained. Then the scientist heated the new compound with potassium amalgam and obtained amalgam of aluminium for the first time. As soon as Oersted distilled off the mercury, he discovered pieces of metal that looked like tin. The product contained impurities but, nevertheless, this was the birth of metallic aluminium. Oersted published an article in a little known Danish journal which passed practically unnoticed in the scientific circles. And news of Oersted's achievement did not reach

many chemists. Therefore, some historians believe that aluminium was discovered not by Oersted but F. Wohler.

6. The second discovery of aluminium took place two years later, in 1827. Undoubtedly, F. Wohler was a more skillful experimenter than Oersted and his process of separating pure aluminium was more sophisticated<sup>8</sup>. At first Wohler's attempt to obtain the metal using the Danish scientist's method failed but soon he succeeded in preparing small amounts of anhydrous aluminium chloride. Wohler developed his own procedure for the process: (1) preparation of aluminium hydroxide; (2) preparation of a thick paste from aluminium hydroxide, charcoal, and vegetable oil; (3) calcination of the paste and preparation of a mixture of aluminium with charcoal powder; (4) preparation of pure anhydrous  $AlCl_3$  by passing dry chlorine through the mixture. The complexity of this procedure was rewarded by the purity of the product. The scientist decomposed  $AlCl_3$  with potassium under conditions ensuring the highest possible purity of the metal. F. Wohler was the first chemist to describe the most important properties of metallic aluminium and in 1845 he prepared aluminium in the form of an ingot<sup>9</sup>.

7. However, Wohler, like his predecessors, did not obtain pure aluminium. The decisive word was said by the French chemist A. Saint Claire Deville. In 1854 he prepared the samples of pure metal, using sodium instead of potassium for the reduction stage. Simultaneously with Bunsen he performed electrolysis of melted double chloride of aluminium and sodium: this was the first instance of producing aluminium electrochemically. A. Saint Claire Deville also pioneered the development of an industrial process of aluminium production.

8. It is difficult to believe that only one hundred years ago this silvery metal was extremely expensive and was even called "clay silver". Things made of aluminium cost no less than gold ones. Only after the processes for producing cheap electric energy had been developed and rich deposits of aluminium ore had been found, did aluminium become a metal for everyday uses.

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**Notes:**

1. tall order – трудная задача
2. to say nothing of – не говоря уже
3. are nothing but – представляет собой (ничто иное)
4. shed light – «пролить свет»
5. Had history so willed it – Если бы так повернулась история
6. in vain – безуспешно
7. the first who managed – первый, кому удалось
8. sophisticated – сложный; современный
9. ingot – слиток

## DISCOVERY OF NITROGEN

In 1674 the English physician John Mayow demonstrated that air is not a single element, it is made up of different substances. He did this by showing that only a part of air is combustible. Most of it is not.

Almost a century later, Scottish chemist Joseph Black carried out more detailed work on air. After removing oxygen and carbon dioxide, part of the air remained.

Black used burning phosphorus as the final step in oxygen removal. (Burning phosphorus has a very high affinity for oxygen and is efficient at removing it completely.) Black then assigned further study of the gases in air to his doctoral student, Daniel Rutherford.

Rutherford built on Black's work and in a series of steps thoroughly removed oxygen and carbon dioxide from air. He showed that, like carbon dioxide, the residual gas could not support combustion or living organisms. Unlike carbon dioxide, however, nitrogen was insoluble in water and alkali solutions. Rutherford reported his discovery in 1772 of 'noxious air,' which we now call nitrogen. <sup>(3)</sup>

Swedish pharmacist Carl Scheele discovered nitrogen independently, calling it spent air.

Scheele absorbed oxygen in a number of ways, including using a mixture of sulfur and iron filings and burning phosphorus. After removing the oxygen, he reported a residual gas which would not support combustion and had between two-thirds and three-quarters of the volume of the original air. Scheele published his results in 1777, although it is thought the work was carried out in 1772.<sup>(4)</sup>

Although Rutherford and Scheele are now jointly credited with nitrogen's discovery, it appears to have been discovered earlier by Henry Cavendish, but not published.

Prior to 1772 (the precise date is unknown – Priestley refers to it in his work “Experiments and Observations Made in and Before the Year 1772”) Cavendish wrote to Joseph Priestley describing ‘burnt air’.

The ‘burnt air’ had been prepared by passing air repeatedly over red hot charcoal (removing the oxygen) and then bubbling the remaining gas through a solution of caustic potash (potassium hydroxide) which would have removed the carbon dioxide.

Cavendish wrote: “The specific gravity of this air was found to differ very little from that of common air; of the two, it seemed rather lighter. It extinguished flame, and rendered common air unfit for making bodies burn in the same manner as fixed air, but in a less degree, as a candle which burnt about 80” in pure common air, and which went out immediately in common air mixed with 6/55 of fixed air, burnt about 26” in common air mixed with the same portion of this burnt air.”

