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ENGLISH FOR FUTURE CHEMISTS (Part II)

Англійська мова для майбутніх хіміків (Частина II)

Рекомендовано Методичною радою КПІ ім. Ігоря Сікорського
як навчальний посібник для студентів, які навчаються за спеціальністю
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Навчальний посібник призначений для навчання англійській мові студентів першого курсу хіміко-технологічного факультету спеціальності 161 «Хімічні технології та інженерія». Видання складається з п’яти розділів, які охоплюють загальні хімічні теми: «Розчини», «Періодична таблиця хімічних елементів», «Лужні метали», «Лужно-земельні метали» та «Інертні гази». Розроблені вправи спрямовані на розвиток і удосконалення вмінь у читанні, усному мовленні, аудіюванні, письмі та перекладі, а також поліпшення фонетичних, лексичних та граматичних знань студентів. Завданням посібника є підвищення ефективності організації навчання іноземної мови в аудиторний і позааудиторний час, а також розширення професійного тезаурусу студентів, та формування інтересу до спілкування англійською мовою.

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Передмова

Навчальний посібник «Англійська мова для майбутніх хіміків» призначено для навчання професійно орієнтованого англомовного спілкування студентів – майбутніх фахівців хімічної галузі, які здобувають ступінь бакалавра (перший курс) у технічних вишах.

Метою навчального посібника є формування професійно орієнтованих англомовних компетентностей у читанні, аудіюванні, перекладі, говорінні та письмі; підвищення ефективності процесу навчання іноземної мови в аудиторний та позааудиторний час, а також поглиблення знань з професійно орієнтованих дисциплін, розвиток творчого та критичного мислення.

Навчальний посібник містить п’ять розділів, розроблених на основі текстів загально-хімічної професійно орієнтованої тематики («Розчини», «Періодична таблиця хімічних елементів», «Лужні метали», «Лужно-земельні метали», «Інертні гази»). Посібник укладено на основі автентичних текстів та відеоматеріалів. Кожнен розділ включає п’ять блоків завдань, націлених на розвиток професійно орієнтованих англомовних компетентностей у читанні, аудіюванні, говорінні та письмі, а також спрямованих на формування фонетичних, лексичних та граматичних знань, навичок і вмінь використання мови. Всі розділи доповнює тест для самостійної оцінки знань після опрацювання теми, відповіді до якого розміщені у додатку в кінці посібника.

Завдяки різноманітності та достатній кількості вправ викладач має можливість ефективно організувати як аудиторну, так і позааудиторну самостійну роботу студентів, спрямовану на досягнення високих результатів у формуванні англомовних компетентностей. Значна увага у посібнику приділяється парній та груповій роботі, розвитку творчих здібностей та самостійності у процесі навчання.

Навчальний посібник включає наступні додатки: 1) міні-словник, 2) стенограми відеозаписів, 3) довідковий матеріал для успішного виконання граматичних вправ, 4) рекомендації щодо написання текстів окремих академічних жанрів.

Автентичні матеріали, використані у посібнику, було взято із англомовних друкованих та електронних джерел, посилання на які подано у списку літератури.

Автори

UNIT 1. SOLUTIONS

Lead-in

1. Discuss the following questions in pairs.

- ***What is a mixture?***
- ***What types of mixtures do you know?***
  Give examples of mixtures.
- ***What is a solution?***
- ***What types of solutions do you know?***

Reading 🕮

2. The following words appear in the texts you are going to read. Check whether you know their pronunciation and meaning.

aqueous solutions [ˈeɪkwɪəs, ˈækwɪ-] [sə'luːʃ(ə)nz]

gaseous solutions ['gæsɪəs, 'geɪʃəs]

acidic [ə'sɪdɪk] / basic ['beɪsɪk] / neutral ['nju:trəl] solutions

dilute [daɪ'lu:t] / concentrated solutions

saturated ['sætʃəreɪtɪd] /supersaturated/ unsaturated solution

solute ['sɔlju:t], solvent ['sɔlvənt], solubility [ˌsɔlju'bɪlətɪ]

the solute's surface particles [ðə 'sɔlju:ts 'sɜ:fɪs 'pɑ:tɪklz]

a given amount of solvent ['sɔlvənt]

be soluble in water ['sɔljəbl] (*OPP* insoluble)

dissolve [dɪ'zɔlv], dissolved [dɪ'zɔlvd]

affect greatly the solubility [ə'fekt ðə ˌsɔlju'bɪlətɪ]

be affected by pressure [bi ə'fektɪd baɪ 'preʃə]

the net effect [ðə ˈnet ɪ'fekt]

be compressible [kəm'presəbl] (*OPP* incompressible)

be miscible with sth [bi 'mɪsɪb(ə)l] (*OPP* immiscible)

acetic acid [ə'si:tık 'æsıd]

solvation [sɒlˈveıʃən]; the solvation rate [ðə sɒlˈveıʃən ˈreıt]

solvated solute particles [ˈsɒlveıtid 'sɔlju:t 'pɑ:tıklz]

at a specified temperature ['spesıfaıd]

frequent collisions ['fri:kwənt kə'lıʒ(ə)nz]; collide with [kə'laıd]

crystallize ['krıstəlaız], crystallization [ˌkrıstəlaı'zeıʃ(ə)n]

reach equilibrium [ri:ʧˈi:kwı'lıbrıəm], [ˌekwı'-]

increase *noun* ['ınkri:s]; *verb* [ın'kri:s]

conduct a current [kən'dʌkt 'kʌr(ə)nt] *BrE*; ['kɜ:r(ə)nt] *AmE*

phenolphthalein [ˌfi:nɒl'(f)θali:n, -'(f)θeıl-]

methyl ['me θıl] ['mi:θʌıl], litmus ['lıtməs]

3. Students are divided into two groups. The students of group A read text A. The students of group B read text B. Then students A and B in pairs ask and answer the questions to the texts they have read.

Student A:

a) Read the text, choose the best title for it and prepare to answer the questions on the obtained information.

- ***Characteristics of Solutions***
- ***Kinds of solutions***
- ***Solubility***
- ***Solutes and solvents***

Text A

Cell solutions, ocean water, and steel may appear quite dissimilar, but they share certain characteristics. **Solutions** are homogeneous mixtures containing two or more substances called the solute and the solvent. **The solute** is the substance that dissolves. **The solvent** is the dissolving medium. When you look at a solution, it is not possible to distinguish the solute from the solvent.

A solution may exist as a gas, liquid, or solid depending on the state of its solvent. Air is a gaseous solution, and its solvent is nitrogen gas; braces may be

made of nitinol, a solid solution of titanium in nickel. Most solutions, however, are liquids. Reactions can take place in aqueous solutions, that is, solutions in which reactants and products are mixed in water. In fact, water is the commonest solvent among liquid solutions. The solutes in the solutions may be gases, liquids, or solids. Note also that solutions such as ocean water can contain more than one solute.

Types and Examples of Solutions

Type of solution	Example	Solvent	Solute
Gas			
Gas in gas	Air	Nitrogen (gas)	Oxygen (gas)
Liquid			
Gas in liquid	Carbonated water	Water (liquid)	Carbon dioxide (gas)
Gas in liquid	Ocean water	Water (liquid)	Oxygen gas (gas)
Liquid in liquid	Antifreeze	Water (liquid)	Ethylene glycol (liquid)
Liquid in liquid	Vinegar	Water (liquid)	Acetic acid (liquid)
Solid in liquid	Ocean water	Water (liquid)	Sodium chloride (solid)
Solid			
Liquid in solid	Dental amalgam	Silver (solid)	Mercury (liquid)
Solid in solid	Steel	Iron (solid)	Carbon (solid)

Some combinations of substances readily form solutions and others do not. A substance that dissolves in a solvent is said to be **soluble** in that solvent. For example, sugar is soluble in water, a fact you probably learned by dissolving sugar in flavored water to make a sweetened beverage such as tea, lemonade, or fruit punch. A substance that does not dissolve in a solvent is said to be **insoluble** in that solvent. Sand is insoluble in water. Have you ever shaken a bottle of oil and vinegar when making salad dressing? If so, what happens to the liquids shortly after you stop mixing them? You are correct if you answered that they separate, or cease to mix. Oil is insoluble in vinegar; and thus, oil and vinegar are said to be **immiscible.** Two liquids that are soluble in each other, such as those that form the antifreeze listed in the table above, are said to be **miscible**.

Some substances in solution called **electrolytes** conduct a current; others called **non-electrolytes** do not permit the current to flow. Solutions can be **acidic, basic,** or **neutral**. The chemist must have some means of determining whether a solution is acidic, basic, or neutral. Chemical indicators can serve this purpose. Essentially, an **indicator** is a dilute, weakly acidic solution that changes colour as the concentration of H_30^+ and OH^- ions varies. Three indicators often used in laboratory work are litmus, methyl orange, and

phenolphthalein. Litmus is an organic dye, which is derived from primitive plants called lichens. It is red in the presence of an acid and blue in the presence of a base. Methyl orange is an indicator which is yellow in basic solutions and red in acidic solutions. Phenolphthalein is colourless in acidic solutions and pink in basic solutions, unless they are very basic, when the indicator becomes colourless again.

Taken from: Buthelezi T., Dingrando L., Hainen N., Wistrom C., Glencoe Chemistry

b) Ask student B the following questions.

1. What is solubility?
2. Can we dissolve any amount of a substance?
3. When does the solvation stop?
4. What is the difference between a saturated solution and unsaturated solution?
5. Does pressure effect the solubility?

Student B:

a) Read the text, choose the best title for it and prepare to answer the questions on the obtained information.

- ***Characteristics of Solutions***
- ***Kinds of solutions***
- ***Solubility***
- ***Solutes and solvents***

Text B

If you have ever added so much sugar to a sweetened beverage that sugar crystals accumulated on the container's bottom, then you know that only a limited amount of solute can dissolve in a solvent at a given set of conditions. In fact, every solute has a characteristic solubility. **Solubility** refers to the maximum amount of solute that will dissolve in a given amount of solvent at a

specified temperature and pressure. Solubility is usually expressed in grams of solute per 100 g of solvent.

Just as solvation can be understood at the particle level, so can solubility. When a solute is added to a solvent, solvent particles collide with the solute's surface particles; solute particles begin to mix randomly among the solvent particles. At first, the solute particles are carried away from the crystal. However, as the number of solvated particles increases, the same random mixing results in increasingly frequent collisions between solvated solute particles and the remaining crystal. Some colliding solute particles rejoin the crystal, or crystallize. As solvation continues, the crystallization rate increases while the solvation rate remains constant. As long as the solvation rate is greater than the crystallization rate, the net effect is continuing solvation.

Depending on the amount of solute present, the rates of solvation and crystallization may eventually equalize: no more solute appears to dissolve and a state of dynamic equilibrium exists between crystallization and solvation (as long as the temperature remains constant). Although solute particles continue to dissolve and crystallize in solutions that reach equilibrium, the overall amount of dissolved solute in the solution remains constant. Such a solution is said to be a **saturated solution**; it contains the maximum amount of dissolved solute for a given amount of solvent at a specific temperature and pressure. An **unsaturated solution** is one that contains less dissolved solute for a given temperature and pressure than a saturated solution. In other words, more solute can be dissolved in an unsaturated solution. A **supersaturated solution** is a solution, which has more solute than it could at the existing temperature. Increasing the temperature of the solvent we increase the stability (if a solid dissolves endothermally).

Pressure does not affect greatly the solubility of solids and liquids because they are incompressible. Gases, on the contrary, are compressible and affected by pressure.

Taken from: Buthelezi T., Dingrando L., Hainen N., Wistrom C., Glencoe Chemistry

b) Ask student A the following questions.

1. How would you define a solution?
2. What is a solvent and what is a solute?
3. In which forms do solutions exist? What is the most common form of solutions?
4. How do we call substances that can and can't be dissolved?
5. What types of solutions are mentioned in the text?
6. What chemical indicators are mentioned in the text?

Listening

4. a) Discuss the following questions in pairs or small groups.

- What is solubility?
- What types of solutions do you know?
- Is it possible to dissolve any substance?

b) Watch the video about solubility and answer the following questions.
(https://www.youtube.com/watch?v=7I8zgrSydsg).

1) What happens to sugar in tea?
2) What terms are explained in this video?
3) Why doesn't sand dissolve in water according to this video?
4) What affects the solubility of a substance? What examples are given in the video?

c) Watch the video again. What facts mentioned in the video weren't mentioned in the texts in ex.3.

Language in Use

5. Explain the meaning of the words in bold in exercise 3.

6. a) Give English equivalents to the following words.

Розчин, розчинність, розчинник, розчинена речовина, розчинюватися, водний розчин, реагент, нерозчинний, кислота, основа, кислотний розчин, оцтова кислота; той, що змішується; розводити, накопичуватися, рідина, тверде тіло, стикатися з, кінцевий результат, зрівнюватися, рівновага, насичений розчин, ненасичений розчин, надлишок, осідати, лакмус.

b) Make up your own sentences in English with any 7 words from the task above. Write them down and ask your groupmates to translate them into Ukrainian.

7. a) Match the words with their definitions.

1. homogeneous	a.	the condition existing when a chemical reaction and its reverse reaction take place at equal rates
2. medium	b.	a liquid, typically one based on ethylene glycol, which can be added to water to lower the freezing point
3. immiscible	c.	any of a class of chemical reactions, such as the formation of hydrated copper sulfate in aqueous solution, in which solute and solvent molecules combine with relatively weak covalent bonds
4. antifreeze	d.	of uniform structure or composition throughout
5. accumulate	e.	cause (a substance) to be deposited in solid form from a solution
6. solvation	f.	the substance in which a specific organism lives and thrives.
7. equilibrium	g.	the ability of a substance to dissolve; the quality of being soluble
8. supersaturated	h.	gather or build up

9.	solubility	i.	not forming a homogeneous mixture when added together
10.	precipitate	j.	containing more solute than a saturated solution and therefore not in equilibrium

b) Cover the left column and recall the terms.

8. Match the words in column A with the words in column B to make word combinations, translate them, then choose any three and make sentences.

Column A	***Column B***
1. aqueous	a. solute
2. acetic	b. effect
3. crystallization	c. constant
4. net	d. rate
5. to reach	e. particles
6. solvated	f. solution
7. dissolved	g. collisions
8. frequent	h. equilibrium
9. dissolving	i. acid
10. to remain	j. medium

9. Fill in the gaps with a suitable word.

mixing homogeneous dilutes lower dissolving(2)
diluted above higher crystallize depend

Liquid solutions

Liquid solutions are made by _____ (1) two liquids (for example, alcohol and water), by _____ (2) a gas in a liquid (for example, carbon dioxide and water), or by _____ (3) a solid in a liquid (for example, sugar and water). The result is a_____ (4) system containing more

than one substance — a solution. In such a liquid, each component is_____ (5) by the other component. In salt water, the salt _____ (6) the water and, of course, the water dilutes the salt. This solution is only partly made up of water molecules and it is found that the vapour pressure of the solution is correspondingly _____ (7) than the vapour pressure of pure water. The boiling point of salt water is _____ (8) the boiling point of pure water. The more salt is added, the _____ (9) is the boiling point. In a similar way, a lower temperature is required to _____ (10) ice from salt water or from an alcohol-water solution than from pure water. In general, the properties of a solution _____ (11) on the relative amounts of the components.

10. Translate the following sentences into English.

1. Розчин — однорідна суміш речовин. Компонентами розчину є розчинник і одна або декілька розчинених речовин.
2. Розчинником називають речовину, яка перебуває в такому самому агрегатному стані, що й розчин.
3. Якщо агрегатний стан усіх речовин, які утворили розчин, однаковий, то розчинником вважають речовину, маса якої найбільша.
4. Вода – найважливіший розчинник. Вона розчиняє багато різних речовин.
5. Речовини, які змінюють забарвлення в розчинах лугів і кислот, називають індикаторами.

Grammar focus

Focus on special questions

11. Make up questions to the words in bold. For grammar reference see page 97.

Life processes depend in large part on **solutions**. Oxygen from the lungs goes **into solution in the blood plasma**, unites chemically with **the hemoglobin in the red blood cells**, and is released **to the body tissues**. **The products of digestion** also are carried in solution to the different parts of the body. The ability of liquids **to dissolve other fluids or solids** has many practical applications.

Chemists take advantage of **differences in solubility** to separate and purify materials and to carry out chemical analysis. Most chemical reactions occur in solution and are influenced by the **solubility of the reagents**. Materials **for chemical manufacturing equipment** are selected to resist the solvent action of their contents.

Taken from: https://www.britannica.com/science/solution-chemistry

Focus on articles

12. a) Fill in the gaps with suitable articles (a/an/the/-) when necessary. For grammar reference see page 98.

Crystals of some salts contain 1) … lattices of ions – i.e., atoms or groups of atoms with alternating positive and negative charges. When such 2) … crystal is to be dissolved, the attraction of 3) … oppositely charged ions, which are largely responsible for cohesion in 4) … crystal, must be overcome by electric charges in 4) … solvent. These may be provided by 5) … ions of 6) … fused salt or by electric dipoles in the molecules of the solvent. Such solvents include 7) … water, methyl alcohol, liquid ammonia, and hydrogen fluoride. 8) … ions of the solute, surrounded by dipolar molecules of 9) … solvent, are detached from each other and are free to migrate to charged electrodes. Such 10) … solution can conduct 11) … electricity, and the solute is called 12) … electrolyte.

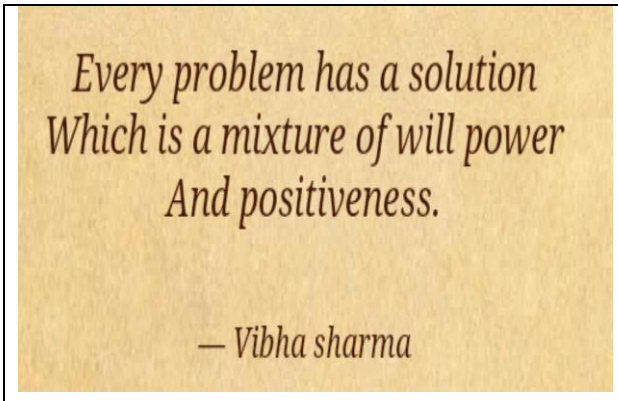
b) Look at the text on page 112. Explain the use of articles.

