

09.	The Periodic Table	
	01. Arrangement of Elements	006
	02. Group I: alkali metal	018
	03. Group VII properties: Halogens	028
	04. Group VIII (or 0): Noble Gases	038
	05. Transition Elements	042
10.	Metal	
	01. Properties of Metals	052
	02. Uses of Metals	058
	03. Alloys and their Properties	062
	04. Reactivity Series	068
	05. Corrosion of Metals	078
	06. Extraction of Metals	086
11.	Chemistry of the Environment	
	01. Water	106
	02. Artificial Fertilisers	112
	03. The Air	116
12.	Organic Chemistry	
	01. Functional Groups and Terminology	130
	02. Alkanes and Alkenes	142
	03. Alcohol and Carboxylic Acid	158
	04. Petrochemicals	184
	05. Polymers	192

13.	Experimental Design and Separation Technique	
	<i>01. Apparatus Used for Measurement</i>	<i>212</i>
	<i>02. Separation and Purification</i>	<i>216</i>
	<i>03. Identification of Ions and Gases</i>	<i>232</i>
	Answers and Detailed Explanations	249



vol. I . Topics

- Topic 01. States of Matter
- Topic 02. Atomic Structure
- Topic 03. Chemical Bonding
- Topic 04. Stoichiometry
- Topic 05. Electrochemistry
- Topic 06. Chemical Energetics
- Topic 07. Chemical Reaction
- Topic 08. Acids, Bases and Salts

736.

Which row describes the trend across Period 3 of the Periodic Table, from left to right?

	number of outer-shell electrons	metallic character	group number
A	increases	decreases	increases
B	increases	decreases	decreases
C	decreases	increases	decreases
D	decreases	decreases	decreases

737.

Below are the elements in group IV of the periodic table.

C carbon	Si silicon	Ge germanium	Sn tin	Pb lead
--------------------	----------------------	------------------------	------------------	-------------------

Which of the following does **not** occur when descending in Group IV?

- A** The elements become more metallic.
- B** The elements have more electron shells.
- C** The proton number of the elements increases.
- D** The elements have more electrons in their outer shell.

738.

The table shows the number of protons and neutrons in atoms of the elements P, Q, and R.

Which of the following statements about elements is correct?

- A** P, Q and R are non-metals.
- B** R forms an ion with a +1 charge.
- C** P and R are isotopes of the same element.
- D** Q and R react together to form an ionic compound.

	number of protons	number of neutrons
P	6	7
Q	7	6
R	8	10

739.

Particle **X** has an atomic number of 18, a mass number of 40, and no overall charge, while particle **Y** has an atomic number of 19, a mass number of 40, and a single positive charge.

Which of the following statements about particles **X** and **Y** is correct?

- A** They are both ions.
- B** Y has more neutrons than X.
- C** Particle X and Y are isotopes of the same element.
- D** They have the same number of electrons in their outer shell.

740.

P, **Q**, **R**, and **S** are elements in Period 2 of the Periodic Table, and the numbers of outer-shell electrons in an atom of each element are shown.

element	P	Q	R	S
number of outer-shell electrons	1	2	7	8

Which elements are non-metals?

- A** P and Q
- B** Q and R
- C** R and S
- D** Q and S

741.

Which row describes the changes across a period of the Periodic Table, from left to right?

	number of outer-shell electrons	metallic character
A	increases	increases
B	increases	decreases
C	decreases	increases
D	decreases	decreases

742.

Given that Element X forms ions with a formula X^{2-} , which column accurately shows this element?

	A	B	C	D
group number	II	II	VI	VI
type of element	metal	non-metal	metal	non-metal

747.

Below are the properties of the newly discovered element jejodium, **Je**.

solubility	electrical conduction	formula of element	bonding in a molecule of Je₂
insoluble in water	does not conduct	Je ₂	Je≡Je

In which group of the Periodic Table should the new element be placed?

- A** Group III **B** Group IV **C** Group V **D** Group VI

748.

Some information about elements in Group II of the Periodic Table is shown below.

element	time taken to make 5cm ³ of hydrogen gas when 1g of metal is added to cold water	density [g/cm ³]	melting point [°C]
beryllium	no reaction	1.85	1280
magnesium	> 100 seconds	1.74	650
calcium	50 seconds	1.55	850
strontium	20 seconds	2.68	768
barium	10 seconds	3.51	714

Which row shows the correct trends in reactivity, density and melting point of the elements going down Group II of the Periodic Table?

	reactivity	density	melting point
A	increases down group	no clear trend	no clear trend
B	increases down group	increases down group	no clear trend
C	decreases down group	no clear trend	no clear trend
D	decreases down group	no clear trend	decreases down group

749.

What statements about the trends across a period of the Periodic Table are correct?

1. Boron is more metallic than lithium.
2. Beryllium is more metallic than carbon.
3. Magnesium is more metallic than silicon.
4. Aluminium is more metallic than sodium.

- A** 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 3 and 4

753.

Moving from right to left across the Periodic Table the elements show increasing metallic character. What is the reason for the increase in metallic character from right to left across a period?

- A The atoms have more electrons in their outer shells.
- B The charge on the nucleus of each atom gets larger.
- C The atoms more readily lose electrons to form positive ions.
- D The atoms more readily gain electrons to form negative ions.

☑ ☒ ANSWER: **254** page

754

The table shows a comparison of elements' mass percentages in both the entire Earth and the oceans.

element	Ca	Cl	H	Fe	Mg	O	Si	others	total
percentage (whole Earth)	1.1	<0.01	<0.01	34.6	12.7	29.5	15.2		100.0
percentage (the oceans)	0.1	1.0	11.0	0.0	1.0	85.0	0	6.9	100.0

Answer these questions using only the information in the table.

- ① Calculate the percentage by mass of the remaining elements in the oceans.

..... [1]

- ② Describe which non-metallic element is present in the whole Earth in the greatest percentage by mass.

..... [1]

- ③ State two major differences in the composition of the whole Earth and of the oceans.

.....

.....

.....

..... [2]

807.