In 1790 the French chemist Jean-Antoine-Claude Chaptal named the element ‘nitrogen’ after experiments showed it to be a constituent of nitre, as potassium nitrate was called then.

#### **Interesting Facts about Nitrogen**

- About 2.5 percent of the weight of living organisms comes from nitrogen in organic molecules.
- Many of the molecules of life contain nitrogen. It is the fourth most abundant element in the human body.
- The nitrogen compound nitroglycerin can be used for relief of angina, a life threatening heart condition.
- Neptune's satellite Triton has five mile high, nitrogen-powered geysers. Like Earth, Triton's atmosphere is mainly nitrogen, but Triton is so cold the nitrogen sits on the surface as a rock-hard solid. The solid nitrogen allows the feeble light arriving from the sun to pass through it. Dark impurities in the nitrogen ice or in darker rocks below the ice warm up slightly in the sunlight, melting and vaporizing the solid nitrogen, which eventually breaks through the solid nitrogen as geysers which push ice particles one to five miles above Triton's frozen surface.
- Nitrogen is the seventh most abundant element in the universe.
- In 1919, the world learned for the first time that atomic nuclei could be disintegrated. Ernest Rutherford reported that he had bombarded nitrogen gas with alpha-particles (helium nuclei) and found hydrogen was produced. (Further research by Patrick Blackett showed that the alpha particles had transmuted nitrogen-14 to oxygen-17 plus hydrogen.)
- The universe's nitrogen was made, and is being made, by the CNO cycle in stars heavier than our sun.

#### **DISCOVERY OF CHLORINE**

Chlorine was first produced in 1774 by Carl Wilhelm Scheele in Sweden. Scheele collected the gas released by the reaction of pyrolusite (manganese dioxide) with spiritus salis – an alchemical term meaning spirit/breath of salt. The new gas had, according to Scheele, “a very perceptible suffocating smell, which was most oppressive to the lungs... and gives the water a slightly acidic taste... the air in it acquires a yellow color...”

Scheele also noted the high reactivity and the bleaching qualities of the new gas he had made: "...all metals were attacked... fixed alkali was converted into common salt... all vegetable flowers – red, blue, and yellow – became white in a short time; the same thing also happened with green plants... insects immediately died.

Despite the accuracy of his observations, Scheele mistakenly thought the new gas was a dephlogostigated form of muriatic acid.

The famous French chemist Antoine Lavoisier believed the new gas should be called oxymuriatic acid (an oxide of hydrochloric acid) based on the as yet undiscovered element murium.

The confusion about chlorine's true identity was caused by the phlogiston theory; phlogiston had been accepted by chemists for most of the 1700s – until Lavoisier himself debunked it. Phlogiston was a 'substance' used to explain the then inexplicable. Conveniently, it had negative weight when it needed to, and 'explained' reactions such as rusting and burning.

Lavoisier was the architect of phlogiston's downfall, showing that the chemistry of oxygen was a better explanation in chemical reactions than phlogiston was.

By 1810 the scientific consensus was that the element we now call chlorine was actually a compound that contained oxygen. English chemist Sir Humphry Davy found that the consensus was wrong; he could not get the new yellow-green gas to react with a charcoal electrode, which made him believe it may not contain oxygen. In reactions with phosphorus and ammonia, he demonstrated the new gas did not contain oxygen. He used a huge, 2000 plate voltaic pile (battery) to see whether he could extract oxygen from the gas's phosphorus and sulfur compounds, but again he found no oxygen.

In 1811, Davy concluded the new gas was in fact a new element. He named it chlorine, from the Greek word 'chloros,' meaning pale green or yellow-green.

### **Interesting Facts about Chlorine**

- The first chain reaction discovered was not a nuclear reaction; it was a chemical chain reaction. It was discovered in 1913 by Max Bodenstein, who saw a mixture of chlorine and hydrogen gases explode when triggered by light. The chain reaction mechanism was fully explained in 1918 by Walther Nernst.
- Earth's oceans contain a large amount of chlorine. If this chlorine were released as a gas, its weight would be 5x greater than Earth's total current atmosphere. (Our oceans contain about  $2.6 \times 10^{16}$  metric tons of chlorine, mostly as sodium chloride.)
- Chlorine is not only abundant in our oceans; it is the sixth most abundant element in Earth's crust.
- Exposure to small amounts of chlorine, even for a short time, can be deadly. Fatalities are expected at 1 part in a thousand chlorine in air (or sometimes at even lower concentrations).
- Chlorine is heavier than air. When released, it forms a poisonous blanket that drifts along with the wind. Chlorine was used as a chemical weapon in World War I, first in 1915 by the German army and then by the Western Allies. It was not as 'effective' as had been hoped, because chlorine is easily detected by its strong smell. It is also water soluble, and so soldiers could protect themselves from the worst of its effects by breathing through damp cloths.