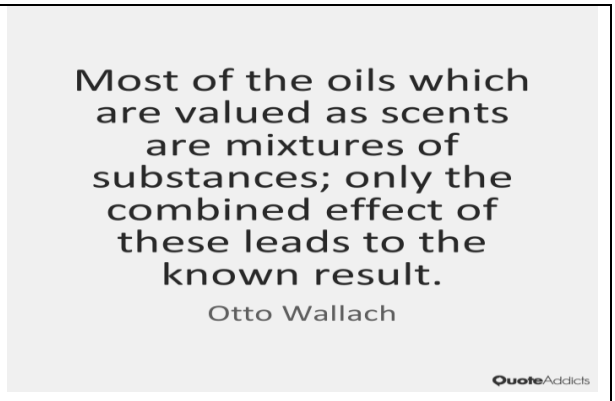
Speaking🗣

13. Discuss the following questions in pairs.

1. What is similar about table salt and table sugar that allows them both to be soluble in water?
2. Why does water by itself not dissolve a grease stain?
3. Chemists often say “like dissolves like.” What does this mean?
4. Can a dilute solution also be saturated? Explain.
5. Increasing the number of collisions between solid and solvent particles, increases the rate at which a solid is dissolved. Explain how stirring, increasing surface area, and heating increase the number of collisions.
6. Describe the characteristics of a solution and identify the various types.
7. What is solubility? Describe two factors that affect solubility.
8. What is solvation? How do we call solvation in water?
9. Which solutions contain gaseous solutes?
10. Which solutions are aqueous?
11. Are water and acetic acid miscible?

14. Work in pairs. Read the following quotes. Explain the meaning of the words *solution* and *mixture* in these contexts. Discuss if you agree with these statements. Share your ideas with the group.





15. a) Fill in the gaps in the table. What would you change or add to this table if you were going to give a lecture on "Mixtures and Solutions"? b) Using the information in the table, prepare a lecture on the topic 'Solutions'. Practise in pairs delivering this lecture to each other.

A mixture is a substance made by mixing other substances together

MIXTURES

A …… mixture consists of distinct phases. Its properties are well-defined. …… …… …… are examples of such mixtures.	**A …… mixture** consists of a single phase. Its properties are different from those of its components. …… …… are examples of such mixtures.

SOLUTIONS

Solutions are **……**mixtures containing two or more substances called the **……..……** (the substance that dissolves) and the **……..** (the dissolving medium).

- A solute dissolves in a solvent during a process called **…….....**. When the solvent is water, the process also is called **…….** .
- Every substance has a characteristic **solubility** in a given solvent.
- Factors that affect solubility include **the nature of the solute** and **solvent, ……. ,** and **pressure**.
- **……. particles** attract solute particles, and the energy is released.
-

TYPES OF SOLUTIONS

A(An) ….……... contains the maximum amount of dissolved solute for a given amount of solvent at a specific temperature and pressure.

A(An) ……..……... contains less dissolved solute for a given temperature and

pressure than a saturated solution.

A(An) …….. has more solute than it could at the existing temperature.

A(An) …….. is a weak solution that contains little solute. It can be prepared from a more concentrated standard stock solution.

A(An) …….. is a strong solution that contains a large amount of solute.

An Acidic Solution ……

……

A Basic Solution ……

……

A Neutral solution ……..

.....

Solutions	Indicators		
	Litmus	Methyl orange	Phenolphthalein
Acidic			
Basic			
Neutral	-	-	-

Writing

16. Write 5-7 sentences summarizing the texts in exercise 3.

17. Write an instruction for a 10-12-year-old child how to grow crystals from solutions (120-180 words). Use positive and negative imperative sentences. For grammar reference see page 104.

SELF-ASSESSMENT

UNIT 1. SOLUTIONS

Choose the answer that best fits each space. Indicate your answer with a letter A, B, C or D in your answer sheet paper.

1. Solutions are homogeneous ____ containing two or more substances.
A. solutes B. compounds C. mixtures D. mediums

2 In fact, water is the commonest ____ among liquid solutions.
A. solvent B. solute C. base D. acid

3. A(An) ____ is a dilute, weakly acidic solution that changes colour as the concentration of H_30+ and OH- ions varies.
A. precipitate B. electrolyte C. indicator D. dye

4. ____ is the ability of a substance to dissolve; the quality of being soluble.
A. Solubility B. Solvation C. Dilution D. Conductivity

5. When a solute is added to a solvent, solvent particles collide ____ the solute's surface particles.
A. to B. in C. into D. with

6. A solution is said to be a ____ solution if it contains the maximum amount of dissolved solute for a given amount of solvent at a specific temperature and pressure.
A. unsaturated B. saturated C. dilute D. acidic

7. ____ does not affect greatly the solubility of solids and liquids because they are incompressible.
A. Current B. Temperature C. Pressure D. Collision

8. Two liquids that are soluble in each other are said to be ____.
A. diluted B. immiscible C. dissolving D. miscible

9. A(An) ____ is a substance that dissolves.
A. solvent B. alloy C. additive D. solute

10. As solvation continues, the crystallization ____ increases while the solvation ____ remains constant.
A. rate B. equilibrium C. state D. flammability

UNIT 2. THE PERIODIC TABLE OF ELEMENTS

Lead-in

1. Discuss the following questions in pairs.

- ***What do you know about the discovery of the periodic table?***
- ***Has it changed since its discovery?***

Reading 🕮

2. The following words appear in the texts you are going to read. Check whether you know their pronunciation and meaning.

periods['pɪərɪədz], the periodic table [ðə ˌpɪərɪ'ɒdɪk 'teɪbl]

the periodic pattern of properties [ðə ˌpɪərɪ'ɒdɪk 'pætn]

propose an organization scheme [prə'pəuz ən ˌɔ:gənaɪˈzeɪʃən 'ski:m]

classify the elements ['klæsɪfaɪ ði: 'elɪmənts]

arrange the elements [ə'reɪndʒ ði: 'elɪmənts]

arranged in order of increasing [ə'reɪndʒd ɪn ˈɔ:də əv ɪnˈkri:sɪŋ]

predict the existence [prɪ'dɪkt ði: ɪg'zɪst(ə)ns]

leave blank spaces ['li:v 'blæŋk 'speɪsɪz]

accept the Periodic law [ək'sept ðə ˌpɪərɪ'ɒdɪk 'lɔ:]

triple the number ['trɪp(ə)l ðə 'nʌmbə]

alkali ['ælkəlaɪ] *plural* alkalis ['alkəlʌɪz]

alkaline (solutions) ['ælk(ə)laɪn]

lanthanide series [ˈlænΘə,naɪd 'sɪəri:z]

actinide series ['æktinaid 'sɪəri:z]

3. Students are divided into three groups. The students of group A read text A. The students of group B read text B. The students of group C read text C. Then students A, B and C in grops of three ask and answer the questions to the texts they have read.

Student A:

a) Look through text A. Decide if the following statements are true (T), false (F) or not given (NG) in the text.

1. At the end of the 18th century scientists knew only 23 chemical elements.
2. The term "periodic" reflects the fact that the elements show patterns in their properties in certain regular intervals.
3. John Newlands's law was not generally accepted because it was not correct.

Development of the Periodic Table

Text A

In the late 1790s, French scientist Antoine Lavoisier compiled a list of elements known at the time. The list contained 23 elements. Many of these elements, such as silver, gold, carbon, and oxygen, were known since prehistoric times. The advent of electricity, which was used to break compounds down into their component elements, and the development of the spectrometer, which was used to identify the newly isolated elements, played major roles in the advancement of chemistry. By 1870, there were approximately 70 known elements – almost triple the number known in Lavoisier's time. Along with the discovery of new elements came volumes of new scientific data related to the elements and their compounds. Chemists of the time were overwhelmed with learning the properties of so many new elements and compounds. What chemists needed was a tool for organizing the many facts associated with the elements.

In 1864, English chemist John Newlands proposed an organization scheme for the elements. Newlands noticed that when the elements were arranged by increasing atomic mass, their properties repeated every eighth element. In other words, the first and eighth elements had similar properties, the second and ninth elements had similar properties, and so on. A pattern such as this is called periodic because it repeats in a specific manner. Newlands named the periodic relationship that he observed in chemical properties the law of

octaves, because an octave is a group of musical notes that repeats every eighth tone. Acceptance of the law of octaves [ˈɒktɪvz] was hampered because the law did not work for all of the known elements. Also, unfortunately for Newlands, the use of the word *octave* was harshly criticized by fellow scientists who thought that the musical analogy was unscientific. While Newlands's law was not generally accepted, the passage of a few years would show that he was basically correct; the properties of elements do repeat in a periodic way.

Taken from: Buthelezi T., Dingrando L., Hainen N., Wistrom C., (2008). Glencoe Chemistry

b) Ask student B the following questions.

1. Why did Mendeleev succeed in the organization of elements?
2. Why did Mendeleev's table require changes?
3. What changes did Moseley make in the periodic table?
4. What does the periodic law state?

Student B:

a) Look through text B. Decide if the following statements are true (T), false (F) or not given (NG) in the text.

1) Meyer and Mendeleev worked together and demonstrated a connection between atomic mass and elemental properties.
2) Mendeleev's table was not ideal.
3) At the end of the 19th century the noble gases were added to the periodic table.

The Development of the Periodic Table

Text B

In 1869, German chemist Lothar and Russian chemist Dmitri Mendeleev each demonstrated a connection between atomic mass and elemental properties. Mendeleev, however, is generally given more credit than Meyer because he published his organization scheme first and went on to better demonstrate its usefulness. Like Newlands several years earlier, Mendeleev noticed that when

the elements were ordered by increasing atomic mass, there was a repetition, or periodic pattern, in their properties. By arranging the elements in order of increasing atomic mass into columns with similar properties, Mendeleev organized the elements into the first periodic table. Part of the reason Mendeleev's table was widely accepted was that he predicted the existence and properties of undiscovered elements. Mendeleev left blank spaces in the table where he thought the undiscovered elements should go. By noting trends in the properties of known elements, he was able to predict the properties of the yet-to-be discovered elements scandium, gallium, and germanium.

Mendeleev's table, however, was not completely correct. After several new elements were discovered and atomic masses of the known elements were more accurately determined, it became apparent that several elements in his table were not in the correct order. Arranging the elements by mass resulted in several elements being placed in groups of elements with differing properties. The reason for this problem was determined in 1913 by English chemist Henry Moseley. He discovered that atoms of each element contain a unique number of protons in their nuclei – the number of protons being equal to the atom's atomic number. By arranging the elements in order of increasing atomic number instead of increasing atomic mass, as Mendeleev had done, the problems with the order of the elements in the periodic table were solved. Moseley's arrangement of elements by atomic number resulted in a clear periodic pattern of properties. The statement that there is a periodic repetition of chemical and physical properties of the elements when they are arranged by increasing atomic number is called the periodic law.

Taken from: Buthelezi T., Dingrando L., Hainen N., Wistrom C., Glencoe Chemistry

b) Ask student A the following questions.

1. What technological developments brought up the advances in chemistry?
2. What problem did scientists face in 1870s?
3. Who was the first to notice the periodicity in properties of the elements?

4. How do you understand the law of octaves?
5. Why was Newland's law not generally accepted?

4. a) Look through the text about the modern periodic table. Discuss the question: *How has the periodic table changed since 1969?*

Text C

The Modern Periodic Table

The modern periodic table consists of boxes, each containing **an element name, symbol, atomic number, and atomic mass**. The boxes are arranged in order of increasing atomic number into a series of *columns,* called **groups** or families, and *rows*, called **periods**. Beginning with hydrogen in period 1, there are a total of seven periods. Each group is numbered 1 through 8, followed by the letter A or B. The groups designated with an A (1A through 8A) are often referred to as the main group, or **representative elements** because they possess a wide range of chemical and physical properties. The groups designated with a B (1B through 8B) are referred to as **the transition elements.** A more recent numbering system, which uses the numbers 1 through 18, also appears above each group.

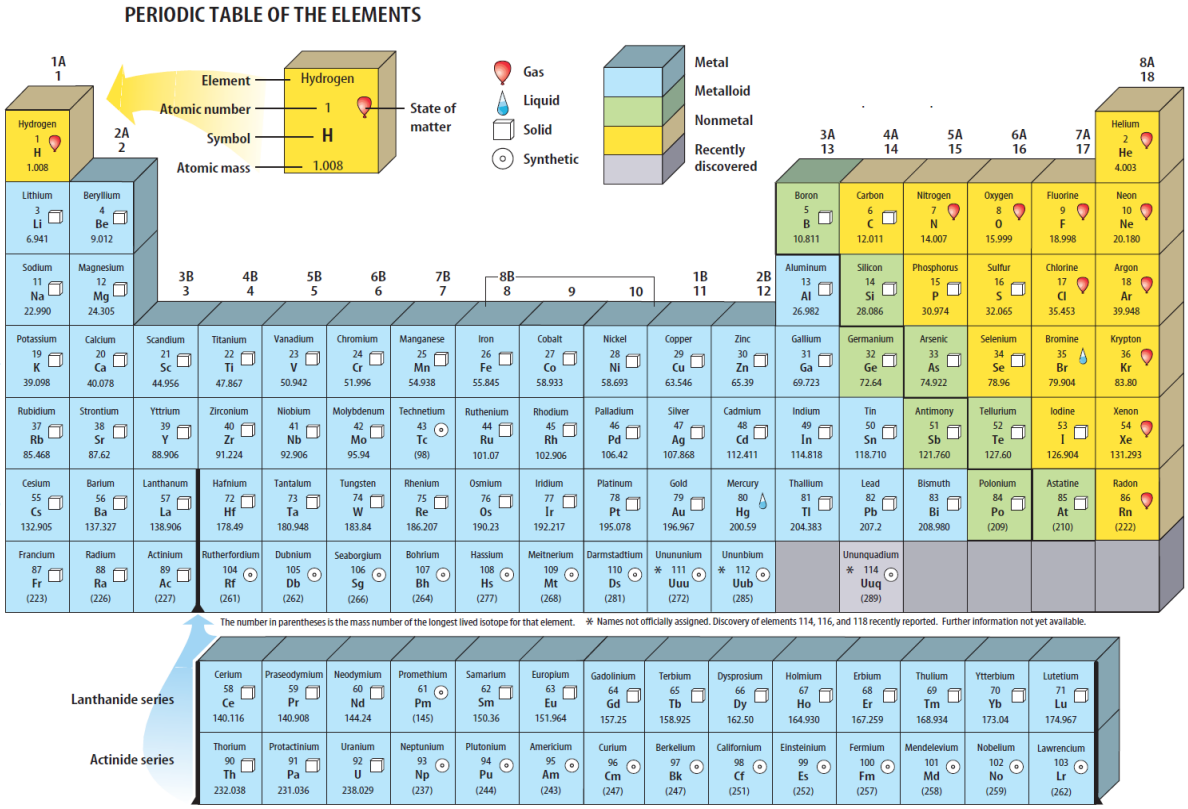
Classifying the elements There are three main classifications for the elements – metals, nonmetals, and metalloids. **Metals** are elements that are generally shiny when smooth and clean, solid at room temperature, and good conductors of heat and electricity. Most metals also are malleable and ductile, meaning that they can be pounded into thin sheets and drawn into wires, respectively.

Most group A elements and all group B elements are **metals**. If you look at boron (B) in column 3A, you see a heavy stair-step line that zigzags down to astatine (At) at the bottom of group 7A. This stair-step line serves as a visual divider between the metals and the nonmetals on the table. Metals are represented by the light blue boxes. Except for hydrogen, all of the elements on the left side of the table are metals. The group 1A elements (except for

hydrogen) are known as **the alkali metals**; the group 2A elements are known as **the alkaline earth metals**. Both the alkali metals and the alkaline earth metals are chemically reactive, with the alkali metals being the more reactive of the two groups.

The group B elements, or **transition elements**, are divided into transition metals and inner transition metals. The two sets of inner transition metals, known as the lanthanide and actinide series, are located along the bottom of the periodic table. The rest of the group B elements make up the transition metals. Elements from the lanthanide series are used extensively as phosphors, substances that emit light when struck by electrons.

Nonmetals occupy the upper right side of the periodic table. They are represented by the yellow boxes. Nonmetals are elements that are generally gases or brittle, dull-looking solids. They are poor conductors of heat and



electricity. The only nonmetal that is a liquid at room temperature is bromine (Br). The highly reactive **group 7A** elements are known as **halogens**, and the extremely unreactive **group 8A** elements are commonly called **the noble gases**.

The elements in green boxes are called metalloids, or semimetals. Metalloids are elements with physical and chemical properties of both metals and nonmetals. Silicon and germanium are two of the most important metalloids, as they are used extensively in computer chips and solar cells.

Taken from: Buthelezi T., Dingrando L., Hainen N., Wistrom C., Glencoe Chemistry

b) Discuss the following questions.

1. What does the modern periodic table consist of?
2. How are the boxes arranged?
3. How many periods are there?
4. How many groups of elements do you know?
5. How would you describe metals, their physical and chemical properties?
6. Can you give examples of alkali and alkali-earth metal according to the periodic table?
7. What elements does the group B comprise? Characterize this group of elements.
8. What are the physical and chemical properties of nonmetals?
9. What elements do we call metalloids and where are they mainly used?

Listening

5. a) Discuss the following questions.

- What is the role of Mendeleev in the discovery of the periodic table?
- What is similar between the periodic table and music?

b) Watch the video "Periodic table of elements" (https://www.youtube.com/watch?v=7I8zgrSydsg**) and write down the most important information presented in it.**

c) Watch the video again. What facts mentioned in the video weren't mentioned in texts A and B above?

Language in Use

6. a) Match the words with their definitions.

1. spectrometer	A. easily stretched without breaking or lowering in material strength
2. overwhelmed	B. resembling the steps in a stairway
3. arrange	C. a synthetic fluorescent or phosphorescent substance, especially one used to coat the screen of a cathode ray tube
4. credit	D. be strongly affected by a feeling or event that you do not know how to deal with it
5. halogen	E. any of the series of fifteen metallic elements from lanthanum to lutetium in the periodic table
6. stair-step	F. an apparatus used for recording and measuring spectra, especially as a method of analysis
7. ductile	G. good reputation
8. lanthanide	H. any of the series of fifteen metallic elements from actinium to lawrencium which is radioactive, the heavier members being extremely unstable and not of natural occurrence
9. phosphor	I. put (things) in a required order
10. actinide	J. any of the elements fluorine, chlorine, bromine, iodine, and astatine, occupying group VIIA of the periodic table

b) Cover the left column and recall the terms.