Use the key to complete the table to show the results of adding aqueous halogens to aqueous solutions of halides.

		halogen		
		Cl ₂ (g)	Br ₂ (g)	I ₂ (g)
halides	KCl(aq)			
	KBr(aq)			
	KI(aq)			

key
✓: reaction
X: no reaction

808.

The table shows some properties of four halogen elements.

elements	melting point [°C]	boiling point [°C]	density [g/cm ³]
fluorine	-219	-188	
chlorine	-101		0.003
bromine		60	3.12
iodine	114	185	4.93

① Complete the table by making prediction:

- the melting point of bromine
- the boiling point of bromine
- the density of fluorine

[3]

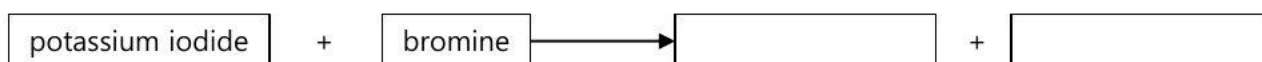
② Predict the state of fluorine at 0 °C and provide a reason for your answer.

.....

..... [2]

809.

Complete the word equation for the reaction where aqueous potassium iodide reacts with aqueous bromine.



A All metals are hard.

B All metals react with dilute acids.

C All metals have high melting points.

D All metals are good conductors of electricity.

A They all conduct electricity and form negative ions.

B They all have high melting points and boiling points, and form positive ions.

C They all conduct electricity and react with dilute acids to release hydrogen gas.

D They all form negative ions and react with dilute acids to form hydrogen gas.

A P and Q **B** Q and R **C** P and S **D** R and S

904.

What explains the reason that steel, an alloy of iron, is stronger than iron itself?

- A Steel contains carbon which is a very hard substance.
- B The carbon atoms in steel bond together very strongly.
- C The carbon atoms prevent layers of iron atoms from sliding over each other.
- D The carbon atoms in steel make the iron atoms bond together very strongly.

905.

What is the correct description of brass?

- A a mixture of copper and tin
- B a mixture of copper and zinc
- C a compound of copper and tin
- D a compound of copper and zinc

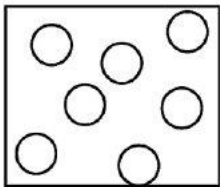
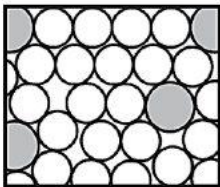
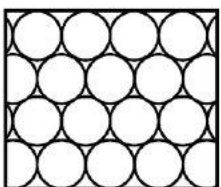
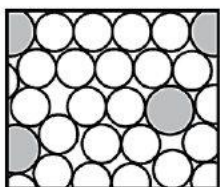
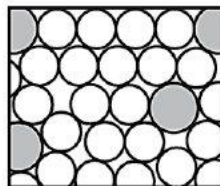
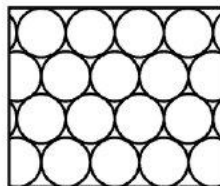
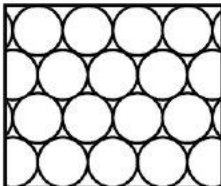
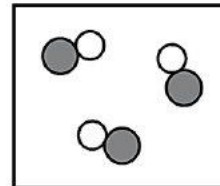
906.

What metallic element is added to iron during the manufacture of stainless steel?

- A lead
- B nickel
- C carbon
- D copper

907.

What pair of diagrams represents both a pure metal and an alloy?

A  pure metal	 alloy	B  pure metal	 alloy
C  pure metal	 alloy	D  pure metal	 alloy

934.

When zinc granules are added to aqueous copper(II) sulfate, a reaction occurs that results in the formation of a red-pink solid and turns the solution colourless.

① What is the name of the red-pink solid?

..... [1]

② What is the name of the colourless solution?

..... [1]

935.

Part of the reactivity series is shown.

Two experiments are carried out using an aqueous solution of lead(II) nitrate, which contains Pb^{2+} ions.

In Experiment X, magnesium is added to aqueous lead(II) nitrate.

In Experiment Y, copper is added to aqueous lead(II) nitrate.

magnesium	most reactive
lead	↑
copper	least reactive

What are the ionic equations for any reactions that occur in each experiment?
(If no reaction occurs write 'no reaction'.)

Experiment X

Experiment Y [2]

936.

The observations from the reactions of four different metals with dilute hydrochloric acid of the same concentration are presented in the table below.

Put the four metals in order of reactivity, with the least reactive metal at the beginning.

metal	observations
iron	bubbles form slowly
lead	no bubbles formed
magnesium	bubbles form rapidly
nickel	bubbles form very slowly

least reactive
→
 most reactive

991.

During the electrolysis of aluminium oxide, there is a change in the mass of the carbon anode. What describes the change and provides a reason for this change in the given row?

	mass change of the anode	reason
A	decreases	carbon dissolves in molten cryolite
B	decreases	carbon reacts to form carbon dioxide
C	increases	electrodes become coated with cryolite
D	increases	electrodes become coated with aluminium

992.

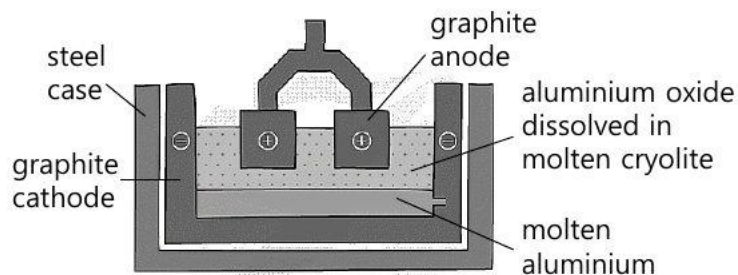
What is the purpose of using cryolite in the aluminum extraction process through electrolysis?

- A** It dissolves the aluminium oxide.
- B** It changes bauxite to aluminium oxide.
- C** It protects the anodes from corrosion.
- D** It decreases the melting point of the aluminium.

993.

Aluminium is extracted by electrolysis, as shown.