## **DISCOVERY OF HYDROGEN**

A favorite school chemistry experiment is to add a metal such as magnesium to an acid. The metal reacts with the acid, forming a salt and releases hydrogen from the acid. The hydrogen gas bubbles up from the liquid and students collect it in small quantities for further experiments, such as the ‘pop-test.’

The first recorded instance of hydrogen made by human action was in the first half of the 1500s, by a similar method to that used in schools now. Theophrastus Paracelsus, a physician, dissolved iron in sulfuric acid and observed the release of a gas. He is reported to have said of the experiment, “Air arises and breaks forth like a wind.” He did not, however, discover any of hydrogen’s properties.

Turquet De Mayerne repeated Paracelsus’s experiment in 1650 and found that the gas was flammable. Neither Paracelsus nor De Mayerne proposed that hydrogen could be a new element. Indeed, Paracelsus believed there were only three elements – the tria prima – salt, sulfur, and mercury – and that all other substances were made of different combinations of these three.

In 1670, English scientist Robert Boyle added iron to sulfuric acid. He showed the resulting (hydrogen) gas only burned if air was present and that a fraction of the air (we would now call it oxygen) was consumed by the burning.

Hydrogen was first recognized as a distinct element in 1766 by English scientist Henry Cavendish, when he prepared it by reacting hydrochloric acid with zinc. He described hydrogen as “inflammable air from metals” and established that it was the same material (by its reactions and its density) regardless of which metal and which acid he used to produce it. Cavendish also observed that when the substance was burned, it produced water.

French scientist Antoine Lavoisier later named the element hydrogen (1783). The name comes from the Greek ‘hydro’ meaning water and ‘genes’ meaning forming – hydrogen is one of the two water forming elements.

In 1806, with hydrogen well-established as an element, English chemist Humphry Davy pushed a strong electric current through purified water.

He found hydrogen and oxygen were formed. The experiment demonstrated that electricity could pull substances apart into their constituent elements. Davy realized that substances were bound together by an electrical phenomenon; he had discovered the true nature of chemical bonding.

## **DISCOVERY OF OXYGEN**

Oxygen was discovered in 1774 by Joseph Priestley in England and two years earlier, but unpublished, by Carl W. Scheele in Sweden. Scheele heated several compounds including potassium nitrate, manganese oxide, and mercury oxide and found they released a gas which enhanced combustion.

Priestley heated mercury oxide, focusing sunlight using a 12-inch ‘burning lens’ – a very large magnifying glass – to bring the oxide to a high temperature. Priestley’s lens was smaller than the enormous one used by Antoine Lavoisier in his investigation of carbon.

Totally unexpectedly, the hot mercury oxide yielded a gas that made a candle burn five times faster than normal. Priestley wrote: “But what surprised me more than I can well express was that a candle burned in this air with a remarkably vigorous flame. I was utterly at a loss how to account for it.”

In addition to noticing the effect of oxygen on combustion, Priestley later noted the new gas’s biological role. He placed a mouse in a jar of oxygen, expecting it would survive for 15 minutes maximum before it suffocated. Instead, the mouse survived for a whole hour and was none the worse for it.

Antoine Lavoisier carried out similar experiments to Priestley’s and added to our knowledge enormously by discovering that air contains about 20 percent oxygen and that when any substance burns, it actually combines chemically with oxygen.

Lavoisier also found that the weight of the gas released by heating mercury oxide was identical to the weight lost by the mercury oxide, and that when other elements react with oxygen their weight gain is identical to the weight lost from the air.

This enabled Lavoisier to state a new fundamental law: the law of the conservation of matter; “matter is conserved in chemical reactions” or, alternatively, “the total mass of a chemical reaction’s products is identical to the total mass of the starting materials.” In addition to these achievements, it was Lavoisier who first gave the element its name oxygen.

The word oxygen is derived from the Greek words ‘oxys’ meaning acid and ‘genes’ meaning forming. Before it was discovered and isolated, a number of scientists had recognized the existence of a substance with the properties of oxygen. In the early 1500s Leonardo da Vinci observed that a fraction of air is consumed in respiration and combustion.

In 1665 Robert Hooke noted that air contains a substance which is present in potassium nitrate (potassium nitrate releases oxygen when heated) and a larger quantity of an unreactive substance (which we call nitrogen).

In 1668 John Mayow wrote that air contains the gas oxygen (he called it nitroarial spirit), which is consumed in respiration and burning. Mayow observed that: substances do not burn in air from which oxygen is absent; oxygen is present in the acid part of potassium nitrate; animals absorb oxygen into their blood when they breathe; air breathed out by animals has less oxygen in it than fresh air.