7. Match the words from column A with their synonyms in column B and translate them into Ukrainian.

Column A	**Column B**
1. isolated	a. organize

2. use	b. empty
3. arrange	c. flexible
4. pattern	d. fragile
5. blank	e. insulated
6. brittle	f. include
7. contain	g. give off
8. noble gas	h. application
9. ductile	i. inert gas
10. emit	j. model

8. a) Give English equivalents to the following words.

Склав список, розвиток хімії, розташував елементи в порядку збільшення, передбачити існування і властивості, мати подібні властивості, відкрив і сформулював періодичний закон, перебувати у періодичній залежності від значень атомних мас, відносна атомна маса, співвідношення властивостей з, застосування, лужні метали, лужно-земельні метали, перехідні метали, випромінювати світло, крихкий, ковкий, інертні гази, фотоелемент, тепло, електроенергія.

b) Make up your own sentences in English with any 7 words from the task above. Write them down and ask your groupmates to translate them into Ukrainian.

_____

_____

_____

_____

_____

_____

_____

_____

9. Fill in the gaps with a suitable word.

occupy	***involve***	***completed***	***bonding***
configuration	***contain***	***noble***	***shells***
	inert	***properties***	

Electron Shell Theory

In the periodic classification, _____ (1) gases, which in most cases are unreactive, are interposed between highly reactive metals that form compounds in which their valence is +1 on one side and highly reactive nonmetals forming compounds in which their valence is -1 on the other side. This phenomenon led to the theory that the periodicity of _____ (2) results from the arrangement of electrons in _____ (3) about the atomic nucleus. According to the same theory, the noble gases are normally _____ (4) because their electron shells are completely filled; other elements, therefore, may have some shells that are only partly filled, and their chemical reactivities _____ (5) the electrons in these incomplete shells. Thus, all the elements that _____ (6) a position in the table preceding that of an inert gas have one electron less than the number necessary for _____ (7) shells and show a valence of -1, corresponding to the gain of one electron in reactions. Elements in the group following the inert gases in the table have one electron in excess of the completed shell structure and in reactions can lose that electron, thereby showing a valence of +1.

An analysis of the periodic table, based on this theory, indicates that the first electron shell may _____ (8) a maximum of 2 electrons, the second builds up to a maximum of 8, the third to 18, and so on. The total number of elements in any one period corresponds to the number of electrons required to achieve a stable_____ (9). The distinction between the A and B subgroups of a given group also may be explained on the basis of the electron shell theory. Both subgroups have the same degree of incompleteness in the

outermost shell but differ from each other with respect to the structures of the underlying shells. This model of the atom still provides a good explanation of chemical_____ (10).

10. Translate the following sentences into English.

1 Перший перелік хімічних елементів склав в 1789 р. французький хімік Лавуазьє.

2 У 1864 р. свій варіант періодичної системи запропонував хімік Джон Ньюлендс. Згідно його правила *«Всі елементи при впорядкуванні їх за атомною масою повторюють хімічні властивості періодично у кожній восьмій позиції»*. Він назвав цю періодичну зміну Законом Октав.

3 У 1864 Лотар Маєр у своїй книзі «Сучасні теорії хімії» впорядковує у таблицю відомі на той час елементи за значеннями їх відносної атомної маси.

4 Менделєєв опублікував свою першу схему періодичної таблиці у 1869 р. у статті «Співвідношення властивостей з атомною вагою елементів».

5 Сутність відкриття Менделєєва полягала у тому, що зі зростанням атомної маси хімічних елементів їхні властивості змінюються періодично.

6 У 1871 році Дмитро Менделєєв сформулював Періодичний закон таким чином: властивості хімічних елементів, простих речовин, а також склад і властивості сполук, перебувають у періодичній залежності від значень атомних мас.

7 У 1913 році законом Генрі Мозлі підтверджено та відкориговано порядок розташування елементів у Періодичній системі елементів та передбачено невідомі на той час елементи.

11. Answer the Periodic Table quiz. Compare your answers in pairs.

1. The majority of the elements in the periodic table are

a) nonmetals b) metals c) metalloids

2. The horizontal rows of the periodic table are known as

a) groups b) series c) periods

3. The first list of elements and their characteristics was written by

a) Antoine Lavoisier b) Dmitrii Mendeleev c) John Newlands

4. In the modern periodic table, elements are ordered according to increasing atomic_____ .

a) weight b) number c) mass

5. The discovery of the noble gases changed Mendeleev's periodic table by _____a new group.

a) adding b) attaching c) enclosing

6. The most distinctive property of the noble gases is that they are largely_____.

a) unresponsive b) active c) unreactive

7. The most common physical state of the elements is_____.

a) liquid b) solid c) gaseous

8. The vertical columns of the periodic table are known as _____ .

a) groups b) series c) periods

9. The atomic number tells you how many _____and electrons there are in a neutral atom of the element.

a) protons b) neutrons c) quarks

10. The periodic law has undergone two principal elaborations since its original _____by Mendeleyev and Meyer.

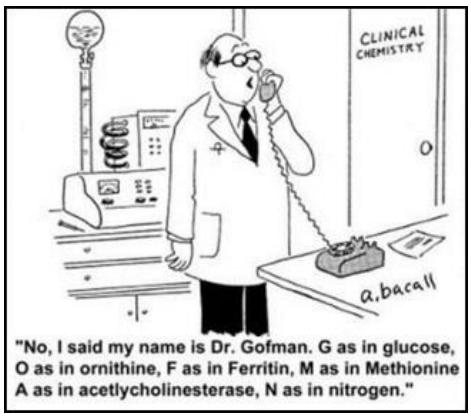
a) foundation b) formulation c) generation

11. The series of elements that contains mostly man-made elements:

a) transition metals b) lanthanides c) actinides

12. Elements that have properties of both metals and nonmetals:

a) inert gases
b) metalloids
c) transition metals



13. The stair-step line running diagonally from aluminum to polonium divides the
a) lanthanides and actinides
b) transition metals and metals
c) metals and nonmetals

14. Elements that are malleable are
a) noble gases
b) halogens
c) metals

15. Which element includes the first letter of its name as the first letter of the symbol for the element?
a) potassium
b) lead
c) copper
d) sodium

16. The transition elements are located
a) on the left side of the periodic table
b) on the right side of the periodic table
c) in central section of the periodic table

17. In general, metals
a) are brittle and dull in appearance.
b) are gases at room temperature.
c) have high electrical and thermal conductivities.

18. In general, nonmetals
a) have low electrical and thermal conductivities.
b) are liquids at room temperature.
c) have high electrical and thermal conductivities.

19. Identify each of the following as a metal, nonmetal, or metalloid.
a. oxygen
b. barium
c. germanium
d. iron
e. neon
f. praseodymium

20. Match each numbered item on the right with the lettered item that it is related to on the left.

a. alkali metals	1. group 8A
b. halogens	2. group 1A
c. alkaline earth metals	3. group 2A
d. noble gases	4. group 7A

21. Match each numbered item on the right with the lettered item that it is related to on the left.

a. group A elements	1. periods
b. columns	2. representative elements
c. group B elements	3. groups
d. rows	4. transition elements

22. Identify each of the following as a representative element or a transition element.

a. lithium (Li)	c. promethium (Pm)
b. platinum (Pt)	d. carbon (C)

23. Give the chemical symbol of each of the following elements.

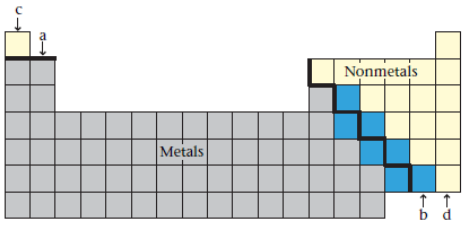
a. The two elements that are liquids at room temperature.

b. The noble gas with the greatest atomic mass.

c. Any metal from group 4A.

d. Any inner transition metal.

24. Write the correct letter in the space provided.



____Noble gases

____Alkaline earth metals

____Halogens

____Alkali metals

Taken from: Buthelezi T., Dingrando L., Hainen N., Wistrom C., Glencoe Chemistry

Grammar focus

Focus on numbers and passive voice.

12. a) Read the years given in the text. For grammar reference see page 103.

b) Open the brackets using the verbs given in Past or Present Simple Active or Passive voice. For grammar reference see page 99.

History of the periodic table of chemical elements

In **1669** German merchant and alchemist Hennig Brand (attempt) _____ to create a *Philosopher's Stone*; an object that supposedly could turn metals into pure gold. He (heat) _____ residues from boiled urine, and a liquid (drop) _____ out and (burst) _____ into flames. This (be) _____ the first discovery of phosphorus.

In **1809** at least 47 elements (discover) _____, and scientists (begin) _____ to see patterns in their characteristics.

In **1863** English chemist John Newlands (divide) _____ 56 elements discovered at that time into 11 groups basing on their characteristics.

In **1869** Russian chemist *Dimitri Mendeleev* (start) _____ the development of the periodic table, arranging chemical elements by atomic mass. He (predict) _____ the discovery of other elements, and left spaces open in his periodic table for them.

In **1886** French physicist Antoine Bequerel first (discover) _____ radioactivity. Marie and Pierre Curie (start) _____ working on the radiation of uranium and thorium, and subsequently (discover) _____ radium and polonium.

In **1894** Sir William Ramsay and Lord Rayleigh (discover) _____ the noble gases, which were added to the periodic table as group 0.

In **1897** John Townsend and Robert Millikan (determine) _____ their exact charge and mass.

In **1900** Bequerel (discover) _____ that electrons and beta particles as identified by the Curies are the same thing.

In **1903** *Rutherford* announced that radioactivity (cause) _____ by the breakdown of atoms.

In **1911** Rutherford and German physicist Hans Geiger discovered that electrons (orbit) _____ the nucleus of an atom.

In **1913** Bohr discovered that electrons (move) _____ around a nucleus in discrete energy called orbitals. Radiation (emit) _____ during movement from one orbital to another.

In **1914** Rutherford first (identify) _____ protons in the atomic nucleus. English physicist Henry Moseley (provide) _____ atomic numbers, which (base) _____ on the number of electrons in an atom, rather than on atomic mass.

In **1932** James Chadwick first discovered neutrons, and isotopes (identify) _____. This (be) _____ the complete basis for the periodic table.

In **1945** *Glenn Seaborg* (identify) _____ lanthanides and actinides (atomic number >92), which (usually/ place) _____ below the periodic table.

c) Rewrite the following sentences in the Passive voice.

1) English chemist John Newlands divided 56 elements into 11 groups.
2) In 1869 Mendeleev started the development of the periodic table.
3) He predicted the discovery of other elements.
4) In 1886 Antoine Bequerel first discovered radioactivity.
5) In 1914 Rutherford first identified protons in the atomic nucleus.

Speaking 🗣

13. Discuss the following questions in pairs. Share your ideas with the class.

1. What similirities do the elements in the same family of the periodic table have?

2. How does the location of an element in the periodic table help you determine its properties?

3. Explain why elements in the same group in the periodic table have similar chemical properties.

4. What do you think of when you hear the word *alchemists*? Do alchemists exist now? What do they do?

5. How are the modern alchemists different from the alchemists of the past? If you were an alchemist what would you concentrate on in your research? Why? Is transmutation of elements possible now?

14. Follow the links bellow and choose one of the articles. Prepare a short report about modern alchemists. Present your findings in pairs.

A. https://www.sciencedaily.com/releases/2018/06/180614212914.htm

B. https://www.bbc.com/future/article/20200204-the-modern-alchemists-racing-to-create-a-new-element

15. a) Work in small groups. Try to figure out drawbacks and positive features of the Periodic table. Write them down.

b) Work in pairs. Student A: persuade student B that the Periodic table has a lot of drawbacks and has to be improved. Student B: persuade student A that it is not necessary to improve the Periodic table.

16. a) Make up 5 questions to the summary given below. Discuss your questions in small groups.

b) Using the summary and the texts given in this unit think of 5 facts which you will definitely include into your speech for:

1) 16-17-year-old school leavers;
2) students of the chemical department at university.

Summary

6.1 Development of the Modern Periodic Table

- Periodic law states that when the elements are arranged by increasing atomic number, there is a periodic repetition of their chemical and physical properties.
- Newlands's law of octaves, which was never accepted by fellow scientists, organized the elements by increasing atomic mass. Mendeleev's periodic table, which also organized elements by increasing atomic mass, became the first widely accepted organization scheme for the elements. Moseley fixed the errors inherent in Mendeleev's table by organizing the elements by increasing atomic number.
- The periodic table organizes the elements into periods (rows) and groups (columns) by increasing atomic number. Elements with similar properties are in the same group.
- Elements are classified as either metals, nonmetals, or metalloids. The stair-step line on the table separates metals from nonmetals. Metalloids border the stair-step line.

6.2 Classification of the Elements

- Elements in the same group on the periodic table have similar chemical properties because they have the same valence electron configuration.
- The four blocks of the periodic table can be characterized as follows:

  s-block: filled or partially filled s orbitals.
  p-block: filled or partially filled p orbitals.
  d-block: filled outermost s orbital of energy level n, and filled or partially filled d orbitals of energy level $n - 1$.
  f-block: filled outermost s orbital, and filled or partially filled 4f and 5f orbitals.
- For the group A elements, an atom's group number equals its number of valence electrons.
- The energy level of an atom's valence electrons equals its period number.
- The s^2p^6 electron configuration of the group 8A elements (noble gases) is exceptionally stable.

6.3 Periodic Trends

- Atomic radii generally decrease as you move left-to-right across a period, and increase as you move down a group.
- Positive ions are smaller than the neutral atoms from which they form. Negative ions are larger than the neutral atoms from which they form.
- Ionic radii of both positive and negative ions decrease as you move left-to-right across a period. Ionic radii of both positive and negative ions increase as you move down a group.
- Ionization energy indicates how strongly an atom holds onto its electrons. After the valence electrons have been removed from an atom, there is a tremendous jump in the ionization energy required to remove the next electron.
- Ionization energies generally increase as you move left-to-right across a period, and decrease as you move down a group.
- The octet rule states that atoms gain, lose, or share electrons in order to acquire the stable electron configuration of a noble gas.
- Electronegativity, which indicates the ability of atoms of an element to attract electrons in a chemical bond, plays a role in determining the type of bond formed between elements in a compound.
- Electronegativity values range from 0.7 to 3.96, and generally increase as you move left-to-right across a period, and decrease as you move down a group.

Taken from: Buthelezi T., Dingrando L., Hainen N., Wistrom C., Glencoe Chemistry

17. Look through the texts in this unit. Prepare a 5-minute presentation about the periodic table and its development. Use the phrases given below.

WELCOMING YOUR AUDIENCE AND INTRODUCING YOURSELF

- Good morning/afternoon/evening (ladies and gentlemen). I welcome you here today. My name is … and I am …
- Hello everyone. I'd like to welcome you. My name is … and I am …
- Hi everyone. Thanks for coming. I am …

INTRODUCING THE TOPIC

- Today, I'd like to talk to you about …
- I would like to take this opportunity to talk to you about …
- By the end of the presentation, you will know how to …

OVERVIEW AND OUTLINE PHRASES

- My presentation is divided into (number) parts/sections.
- My presentation is in 3 parts.
- To begin with/Firstly, I'm going to look at/I'll show you …
- Following that I'll/Next/Then …
- And finally, we'll look at …

TIMING AND QUESTION POLICY

- My presentation will take about X minutes.
- My presentation will last for about X minutes.
- Feel free to interrupt if you have any questions.
- I'd be happy to answer any questions at the end of my talk.

BEGINNING THE MAIN BODY

- I'd like to start with …
- Okay, so let's start with …
- To begin with …

BEGINNING A NEW SECTION OF THE MAIN BODY

- So, let's move on to …
- So, let's turn to …
- So, now we've come to …
- Now, I'd like to discuss …

ENDING OF THE MAIN BODY

- That's all for now on …
- Okay, that ends the third part of my talk …

ENDING OF A PRESENTATION

- That's it on … for today. In brief, we've covered …

- Well, that concludes my presentation for today. We've talked about …
- That brings me to the end of my presentation. I hope you're a little clearer on …

Adopted from: https://preply.com/en/blog/2018/06/15/50-essential-business-presentation-phrases-for-better-performance/

Writing ✍

18. Write 5-7 sentences summarizing the texts in exercises 3-4.

19. Write an article to a popular magazine for young teenagers about the Periodic table. You can use the information from this unit or from the Internet. Write between 120-180 words.

Write:

- ***what the periodic table is;***
- ***about the history of its development;***
- ***if there are still blank spots in the modern periodic table.***

SELF-ASSESSMENT

UNIT 2. THE PERIODIC TABLE OF CHEMICAL ELEMENTS

Choose the answer that best fits each space. Indicate your answer with a letter A, B, C or D in your answer sheet paper.

1. In modern chemistry, the periodic table is a table showing the chemical elements arranged according to their atomic _____ .

a) weights b) numbers c) masses d) periods

2. Mendeleev noticed that certain similarities in the chemical properties of elements appeared at regular intervals when the elements were _____ in order of increasing atomic mass.

a) put b) ordered c) referred d) arranged

3. The modern periodic law _____that the physical and chemical properties of an element are functions of its atomic number.

a) objects b) states c) claims d) accepts

4. Mendeleev noticed that when the elements were ordered by increasing atomic mass, there was a repetition, or periodic _____, in their properties.

a) pattern b) similarity c) trend d) statement

5. In 1790 Antoine Lavoisier _____ a list of elements known at the time.

a) predicted b) accepted c) tripled d) compiled

6. Part of the reason Mendeleev's table was widely accepted was that he _____ the existence and properties of undiscovered elements.

a) arranged b) noticed c) proved d) predicted

7. The advent of electricity and the development of the spectrometer played major roles in the _____ of chemistry.

a) advancement b) progress c) existence d) acceptance

8. Mendeleev left _____ in the table where he thought the undiscovered elements should go.

a) unfilled cards b) empty boxes c) blank spaces d) vacant points

9. Newlands named the periodic relationship that he observed in chemical properties the _____.

a) law of periodicity b) periodic law c) law of notes d) law of octaves

10. Mendeleev is generally given more _____ than Meyer because he published his organization scheme first and went on to better demonstrate its usefulness.

a) importance b) credit c) value d) acceptance

UNIT 3. ALKALI METALS

Lead-in

1. Discuss the following questions in pairs.

1A
Lithium 3 **Li** [He]$2s^1$
Sodium 11 **Na** [Ne]$3s^1$
Potassium 19 **K** [Ar]$4s^1$
Rubidium 37 **Rb** [Kr]$5s^1$
Cesium 55 **Cs** [Xe]$6s^1$
Francium 87 **Fr** [Rn]$7s^1$

- ***What are alkali metals?***
- ***What are their physical properties?***
- ***What are their chemical properties?***

Reading 🕮

2. The following words appear in the text you are going to read. Check whether you know their pronunciation and meaning.

a) lithium [ˈlɪθɪəm], sodium [ˈsəʊdɪəm], potassium [pəˈtæsiəm], rubidium [rʊˈbɪdɪəm], cesium [ˈsiːziəm], francium [ˈfrænsiəm];

b) hydroxide [haɪˈdrɒksaɪd], occur [əˈkəː], spodumene ['spɒdjʊmiːn], alloy [ˈælɔɪ], strengthen ['streŋθ(ə)n], enamel [ɪ'næm(ə)l], ceramic [sə'ræmɪk], dye [daɪ], caustic ['kɔːstɪk], detergent [dɪˈtəːdʒ(ə)nt], lead [led], vehicle ['viːɪkl].