What row correctly shows the ionic half-equations at both the cathode and the anode?



	cathode	anode
A	$\text{Al}^{3+} \rightarrow \text{Al} + 3\text{e}^-$	$2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^-$
B	$\text{Al}^{3+} \rightarrow \text{Al} + 3\text{e}^-$	$2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^-$
C	$\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$	$2\text{O}^{2-} + 4\text{e}^- \rightarrow \text{O}_2$
D	$\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$	$2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^-$

1015.

The process of electrolysis is used to extract aluminium from its ore.

- ① What is the name of aluminum ore whose main component is aluminum oxide?

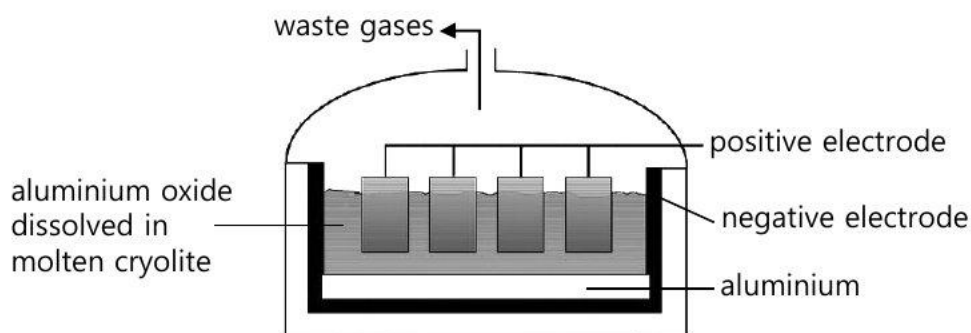
..... [1]

- ② State what is meant by the term **electrolysis**.

.....

..... [2]

- ③ Electrolysis is carried out on aluminium oxide dissolved in molten cryolite.



- Ⓐ Give two reasons why the electrolysis is carried out on aluminium oxide dissolved in molten cryolite instead of electrolysis molten aluminium oxide only.

.....

..... [2]

- Ⓑ Write the ionic half-equation for the reaction occurring at the negative electrode.

..... [2]

- Ⓒ The positive electrodes are made of carbon.
Describe why the positive carbon electrodes are replaced regularly.

.....

..... [2]

1016.

In a blast furnace, iron is extracted from iron ore using carbon.

- ① What is the main ore of iron?

..... [1]

- ② Iron(III) oxide in the iron ore is reduced by carbon monoxide.

What are the two substances that react to produce carbon monoxide in the blast furnace?

..... and [2]

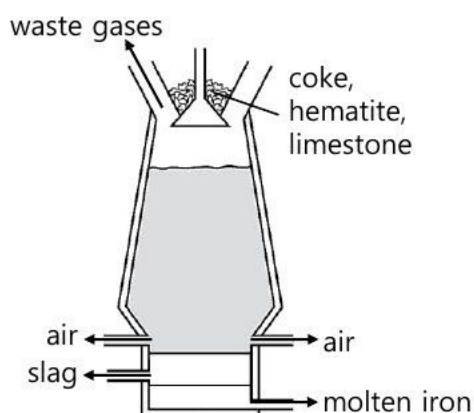
1017.

As shown in figure, iron is extracted from hematite in the blast furnace.

- ① State two reasons why coke is added to the blast furnace.

1.

2. [2]



- ② Describe how limestone removes the impurities in the hematite.

.....

 [2]

- ③ Given that hematite contains iron(III) oxide, provide a symbol equation for its conversion to iron in the blast furnace.

..... [2]

- ④ Suggest why the iron produced in the blast furnace is molten.

..... [1]

1036.

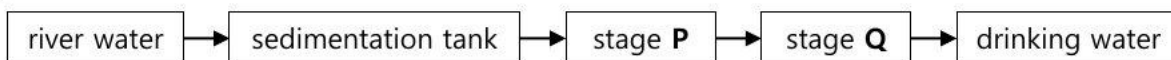
Water undergoes treatment at a waterworks to ensure its safety for drinking.

Which substances are present in the water when it leaves the waterworks?

- A** bacteria only
- B** chlorine compounds only
- C** bacteria and insoluble substances
- D** soluble substances, including chlorine compounds

1037.

The stages involved in the process of converting river water into drinking water are shown in the flow chart.



Which processes take place at stages **P** and **Q**?

	A	B	C	D
stage P	distillation	distillation	filtration	filtration
stage Q	filtration	chlorination	distillation	chlorination

✓ ✗ ANSWER: **299** page

1038.

- ① Dissolved gases are present in water from natural sources.

Choose the gas that is essential for aquatic life from the list and encircle your choice.

argon**hydrogen****nitrogen****oxygen**

- ② Harmful substances like metal compounds, plastics, nitrates, and phosphates can be present in polluted water.

- Ⓐ What is another harmful substance that can be found in polluted water?

..... [1]

- Ⓑ Describe why nitrates are harmful to aquatic life.

..... [1]

1080.

Descriptions of three air pollutants, **P**, **Q**, and **R**, are shown below.

P is a cause of breathing problems and acid rain.

Q is a toxic gas formed by the incomplete combustion of an alkane.

R is formed by decomposing vegetation and increases global warming.

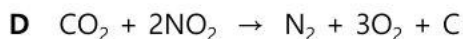
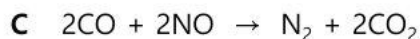
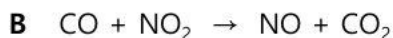
What are the pollutants represented by **P**, **Q**, and **R**?

	P	Q	R
A	particulates	carbon monoxide	methane
B	carbon monoxide	particulates	oxides of nitrogen
C	oxides of nitrogen	carbon monoxide	methane
D	oxides of nitrogen	particulates	carbon monoxide

1081.

Car engines produce oxides of nitrogen, which are then removed by catalytic converters.

Which equation represents a reaction that occurs in a catalytic converter?



☑ ☒ ANSWER: **305** page

1082.

During incomplete combustion of a hydrocarbon, the formation of carbon monoxide occurs.

① Describe the meaning of the term **incomplete combustion**.

..... [1]

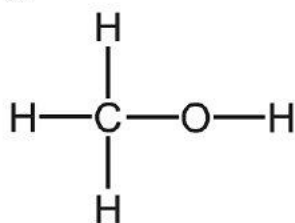
② Give one adverse effect of carbon monoxide on health.