## NEW ELEMENTS

The school science labs have a periodic table on the wall but until now, there have been a few missing elements towards the bottom. Ben Pilgrim explained to Kat Arney why everyone is suddenly very excited about this historic table...

Ben - Yes, there's been a very exciting week for chemistry. So IUPAC (The International Union of Pure and Applied Chemistry), announced that four elements (elements number 113, 115, 117 and 118) have been discovered. Now these haven't all been discovered in the last few days - that would be quite a coincidence. It's actually been about 10 or 15 years since scientists first started gathering evidence to suggest that these elements did exist. So there have been gaps in the periodic table; they've been predicted to be there for a long time, but it's all about the scientists getting enough data to be able to be sure that these elements are actually there.

Kat - The periodic table - a lot of people have heard of it, a lot of people probably recognise it. What exactly is it as a way of categorising elements? How did they know that there were these gaps in there?

Ben - So, elements are placed in a periodic table depending on the number of protons, which are a particle found in the nucleus of every atom, and there's basically, you know, the first element hydrogen has one proton, the second element helium has two, and so on. The number of protons defines what element you have and, it so happens these numbers I said earlier, they are the number of protons that we hadn't found yet but, you know, they should be there because it should be possible to have one with that particular number.

Kat - So how do you go about discovering a new element - I assume you don't find it down the back of the sofa?

Ben - Yes, I mean the problem is that there's about 90 elements on the earth, sort of naturally occurring, we find them around. They might be bound up with other things but they will always be there, they're stable. An oxygen will always be an oxygen, a gold will always be a gold. The trouble with these elements is they're radioactive, they're unstable. They fall apart after a very short amount of time - sometimes fractions of a second, and so the scientists actually have to make them and they do this by

firing two lighter elements at each other. So, for example, they fire a calcium atom at an atom of americium. Calcium has a number of 20 and americium has a number of 95 and that adds together to make 115. Part of the difficulty is that these new ones we make, they are unstable, they fall apart, so how do we know we've made them?

Chris - They hang around for something in the region of about a microsecond through to a couple of seconds, don't they. I mean someone was saying that one of these new elements, they'd only ever made 90 atoms ever.

Ben - Yes. One of the ones I found out that 117 apparently 15 atoms have been observed, so...

Chris - As many as that.

Ben - You don't want to...

Kat - Don't spend them all at once.

Ben - You don't want to go to the toilet and miss it or something, do you? But, imagine if you had a video, for example, of a game of snooker and someone had, by some computer wizardry, removed the cue ball from the piece of videotape that you might be able to think about where the cue ball was based on what the other balls were moving and how they were moving around the table, and that's a bit like what they have to do here. They have to kind of use what these heavy atoms decay into, and then kind of reconstruct and then assume what they had before.

Chris - Can I just ask you the really simple question though which is - why are we doing this?

Ben - Well I think it's very exciting because there's something that's referred to as the 'island of stability'. So, as we get heavier and heavier, the atoms are becoming less stable but, it's been hypothesised by a number of people that, once we get a little bit higher up we might actually get back into some stable elements again, some stable atoms and these may have new properties that, you know, haven't been seen before. So that's very exciting.

Kat - And, of course, the big question is - what are we going to call them, because numbers aren't cool? We need like brilliant names. What's the...

Chris - Ununtrium and ununpentium and ununseptium. Is that not sexy enough?

Kat - Come on, no!

Ben - Those names are a little dull, so they can be called after a number of things. A number are called after countries or places or after famous scientists.

Chris - There was a petition this week to call one after Lemmy from Motorhead.

Ben - Yes, this would be one of the heaviest of the heavy metals. Unfortunately, I think it has to be a scientist, according to the rules. There are certainly some British scientists - Humphry Davy, Michael Faraday that don't have elements named after them. Even perhaps one of our most famous scientist overall, Isaac Newton, doesn't have an element. But because the research groups - 113 was discovered by a Japanese group, the others by a collaboration between Russian scientists and American scientists, I think we might maybe see a reference to Japan in one of them, one based on the name of Moscow I've heard, and so I think that's perhaps slightly more likely.

Kat - Well, I think we shall have to see.

### **Тексты для перевода к разделу 5 «Моя будущая профессия»:**

When thinking about biotechnology, many people picture a scientist in a lab coat developing a lifesaving drug or medical device. While this image represents one common biotechnology career path, lab work is not the only option. With many exciting discoveries to make and new problems to solve, biotechnology professionals can make a difference in the lives of others in many ways.