3. Students are divided into two groups. The students of group A read text A. The students of group B read text B. Then students A and B in pairs ask and answer the questions to the texts they have read.

Student A:

a) Look through the text A. Decide if the following statements are true (T), false (F) or not given (NG) in the text. Correct the false statements.

1) All alkali metals are very reactive; they burn in air and react with water.
2) Alkali metals are not very hard.

3) Alkaline metals are very common.

Text A

The six elements of Group 1A of the periodic table are known as the **alkali metals.** They are lithium (Li), sodium (Na), potassium (K), rubidium (Rb), cesium (Cs), and francium (Fr). All except lithium are highly reactive chemically. They burn in air and react vigorously – sometimes explosively – with water to form strongly alkaline hydroxides. These are compounds containing the positive ion of an alkali metal and the negative ion of a hydroxide molecule (hydrogen and oxygen). Because of their reactivity, the free metals (except lithium) are normally stored out of contact with air, usually under a layer of hydrocarbon oil.

Sodium and potassium occur widely in nature as salts and are essential for many forms of life, whereas francium, on the other hand, is one of the rarest naturally occurring elements. Sodium and potassium have by far the most industrial importance of all the alkali metals. All six alkali metals, with the exception of francium, are light and silvery white. They are soft enough to be cut with a knife.

The first member of the series, **lithium**, is the lightest known metal, being only half as heavy as an equal volume of water. Lithium is found only in combination with other elements, its usual source being spodumene. This is a compound composed of lithium, aluminum, and silicon, containing about 3.7 per cent lithium. Lithium, like sodium, reacts with water to release hydrogen gas. Unlike sodium, however, the reaction does not set the hydrogen on fire. There are many uses for lithium. Being very light, it is used in various alloys, notably with copper, helping to strengthen the alloy without adding too much weight. Lithium is used in the manufacture of certain types of batteries, enamels, glass, and ceramic products. Lithium soaps are used in lubricating greases employed at high temperatures. Lithium compounds are used in rubber products and in dyes for textiles. One compound, lithium carbonate, is a drug used in the treatment of some types of mental disorders.

Rubidium is widely distributed in the earth's crust, being more abundant overall than lead, copper, or zinc. However, it appears in such small amounts that its production is limited. It is most often used industrially as a catalyst to speed up chemical reactions. It is also used in making photocells and vacuum tubes.

Cesium is widely distributed in low concentrations in brines and mineral waters. It is used as the time-measuring element in atomic clocks. Scientists are also studying the possibilities of using cesium in the generation of power and as a fuel for space vehicles.

Francium has more than 20 isotopes, all of which are short-lived and radioactive. No weighable amount of the element has even been extracted, and at any one time there is only about 25 grams of it throughout the whole of the earth's crust.

Taken from: Sherwood, M. (Ed.). Chemistry today

b) Ask student B the following questions.

1. Where is sodium chloride usually used?
2. Why are sodium and potassium important for humans?
3. How are sodium and potassium obtained?
4. Where is potassium used?

Student B:

a) Look through the text B. Decide if the following statements are true (T), false (F) or not given (NG) in the text. Correct the false statements.

1) The only source of sodium in nature is table salt.
2) The amount of sodium and potassium in the earth's crust is almost the same.
3) Potassium is found in a variety of fruits, vegetables and fish like salmon.

Text B

Sodium is the sixth most abundant element, making up about 2.8 per cent of the earth's crust. It occurs in nature mainly as sodium chloride – common table salt – a major component of seawater.

In some tropical countries, evaporation of seawater under the heat of the sun has been used for many centuries as a production method. In other parts of the world, underground salt mines are the principal source of salt. Other natural sources of sodium include soda ash and borax.

Much of the sodium chloride produced is converted to sodium hydroxide (caustic soda) and chlorine, both of which have many industrial applications. Different sodium salts are used in the manufacture of glass and some ceramics. Other salts are used in household detergents, weed killers, photographic chemicals, and in tanning leather. Metallic sodium is used as a coolant in some nuclear reactors.

In higher animals, a certain amount of sodium as well as potassium are necessary to maintain a normal flow of water between the body fluids and the cells. Sodium and potassium are also essential for tissue formation, muscle contraction, and changing food into energy.

Potassium is also an abundant element, but occurs mainly in rocks and clays and is difficult to extract. It makes up about 2.5 per cent of the earth's crust. Seawater contains potassium chloride (a compound of potassium and chlorine), but the main economic sources are dried salt beds and the Dead Sea, located in southwestern Asia. Large amounts of impure potassium chloride are mined for use as fertilizers, because potassium is an essential element for plant growth and is found in all soils.

Potassium salts are more expensive than those of sodium, but because they are not hygroscopic (water-attracting), they are employed where water resistance is important. Examples include the use of potassium nitrate in

gunpowder and fireworks and potassium chlorate in match heads. Potassium and its compounds are also used in some types of nuclear reactors and in certain kinds of glass and soaps. Other compounds are used in medicine.

Potassium is slightly unstable because of the presence of an unstable isotope, potassium-40. The rate at which it decays can be measured and is used to determine the ages of certain rocks.

Taken from: Sherwood, M. (Ed.). Chemistry today

b) Ask student A the following questions.

1. What features are characteristic of alkali metals?
2. Where can alkali metals be found?
3. What properties distinguish lithium from other alkali metals?
4. What are the industrial applications of lithium?
5. Where are rubidium, cesium, and francium mostly used?
6. Which of alkali metals is the rarest? Has it ever been extracted?

Listening

4. a) Discuss the following questions in pairs or small groups.

- What alkali metals do you know?
- What are their common properties?
- How are they different?

b) Watch the video about Alkali Metals and answer the following questions (https://www.youtube.com/watch?v=dZGDUKQa_6g).

1) What are alkali metals?
2) Why are they so reactive?
3) What are the trends as you go down the group?
4) How do they react with water, oxygen and chlorine?

c) Watch the video again. What facts in the video were not mentioned in the texts above?

Language in Use

5. a) Match the words with their definitions.

1. tanning	a) tending to absorb moisture from the air
2. borax	b) a translucent, typically greyish-white aluminosilicate mineral which is an important source of lithium
3. spodumene	c) to use as a means
4. hydrocarbon oil	d) a dome-shaped structure in sedimentary rocks, formed where a large mass of salt has been forced upwards
5. employ	e) the art or process of making leather from rawhides
6. atomic clock	f) water strongly impregnated with salt
7. salt dome	g) any of various oily liquids consisting chiefly or wholly of mixtures of hydrocarbons (as petroleum or many of its products)
8. soda ash	h) an extremely accurate type of clock which is regulated by the vibrations of an atomic or molecular system such as cesium or ammonia
9. hygroscopic	i) a white compound which occurs as a mineral in some alkaline salt deposits and is used in making glass and ceramics
10. brine	j) commercially manufactured anhydrous sodium carbonate

b) Cover the left column and recall the terms.

6. Match the words in column A with the words in column B to make word combinations.

1. lubricating	a) distributed
2. mental	b) luster
3. production	c) resistant
4. metallic	d) disorder
5. muscle	e) amount
6. heat	f) grease
7. widely	g) lamp
8. trace	h) method
9. gas-discharge	i) agent
10. reducing	j) contraction

7. Fill in the gaps in the sentences using the word combinations from exercise 7.

1. A common application of the compounds of sodium is the sodium-vapour lamp, a type of a _____, which emits very efficient light.
2. Outside the laboratory, francium is extremely rare, with _____ found in uranium and thorium ores, where the isotope francium-223 continually forms and decays.
3. Lithium and its compounds have several industrial applications, including _____ glass and ceramics, high strength-to-weight alloys used in aircraft, lithium batteries and lithium-ion batteries.
4. Potassium metal is a powerful _____ that is easily oxidized to the monopositive cation, K+.
5. Unless the surface of a sample of an alkali metal is scraped clean, it will appear white or gray instead of having a silvery_____.

8. a) Give English equivalents to the following words.

Лужний метал, зберігати тепло, мінеральне масло, натрій, калій, зустрічатися у природі, зміцнювати структуру, емаль, кераміка, змащувальна речовина, використовувати у промисловості, гума, барвник, випаровування, кальцинована сода, каустична сода, миючий засіб, гербіцид, підтримувати (процес), глина, видобувати корисні копалини.

b) Make up your own sentences in English with any 7 words from the task above. Write them down and ask your groupmates to translate them into Ukrainian.

9. Read the text about Humphry Davy.

a) Fill in the gaps with a suitable word from the box.

flammable reactive distinction glowed wires potash earth passing isolate pile

Humphry Davy

Sir Humphry Davy, was an English chemist and inventor. He is probably best remembered today for his discoveries of several alkali and alkaline _____ (1) metals, as well as contributions to the discoveries of the elemental nature of chlorine and iodine.

Davy was a pioneer in the field of electrolysis using the voltaic _____ (2) to split up common compounds and thus prepare many new elements. He went on to electrolyse molten salts and discovered several new metals, especially sodium and potassium, highly _____ (3) elements known as the alkali metals. Potassium was discovered in 1807 by Davy, who derived it from caustic _____ (4) (KOH). Before the 19th century, no _____ (5) 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 _____ (6) an electric current through molten sodium hydroxide. Davy went on to discover calcium in 1808 by electrolyzing a mixture of lime and mercuric oxide. Davy was trying to _____ (7) 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.

In 1809, Humphry Davy invented the first electric light. Davy connected two _____ (8) to a battery and attached a charcoal strip between the other ends of the wires. The charged carbon _____ (9) making the first arc lamp. Davy later invented the miner's safety lamp in 1815. The lamp called firedamp, allowed for the mining of deep seams despite the presence of methane and other _____ (10) gases.

Humphry Davy's laboratory assistant was Michael Faraday, who went on to extend Davy's work and became famous in his own right.

b) Make up 5 questions to the text. Answer them in pairs. For grammar reference see page 97.

Speaking

10.Fill in the table using the texts from exercises 3 and 4. Add relevant information from the Internet. With the help of your notes tell your groupmates about the alkali metals.

Lithium (Li)	
Properties	
Abundance	
Compounds	

Applications	
Interesting facts	
Sodium (Na)	
Properties	
Abundance	
Compounds	
Applications	
Interesting facts	
Potassium (K)	
Properties	
Abundance	
Compounds	
Applications	
Interesting facts	
Rubidium (Rb)	
Properties	

Abundance	
Compounds	
Applications	
Interesting facts	
Cesium (Cs), Francium (Fr)	
Properties	
Abundance	
Compounds	
Applications	
Interesting facts	

11. Strong alkalis are corrosive. Corrosive substances are labeled with standard hazard symbols. According to the *Globally Harmonized System of Classification and Labeling of Chemicals* (GHS), corrosive substances are marked with the following symbol.

a) Describe the new symbol on the left.

b) Look at the old symbol on the right. Why do you think it was changed?

c) In small groups design your own symbol for corrosive substances. Defend your project.

Speaking

12. Watch the series of Brainiac and comment on it (https://www.youtube.com/watch?v=m55kgyApYrY). Is the experiment real or fake? Why do you think so? Agree or disagree with your groupmates. Express your opinion using the phrases below.

USEFUL EXPRESSIONS TO EXPRESS YOUR OPINION

In my opinion, ...
To my mind, ...
From my point of view, ...
I think / consider / find / feel / believe / suppose / assume that ...
I would say that ...
As for me / As to me, ...

My view / opinion / belief / impression / conviction is that ..
It seems to me that ...
I have the feeling that ...
I have no doubt that ...
I am sure / I am certain that ..

USEFUL WORDS TO EXPRESS YOUR AGREEMENT

I agree with you / him ...
I share your view
He is quite right / absolutely right.
I have come to the same conclusion.
I hold the same opinion.
We are of one mind / of the same mind on (that question).
It is true/That is right.

USEFUL WORDS TO EXPRESS YOUR DISAGREEMENT

I don't agree.
I don't agree with you/him.
I disagree.
I don't think so.
I think otherwise.
I don't think that's quite right.
I am afraid that is not quite true.
I don't share his/her/your view

Adopted from: http://www.franglish.fr/methodo/opinion

Writing ✍

13. Write 5-7 sentences summarizing the texts in exercise 3.

14. You have got an email from your friend who is teaching Science to young teenagers abroad. He/she has to speak about Alkali Metals at the next lesson. He/she needs your advice.

Write him/her

what information he/she should include into his/her lesson,

what information he/she should avoid as boring for teens,

what interesting experiments can be shown during the lesson.

Write an informal letter (120-180 words). For writing reference see page 107.

SELF-ASSESSMENT

UNIT 3. ALKALI METALS

Choose the answer that best fits each space. Indicate your answer with a letter A, B, C or D in your answer sheet paper.

1. _____ is an alkaline material that can cause irritation to eyes, skin, or respiratory tract.

a) Water b) Soda ash c) Solution d) Acid

2. Plastic materials are highly _____ and can generate toxic fumes when burning.

a) light b) inflammable c) shortlived d) soluble

3. This alloy can be used to _____ the stucture.

a) release b) extract c) strike d) strengthen

4. _____ may refer to salt solutions ranging from about 3% up to about 26%.

a) Brine b) Softener c) Grease d) Borax

5. Silicon dioxide is the most abundant mineral in Earth's _____.

a) resistance b) pattern c) crust d) melt

6. It is _____ to many corrosive substances such as acids and alkalis.

a) ductile b) resistant c) brittle d) hydroscopic

7. The new catalyst will significantly _____ the chemical reaction.

a) strengthen b) speed up c) predict d) extract

8. Old chemical containers _____ poisonous gasses when they are burnt.

a) resist b) gain c) absorb d) release

9. _____ includes various mined and manufactured salts that contain potassium in water-soluble form.

a) Potash b) Grease c) Copper d) Oils

10. Lithium and its compounds have several industrial _____.

a) properties b) manufactures c) applications d) treatments

UNIT 4. ALKALINE EARTH METALS

Lead-in

1. Discuss the following questions in pairs.

Which elements are named "alkaline earth"?

Why are they named so?

What do you know about their properties?

Where are they used?

2A
Beryllium 4 **Be** [He]$2s^2$
Magnesium 12 **Mg** [Ne]$3s^2$
Calcium 20 **Ca** [Ar]$4s^2$
Strontium 38 **Sr** [Kr]$5s^2$
Barium 56 **Ba** [Xe]$6s^2$
Radium 88 **Ra** [Rn]$7s^2$

2. The following words appear in the texts you are going to read. Check whether you know their pronunciation and meaning.

a) beryllium [bəˈrɪlɪəm], magnesium [magˈniːzɪəm], calcium [ˈkælsiəm], strontium [ˈstrɒntɪəm], barium [ˈbɛərɪəm], radium [ˈreɪdjəm]

b) valence [ˈveɪl(ə)ns], beryl [ˈbɛrɪl], neutrons [ˈnjuːtrɒnz], antacid [anˈtasɪd, æntˈæsɪd], pollutants [pəˈluːtənts], mortar [ˈmɔːtə], furnaces [ˈfɜːnɪsiz], chlorophyll [ˈklɒrəfɪl], muscle [ˈmʌs(ə)l], metabolism [mɪˈtabəlɪz(ə)m], detergents [dɪˈtəːdʒ(ə)nts], appliances [əˈplʌɪənsɪz], softeners [ˈsɒfənəz], interfere [ˌɪntəˈfɪə], supply [səˈplaɪ], reveal reactivity [rɪˈviːl rɪˈækˈtɪvɪti], react vigorously [riˈækt ˈvɪgərəsli], diagnostic [ˌdaɪəgˈnɒstɪk], shiny solids [ˈʃaɪni ˈsɒlɪdz].

Reading 🕮

3. a) Look through the text A. Decide if the following statements are true (T), false (F) or not given (NG) in the text. Correct the false statements.

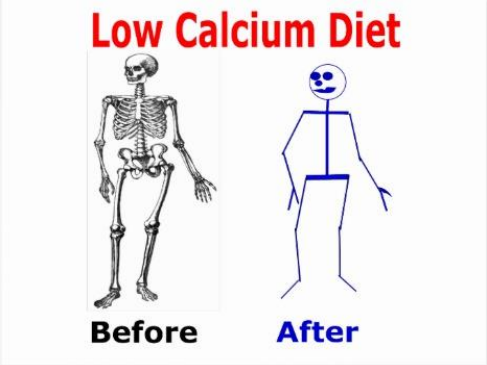
1) Alkaline earth metals were discovered by medieval chemists.
2) All of the alkaline earth metals react with the halogens to form the alkaline earth metal halides.

3) Calcium is important not only for humans but also for sea animals.

Alkaline earth metals

Medieval alchemists classified solids that did not melt in their fires as "earths." Group 2A elements form compounds with oxygen, called oxides, that qualify as "earths" by this definition. Except for beryllium oxide, these oxides produce alkaline solutions when they react with water. The label alkaline earth reflects these two properties.

Alkaline earth metals are shiny solids that are harder than alkali metals. Although alkaline earth metals are less reactive than alkali metals, they are usually found combined with oxygen and other nonmetals in Earth's crust. Alkaline earth metals lose their two valence electrons to form ions with a 2+ charge. Reactions with water reveal the relative reactivity of the alkaline earth metals. Calcium, strontium, and barium react vigorously with room temperature water. Magnesium will react in hot water. Beryllium does not appear to react with water. When exposed to oxygen, alkaline earth metals form a thin oxide coating. Most compounds of alkaline earth metals do not dissolve easily in water.