..... [1]

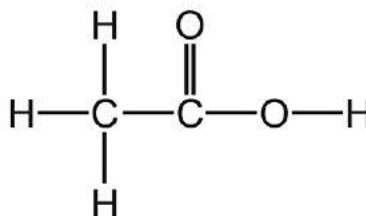
1111.

Which diagram shows the displayed formula of propanol?

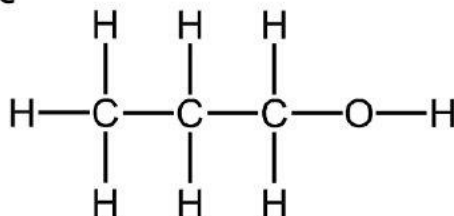
A



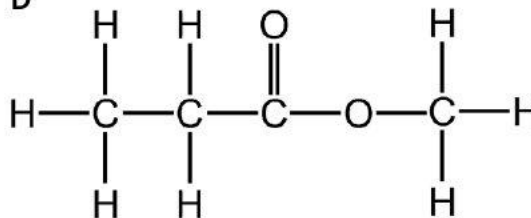
B



C



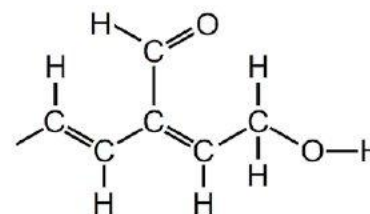
D



1112.

A part of the molecular structure of vitamin is shown.

What are the correct statements about this part of the structure shown below?



- X. It is saturated.
 Y. There are two alkene groups.
 Z. The structure shows a carboxylic acid.

A X only

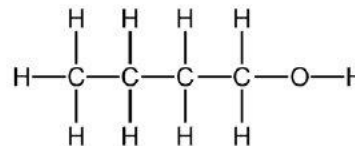
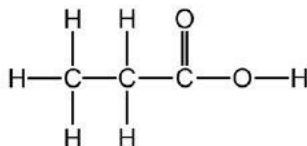
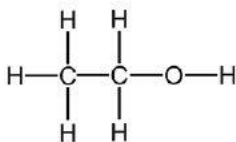
B Y only

C X and Y

D X, Y and Z

1113.

The structures of three organic molecules are shown.



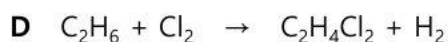
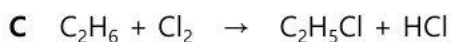
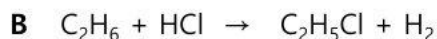
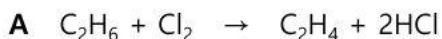
Which description of the three molecules is correct?

	A	B	C	D
all belong to the same homologous series	YES	NO	YES	NO
all have the same general formula, $\text{C}_n\text{H}_{2n+1}\text{OH}$	YES	YES	NO	NO

1173.

In the presence of UV light, alkanes undergo substitution reactions.

What equation correctly represents the substitution reaction of ethane?



1174.

✓ ⊗ ANSWER: 319 page

The structure of but-2-ene is shown.

- ① Describe the colour change observed when but-2-ene undergoes an addition reaction with aqueous bromine.

from to [1]

- ② State what is meant by the term addition reaction.

..... [1]

- ③ What is the chemical equation for the reaction between but-2-ene and bromine?

..... [1]

- ④ But-2-ene forms a polymer. Suggest the name of the polymer formed from but-2-ene.

..... [1]

- ⑤ Name and draw a structural isomer of but-2-ene. (Show all of the atoms and all of the bonds.)

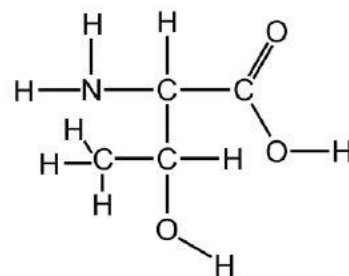
name structure

1241.

The structure of compound X, which is found in river water, is shown.

- ① On the structure draw a circle around the alcohol functional group.

[1]



- ② Deduce the formula of compound X to show the number of carbon, hydrogen, oxygen and nitrogen atoms.

..... [1]

1242.

Butanoic acid, $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$, is a carboxylic acid.

- ① What is the empirical formula of butanoic acid?

..... [1]

- ② An organic compound and water are formed when butanoic acid reacts with methanol. Name and draw the structure of the organic compound formed.

name structure

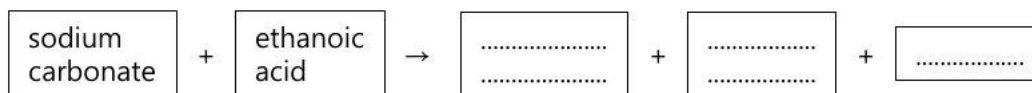
1243.

Draw the complete structure of a carboxylic acid functional group, showing all atoms and bonds. [1]

1244.

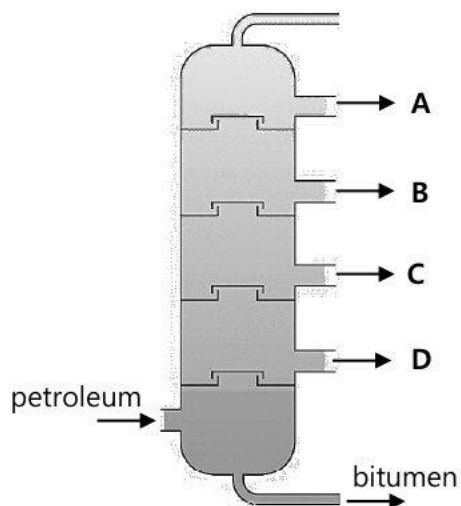
Ethanoic acid, a carboxylic acid, exhibits reactions characteristic of a typical acid.

Complete the word equation for the reaction of ethanoic acid with sodium carbonate. [3]



1287.

In the shown fractional distillation of petroleum, which fraction contains the hydrocarbons with the longest chain length?



1288.

Ethene can be manufactured by cracking larger alkane molecules.

① What are the two conditions required for cracking?

1.