So what types of jobs are available in the biotechnology industry? And what kind of skills will give you a competitive advantage in the job market? Because biotechnology has applications in many industries, professionals can choose to work for a variety of organizations, including government agencies, private companies, regulatory bodies, or clinical laboratories. Biotechnology employers range in size and type from small start-ups to global pharmaceutical leaders to federally-funded organizations such as the Department of Agriculture and National Institutes of Health.

Here are some of the most in-demand biotechnology careers that are shaping our future.

### **Biomedical Engineer**

Biomedical engineers combine engineering and biological expertise to design solutions to problems in biology and medicine. With the goal to improve the quality and effectiveness of patient healthcare, they design biomedical equipment, devices, and medical software, such as artificial organs, prostheses, and diagnostic machines.

### **Biochemist**

Biochemists study the chemical properties of living things and biological processes, such as cell development, cell growth, heredity, and disease. They conduct complex research projects and frequently isolate, analyze, and synthesize proteins, lipids (fats), DNA, carbohydrates (sugars), and other molecules. They also research the effects of drugs, hormones, and nutrients on tissues and biological processes to develop products and processes that may improve human health.

### **Medical Scientist**

Medical scientists conduct clinical research to improve patient health by investigating diseases and prevention methods. They may also develop and test medical devices. They frequently prepare and analyze medical samples to investigate the causes and treatments of toxicity, pathogens, and chronic diseases. These scientists also help standardize drug potency, doses, and methods for the mass manufacturing and distribution of drugs and medicinal compounds.

### **Microbiologist**

Microbiologists study viruses, bacteria and the immune system to produce biomedical and industrial products. These professionals conduct complex research projects and lab experiments to aid in the diagnosis and treatment of infectious illnesses.

As the field continues to evolve, there's a growing need for skilled professionals to innovate and bring new technologies to market. Remember, no matter what part of the field you're in, you can truly have an impact on the world around you.

## **BIOTECHNOLOGY**

The benefits of biotechnology in medicine are without doubt staggering. Although many exciting developments have taken place in the past few years, with continuing research, it is expected that more and more revolutionary procedures, substances, and devices will be developed to improve and enhance human life. When it comes to biotechnology in medicine, there are many different things that have already been discovered and even more on the near horizon.

For instance, today's biotechnology is now being used to develop much-needed vaccines, new drugs to combat tough illnesses, creating xenotransplant organs, developing a variety of nanomedical diagnostic techniques, and even determining origins of disease. Because of the vastness of biotechnology specific to medicine, millions more people will be helped over those who have already benefited from different opportunities.

## ***Antibiotics through Biotechnology***

Keep in mind that biotechnology is nothing new. If you look back to 1929 when Alexander Fleming discovered penicillin, followed by the development of antibiotics, we can see this has been around for a long time. Interestingly, penicillin was created completely by accident when Fleming noticed that *Staphylococcus aureus* cultures were killed after being contaminated by the *Penicillium notatum* fungus. Through his research, it was found that if the substance found in the cell free culture media were inhibited once the fungal cells were removed, the result was a drug that is still widely used today – Penicillin.

## ***Medical Advancements with Biotechnology***

However, along with the earlier developments specific to biotechnology in medicine, many new and exciting discoveries have been made. These breakthroughs are so impressive but just a few examples of how far biotechnology in medicine has come, which provides a small glimpse into where it will go in the future.

- **Artificial Lymph Nodes** – To begin with, Japanese scientists have been able to use biotechnology to develop artificial lymph nodes. Since these organs produce immune cells that help fight infection and are sometimes affected in cases of cancer, this discovery is truly revolutionary. The goal would be for doctors to fill these artificial nodes with cells that could help fight and treat specific types of illnesses to include cancer but also HIV.

- **Fighting Tooth Decay** – Another way in which biotechnology in medicine is making a difference is the fight against tooth decay using special decay fighting microbes. A company in Florida called ONI BioPharma has been able to develop a strain of bacteria called SMaRT. This bacterium is incapable of producing lactic acid while also releases an antibiotic capable of killing the standard bacteria strain causing tooth decay. For SMaRT to work, dentists simply swab a small amount onto the teeth, which in turn creates health that lasts for life.

- **Spitting for Cancer** – Unlike invasive biopsies used to check for oral cancer, biotechnology has made it possible for a person's saliva to be tested. In this case, cancerous cells react to dyes using a special sensor. With fluorescent illumination viewed under a microscope, the dentist would know whether a person had oral cancerous cells.

- **Contact Lens** – Unfortunately, the number two reason people go blind is glaucoma. As pressure builds behind the eye, retina cells become damaged. Thanks to biotechnology in medicine, the University of California-Davis has been able to develop contact lens with conductive wires to check pressure on a continual basis. In addition, these contact lenses have the ability to check the eye's fluid for people at high risk of developing glaucoma.