Calcium is an essential element for humans, especially in maintaining healthy bones and teeth. Calcium is found widely in nature, mainly combined with carbon and oxygen in calcium carbonate. This compound is the main ingredient in rocks such as limestone, chalk, and marble. Coral reefs build up from calcium carbonate exoskeletons that are created by marine animals called corals. Calcium carbonate is used in antacid tablets and as an abrasive in toothpaste. An abrasive is a hard material used to polish, smooth, or grind a softer material. Emery boards and sandpaper are examples of abrasive materials. When calcium carbonate decomposes, it forms an oxide of calcium called lime. Lime is one of the most important industrial compounds. For

example, lime plays a role in the manufacture of steel, paper, and glass. Gardeners use lime to make soil less acidic. Wastewater treatment plants use lime, as do devices that remove pollutants from smokestacks. Lime is mixed with sand and water to form a paste called mortar.

Taken from: Buthelezi T., Dingrando L., Hainen N., Wistrom C., Glencoe Chemistry

b) Make up 5 questions to text A. Answer them in pairs. Send two best questions to the group chat.

4. a) Look through the text B. Decide if the following statements are true (T), false (F) or not given (NG) in the text. Correct the false statements.

1) Beryllium is used in nuclear reactors.
2) Water with large quantities of magnesium is named hard water.
3) Strontium is a soft silver-white yellowish metallic element that is highly chemically reactive.

Beryllium

The lightest member of group 2A, **beryllium**, is found combined with aluminum, silicon, and oxygen in a material called beryl. Finding aluminum and beryllium together is not surprising because these elements have a diagonal relationship and, thus, similar chemical properties. Beryllium is used to moderate neutrons in nuclear reactors. Tools made from an alloy of beryllium and copper are used in situations where a spark from steel tools touching steel equipment could cause a fire or explosion. For example, beryllium–copper tools are used in petroleum refineries.

Magnesium

Magnesium is an abundant element that can be formed into almost any shape. Alloys of magnesium with aluminum and zinc are much lighter than steel but equally strong. The oxide of magnesium has such a high melting point that it is used to line furnaces. Plants cannot function without a supply of magnesium

because each chlorophyll molecule contains a magnesium ion. Your body depends on magnesium ions, too; they play key roles in muscle function and metabolism. When large quantities of calcium and magnesium ions are found in the water supply, the water is referred to as hard water. Hard water makes it difficult to wash oil from your hair or grease from your dishes because the ions interfere with the action of soaps and detergents. If there are large amounts of hydrogen carbonate ions in the water, they can combine with the calcium and magnesium ions to form deposits that can clog pipes, water heaters, and appliances such as steam irons. Devices called water softeners exchange sodium or hydrogen ions for the calcium and magnesium ions.

Uses of other alkaline earth metals

Strontium gives some fireworks their crimson color. Colorful barium compounds are used in paints and some types of glass. Barium also is used as a diagnostic tool for internal medicine. Radium is a highly radioactive element. Radium atoms emit alpha, beta, and gamma rays. Before people understood the danger, they used radium compounds to paint the hands on watches because paint containing radium glows in the dark**.**

Taken from: Buthelezi T., Dingrando L., Hainen N., Wistrom C., Glencoe Chemistry

b) Make up 5 questions to text B. Answer them in pairs. Send two best questions to the group chat.

Listening

5. a) Discuss the following questions in pairs or small groups.

- What alkaline earth metals do you know?
- What are their common properties?
- How are they different?

b) Watch the video about alkaline-earth metals and answer the questions (*https://www.youtube.com/watch?v=8qh5myTmcRs*).

1) What metals in particular is the video about?
2) What is said about melting and boiling points of alkaline-earth metals in the video?
3) What is said about softness of metals in the group?
4) What is limewater? How is it formed?
5) What is said about reactivity of metals in the group?

c) Watch the video again. What facts mentioned in the video weren't mentioned in the texts above?

Language in Use

6. a) Match the terms with their definitions.

1.	reduce	a)	A binary compound of oxygen with another element or group.
2.	valency	b)	The emission of ionizing radiation or particles caused by the spontaneous disintegration of atomic nuclei.
3.	halogen	c)	The combining power of an element, especially as measured by the number of hydrogen atoms it can displace or combine with.
4.	halide[ˈheɪlʌɪd]	d)	The amount of energy required to remove an electron from an atom or molecule of a gas to an indefinite distance
5.	ionization energy	e)	Any of the elements fluorine, chlorine, bromine, iodine, and astatine, occupying group VIIA (17) of the periodic table. They are reactive non-metallic elements that form strongly acidic

			compounds with hydrogen from which simple salts can be made.
6.	chemical bond	f)	A hard sedimentary rock, composed mainly of calcium carbonate or dolomite, used as building material and in the making of cement.
7.	compound	g)	A binary compound of a halogen with another element or group.
8.	radioactivity	i)	Undergo or cause to undergo a reaction in which electrons are gained from another substance or molecule.
9.	oxide	j)	A substance formed from two or more elements chemically united in fixed proportions.
10.	limestone	k)	A strong force of attraction holding atoms together in a molecule or crystal, resulting from the sharing or transfer of electrons.

Taken from: https://www.lexico.com/definition

b) Cover the left column and recall the terms.

7. Use the words (1-10) from exercise 6 to complete the gaps.

1. All the alkaline earth metals have two electrons in their _____ shell, so they lose two electrons to form cations with a 2+ charge.
2. The chemistry of radium is not well established due to its _____ .
3. In chemical terms, all of the alkaline metals react with the _____ to form ionic alkaline earth metal _____.
4. _____ of all alkaline metals is low.
5. All _____ that include beryllium have a covalent _____.
6. The metals _____halogens to form ionic halides: $E(s)+X_2 \rightarrow EX_2(s)$ where X = F, Cl, Br or I.
7. The metals reduce O_2 to form the _____: $2E(s)+O_2 \rightarrow 2EO(s)$

8. Calcium carbonate ($CaCO_3$) is mainly used in the construction industry and for making _____, marble, chalk, and coral.

8. a) Give English equivalents to the following words.

Лужноземельні метали, тверді речовини, лужні розчини, блискучий, реактивний, твердий, сильно (бурхливо) реагує, під дією кисню, легко розчинятись, іскра, викликати вибух, підтримувати здоров'я, переважно поєднуватись, вапно і мармур, абразивний матеріал, наждачна дошка, розкладатись, димова труба, будівельний розчин, функціонування м'язів, жорстка вода, забивати труби, пом'якшувач води, стрілки годинника.

b) Make up your own sentences in English with any 7 words from the task above. Write them down and ask your groupmates to translate them into Ukrainian.

9. a) Write the missing words. Mind the spelling. The first letter is given for you.

Properties of Alkaline Earth Metals

The alkaline earth metals (b….. (Be), m…. (Mg), c….. (Ca), s…….. (Sr), b…… (Ba), and r…..(Ra)) are a group of chemical elements in the s-block of the periodic table with very similar properties:

- shiny
- s…….-white
- somewhat reactive metals at standard t…….. and p……..
- readily lose their two outermost electrons to form c…… with a 2+ charge
- low d……..
- low m…… points
- low b…….. points.

The alkaline earth metals comprise the group 2 elements. All the discovered alkaline earth metals occur in n…….

Taken from: Boundless. (n.d.). The Alkaline Earth Metals

b) Decide whether the sentences are true or false. Correct the false ones.

1) Alkaline Earth Metals are characterized by high densities.
2) Most of them are blue.
3) Alkaline Earth Metals are characterized by low boiling points.
4) Alkaline Earth Metals can form cations with a 2+ charge
5) A few Alkaline Earth Metals can be found in nature.

10. Fill in the missing words. Use the words from the box.

further naturally maximum mined radioactive abundant heavier forming smaller

Occurrence in Nature

Emerald is a …… occurring compound of beryllium. Calcium and magnesium are …… in the earth's crust, making up several important rock …… minerals such as dolomite (dolostone) and calcite (limestone). The other non-radioactive members of the group are only present in …… quantities. Deposits of each of these minerals are …… to extract the elements for …… use. Radium, with a …… half-life of 1,601 years, is only present in nature when it is resupplied by a decay chain from the …… decay of …… elements.

Grammar Focus

Focus on Active and Passive Voice

11. Open the brackets using the words given in Present Simple, Active or Passive voice. For grammar reference see page 99.

Biological Role and Toxicity of Alkaline Earth Metals

Magnesium and calcium (be) _____ essential to all known living organisms. They (involve) _____ in more than one role. For example, magnesium or calcium ion pumps (play) _____ a role in some cellular processes. Magnesium (function) _____ as the active center in some enzymes, and calcium salts (take) _____ a structural role in bones.

Strontium (play) _____ an important role in marine aquatic life, especially hard corals, which use strontium to build their exoskeletons. Strontium and barium have some uses in medicine. For example, "barium meals" (use) _____ in radiographic imaging, while strontium compounds (employ) _____ in some toothpastes.

However, beryllium and radium are toxic. Beryllium's low aqueous solubility means it (be) _____ rarely available to biological systems. It (have) _____ no known role in living organisms, and, when encountered by them, is usually highly toxic. Radium (have) _____ a low availability and is highly radioactive, making it toxic to life.

Focus on prepositions and conjunctions

12. Fill in the gaps using appropriate prepositions or conjunctions.

Alkaline earth metals are shiny solids that are harder …… alkali metals. …… alkaline earth metals are less reactive …… alkali metals, they are usually found combined …… oxygen …… other nonmetals in the Earth’s crust. Alkaline earth metals lose their two valence electrons to form ions …… a 2+ charge.

Reactions …… water reveal the relative reactivity …… the alkaline earth metals. Calcium, strontium, …… barium react vigorously …… room temperature water. Magnesium will react …… hot water. Beryllium does not appear to react …… water. When exposed …… oxygen, alkaline earth

metals form a thin oxide coating. Most compounds …… alkaline earth metals do not dissolve easily …… water.

Speaking

13. Find three interesting facts about any Alkaline Earth Metals and write them in the table. Present the information to your groupmates. Do not name the element, let them guess.

№	Name	Interesting information you have found
1.		
2.		
3.		

14. Work in pairs.

Student A: Look at table A, ask questions to student B to fill in the gaps in your table.

Student B: Look at table B, ask questions to student A to fill in the gaps in your table.

Some properties of the alkaline metals. Table A

	beryllium	**magnesium**	**calcium**	**strontium**	**barium**	**radium**
atomic number	4		20		56	
atomic weight		24.305		87.62		226
colour of element	gray		silvery white		silvery white	
melting point (°C)		650		769		about 700

	beryllium	magnesium	calcium	strontium	barium	radium
boiling point (°C)	2,471		1,484		1,805	
density at 20 °C (grams per cubic centimetre)		1.74		2.63		3.51

Some properties of the alkaline metals. Table B

	berylliu m	magnesiu m	calciu m	strontiu m	bariu m	radium
atomic number		12		38		88
atomic weight	9.0122		40.07 8		137.3 3	
colour of element		silvery white		silvery white		bright white
melting point (°C)	1,287		842		727	
boiling point (°C)		1,090		1,384		not well established ; about 1,100–1,700
density at 20 °C (grams per cubic centimetre)	1.85		1.55		3.51	

Writing

15. Write 5-7 sentences summarizing the texts in exercises 3 and 4.

16. Write an article for a popular non-scientific magazine about hard water. Answer the following questions in your article.

1. What is hard water? What makes water hard?
2. Why is it a problem?
3. Should we soften hard water or not?
4. What are the ways to soften hard water?

YOUR ARTICLE MUST MEET THE FOLLOWING REQUIREMENTS

- It has to be interesting and get attention (use an eye-catching title, ask a rhetorical question in the first paragraph (introduction) to make readers want to find out the answer).
- It has to be easy to read (do not use too formal language and scientific terms, write in a semi-informal, conversational style; make clear paragraphs; avoid words like: to sum up, some people say, nevertheless, on one hand etc.
- Write a good ending (give the reader something to think about, perhaps by asking them another question or giving them a call to action).
- Give appropriate real life examples.
- Use rhetorical questions but not many (not more than one per paragraph).

EXAMPLES OF RHETORICAL QUESTIONS

- Have you ever ……..?
- What do you think about ……..?
- Are you one of those people who thinks that ……?
- What would life be like if ……?
- Will the future bring us ….. ?

Adopted from: Prentis, N. Five Things You Need to Know about Writing Articles

SELF-ASSESSMENT

UNIT 4. ALKALINE EARTH METALS

Choose the answer that best fits each space. Indicate your answer with a letter A, B, C or D in your answer sheet paper.

1. When _____ to oxygen, alkaline earth metals form a thin oxide coating.

a) exposed b) referred c) extracted d) accepted

2. Alkaline metals are usually _____ solids that conduct heat or electricity.

a) shiny b) flammable c) rare d) resistant

3. When calcium carbonate _____, it forms an oxide of calcium called lime.

a) emits b) releases c) decomposes d) gains

4. _____ treatment plants use lime, as do devices that remove pollutants from smokestacks.

a) Brine b) Wastewater c) Waterresistant d) Nuclear

5. A spark from steel tools could _____ a fire or explosion.

a) predict b) occur c) release d) cause

6. Plants cannot function without a _____ of magnesium.

a) value b) alloy c) series d) supply

7. This type of water is _____ to as hard water.

a) called b) referred c) existed d) dealt

8. The activity of alkaline earth metals as _____ agent increases from Be to Ba.

a) resulting b) negligible c) reducing d) releasing

9. Alkali metals are also known to react _____ and explosively with water.

a) violently b) forcefully c) highly d) primarily

10. Radium atoms _____ alpha, beta, and gamma rays.

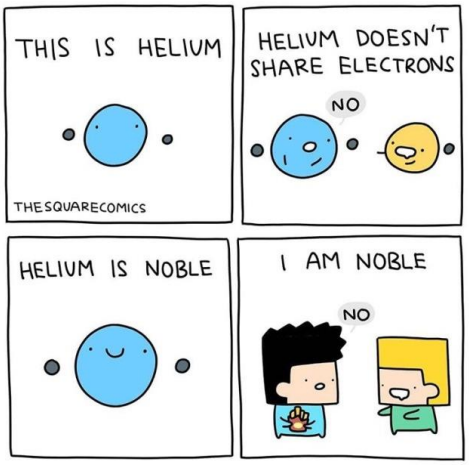
a) supply b) gain c) reduce d) emit

UNIT 5. THE NOBLE GASES

Lead-in

1. Discuss the following questions in pairs.

- ***Where are nonmetals in the Periodic table?***
- ***Which groups of elements comprise nonmetals?***
- ***Which elements are there in group 8A? What different names does the group have? Why?***



Reading 🕮

2. The following words appear in the text you are going to read. Check whether you know their pronunciation and meaning.

a) helium ['hiːlɪəm], neon ['niːɔn], xenon ['ziːnɔn], radon ['reɪdɔn], nitrogen ['naɪtrədʒən], krypton ['krɪptɔn], fluorine [ˈflʊəriːn, ˈflɔːriːn], chlorine [ˈklɔːriːn].

b) rare gases ['rɛə 'gæsɪz], noble gases ['nəubl 'gæsɪz], occur [əˈkəː], compounds *(noun, plural)* [ˈkɒmpaʊndz], total inertness [ˈtəʊt(ə)l ɪˈnəːtnəs], breakthrough [ˈbreɪkθruː], primarily [ˈprʌɪm(ə)rɪli], outer shells [ˈaʊtə ʃɛlz], outermost [ˈaʊtəməʊst], ionization energies [ˌʌɪənʌɪˈzeɪʃ(ə)n ˈɛnədʒiz], negligible [ˈnɛglɪdʒɪb(ə)l], incandescent [ɪnkænˈdesənt], discharge [dɪsˈtʃɑːdʒ], fluorescent [flʊəˈrɛs(ə)nt, flɔːˈrɛs(ə)nt], light fixtures [lʌɪt ˈfɪkstʃəz], alloys [ˈælɔɪz].

3. Look through the text. Decide if the following statements are true (T), false (F) or not given (NG) in the text. Correct the false statements.

1) The inert gases were the last discovered elements.

2) The noble gases traditionally have been labeled Group 0 in the periodic table because after their discovery it was believed that they could not bond to other atoms.
3) According to the text radon is not used in any lamps.

The rare gases

8A
Helium 2 **He** $1s^2$
Neon 10 **Ne** $[He]2s^22p^6$
Argon 18 **Ar** $[Ne]3s^23p^6$
Krypton 36 **Kr** $[Ar]4s^23d^{10}4p^6$
Xenon 54 **Xe** $[Kr]5s^24d^{10}5p^6$
Radon 86 **Rn** $[Xe]6s^24f^{14}5d^{10}6p^6$

The rare gases are located in Group VIII of the periodic table. They form a group of six elements – *helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe),* and *radon (Rn)*. They are also known as the *noble gases*, *inert gases*, or *argonons*. They occur naturally and are found in the atmosphere. All the gases are colorless, tasteless, and odorless. They are monoatomic. This means they exist as single atoms, rather than as molecules of two or more atoms. For example, oxygen in the air occurs in molecules composed of two atoms of oxygen. Each of the rare gases, however, occurs as a single atom in the air.

The noble gases were among the last naturally occurring elements to be discovered because they are colorless and unreactive. Scientists assumed that noble gases could not form compounds. The rare gases lost their claim to total inertness, however, in the early 1960's, when several compounds of krypton, xenon, and radon were prepared by treating them with fluorine and chlorine. Today, these same three noble gases are combined with fluorine and oxygen to form compounds. Despite this breakthrough, group 8A elements are still known primarily for their stability. Remember that under normal conditions, they do not enter into chemical combination with other elements to form compounds. This is because the outer shells of their atoms have the maximum possible number of electrons. Noble gases have the maximum number of electrons in their outermost energy levels – eight - except for helium, which has two. They rarely react because of their stable electron configurations. As a consequence, the

atoms have no strong attraction for electrons from other atoms, nor do they readily give up electrons to other atoms. In fact, there are no known compounds of helium, neon, or argon. They have little tendency to gain or lose electrons. The noble gases have high ionization energies and negligible electronegativity. The noble gases have low boiling points and are all gases at room temperature.