2. [2]

② What is the symbol equation for the cracking of decane, $C_{10}H_{22}$, to produce ethene and one other hydrocarbon?



1289.

Propane, propene, and another product are produced by heating decane, $C_{10}H_{22}$, in the presence of a catalyst.

① Complete the equation for this reaction.



② What is the name of this manufacturing process?

..... [1]

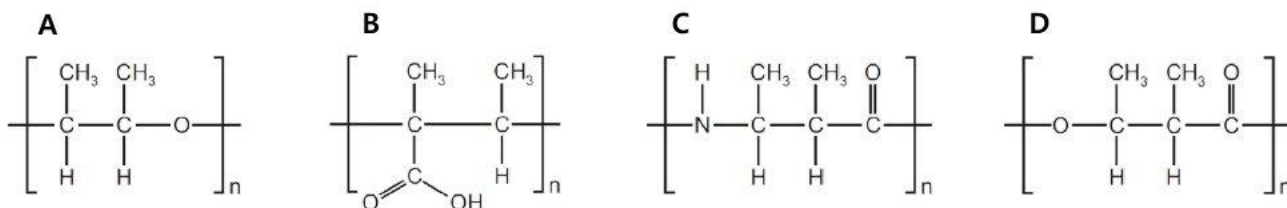
1302.

Which of the following polymers is a synthetic polyamide?

- A** protein **B** Terylene **C** nylon **D** poly(ethene)

1303.

Which of the following structural formulas has the same linkages as Terylene?



1304.

Which type of polymerisation from the list occurs when the polymer poly(ethene) is made?

- A** addition **B** oxidation
C substitution **D** aluminium chloride

1305.

Which statements are correct about the polymers, Nylon and PET?

- I.** They are both condensation polymers.
II. $\text{HOCH}_2\text{CH}_2\text{CH}_2\text{OH}$ could be a monomer for both polymers.
III. The complete combustion of both polymers gives two products only.

- A** I only **B** II only **C** III only **D** I and III

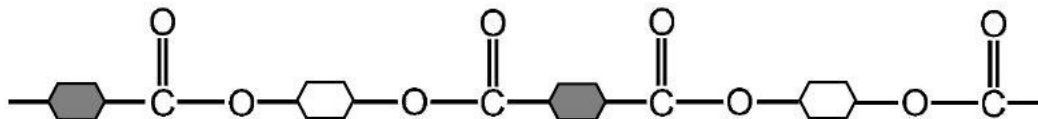
1306.

Which term describes nylon?

- A** polyester **B** polyamide
C natural polymer **D** addition polymer

1342.

PET, which is a polyester, has part of its structure shown in the figure.



(a) Circle one repeat unit of this polymer. [1]

(b) Draw the structures of the monomers that make up PET, including the functional groups represented using displayed formulae. [2]

(c) What type of polymerisation is used in the production of PET?

..... [1]

1343.

Ethene, which can be made from long chain hydrocarbons such as decane, $C_{10}H_{22}$, is subsequently converted into ethanol.

(1) What is the name of the process used to obtain ethene from long-chain hydrocarbons like decane ($C_{10}H_{22}$)?

..... [1]

(2) Complete the chemical equation to show the formation of ethene from decane, $C_{10}H_{22}$.



(3) What is the chemical equation for the conversion of ethene into ethanol?

..... [1]

(4) What is the name of the type of reaction that takes place when ethene is converted into ethanol?

..... [1]

(5) State one condition for the reaction in which ethene is converted into ethanol.

..... [1]

1379.

An acid is neutralised by adding an excess of an insoluble solid base, forming a soluble salt.

How is the pure salt obtained from the reaction mixture?

- A evaporation → crystallisation → filtration
- B crystallisation → evaporation → filtration
- C filtration → evaporation → crystallisation
- D filtration → crystallisation → evaporation

1380.

Rock salt is a mixture of salt and sand, and the method used to separate the sand from the salt is described.

step 1 Crush the rock salt, add to warm water and stir.

step 2 Pour the mixture through a filter paper held in a funnel.

step 3 Evaporate the water to crystallise the salt.

What is the correct statement about the method?

- A The solute is salt.
- B The filtrate in step 2 is pure water.
- C The solvent is a mixture of salt and water.
- D The residue in step 2 is pure crystals of salt.

1381.

A mixture contains sand and an aqueous solution of sodium chloride.

What processes are used to obtain a sample of solid sand and a sample of solid sodium chloride from the mixture?

- | | |
|--|---|
| A evaporation followed by filtration | B filtration followed by crystallisation |
| C crystallisation followed by filtration | D simple distillation followed by crystallisation |

1382.

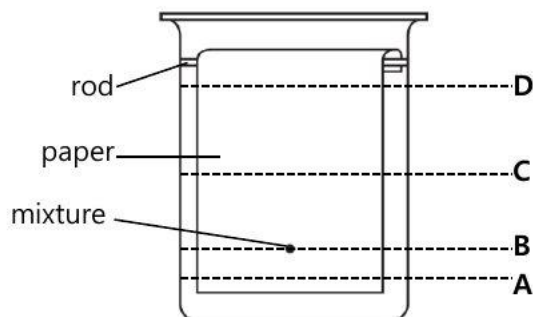
Chromatography is a process used to separate components of a colored dye. One component of the dye moves a distance of 16 cm and has an R_f value of 0.85.

What was the distance traveled by the solvent front?

- | | | | |
|-----------|-----------|-----------|-----------|
| A 18.4 cm | B 18.6 cm | C 18.8 cm | D 19.0 cm |
|-----------|-----------|-----------|-----------|

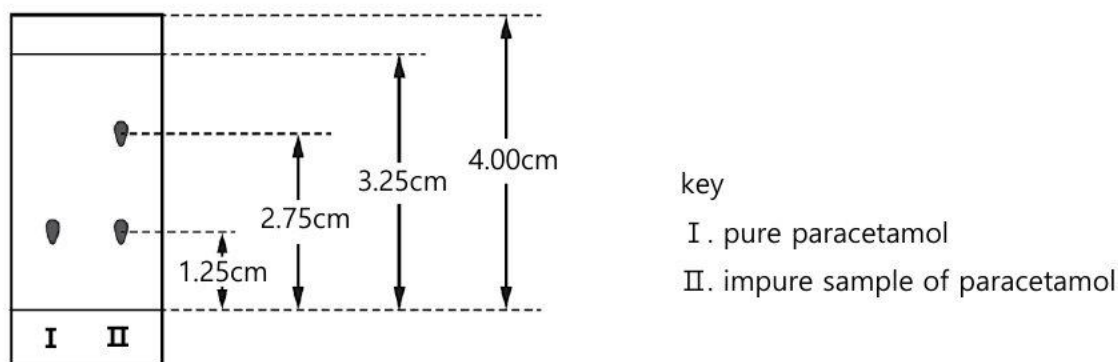
1383.