- **Sensory for Asthma** – Sadly, people die every year from asthma. Because the airways become constricted, a person having an asthma attack cannot breathe and if not treated on an emergency basis, death would be imminent. However, the University of Pittsburgh has used biotechnology in

medicine to create a polymer-coated carbon nanotube that can analyze even tiny amounts of nitric oxide, gas that is produced within the lungs just before an attack. What makes this so amazing is that the nanotube housed within the device is 100,000 times smaller than a human hair yet extremely sensitive.

- **Regenerating Nerves** – The last example we wanted to provide for advancements in biotechnology in medicine is the nanogel, which can be injected as a liquid to help regenerate nerves. In this case, fibers have peptides that send signals to stem cells to produce healthy cells that support regrowth of damaged nerves.

### **Biotechnology Applications In Medicine**

You may have already learnt about Recombinant DNA (rDNA) technology. This biotechnology application is very important in healthcare because it allows for the mass production of safe and more effective medicines. It also prevents undesirable immune responses which are common with medical products from non-human sources.

Currently, about 30 recombinant therapeutics have been approved for human use worldwide, and 12 of these are presently being marketed in India. Let's take a look at some of the applications.

#### **1) Genetically Engineered Insulin**

Earlier, diabetes was treated using insulin from the pancreas of slaughtered pigs and cattle. Do you think this insulin causes any side-effects in humans? Yes! Insulin from animal sources induces allergies and other unwanted immune reactions in humans. This is why there was a need to isolate human insulin. Is there a way to do this? What if we can use bacteria to produce human insulin? Not only can we grow bacteria in large amounts, but we can also mass-produce human insulin!

Insulin consists of two short, polypeptide chains – chain A and B, linked via disulfide bridges. Insulin is produced as a 'prohormone' in mammals (including humans). This prohormone has an extra peptide, the **C peptide**, which needs to be removed to give rise to mature insulin.

#### **Maturation of Insulin.**

The major challenge while generating human insulin is to assemble insulin into its mature form. An American company called 'Eli Lilly' overcame this hurdle in 1983. They prepared two DNA sequences that correspond to the A and B chains of human insulin. They then incorporated these sequences into plasmids of *E. Coli* to generate insulin chains. Further, they produced the chains separately, extracted and combined them by creating disulfide bonds to give rise to human insulin.

#### **2) Gene Therapy**

If a child is born with a genetic defect, is there a way to correct that defect? Yes, there is, with gene therapy! Gene therapy is a biotechnology application involving a collection of methods that can correct a gene defect in a child or an embryo. It involves inserting a normal gene into the person's cells or tissues to compensate for the non-functional gene. Let's understand how this works.

In 1990, the first clinical gene therapy was applied to treat a 4-year old girl with a deficiency in the enzyme adenosine deaminase (ADA). This disorder is due to the lack of the gene for ADA, which is an enzyme important for the function of the immune system. Bone marrow transplantation helps cure this disorder in some cases. Enzyme replacement therapy, which involves injecting the patient with functional ADA, is also effective in some cases. However, both these procedures are not completely curative.

In gene therapy, blood lymphocytes of the patient are grown in a culture outside the body. Subsequently, a functional ADA cDNA is incorporated into these lymphocytes and re-introduced into the patient. This alleviates the symptoms of the disorder. However, the patient requires periodic infusions of these genetically-engineered lymphocytes, since these cells are not immortal. A permanent cure for this

could be to introduce the gene producing ADA from marrow cells into cells at early embryonic stages of life.

### **3) Molecular Diagnosis**

We all know that early diagnosis of a disease is important to effectively treat the disease. Early detection is not possible using conventional methods like serum and urine analysis. Let's look at some biotechnology applications that help in early diagnosis of diseases.

#### **i) Polymerase Chain Reaction (PCR)**

Normally, we can detect a pathogen (bacteria, virus etc.) only when the disease symptoms start to appear. However, by this time, the pathogen concentration in the body is very high! Is there a way to detect pathogens at initial stages of the disease when their concentrations are low?

Yes, using a technique called PCR. PCR involves amplification of the nucleic acid in the pathogen allowing us to detect the pathogen at very low concentration. Today, we use PCR routinely to detect HIV in suspected AIDS patients and to detect gene mutations in suspected cancer patients.

Steps in Polymerase Chain Reaction (PCR) [Source: thebalance]

#### **ii) Enzyme-Linked Immunosorbent Assay (ELISA)**

The basic principle of ELISA is antigen-antibody reactions. ELISA can diagnose infections by detecting the presence of antigens (proteins of the pathogen) in the patient serum or by detecting the antibodies produced against the pathogen.

#### **iii) In Situ Hybridisation**

This technique involves tagging a single-stranded DNA or RNA with a radioactive molecule (probe). This then hybridizes with its complementary DNA in a clone of cells. On detection using autoradiography, the clone with the mutated gene will not appear on the photographic film because the probe is not complementary to the mutated gene.