Because of their non-reactivity, the noble gases have important industrial uses. Except for radon, which is highly radioactive, all of them are used as light sources in incandescent and gas discharge lamps. These lamps include electric light bulbs and fluorescent light fixtures. The rare gases are also used in making metals and alloys, in chemical processing, and in nuclear reactors.

Taken from: Buthelezi T., Dingrando L., Hainen N., Wistrom C., Glencoe Chemistry, Sherwood, M. (Ed.), Chemistry today

4. Read the text again and answer the following questions.

1) Why were the noble gases among the last naturally occurring elements to be discovered?
2) What physical and chemical properties do the noble gases have?
3) What does *monoatomic* mean?
4) Why are the noble gases unreactive?
5) What elements do the noble gases react with?
6) Do they all have practical applications? Why? What are their applications?

Listening

5. a) Discuss the following questions in pairs or small groups.

- What are noble gases?
- What do you know about them?

b) Watch the video "Noble Gases - The Gases In Group 18" (https://www.youtube.com/watch?v=qNaBMvJXdJ4) and write down how they are used.

c) Watch the video again. What facts mentioned in the video were not mentioned in the text in ex.3?

Language in use

6. a) Match the words in column A with the words in column B to make word combinations and translate them into Ukrainian.

1. become	a) up
2. makes	b) the life
3. referred	c) crust
4. prolong	d) excited
5. energy	e) to
6. earth's	f) artificially
7. high-temperature	g) state
8. produced	h) bulbs
9. large	i) welding
10. light	j) quantities

b) Make up your own sentences in English with any 5 word combinations from the task above. Write them down and ask your groupmates to translate them into Ukrainian.

7. Complete the sentences with word combinations from ex.6.

Neon is used in light displays that are commonly 1) _____as neon lights. When high-voltage electricity passes through the neon gas stored in a gas discharge tube, electrons in the atoms 2) _____. When the

electrons return to a lower 3) _____, the atoms emit a bright orange light. The color of neon lights is not a constant because gases other than neon can be used in the displays. For example, argon emits blue light and helium emits a pale yellow light.

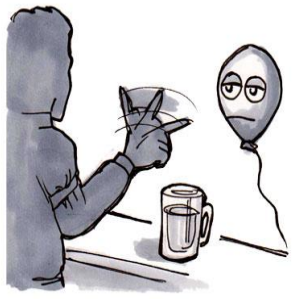
Argon is the most abundant of the noble gases on Earth; it 4) _____ about 1% of Earth's atmosphere. Argon provides an inert atmosphere for procedures such as 5) _____. This substitution avoids the dangerous mixture of electrical sparks, heat, and oxygen. Argon and **krypton** are used to 6) _____ of filaments in incandescent 7) _____ and as a layer of insulation between panes of glass.

Radon is a radioactive, heavy gas produced by the radioactive decay of radium in the 8) _____. It is released by soil and rocks. There are at least 28 known isotopes (forms) of radon – 3 in nature and 25 9) _____ in nuclear reactions. Radon has been used in medicine for treating tumors. However, if inhaled in 10) _____, it can cause lung cancer.

Taken from: Buthelezi T., Dingrando L., Hainen N., Wistrom C., Glencoe Chemistry

8. a) Fill in the gaps with a suitable word:

inflammable ***replacing*** ***mixture*** ***mixing***
prevent ***caused*** ***breathing*** ***emission spectrum***
less dense ***side effect***



HELIUM WALKS INTO A BAR. BARTENDER SAYS, "WE DON'T SERVE NOBLE GASES HERE."

He DOES NOT REACT.

The lightest noble gas, helium, was discovered first in the 1) _____ of the Sun. Although helium is light enough to escape Earth's gravity, it can be found on Earth in natural-gas wells. Helium, being

2) _____ than air, is used to inflate balloons and airships as an alternative to highly 3) _____ hydrogen. It is also used to 4) _____ chemicals from reacting with other elements during storage, handling, and transportation. A 5) _____ of helium and oxygen sometimes makes breathing easier for persons with asthma or other 6) _____ difficulties. A mixture of helium and oxygen is used by deep-sea divers. By 7) _____ the nitrogen in air with helium, divers can return to the surface quickly without experiencing a painful condition called the "bends." Artificial air made by 8) _____ helium and oxygen overcomes this problem. The only 9) _____ is the squeaky "Donald Duck" voice quality 10) _____ by breathing the mixture. Liquid helium is used as a coolant for superconducting magnets.

b) Make up 5 questions to the text. Answer them in pairs. Send two best questions to the group chat.

Grammar focus

Focus on prepositions and conjunctions.

9. Use correct prepositions or conjunctions in the following sentences.

Interesting Facts about Noble Gases

1. As helium is non-flammable it is much safer to use it … balloons than hydrogen.
2. Krypton gets its name … the Greek word "kryptos" meaning "the hidden one."
3. Many … the noble gases were either discovered … isolated … Scottish chemist Sir William Ramsay.
4. Helium has the lowest melting … boiling points … any substance.
5. All …the noble gases except … radon have stable isotopes.

6. Neon signs do not use just neon gas, … a mixture … different noble gases … other elements to create bright lights … different colors.
7. Noble gases are often used to create a safe … inert atmosphere due … their stable nature.
8. Xenon gets its name … the Greek word ‘xenos’ which means ‘stranger … foreigner.’

Taken from: Noble Gases

b) Look at the text on page 112. Check yourself, write out word combinations with mistakes and make up sentences with them in written.

Focus on numbers and tenses (active and passive voice)

10. a) Read the numbers in the text given in bold. For grammar reference see page 102.

b) Open the brackets using the verbs in a proper tense and voice (Present Simple or Past Simple in Active or Passive voice). For grammar reference see page 99.

1. The name neon (come) _____ from the Greek word νέον meaning new.
2. While experimenting on liquid air, Sir William Ramsay and Morris Travers (discover) _____ neon in **1898.**
3. The scientists (discover) _____ krypton prior to their discovery of neon, and discovered xenon shortly afterwards.
4. The concentration of neon in the atmosphere (be)_____ about 1 part in **55,000**, or **18.2 ppm** by volume or 1 part in **79,000** of air by mass.
5. Neon (be)_____ about **2/3** as dense as air.
6. Georges Claude (begin) _____ creating neon lighting in **1902,** as he (have) _____ surplus neon leftover as a byproduct of his air liquefaction company.

7. In **1910**, Georges Claude (attempt) _____ to create interior home lighting using neon lights in vacuum tubes, but homeowners (not/ accept) the idea due to their color.
8. Neon's rarity (make) _____ it fairly expensive, making liquid neon about **55** times more expensive than liquid helium.
9. The melting point of neon is **-433.46 °F (-258.59 °C)** and the boiling point is **-410.94 °F (-246.08 °C).**

Speaking 🗣

11. Find three interesting facts about any Noble gas and write them in the table. Present the information to your groupmates. Do not name the gas, let them guess.

Name	***Interesting information you have found***
	1. **2.** **3.**

12. Fill in the table. Using the table tell about the rare gases.

	Properties	**Applications**
RARE GASES		
helium (He)		

neon (Ne)		
argon (Ar)		
krypton (Kr) **xenon (Xe)**		
radon (Rn)		
oganesson (Og)		

13. a) Do you agree with the following quote: *Be humble for you are made of earth, be noble for you are made of stars?* Share your ideas with the group. Make notes for 1 minute and prepare a 2-3-minute speech expressing your ideas on the quote. Answer the following question in your speech:

Why are people made of earth?

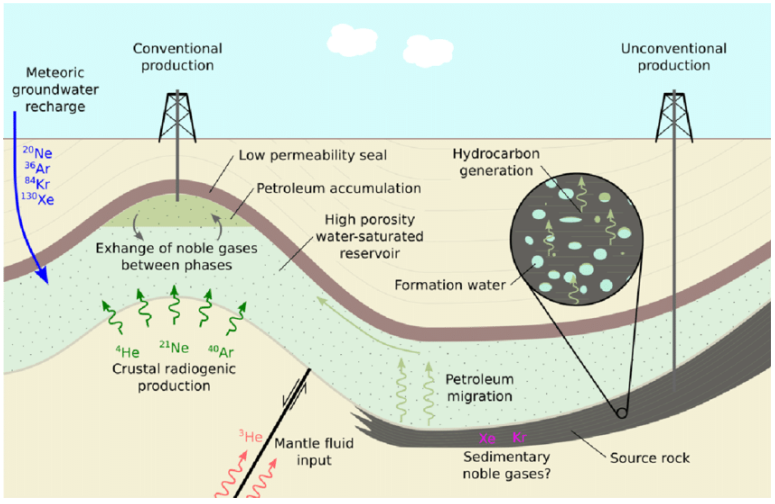
Why are people made of stars?

What is the meaning of this saying?

Do you agree with it?

Present your speech to your partner.

b) Describe the following diagram of the sources of noble gases in petroleum systems.



Writing ✍

14. Write 5-7 sentences summarizing the text in exercises 3 and 7.

15. After posting your presentation about Noble gases on the Internet you were contacted by a young teacher of Science (John Nettleship) who is going to use it at his lesson for 14-15 year-old students. Write a formal email to this teacher and include the following information.

- ***give you permission to use the presentation;***
- ***offer the points to be covered at the lesson about the noble gases with this age group;***
- ***give advice which everyday objects can be demonstrated at the lesson to show the application of Noble gases.***

Write 120-180 words. For writing reference see page 110.

SELF-ASSESSMENT

UNIT 5. THE NOBLE GASES

Choose the answer that best fits each space. Indicate your answer with a letter A, B, C or D in your answer sheet paper.

1. The _____ have very high electronegativity:
   a) metalloids c) noble gases
   b) halogens d) alkali metals
2. _____ has the highest electronegativity of all elements:
   a) Bromine c) Fluorine
   b) Helium d) Radon
3. Tennessine is a _____, and oganesson is a _____ .
   a) halogen c) metalloid
   b) noble gas d) metal
4. What noble gases do **NOT** have_____ .
   a) high electronegativity c) low boiling points
   b) high ionization energies d) low reactivity
5. The lightest noble gas is _____.
   a) neon c) helium
   b) xenon d) argon
6. _____ is a radioactive gas produced by the radioactive decay of radium in the earth's crust.
   a) Polonium c) Radon
   b) Astatine d) Thalium
7. All of these elements have known compounds **except** _____.
   a) helium c) argon
   b) xenon d) neon
8. _____ is less dense than air, is used to inflate balloons and airships as an alternative to highly inflammable hydrogen.
   a) Argon c) Neon
   b) Helium d) Krypton
9. Ammonia is not highly _____ , but containers of ammonia may explode when exposed to high heat.
   a) abundant c) shiny
   b) rare d) flammable
10. Oxygen in the air _____ in molecules composed of two atoms of oxygen.
    a) occurs c) gains
    b) reveals d) explodes

Appendix 1. Mini-Dictionary

Unit 1. Solutions

1. **accumulate** накопичувати
2. **acetic acid** [ə'si͟ːtɪk 'æ͟sɪd] оцтова кислота
3. **acidic solution** [ə'sɪdɪk] кислотний розчин
4. **affect greatly the solubility** суттєво впливати на розчинність
5. **aqueous solution** [ˈeɪkwɪəs, ˈækwɪ-] водний розчин
6. **at a specified/ specific/definite temperature** ['spesɪfaɪd] при зазначеній / заданій температурі
7. **basic** ['beɪsɪk]/ **neutral** ['nju:trəl] **solution** основний/ нейтральний розчин
8. **collide with** [kə'laɪd] зіштовхуватися, стикатися з
9. **concentrated solutions** концентровані розчини
10. **conduct a current** [kən'dʌkt] ['kʌr(ə)nt] *BrE*; ['kɜːr(ə)nt] *AmE* проводити струм
11. **dilute** (**with)** *obj*.] [daɪ'lu:t] розріджувати, розбавляти
12. **dilute solution** [daɪ'lu:t] розбавлений, розведений розчин
13. **dissolved** [dɪ'zɔlvd] розчинений
14. **dissolving medium** середовище, що розчиняє
15. **frequent collisions** ['fri:kwənt] [kə'lɪʒ(ə)nz] часті зіткнення
16. **given amount of solvent** ['sɔlvənt] обумовлена / задана кількість розчинника
17. **immiscible (with)** що не змішується; нездатний змішуватися
18. **miscible (with)** ['mɪsɪb(ə)l] (of liquids) capable of mixing змішуваний, що змішується; розчинний
19. **net effect** 1) результуючий / сукупний ефект 2) сумарний вплив
20. **nitinol** ['nɪtɪnɒl] [mass noun] an alloy of nickel and titanium нітинол
21. **precipitate** осад, виділяти осад
22. **reach equilibrium** [ri:ʧ] [ˌi:kwɪ'lɪbrɪəm], [ˌekwɪ'-] досягти рівноваги
23. **saturated** ['sæʧəreɪtɪd] /**supersaturated/ unsaturated solution** насичений/перенасичений / ненасичений розчин
24. **solubility** [ˌsɔlju'bɪlətɪ] розчинність
25. **soluble** ['sɔljəbl] розчинний ≠ **insoluble**
26. **solute** ['sɔlju:t] (*N-MASS*) розчинена речовина, розчин
27. **solution** [sə'lu:ʃ(ə)n] (*countable*) розчин; (*uncountable*) розчинення
28. **solvation** [sɒlˈveɪʃən] сольватація
29. **solvation rate** [sɒlˈveɪʃən] [reɪt] швидкість сольватації
30. **solvent** ['sɔlvənt] is (*N-MASS*) розчинник

Unit 2. The Periodic Table

1. **accept the law** [ək'sept] приймати/ визнавати закон
2. **acceptance of the law** [ək'septəns] [lɔ:] прийняття/визнання закону
3. **advancement of chemistry** [əd'vɑ:nsmənt] розвиток хімії
4. **arranged/ ordered by increasing atomic mass/number** впорядкований за збільшенням атомної маси/атомного числа
5. **bad/good conductors of heat and electricity** погані / хороші провідники тепла та електрики
6. **be designated with** ['dezɪgneɪtid] позначатися
7. **be often referred to** часто називатися
8. **be solid at room temperature** бути твердим при кімнатній температурі
9. **be struck/bombarded by electrons (*strike, struck, struck*)** бомбардуватися електронами
10. **brittle/ dull-looking solids** ламкі/ тьмяні тверді тіла
11. **by arranging the elements in order of increasing atomic mass** шляхом розташування елементів в порядку зростання атомної маси
12. **by noting trends** помітивши тенденції
13. **compile a list** [kəm'paɪl] укладати/ складати список
14. **contain a unique number of protons** ['prəutɒnz] містити унікальне число протонів
15. **ductile** ['dʌktaɪl] ковкий; эластичный, гибкий *able to be drawn out into a thin wire; pliable, not brittle*
16. **electron shell** електронна оболонка
17. **emit light** [ɪ'mɪt laɪt] випромінювати світло
18. **give sb credit for sth** визнавати когось за щось
19. **have similar properties** [hæv 'sɪmɪlə 'prɔpətɪz] мати подібні властивості
20. **increase** [ɪn'kri:s] зростати; збільшувати(ся)
21. **leave blank spaces in the table** залишити порожні місця в таблиці
22. **malleable** ['mælɪəbl] ковкий, пластичный *able to be hammered or pressed permanently out of shape without breaking or cracking*
23. **more accurately determined** ['ækjərətlɪ] [dɪ'tɜ:mɪnd] більш точно визначений
24. **notice (that)** ['nəutɪs] помічати; звертати увагу на те (що)
25. **periodic pattern** [ˌpɪərɪ'ɒdɪk 'pætn] періодична повторюваність/ закономірність
26. **possess a wide range of properties** мати широкий діапазон властивостей
27. **predict the existence** [ɪg'zɪst(ə)ns] передбачити існування
28. **properties of undiscovered elements** властивості невідкритих елементів
29. **propose an organization scheme** [ski:m] запропонувати схему організації
30. **repetition** повторення;
31. **representative elements** репрезентативні елементи

32. **respectively** відповідно
33. **result** [rɪ'zʌlt] **in a clear periodic pattern of properties** призводити до чіткого періодичного повторення властивостей
34. **series of columns** ['sɪ(ə)riːz] ['kɒləmz] ряд стовпчиків
35. **state** 1) констатувати; формулювати; 2) встановлювати, точно визначати;
36. **statement** твердження
37. **the actinide series** ['æktinaid] ['sɪəriːz] ряд актинидів/ актиноїдов
38. **the lanthanide series** ['lænθənaid] ['sɪəriːz] ряд лантанидів/ лантаноїдів/ рідкоземельних елементів
39. **triple the number** ['trɪp(ə)l] потроювати число/кількість

Unit 3. Alkali Metals

1. **abundant (element)** [ə'bʌndənt] поширений (елемент)
2. **abundance (of elements)** поширеність елементів
3. **alkali** ['ælkəlaɪ] (-s [-z]) (pl. -lis) луг
4. **alkali metal** лужний метал
5. **alkaline (solutions)** ['ælk(ə)laɪn] лужний (розчин)
6. **alloy (of magnesium)** ['ælɔɪ] [mæg'niːzɪəm] сплав магния
7. **borax** [ˈbɔːraks] бура (тетраборнокислий натрій); боракс
8. **brine** розсіл; ропа; солона вода; соляний розчин
9. **cesium** ['siːzɪəm] цезій, Cs
10. **extract (sth from sth)** видобувати (щось з чогось)
11. **francium** францій
12. **highly reactive** надзвичайно хімічно активний/високоактивний ≠ **the least reactive (little; less; the least**) найменш / в найменшій мірі хімічно активний
13. **hydrocarbon oil** вуглеводневе/ мінеральне масло
14. **hygroscopi**c [hʌɪgrə(ʊ)ˈskɒpɪk] гігроскопічний
15. **in the earth's crust** в земній корі
16. **lubricating grease** густе мастило; пластичний мастильний матеріал
17. **molten salt** розплавлена сіль; соляний розплав
18. **occur in nature** [əˈkɜː ɪn ˈneɪtʃə] зустрічатися в природі
19. **photocell** [ˈfəʊtəʊsɛl] фотоелемент
20. **potassium** [pə'tæsɪəm] калій
21. **react (vigorously)** вступати в реакцію (активно)
22. **react with water** вступати в реакцію з водою
23. **reactivity** [rɪˈakˈtɪvɪti] реакційність; нестабільність
24. **release hydrogen gas** [rɪˈliːs] виділяти вуглеводневий газ
25. **salt bed** соляний шар, пласт
26. **shortlived** недовговічний
27. **soda ash** кальцинованна сода
28. **sodium** ['səudɪəm] натрій
29. **speed up chemical reactions** прискорювати хімічні реакції
30. **spodumene** [ˈspɒdjʊmiːn] сподумен
31. **strengthen glass** ['streŋθ(ə)n] зміцнювати / робити більш міцним скло
32. **tanning leather** дублення шкіри
33. **water resistance** водостійкість; вологонепроникність
34. **water-attracting** який (що) всмоктує воду
35. **weighable amount** кількість, що піддається зважуванню