Which line indicates the initial depth of the solvent in the beaker in the chromatography experiment?



1384.

The painkiller paracetamol is synthesised from 4-aminophenol. Chromatography is done on an impure sample of paracetamol, and the results are shown.



Which R_f value corresponds to the 4-aminophenol that only contaminates the paracetamol sample?

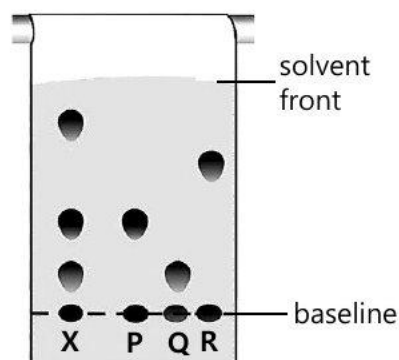
- A** 0.47 **B** 0.69 **C** 0.85 **D** 0.91

1385.

The chromatogram that shows the results of four substances, P, Q, R, and X, is presented.

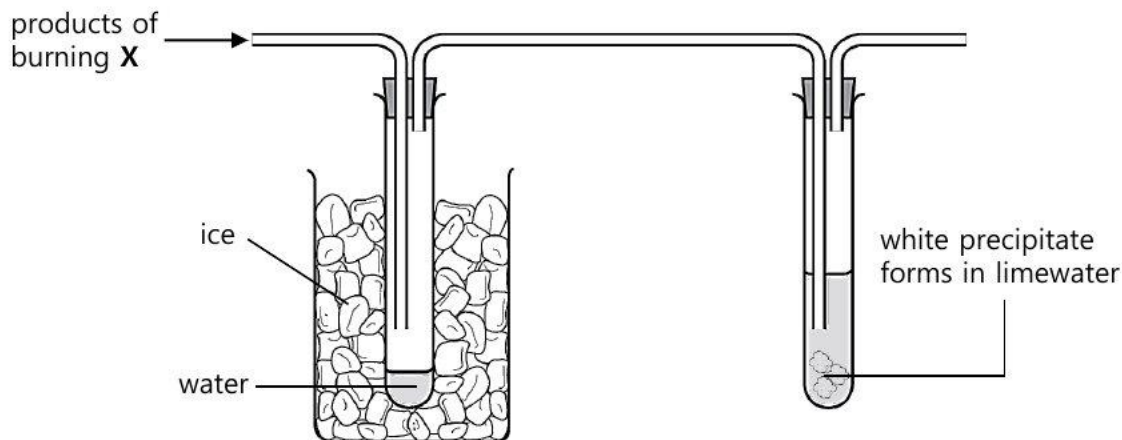
What is the correct statement about X?

- A** It is a pure substance.
B It is a mixture of P, Q and R.
C It is a mixture of P and Q only.
D It is a mixture of P, Q and an unknown substance.



1418.

The product formed by burning substance **X** passes through the apparatus below.



What is the burning substance **X**?

- A** ethanol **B** carbon monoxide **C** carbon **D** hydrogen

1419.

Which of the following ions forms precipitates that dissolves in excess with aqueous ammonia and aqueous sodium hydroxide solutions?

- A** iron(III) ion, Fe^{3+} **B** zinc ion, Zn^{2+}
C calcium ion, Ca^{2+} **D** copper(II) ion, Cu^{2+}

1420.

What could substance **X** be, given the listed results of some tests on its aqueous solution?

- I. A cream precipitate is produced when adding aqueous silver nitrate.
 II. Adding aqueous ammonia produces a green precipitate which is insoluble in excess ammonia.
 III. Adding aqueous sodium hydroxide produces a green precipitate which dissolves in excess alkali.

- A** iron(II) bromide **B** iron(II) chloride
C chromium(III) chloride **D** chromium(III) bromide

909. Answer (B)

Alloys are generally **stronger than pure metals**. This is because alloys are mixtures of different metals (and sometimes non-metals) and the atoms of these different elements are of different sizes.

In a pure metal, the atoms are all the same size, so they can **slide over each other easily when a force is applied**. This is why metals are malleable and ductile. However, **in an alloy, the different-sized atoms disrupt the regular arrangement of the metal atoms**. This means the layers of atoms **cannot slide over each other as easily when a force is applied**. As a result, **alloys are harder and stronger** than pure metals.

Therefore the correct answer is **B**.

910. Answer (A)

Brass is an alloy, which is a mixture of two or more metals. **In brass, copper and zinc atoms** are randomly arranged, creating a structure that combines the properties of both metals.

The structure of an alloy like brass is different from that of pure metals. In pure metals, atoms are regularly arranged, and layers can slide over each other easily, making them malleable. In an alloy like brass, the **different-sized atoms of copper and zinc disrupt this regular arrangement**, which prevents the layers from sliding and makes the alloy harder than the pure metals.

Therefore the correct answer is **A**.

911. Answer

① **zinc** ② **alloy**

The other metal in brass besides copper is zinc. **Brass** is a metal alloy made primarily of **copper and zinc**. The term given to a mixture of **a metal with another element (which can be another metal or a nonmetal)** is an alloy. Alloys are created to improve the properties of the base metal, such as increasing strength, corrosion resistance, or reducing cost. The **atoms of the added elements** can either take the place of **some metal atoms in the lattice** or **fit into spaces between the metal atoms**.