#### **Solved Example For You**

Q: Which of the following techniques is based on antigen-antibody reactions?

- a. rDNA technology
- b. ELISA
- c. PCR
- d. Gene therapy

Solution: The answer is 'b'. ELISA is based on antigen-antibody reactions.

#### **Overview**

Medicinal chemistry is a stimulating field as it links many scientific disciplines and allows for collaboration with other scientists in researching and developing new drugs.

Medicinal chemists apply their chemistry training to the process of synthesizing new pharmaceuticals. They also improve the processes by which existing pharmaceuticals are made. Medicinal chemists are focused on drug discovery and development and are concerned with the isolation of medicinal agents found in plants, as well as the creation of new synthetic drug compounds. Most chemists work with a team of scientists from different disciplines, including biologists, toxicologists, pharmacologists, theoretical chemists, microbiologists, and biopharmacists. Together, this team uses sophisticated analytical techniques to synthesize and test new drug products and to develop the most cost-effective and environmentally friendly means of production.

#### **Careers in this Field**

- Basic research into how various chemicals affect biological systems

- Drug development, including formulating drugs used to treat patients with diseases
- Testing potential new bio-active compounds in patient populations
- Developing guidelines for how new pharmaceuticals will be such as chemists at the U.S. Food and Drug Administration (FDA) who review new drug applications from pharmaceutical companies and the processes by which the substances are made

### **Education**

Generally, pharmaceutical companies prefer to hire people with research experience, advanced degrees (especially in organic chemistry), and at least two years of post-doctoral experience. Most chemists in traditional research careers are Ph.D. chemists, while chemists with B.S. degrees generally serve as research technicians. You can place yourself in a competitive position by getting as much industrial experience as possible, with a strong background in organic chemistry and biochemistry. A number of universities have medicinal chemistry departments, often associated with biological chemistry, pharmaceutical chemistry, pharmacology, or pharmacy programs.

### **Workspace**

Medicinal chemistry offers a wide variety of lab opportunities in pharmaceutical, biotechnology, and medical device companies. Most chemists use their research skills to formulate, produce, characterize, and analyze new compounds for specific applications. However, each lab environment is unique in regards to daily activities and career opportunities. In some cases, laboratory work is not always required, for example, when reviewing drug applications at the FDA.

### **Technical Skills**

<b>Analytical</b>	<b>Background Knowledge</b>	<b>Communication</b>
<ul style="list-style-type: none"> <li>• Analytical instrumentation skills for compound identification.</li> </ul>	<ul style="list-style-type: none"> <li>• Synthetic organic chemistry skills, including purification and synthesized and tested, so the medicinal chemist identification of products.</li> <li>• Broad understanding of biology and biological functions and how drugs work.</li> </ul>	<ul style="list-style-type: none"> <li>• Teamwork and interpersonal skills are required. In most cases a large, interdisciplinary team will decide which compounds should be synthesized and tested, so the medicinal chemist needs to work well with everyone on the team.</li> <li>• Communication skills—medicinal chemists often have to write reports and present the results of their research. They need to be able to communicate clearly with other chemists, with other types of scientists, and with nonscientists.</li> </ul>

### **Career Path**

Many medicinal chemists start out in the lab and then move on to other laboratory career such as process chemistry, formulation chemistry, quality control or quality assurance. They may also move to nonlaboratory careers such as regulatory affairs, intellectual property (patents), project management, or technology transfer.

### **Future Employment Trends**

The outlook for this field is mixed due to changing economy and government health care reform regulations. Pharmaceutical companies have been downsizing their research labs, merging with other companies, and outsourcing research for many years. Some outsourcing has also taken place overseas, reducing opportunities for domestic pharmaceutical jobs. Small companies and contract research firms are some of the more promising places for employment in medicinal chemistry.

### **Is This Career a Good Fit for You?**

Medicinal chemists must enjoy varied activities and be excited about exploring the unknown. A good imagination and persistence are also two important qualities to have when considering a career in medicinal chemistry. Being a team player with good written and verbal communication skills are invaluable assets when interacting with scientists from other disciplines. Knowing that your work is helping to improve human health and reduce suffering is a strong motivating factor for many in this field.

## **LABORATORY INSTRUMENTATION IN CLINICAL BIOCHEMISTRY: A HISTORICAL PERSPECTIVE**

Great strides have been made over the centuries in analysing biochemically the various body fluids, prime amongst which are urine, blood and cerebrospinal fluid. Such clinical advances have been intimately related to, and necessarily constrained by, the analytical capabilities of the day; and these, in turn, have been heavily dependent upon technological advances in scientific instrumentation.