Unit 4. Alkali Earth Metals

1. **appliances** прилади
2. **cause a fire** спричинити пожежу
3. **comprise the group** складати/ утворювати групу
4. **copper** мідь
5. **crimson colour** малиновий колір
6. **depend on** залежати від
7. **detergent** миючий засіб
8. **emit rays** випромінювати промені
9. **essential element** есенціальний/життєво необхідний елемент
10. **expose to sth** піддавати дії (чого-небудь)
11. **exposed to** той, що знаходиться в умовах впливу
12. **form (a coating)** утворювати (покриття)
13. **furnace** піч
14. **glow (in the dark)** світитися (в темряві)
15. **grease** мастило
16. **grind (a soft material)** [ɡraɪnd] **(ground, ground** [ɡraʊnd]) шліфувати (м'який матеріал)
17. **hard sedimentary rock** тверда осадова гірська порода
18. **interfere with** (smth/sb) перешкоджати (чому-небудь/кому-небудь)
19. **label** (**something with something)** [ˈleɪbəl] (***labelled, labelling*** *BrE*, ***labeled, labeling*** *AmE*) маркувати (щось чимось)
20. **lime** вапно
21. **limestone** вапняк
22. **lose electrons (*lost, lost*)** втрачати електрони
23. **marine animals** морські тварини
24. **melt** плавити
25. **mortar** ступка
26. **muscle function** функція м’язів
27. **reveal relative reactivity** проявляти відносну реакційну здатність
28. **shiny solid** блискуче тверде тіло
29. **smooth sth** шліфувати, полірувати
30. **softener** пом'якшувач
31. **spark** іскра
32. **supply of magnesium** запас магнію
33. **tools** інструменти
34. **undergo a reaction** зазнавати реакції
35. **wastewater treatment plants** очисні споруди

Unit 5. The Noble Gases

1. **alloy** ['ælɔɪ] сплав
2. **assume** [əˈsjuːm] припустити, допускати
3. **breakthrough (in science)**[ˈbreɪkθruː] прорив; відкриття (в науці)
4. **coolant** ['kuːlənt] охолоджувач, хладагент
5. **dense** щільний
6. **discharge tube** відвідна трубка
7. **during handling (of sth)** при поводженні (з чимось)/ під час користування (чимось)/ під час транспортування (чогось)
8. **emission spectrum** [ɪ'mɪʃ(ə)n] спектр випромінювання
9. **fixture** ['fɪksʧə] 1) (fixtures) пристосування, прилад
10. **flammable** ['flæməbl] easily set on fire ***Syn: inflammable***[ɪn'flæməbl] легко займистий, горючий
11. **flammable** *Syn* **inflammable** вогненебезпечний ≠ **non-flammable, non-inflammable** незаймистий, негорючий
12. **gain electrons** приєднувати електрони
13. **incandescent lamp** [ˌɪnkæn'des(ə)nt] лампа розжарювання
14. **inhale (ammonia fumes)** [ɪnˈheɪl] (вдихати пари аміаку) ***Opp*** **exhale**
15. **ionization energy** [ˌaɪənaɪˈzeɪʃən] енергія іонізації
16. **light-emitting diode display (LED display**) світлодіодне табло
17. **lighting fixtures** освітлювальна апаратура; **fluorescent fixture** освітлювальна арматура з люмінесцентними лампами
18. **lose electrons** втрачати електрони
19. **negligible electronegativity** [ˈneglәjәb(ə)l] незначна електронегативність
20. **noble gases** *Syn* **rare gases** інертні гази
21. **occur in** зустрічатися в
22. **outer shells** зовнішні оболонки
23. **outermost energy level** зовнішній енергетичний рівень
24. **provide** забезпечити
25. **readily give up electrons** легко віддавати електрони
26. **squeacky voice** писклявий голос
27. **strong attraction for electrons** сильне тяжіння до електронів
28. **superconducting magnet** надпровідний електромагніт
29. **tennessine** [ˈtɛnəsiːn] тенесин
30. **the atomic radius** ['reɪdɪəs] атомний радіус
31. **treat tumors** лікувати пухлини
32. **welding** зварювання

Appendix 2. Video scripts

Unit 1

Video script 1

SOLUBILITY

Why do some substances appear to disappear when they're put into water when others do not? Let's answer that.

In order to discuss solubility, we're going to need an example. Let’s use tea. When a lot of people drink tea they find it's too bitter to drink. Naturally, they add sugar to sweeten the taste. So, if we take our cup of tea and add sugar to it, there’s now sugar floating around in the tea. With a little stirring the sugar seems to disappear. But has the sugar actually disappeared? Well, the answer is no. The sugar is still there. But we can no longer see it. The sugar is said to have been dissolved in the tea.

Now, there is some terminology we need to know. But luckily there's not too much. Now, the first component we are dealing with is the sugar which in this case is referred to as the solute. The second component we are dealing with is the tea itself, which in this case is called the solvent. So, the solute is dissolved in the solvent and the solvent dissolves the solute.

Now, there is a third term we need to know which relates to the tea and sugar system as a whole. And this term is solution which is the term for the mixture of the solute dissolved in a solvent. The sugar dissolved in the tea. A sugar tea solution now.

Not all substances will dissolve in the same solvent. Take water, for instance. Some substances will dissolve in water like the sugar or table salt, others will not, like sand or oil. If sand could dissolve in water, our beaches would be quite a bit smaller. Why though? Why are the abilities for solutes to dissolve in solvents selective? The reason is polarity. Polar molecules will dissolve in polar substances. And nonpolar or A-polar molecules will dissolve in

A-polar substances. However, that's a more advanced level of chemistry and will be covered in a separate video.

Now, we head to the term solubility. Solubility is the measure of the amount of a solute able to dissolve in a solvent with units of grams per 100 centimeters cubed or grams per 100 milliliters.

So, to visualize this, for every 100 milliliters of solvent we can dissolve 1 gram of solute. So, the solute in this case-is called soluble. It can dissolve in the solvent. If a substance cannot dissolve at all in a solvent, the solute is said to be insoluble for that particular solvent. Now, the identity of the solute and the solvent will cause different solubilities. As you can see, even by changing just the solute, the solubility of that substance can change dramatically. Now, the solubilities of substances are also affected by the temperature of the solvent. When regarding solid solutes, an increase in the temperature of the solvent results in an increase in the solubility of the solute. This can be shown with sodium chloride in water. With each 10-degree increase in temperature the solubility is increasing by around 0.7 grams per hundred centimeter cubed.

So, if you've ever noticed a pile of sugar in the bottom of your cup of tea after you finish drinking it, then you probably made a cup of tea too cold.

Gases also need to be accounted for when discussing solubility. As they too can be considered a solute. So, like solids, gases can also be dissolved in solvents. Let's take lemonade. Lemonade is a carbonated drink meaning there are actual carbon dioxide molecules dissolved in the juice. That's what creates the fizz. The solubility of that CO_2 is dependent on pressure. As the pressure of the volume of space above the lemonade increases, so does the solubility of that CO_2. So, when the lemonade is produced, the bottling process occurs under pressure as to keep as much of the fizz creating CO_2 in solution. Also upon removing the cap and releasing the pressure naturally the CO_2 comes out of solution. As the solubility is decreasing, this creates a surplus of CO_2 bubbles emerging from the lemonade, often creating a mess now to explain this. The CO_2 particles can be seen to have little space above the solution to move into.

Or, in other words, a high pressure. If we reduce the pressure by increasing the volume of space above the juice, the particles will have more space to move into. Thus, they come out of solution like solids.

Temperature also plays a role in the solubility of gases. However, this time it's reversed. As the temperature of the solvent increases, the solubility of the gas decreases.

Taken from: https://www.youtube.com/watch?v=7I8zgrSydsg

Unit 2

Video script 2

PERIODIC TABLE OF ELEMENTS

In 1869 a Russian chemistry professor named Dmitri Mendeleev was writing a textbook for his students when he began to wonder how he could best explain to them the 63 elements that were known at that time. To help formulate his thoughts, he constructed a card for each element. On each card he wrote a name for each element, its atomic number, its typical properties and its similarities to other elements. He then laid the cards out like a game of solitaire and began arranging them over and over searching for patterns. Then came the moment of discovery. Before him was something extraordinary. The elements fell into 7 vertical groupings. Each periodic grouping had members that resembled one another both chemically and physically.

Mendeleev had discovered the Periodic Table of the elements, a map showing how all the elements related to one another. A map so precise that Mendeleev believed he could also use it to predict the existence and properties of three elements no one had yet discovered. One would be like boron he said. One like aluminum and one like silicon. Eventually the elements were discovered and Mendeleev was proven right.

'There was actually a little bit of controversy because a German chemist named Lothar Meyer had come up with roughly the same idea. But Meyer didn't

quite have as much courage. So, that's actually an interesting thing. He is the German who comes up with the same idea of periodicity of which there were hints already before. But he doesn't make the predictions that Mendeleev does. So, here we see the power of a risky prediction in having people accept a theory. There is nothing more powerful than making a prediction that's not obvious and then have it come true. The periodic table is our icon. I mean that's what we associate with chemistry. When you go into any chemistry room you see it.'

Why is the periodic table of elements significant? It forever changed the way that everyone would learn and understand the elements. The periodic table of elements is chemistry as notes of music are to a Beethoven sonata.

In honor of Mendeleev, his name is now literally attached to the periodic table. The element 101 was named after him. It's called mendelevium.

'It's not only chemists who like the periodic table. I hear you carry one around.'

'I do carry one, yes, sir.'

'Show me.'

'You never know and I seem to use it a lot.'

'Let's see…'

'It's a small.'

'So, I'm going to give you a test. What is under nitrogen?'

'Nitrogen is 7.'

'Yes.'

'Well, I have to think a second. Sulphur.'

'No, you're wrong. It's phosphorus.'

'Phosphorus is 15.'

'Yes, you have to add 8 at that point.'

'I see. That's why I carry it. I can't remember it. So, it's 7 plus 8. 15 – phosphorus. OK, there is a pattern there.'

Taken from: https://www.youtube.com/watch?v=3yzMsnhVuNE

Unit 3

Video script 3.1

ALKALI METALS

The group one elements, which are known as alkali metals, are a bit different from most other metals. They include lithium, sodium, potassium, rubidium, caesium, and francium.

Instead of being strong, having a high density and having a high melting point, like you expect of a metal, the alkali metals are, in fact, very soft with low densities and low melting points.

They are also much more reactive than other metals and react vigorously with water, oxygen, and group 7 elements such as chlorine, as we'll see later.

As you go down the group the elements become even more reactive. With caesium being so reactive they can ignite spontaneously at room temperature.

Another trend as you go down the group is that the melting points and the boiling points decrease.

Now, an easy way to remember this trend in reactivity is that common table salt, which has sodium in it, doesn't just suddenly catch fire as you sprinkle it on your potatoes, or has caesium probably would.

Now, a big part of chemistry is explaining the properties and trends that we see. For example, how would you explain the fact that alkali metals are so reactive? Well, if you remember from our electron arrangement video, all atoms won't have a completely full outermost shell in order to be stable. And because the alkali metals are all in Group 1, we know they all have one electron in the outermost shell. So, in order to react and be stable all they need to do is lose that one single electron, which is pretty easy, because there's only one electron to lose. And because they lose a one negative charge that become a one positive ion. What about the trend that we mentioned, though? That they become more reactive as you go down the group. Well, as you go down the group, the atom's radius gets bigger and so the outer shell is further and further away from that

positive nucleus. Now, as this positive nucleus is the only thing holding the outermost electrode in place, the increased distance weakens the attractive force between our positive nucleus and that outer negative electron, meaning that the electrons we lost more easily, increasing the atoms reactivity.

Remember, the term reactivity isn't anything special, it's just related to how easily atoms can lose or gain electrons and so react with other atoms. Because alkali metals can lose their outer electrons so easily, they almost always form ionic compounds with non-metals. We'll give a closer look at ionic compounds in another video. But it's basically where a metal atom like sodium donates an electron to a non-metal like chlorine, so that both of them have full outer shells. And because these two atoms are now oppositely charged ions will be attracted to each other by electrostatic forces, which we call an ionic bond, and so together they make an ionic compound. This particular example of sodium chloride, actually, happens to be common table salt. But regardless of the alkali metal used, the ionic compounds are generally white solids and they tend to dissolve in water to form colourless solutions.

So, now we've covered alkali metals in general, we'd consider how they react with water chlorine and oxygen. When an alkali metal is put in water, it tracks in vigorously to use a metal hydroxide and hydrogen gas. For example, sodium plus water will form sodium hydroxide plus hydrogen. As we mentioned earlier, the metals become more reactive as we go down the group and so the reactions will release more energy. In fact, from potassium onwards so much energy is released that they ignite the hydrogen gas that gets produced which we can see in the form of flames. Group 1 metals also react rigorously when heated in chlorine gas and in this case if all white metal chloride salts. So, sodium plus chlorine would form sodium chloride and again the reactions will become more vigorous as you go down the group. When alkali metals react to the oxygen, they pull metal oxides. The type of oxide they form will depend on the particular metal, for example lithium plus oxygen forms lithium oxide Li_2O, like sodium plus oxygen from sodium oxide Na_2O. However, sodium and oxygen can also

react to form sodium peroxide instead, which is Na_2O_2. Meanwhile, potassium can react with oxygen to form either potassium peroxide K_2O_2 or potassium superoxide which is KO_2. Now, that's quite a lot to remember and you don't really need to know why these particular compounds form. So, the best trick is probably to just put the ones on flashcards and practice them whenever you need to know them for exams. And that's everything you need to know about alkali metals.

Taken from: https://www.youtube.com/watch?v=dZGDUKQa_6g

Video script 3.2

BRAINIAC ALKALI METALS

Whether you've left school or you're still at school you can appreciate the sheer fun may have that chemistry can be. There's so much to it. Bunsen burners, mixing chemicals. Very nice. Now, you may have been allowed to mix very small amounts of lithium with water. You may if with a responsible adult have mixed H_2O with sodium. And you may under very strict scientific control have witnessed potassium mixed with water. But the odds are if you have it will only ever have been on one of those rubbish science videos. Think, I might present.

These next two of the dogs nuts of the periodic table. They are if you like the king and queen of alkali metals. Mix these babies with water, stand well back and watch the mayhem. And that's just what we're going to do. Mr Tickle, bring on the rubidium. 'Here it is'. Is that it? 'Well, it might not look like much, Richard. But it's a highly reactive metal. It's sealed in this glass tube under argon atmosphere conditions, just for safety'. Right, so what's going to happen when you drop that in the water? 'Well, imagine, if you will let off a hand grenade in a bathtub. Okay. Good luck.

Okay, tickle, drop the rubidium in the water. Stand back, everybody. Soon's gonna be bad. Two grams of rubidium will only react when our specially

designed vial dissolves in the water which gives John a few crucial seconds to get into a safety zone.

Yes, that is more likely to be only on Brainiac do you get that kind of science. But I believe, we can go one better. There is one more alkaline metal we can legally use. Yes, caesium, the emperor of alkali metals particularly nasty to go up at any time. And that's it. Oh, yes. Yeah, I like it already. Now, what's that gonna do when it hits the water? Imagine a depth charge in a bathtub … Thank you. Okay, John, go for it. Warning, warning, warning! Extreme danger! Clean the area. As our caesium sinks in the water, the rapid generation of hydrogen gas should produce quite an explosion. And it does! Magnificent! And I think that concludes today's experiment. There is a should say, one more, even more reactive metal, francium. But for some reason they wouldn't let us have any of that. But the aim of today's lesson? Never mix up alkali metals with water.

Taken from: https://www.youtube.com/watch?v=m55kgyApYrY

Unit 4.

Video script 4

ALKALINE EARTH METALS

In this lesson we will learn about the alkaline earth metals in Group 2 of the periodic table. We will focus on magnesium and calcium and learn about how they react with oxygen and water and the products formed from these reactions.

The alkaline earth metals are beryllium, magnesium, calcium, strontium, barium, and radium. Located in Group 2 of the periodic table these metals all have two electrons in their valence shell and with the exception of beryllium can lose these valence electrons to form an ion with a +2 charge.

Like the alkali metals these metals except for magnesium are stored in oil. Similar properties and reactivity trends are also observed. Moving down the

group their density and reactivity increases, melting points and boiling points decrease and the metals become softer.

We will now learn about the reactions of magnesium and calcium with oxygen and water. Magnesium is shiny and silver. But you will see that your magnesium strip may be dull. This is due to the formation of an oxide layer from exposure to air. Simply clean it with steel wool, so to remove as much of the oxide layer as possible. Using a pair of tongs, take the magnesium strip and hold it to a roaring Bunsen burner flame. The combustion of magnesium proceeds with a bright white flash. Take care not to look at this flash. Magnesium reacts with oxygen to produce magnesium oxide which is a white solid.

Here is a challenge. Do you expect calcium to be softer or harder than magnesium? Please, pause the lesson to think about this and resume when you are ready.

Calcium is softer than magnesium. Moving down the group the metals become softer. Overall, though, these metals are harder than the alkali metals. Calcium is also shiny and silver. Using a pair of tweezers, take out a chunk and cut a small piece using a scalpel. Remove excess oil, using paper towels. Using tongs, place in a roaring Bunsen burner. Flame you will observe that it burns with a red flame. Calcium reacts with oxygen to produce calcium oxide which is a white solid. So, magnesium and calcium react with oxygen to form their respective oxides.

Let the formed calcium oxide cool. It's important that you allow it to cool sufficiently because the next step is exothermic. Place the cooled calcium oxide in cold water. Calcium oxide reacts with water to produce a solution of calcium hydroxide also known as lime water. You will see a white precipitate at the bottom of the beaker, once everything settles. This is solid calcium hydroxide as it is only slightly soluble in water.