912. Answer

- ① **mixture of a metal with another element**
 ② **harder OR stronger OR more resistant to corrosion**

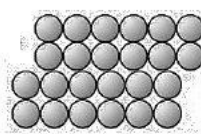
An alloy is a mixture of a metal with one or more other elements. These other elements can be metals or non-metals. Alloys are created to enhance certain properties of metals, such as strength, corrosion resistance, or aesthetic appeal.

Alloys are generally more useful than pure metals because they have improved physical and chemical properties. For instance, they are often harder and stronger than pure metals because the different sized atoms in the mixture disrupt the regular arrangement of atoms in the metal lattice. This makes it harder for layers to slide over each other, thus increasing strength and hardness. Additionally, some alloys can be more resistant to corrosion which makes them suitable for various uses where durability is important.

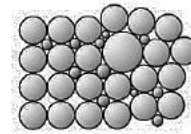
913. Answer

- ① **alloy** ② **nickel OR chromium**

Stainless steel is a type of steel, which is an alloy of iron, carbon, and other elements. The elements that are typically added to iron to create stainless steel are chromium and nickel. The addition of these elements **improves the corrosion resistance of the steel**.

914. Answer

[pure metal]



[alloy]

- **atoms have different sizes AND layers cannot slide over or past each other**

Alloys are harder and stronger than pure metals due to the difference in atomic sizes of the constituent elements. **In an alloy, atoms of different elements, which have different sizes, replace some of the metal atoms in the structure.**

This causes a **distortion in the regular arrangement of atoms in the metal lattice**. As a result, the layers of atoms cannot slide over or past each other easily when a force is applied. In pure metals, the atoms are all the same size, so the layers can slide over each other more easily, making the metal softer and more ductile. Therefore, the atomic structure of alloys, with its disrupted layers, makes them harder and stronger compared to pure metals.

1236. Answer

- ① **carboxylic acid**
 ② **$C_6H_{12}O_2$**

Carboxylic acids are organic compounds that contain a carboxyl functional group ($-COOH$). In the given question, compound X is identified as 2-methyl pentanoic acid, which has a carboxyl group attached to a hydrocarbon chain. Carboxylic acids are characterized by the presence of the carboxyl group and typically have acidic properties.

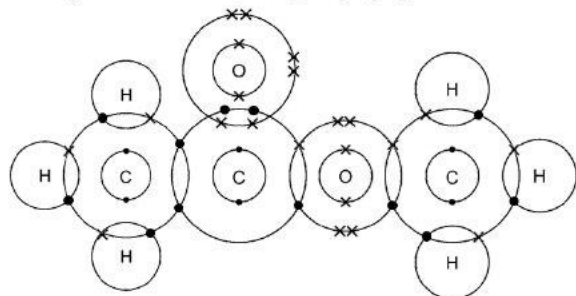
1237. Answer

- ① **C_nH_{2n+1}** ② **ethanoic acid** ③ **CH_2O**

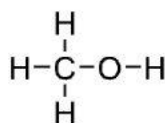
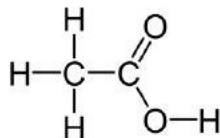
The empirical formula represents the simplest whole-number ratio of atoms in a compound. To determine the empirical formula of carboxylic acid Y, we count the number of each type of atom in the compound. In this case, carboxylic acid Y contains 2 carbon atoms, 4 hydrogen atoms, and 2 oxygen atoms. To obtain the simplest ratio, we divide all the atom counts by the greatest common divisor (GCD) of 2, 4, and 2, which is 2. Dividing each count by 2 gives the empirical formula CH_2O , indicating that the ratio of carbon, hydrogen, and oxygen atoms in the compound is 1:2:1.

1238. Answer

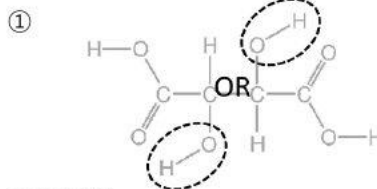
- ① **methyl ethanoate /** ② **$C_3H_6O_2$**
 ③



- ④ **a ethanoic acid** **b methanol**



The synthesis of ester **E** involves the reaction between ethanoic acid (carboxylic acid component) and methanol (alcohol component). Ethanoic acid contains a carboxylic acid functional group ($COOH$), while methanol contains an alcohol functional group (OH). The structures provided for ethanoic acid and methanol show the arrangement of atoms and the bonds formed between them.

1239. Answer

- ② **$C_4H_6O_6$**

The molecular formula of tartaric acid represents the number of each type of atom in one molecule of the compound. In this case, $C_4H_6O_6$ indicates that there are 4 carbon (C) atoms, 6 hydrogen (H) atoms, and 6 oxygen (O) atoms in one molecule of tartaric acid.

1240. Answer

- ① **3**

②

type of atom	number of atoms	relative atomic mass	
carbon	6	12	$6 \times 12 = 72$
hydrogen	8	1	$8 \times 1 = 8$
oxygen	7	16	$7 \times 16 = 112$

192

To calculate the relative molecular mass of citric acid ($C_6H_8O_7$), you need to sum the atomic masses of all the atoms in one molecule:

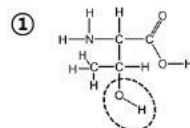
Carbon (C): 6 atoms $\times$ atomic mass of 12 = 72

Hydrogen (H): 8 atoms $\times$ atomic mass of 1 = 8

Oxygen (O): 7 atoms $\times$ atomic mass of 16 = 112

Now, add these values together:

Relative molecular mass = $72 + 8 + 112 = 192$

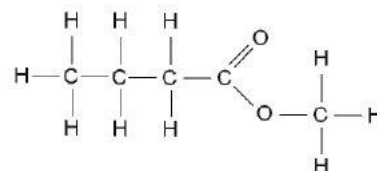
1241. Answer

- ② **$C_4H_9O_3N$**

In organic chemistry, an alcohol is a compound that contains a hydroxyl ($-OH$) functional group attached to a carbon atom. The $-OH$ group is what gives alcohols their specific chemical properties, such as their ability to form hydrogen bonds with water.