The early modes of instrumentation employed in body fluid examination notably urine and blood were very rudimentary; simple household items were commonly used in such tests; for example, Richard Bright (1789-1858) used a candle flame to heat urine in a tablespoon when testing for proteinuria in cases of suspected renal disease.

One of the earliest pieces of more complex equipment was the microscope, introduced in its simple form in 1668 by Antoni van Leeuwenhoek (1632-1723). He used this apparatus, which comprised a set of double-convex lenses mounted between brass plates, to observe the cells in blood, and the first accurate description of red blood corpuscles was published in 1674. Nevertheless, the microscope did not become firmly established in the clinical pathology laboratory until around 1820, shortly after the achromatic objective lens had been designed by Joseph Lister (1786- 1869). This latter development was paramount in advancing the clinical usefulness of microscopy.

Many of the instruments that found application in the emerging science of clinical analytical chemistry had already achieved an established role what might be regarded as pure chemistry. Such equipment included the sensitive weighing balances whose manufacture had been championed by Laurent Lavoisier (1743-1794), recognized the need for much greater accuracy in quantitative measurement and had constantly urged manufacturers to improve the design of their balances.

Figure 1 Laurent Lavoisier's experiments  
respiration



Another piece of apparatus introduced in the eighteenth century was the graduated measuring cylinder, first used for volumetric analysis in 1784 by Louis Bernard Guyton de Morveau (1737-1816). The accuracy and ease of volumetric analysis was greatly increased in 1806 when Franqois Descroizilles

(1751-1825) introduced the burette. This had an air-hole over which a finger could be placed to control the outflow of fluid.

Further developments in the early nineteenth century led to introduction of the refractometer in 1802 by William Hyde Wollaston (1766-1828); the instrument did not come into clinical use until 1900, when Strubell applied it to measuring serum proteins.

In the early 1840s, Robert Wilhelm Bunsen (1811-1899) introduced spectroanalysis and the concept of coefficient of extinction. This led to development of the spectroscope, which by 1860 was well established for detecting the various spectrogenic pigments in blood. Introduction of colorimetry marked a major turning-point in analytical development; the first colorimeter, designed by Jules cardiograph, a microtome, a knife, a paraffin bath, a few Dubosq (1817-1886) in France, became available in 1854 and was used initially to measure caramel in syrup.

Another piece of apparatus widely used in laboratories as a heating device was the Bunsen burner; it had been designed originally by the British chemist and physicist, Michael Faraday (1791-1867). However, it was Robert Bunsen who adapted the concept of the gas-air burner in 1855 and who was responsible for popularizing its use.

The term chromatography was coined by the Russian botanist Mikhail Tsvett (1872-1919); it was he who described the first mode, absorption chromatography, as long ago as 1906. The mass spectrometer – a device which converts molecules into ions and then separates ions according to their mass-to-charge ratio – was developed in 1919 by the British physicist and Nobel laureate Francis William Aston (1877-1945).

Automation is the next crucial step to be mentioned. The introduction of computers into laboratory work for the handling and processing of the vast amount of data being generated has begun a new era in working patterns of biochemists.

## **RULES FOR WORKING IN A BIOCHEMISTRY LABORATORY**

There are two major concerns to be considered when working in a biochemistry laboratory. First is safety: this can never be overemphasized. The second is efficiency in the laboratory work. Although the latter very much depends on the individuals doing the experiments, there are general rules students are advised to follow:

1. keep the benches and shelves clean and well-organized;
2. avoid contaminating the chemicals; use only clean glassware and spatulas; label glassware in use;
3. plan your experiments before starting to carry them out;
4. pay attention to others in the laboratory.

Students working in a biochemistry laboratory must always be aware that the chemicals used are potentially toxic, irritating and flammable. Such chemicals are hazards, however, only when they are mishandled.

Do not work alone in the laboratory. Eating, drinking and smoking in the laboratory are strictly prohibited. Special care for eye protection is required. Safety glasses must be used when certain procedures are being carried out. The instructor will call the students' attention to those procedures.

While heating a solution one should make sure not to overheat it; therefore, vigorous mixing of the solution by shaking or stirring is required. The mouth of the glassware containing the solution to be heated should never be pointed toward anyone.

Handling of strong acids and bases requires special attention. When diluting concentrated acids, the acid should be poured into the water and never the opposite.

The pipettes should never be filled with solutions of toxic substances, biological fluids, strong acids and bases by mouth suction. Volatile liquids and solids that are toxic or irritating should be handled under fume hoods.

While handling flammable liquids such as ether, alcohols, benzene, naked flame (burners, matches) must not be in use. The above liquids must not be stored near radiating heat sources, such as the laboratory oven.

Before using electrical appliances, make sure they are grounded. Flasks with flat-bottoms or thin walls should not be desiccated. Before leaving the laboratory, electrical equipment should be turned off, and gas burners extinguished. No tap water should be left running.