Magnesium will only react with steam, not cold water. The reaction from steam forms magnesium oxide and hydrogen gas. In this practical, it is imperative that the magnesium strip is heated, not the mineral wool, soaked in

water. Hydrogen gas can be collected over water and tested to confirm its presence.

How do you think the reaction of calcium with water compares to the reaction of magnesium with water? Please, pause the lesson to think about this and resume when you are done.

The reaction of calcium with water is expected to be more vigorous as the reactivity of these metals increases, moving down the group. Calcium reacts with cold water to form calcium hydroxide and hydrogen gas. Note that calcium sinks to the bottom in this reaction. The effervescence shows that a gas is being produced.

In summary, the alkaline earth metals are the group 2 metals. They exhibit similar properties and reactivity trends to the alkali metals. Magnesium and calcium react with oxygen to form their respective oxides. Magnesium reacts with steam to produce magnesium oxide and hydrogen gas. Calcium reacts with cold water to produce calcium hydroxide and hydrogen gas.

Taken from https://www.youtube.com/watch?v=8qh5myTmcRs

Unit 5.

Video script 5

NOBLE GASES

What do party balloons, neon signs, and certain lightbulbs have in common? They are all filled with a noble gas. In this lesson we will learn about the noble gases, their properties, and their uses.

The noble gases are the group 18 elements: helium, neon, argon, krypton, xenon, and radon. These elements are notable for having a full valence shell of electrons. Helium has two valence electrons. Whereas the other noble gases each have eight valence electrons. The noble gases all have full valence shells which makes them very stable elements. In fact, they are so stable that in the past chemists thought that they could not react with other elements which is why they were called the inert or unreactive gases.

However, we know today that some noble gases can indeed react to form some compounds. Which is why today this group of elements is called the noble gases instead.

All of the noble gases are colourless and monotonic, meaning that they exist as single atoms. Moving down the group the number of electron shells increases by one shell. Hence, the further down the group the bigger the atom. the size of the atom also affects its boiling point. These boiling points increase because intermolecular forces between larger atoms with more electrons are greater than that between smaller atoms with fewer electrons. Also, moving down the density of the gases increases because larger atoms take up more space in a set volume. Since they are very stable and are hardly reactive as well as their individual characteristics the noble gases have many practical real-life applications. One you might already know is helium, used to fill party balloons. Since it is less dense than air, these balloons float. And because of this property helium is also used to fill airships. There are actually many interesting uses in industry. Krypton and xenon are used in some types of lasers and in flat-panel display manufacturing. Since the 1990s xenon is being used increasingly for car headlights to increase road safety. Xenon lamps produce a very bright light and increase contrasts and colour vision. Although it is very inert, when an electrical current is passed through neon, it emits a bright orange light. Light bulbs are filled with argon. Unlike air, it will not react with the tungsten filament. Noble gases are also applied in medicine. Xenon is an effective natural anaesthetic. It helps doctors maintain the patient’s blood pressure and heart rate during operations and has particularly few side effects. Meanwhile, radon is highly radioactive which is a characteristic that has been put to use in radiotherapy in attempts to cure cancer. These are the traditional uses of noble gases. But it even goes beyond that. Krypton is sometimes used as a filler in double glazing. Set between two glass panels, Krypton will offer very good insulation because it has a lower thermal conductivity than the molecules making up the air and it doesn't stop. In the space industry xenon is used as a propellant that helps us steer

satellites on their orbital paths. It’s mass ensures that we can put the satellite in movement. So, now you know the basics of noble gases. The group 18 elements also known as Group zero. Their stability is one of their main characteristics allowing for many real-life applications.

Taken from: https://www.youtube.com/watch?v=qNaBMvJXdJ4

Appendix 3. Special questions

Special questions begin with ***what, when, where, who, whom, which, whose, why, how many/much/often,*** etc. We use them to ask for information. The answer cannot be yes or no:

A: When will you graduate from university?

B: Next year.

A: Who is this scientist?

B: I don't know.

Forming special questions with an auxiliary verb

We usually form special questions with *a question word (what,where, when, etc.*) + an auxiliary verb or modal verb (*is, does, can, was, would, etc.*) + subject + main verb.

*Be: When **are** you leaving?*	*Who**'s** performing the experiment?*
*Do: Where **do** they study?*	*Why **did**n't you call me?*
*Have: What **has** she done?*	*What **have** they decided?*
*Modal: Who **would** you work with?*	*Where **should** I put it?*

Forming special questions without an auxiliary verb

When *what, who, which* or *whose* is the subject or part of the subject, we do not use the auxiliary. We use the word order subject + verb:

***What** fell off the table? **Which** student got the grant?*

***Who** did this? **Whose** phone rang?*

Appendix 4. Articles

We use *a / an* with singular countable nouns:

- the first time you mention a thing/ person (It is **a** chemical element).
- when you say what something is or what somebody does (He is **a** scientist).
- in expressions of frequency (two times **a** year).

We use the:

- when we talk about something we've already mentioned.
- when it's clear what you're referring to.
- when there's only one of something (**the** Sun).
- with superlatives (**the** best).
- with ordinal numbers (**the** second).

We don't use articles:

- when we are speaking in general (with plural and uncountable nouns).
- with some nouns, (e.g. home, work, school, church) after at / to /from.
- before elements, meals, days, and months.
- before next / last+ day, week, ere.

Appendix 5. Active and Passive Voice

English has two voices: active and passive.

The active voice is used when the subject of the sentence does the action. In the given example *scientists* is the subject and *experiments* is the object.

For example: *Scientists* perform *experiments.*

The passive voice is used when we focus on the object of the sentence. In the given example *experiments* is the subject and *scientists* is the object.

For example: *Experiments are performed **by** scientists*.

When it is important to know who does the action, we use **by**. The noun that follows **by** is called the agent.

When the agent is unknown or unimportant to the meaning of the sentence, we do not use **by**.

For example: *Important experiments are performed all around the world.*

We form the passive with **be + past participle (3rd form of the verb).**

PRESENT SIMPLE (ACTIVE VOICE VS PASSIVE VOICE)

PRESENT SIMPLE IS USED:

- to express habits, general truths, laws of nature, repeated actions or unchanging situations, emotions and wishes;
- to give instructions or directions;
- to express future time, after such conjunctions as: after, when, before, as soon as, until.

Be careful! Present Simple is not used to express actions happening now.

Present Simple Active Voice

+ verb/verb+s/es

- do not/does not+verb

? Do/Does…verb?

Present Simple Passive Voice

+am /is /are + past participle (3rd form of the verb)

-am not/is not/are not+ past participle (3rd form of the verb)

?Am /Is /Are ….+ past participle (3rd form of the verb)

	Active	**Passive**
Affirmative	Scientists perform experiments. A scientist performs experiments.	Experiments are performed by scientists. The experiment is performed by scientists.
Negative	Actors do not perform experiments. An actor does not perform experiments.	Experiments are not performed by scientists. The experiment is not performed by scientists.
Question	Do scientists perform experiments? Does an actor perform experiments?	Are experiments performed by scientists? Is the experiment performed by scientists?

PAST SIMPLE (ACTIVE VOICE VS PASSIVE VOICE)

PRESENT SIMPLE IS USED:

- for actions finished in the past (single or repeated);
- for series of completed actions in the past;
- together with the Past Progressive/Continuous – (the Simple Past interrupted an action which was in progress in the past).

Past Simple Active Voice

+ verb+ed/verb in II form

- did not+verb

? Did…verb?

Past Simple Passive Voice

+was/were + past participle (3rd form of the verb)

-was/were not+ past participle (3rd form of the verb)

?Was/Were ….+ past participle (3rd form of the verb)

	Active	**Passive**
Affirmative	Scientists performed experiments. Scientists did experiments.	Experiments were performed by scientists. The experiment was performed by scientists.
Negative	Scientists did not perform experiments. Scientists did not do experiments.	Experiments were not performed by scientists. The experiment was not performed by scientists.
Question	Did scientists perform experiments? Did scientists do experiments?	Were experiments performed by scientists? Was the experiment performed by scientists?

Appendix 6. Numbers

FRACTIONS		DECIMAL NUMBERS	
We write	**We say**	**We write**	**We say**
½	a half OR one half	**0.3**	nought **point** three zero **point** three
¼	a quarter OR one quarter	**3.45**	three **point** four five (NOT three point forty-five)
¾	three quarters	**98.4**	ninety-eight **point** four
⅓	a third OR one third	**$1.55**	one dollar, fifty-five cents one dollar, fifty-five
⅔	two thirds	**$700.00**	seven hundred dollars
⅕	a fifth OR one fifth	**€3,500.50**	three thousand five hundred euro and fifty cents three thousand five hundred euro, fifty cents
⅖	three fifths		
⅛	an eighth OR one eighth		
⅝	five eighths		
1½	one and a half		
5¾	five and three quarters		

Taken from: https://www.englishclub.com/vocabulary/numbers-fractions.htm
https://www.englishclub.com/vocabulary/numbers-decimal.htm

YEARS	
We write	**We say**
1986	nineteen eighty-six
564	five sixty-four (the year) five hundred and sixty-four
1905	nineteen oh five
1400	foureen hundred
1000	(the year) one thousand
2003	twenty oh three
2019	twenty nineteen two thosand (and) nineteen

Appendix 7. Giving Instructions

We use instructions to tell someone how to do something. We usually use imperatives. They do not sound too direct in this context:

***Beat** four eggs, like this. Then **add** the flour gradually. **Don't beat** the eggs too much though.*

[instructions on how to replace a missing button]

***Thread** your needle with a piece of thread about 25 cm long. **Mark** the spot where you want the button. **Insert** the needle from the back of the fabric and **bring** it through …*

Spoken English:

In speaking, we often use the present simple when we are giving instructions and demonstrations, and we say *like so* meaning 'like this':

***You fold** the A4 piece of paper **like so**. Then **you glue** some shapes onto this side and **sprinkle** some glitter on it **like so**.*

Taken from: https://dictionary.cambridge.org/ru/грамматика/британская-грамматика/commands-and-instructions

Appendix 8. Summary Writing

USEFUL TIPS

- When writing a summary, remember that it should be in the form of a paragraph.
- A summary begins with an introductory sentence that states the text's title, author and main point of the text as you see it.
- A summary is written **in your own words.**
- A summary contains only the ideas of the original text. **Do not insert** any of your own opinions, interpretations, deductions or comments into a summary.
- Write a last sentence that "wraps" up your summary; often a simple rephrasing of the main point.

Adopted from: https://courses.lumenlearning.com/englishcomp1v2xmaster/chapter/how-to-write-a-summary/

PROCEDURE

1. Look through the article to be summarized and be sure you understand it. Pay attention to the subheadings. If there are no subheadings, try to divide the text into sections.
2. Read the text, highlighting important information and taking notes.
3. Without looking at the article, in your own words, write down the main points of each section.
4. Write the first draft of the summary, do not include minor detail.
5. Start your summary with a clear identification of the type of work, title, author, and main point in the present tense.
6. Check with your outline and your original to make sure you have covered the important points.
7. Write using "summarizing language." Periodically remind your reader that this is a summary by using phrases such as the article claims, the author suggests, etc.
8. Go through the process again, making changes as appropriate.

REPORTING VERBS

STRONG ARGUMENT	**NEUTRAL**
argue	state
assert	note
claim	report
contend	explain
maintain	discuss
insist	illustrate

INDICATING RESEARCH RESULTS	**SUGGESTION & CRITICISM**
show	suggest
demonstrate	recommend
illustrate	criticize
indicate	
point out	
(studies/authors) prove	
(studies/authors) found	

Adopted from: http://academics.smcvt.edu/cbauer-ramazani/AEP/EN104/summary.htm

EXAMPLES

In the article (name of the article), the author describes/argues/ claims/ reports/ maintains/ states) that/how/why/what …..

According to *the author of this article*/*this article*…

The main idea of this article is…

In his article 'No Allusions in the Classroom,' Jaime O'Neill emphasises the existing misunderstanding between students and teachers in a college classroom. He claims that teachers assume their students have basic knowledge they do not really possess. Moreover, students do not ask questions because they do not want to show their ignorance. O'Neill supports his conclusions by the results of the general knowledge test he administered to his students, which they answered more incorrectly than correctly. The author adds that, according to recent polls, a large portion of adults in the US are ignorant about the history of the country and the planet they live on. Finally, O'Neill expresses his opinion that instructors should be responsible for giving general information to their students.

Taken from: Bezzabotnova O., Bogolepova S. English for academics

Appendix 9. Writing Informal Emails

Beginnings

Hi+ name (or *Dear*+ name if you want to be a bit more formal)

How are you? / How's it going?

Sorry for not writing earlier, but …..

Thank you/ Thanks (so *much) for (your letter/your comments/ inviting me etc.)*

It's (nice/good/great) to hear from you.

Endings

That's all for now.

Hope to hear from you soon. / Looking forward to hearing from you soon.

Give my *regards / love to ...*

Best wishes / *Love* (from)

See you.

Bye.

PS (when you want to add a short message at the end of an email)

I've attached a photo/document ...

PROCEDURE

1. Read the task carefully. Answer the following questions:
    - Who are you writing to?
    - Is it a reply or you initiate the correspondence?
    - What is the purpose of your letter (to give some advice, invite, describe something, give your opinion etc.)?
2. Start and finish your informal email in an appropriate way.
3. Make sure you answer any questions that were asked.
4. Use informal vocabulary like phrasal verbs
5. Close the email with a phrase *like Looking forward to seeing you! Or Good luck with your exams!*
6. End with *Love*, (for close friends and family) or *Take care/Best wishes* before signing your name on the next line.

7. Remember about paragraphs
8. If you use a comma after the greeting, use a comma after *Love/ Best wishes/ Regards, etc.*

EXAMPLES

Hi Linda,

How's it going?

Sorry I haven't been in touch for such a long time but I've had exams so I've been studying every free minute. Anyway, I'd love to hear all your news and I'm hoping we can get together soon to catch up. We just moved to a bigger flat so maybe you can come and visit one weekend?

How's the new job?

Looking forward to hearing from you!

Helga

Hi Helga,

I've been meaning to write to you for ages now so don't worry! How did your exams go? When will you know your results? I'm sure you did brilliantly as always!

As for me, I'll have been in the new job three months by the end of next week so I'm feeling more settled in. At first I felt like I had no idea what I was doing but now I realise it's normal to feel like that. There was a lot to learn – there still is actually – and I soon had to get used to the idea that I can't know everything. I used to work late a lot and at weekends but I'm slowly getting into a normal routine.

Which means I'd love to come and visit! We really need a good catch up! I can't believe we haven't seen each other since Carl's wedding. How does next month sound?

Anyway, I'd better get back to work.

Congratulations on the new flat! Can't wait to see you!

Love,

Linda

Taken from: http://learnenglish.britishcouncil.org/skills/writing/upper-intermediate-b2/an-informal-email-to-a-friend

Appendix 10. Writing Formal Emails

USEFUL LANGUAGE

Start: *Dear Sir/Madam,* (You don't know the person's name)

Finish: *Yours faithfully,*

Start: *Dear+ Mr/Ms/Mrs Smith,***(**You know the person's name)

Finish: *Yours sincerely,*

* Use the person's job title if you don't know their name (e.g. Dear Admissions Tutor, Dear Marketing Manager)

* *Regards*, (also *With regards, Best regards, or Kind regards*,) is a more friendly-sounding sign-off than *Yours sincerely*, but it is still formal.

USEFUL TIPS

- Don't use contract ions.
- Use formal language.
- Use passives where possible.
- Start your email by clearly giving your reason for writing. Then you can explain the problem.
- Write *I look forward to hearing from you.* As the final sentence.
- Write your full name at the end (name+surname).

EXAMPLE

Dear Professor Henley,

I am writing to inform you that, unfortunately, I am unable to continue to attend the Logic II course this semester. I would like to request permission to defer as I understand that this is only possible with your approval.

The issue is that I am currently doing an internship with ABC Ltd. It started in July and will continue until the end of the semester. The internship takes up 25 hours per week and I am concerned that it does not leave me with enough time to study. I have already asked if I can reduce my hours there, but this is not possible.

With your approval, I could take Logic II next semester instead. I realise that this would mean a heavier workload than usual next semester, but I assure you that I would be able to manage my time and keep up.

Thank you for considering my request and I would be happy to come in and discuss the matter further.

Regards,

Sarah Price

Taken from:http://learnenglish.britishcouncil.org/skills/writing/upper-intermediate-b2/an-email-to-your-professor

Answer Keys to Self-Assessment Tests

Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
1. C	1. B	1. B	1. A	1. B
2. A	2. D	2. B	2. A	2. C
3. C	3. B	3. D	3. C	3. A, B
4. A	4. A	4. A	4. B	4. A
5. D	5. D	5. C	5. D	5. C
6. B	6. D	6. B	6. D	6. C
7. C	7. A	7. B	7. B	7. B
8. D	8. C	8. D	8. C	8. B
9. A	9. D	9. A	9. A	9. D
10.A	10.B	10.C	10.D	10.A

Unit 1. Exercise 13

Crystals of some salts contain lattices of ions - i.e., atoms or groups of atoms with alternating positive and negative charges. When such a crystal is to be dissolved, the attraction of the oppositely charged ions, which are largely responsible for cohesion in the crystal, must be overcome by electric charges in the solvent. These may be provided by the ions of a fused salt or by electric dipoles in the molecules of the solvent. Such solvents include water, methyl alcohol, liquid ammonia, and hydrogen fluoride. The ions of the solute, surrounded by dipolar molecules of the solvent, are detached from each other and are free to migrate to charged electrodes. Such a solution can conduct electricity, and the solute is called an electrolyte.

Unit 5. Exercise 9

1. As helium is non-flammable it is much safer to use it in balloons than hydrogen.
2. Krypton gets its name from the Greek word ‘kryptos’ meaning ‘the hidden one.’
3. Many of the noble gases were either discovered or isolated by Scottish chemist Sir William Ramsay.
4. Helium has the lowest melting and boiling points of any substance.
5. All of the noble gases except for radon have stable isotopes.
6. Neon signs do not use just neon gas, but a mixture of different noble gases and other elements to create bright lights of different colours.
7. Noble gases are often used to create a safe or inert atmosphere due to their stable nature.
8. Xenon gets its name from the Greek word ‘xenos’ which means ‘stranger or foreigner.’

Adopted from: Noble Gases (2020)

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