1242. Answer

- ① **C_2H_4O** ② **methyl butanoate**



13. Experimental Design and Separation Technique

01. Apparatus Used for Measurement

						1349	B	1350	C
1351	D	1352	C	1353	C	1354	A	1355	A
1356	C	1357		1358					
answers to Theory question (1359.) is included in the detailed explanations									

1349. Answer (B)

In this case, the highest point is recorded as 29.2, while the lowest bottom is recorded as 29.1. Since the solution level is **U-shaped**, the **lowest point represents the true volume**.

Therefore the correct answer is **B**.

1350. Answer (C)

By using the stop-clock (P) to measure the time, the measuring cylinder (Q) to measure the volume of dilute sulfuric acid, and the balance (S) to measure the mass of magnesium, the student can carry out the experiment accurately and obtain reliable results.

Therefore the correct answer is **C**.

1351. Answer (D)

To complete the experiment, the essential apparatus required are a stop-clock, a measuring cylinder, and a balance.

Therefore, the correct answer is **D**.

1352. Answer (C)

The stop-watch is essential for measuring the time taken for the reaction to occur, which is crucial for calculating the rate of hydrogen gas production. **Monitoring the time** allows for the observation of how **quickly the reaction proceeds**, providing valuable information about the reaction rate.

Therefore the correct answer is **C**.

1353. Answer (C)

A **titration experiment requires very accurate measurement of volumes** to ensure reliable results. A volumetric pipette, which is calibrated for a single, specific volume, provides this accuracy. The lines on a conical flask or a measuring cylinder are not as precise, and using them could introduce errors into the experiment.

Therefore the correct answer is **C**.

1354. Answer (A)

The rate of a chemical reaction can be **determined by measuring the volume of gas produced over time**. In this case, Zinc reacts with dilute hydrochloric acid to produce hydrogen gas. The **syringe** can be used to **collect and measure the volume** of hydrogen gas produced by the reaction. The **watch** is needed to **measure the time** it takes for the gas to be produced. By dividing the volume of gas produced by the time taken, we can calculate the rate of the reaction.

Therefore the correct answer is **A**.

1355. Answer (A)

A balance is needed to accurately measure the mass of the solid calcium carbonate. A pipette is necessary to transfer a precise volume of the dilute hydrochloric acid into the conical flask. A thermometer is used to measure the change in temperature of the mixture, which is crucial for understanding the reaction between hydrochloric acid and calcium carbonate.

Therefore, the correct answer is **A**.

1356. Answer (C)

In a typical acid-base titration, you need a pipet to accurately measure and transfer a known volume of the analyte (the solution of unknown concentration) into the conical flask. The burette, on the other hand, is used to deliver the titrant (the solution of known concentration). The burette allows for precise control over the volume of titrant added, enabling you to determine exactly how much was needed to react completely with the analyte.

Thermometers and syringes are not typically used in standard acid-base titrations.

Therefore, the correct answer is **C**.

1448. Answer

- silver nitrate (AgNO_3)
- white precipitate

The test for chloride ions is performed using an acidified silver nitrate solution. When a solution that contains chloride ions (Cl^-) is added to an acidified silver nitrate (AgNO_3) solution, a chemical reaction occurs. This reaction forms silver chloride (AgCl), which is insoluble in water and appears as a white precipitate. The chemical equation for this reaction is:

$$\text{AgNO}_3(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s}) + \text{NO}_3^-(\text{aq})$$

This reaction is specific to chloride ions and the formation of a white precipitate confirms their presence in the original solution.

1449. Answer

- ① sulfur dioxide ② propene ③ potassium iodide
- ④ anhydrous copper(II) sulfate
- ⑤ carbon monoxide ⑥ sodium bromide

Sulfur dioxide is an acidic oxide. When dissolved in water, it forms sulfurous acid (H_2SO_3). Carbon monoxide is a product of incomplete combustion of fossil fuels. When there is not enough oxygen for complete combustion, carbon monoxide is produced instead of carbon dioxide.

Anhydrous copper(II) sulfate is used to test for the presence of water. It is **white when anhydrous (without water) and turns blue when it comes into contact with water (hydrated)**.

1450. Answer

- (aqueous) sodium hydroxide /
- red-brown precipitate

The test for iron(III) ions (Fe^{3+}) in a solution involves adding a reagent like sodium hydroxide (NaOH). This is based on the principle of precipitation reactions, where certain combinations of aqueous ions result in an insoluble solid, or precipitate. When aqueous sodium hydroxide is added to a solution containing iron(III) ions, a red-brown precipitate of iron(III) hydroxide ($\text{Fe}(\text{OH})_3$) forms. The reaction can be represented as:

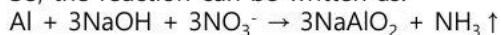
$$\text{Fe}^{3+}(\text{aq}) + 3\text{OH}^-(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{s})$$
1451. Answer

- ① hydroxide ② aluminium ③ ammonia

Firstly, sodium hydroxide (NaOH) is added to the sample. Sodium hydroxide is a strong base that can react with other compounds in the solution.

Then, aluminium powder is added. This reduces nitrate ions (NO_3^-) present in the solution to ammonia (NH_3). Upon gentle warming, ammonia gas is produced. This gas can be detected by its characteristic pungent smell or by turning damp red litmus paper blue due to its basic nature.

So, the reaction can be written as:

**1452. Answer**

- ① thymolphthalein ② ammonium nitrate
- ③ sodium sulfate ④ methane
- ⑤ methane ⑥ copper(II) chloride

Ammonium nitrate, NH_4NO_3 , is a commonly used fertilizer. It provides necessary nitrogen to the plants which is a vital nutrient for their growth.

Sodium sulfate, Na_2SO_4 , is a salt which has a sulfate ion (SO_4^{2-}) as its anion. The sulfate ion carries a 2- charge.

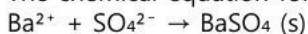
Methane, CH_4 , is a waste gas produced during the digestion process in animals. It is a byproduct of the anaerobic respiration that takes place in the gut.

Methane, CH_4 , is also a hydrocarbon with a total of five atoms in a molecule. It is comprised of one carbon atom and four hydrogen atoms.

1453. Answer

- add barium nitrate ($\text{Ba}(\text{NO}_3)_2$)
- white precipitate forms in the presence of sulfate ions

The chemical equation for this reaction is:



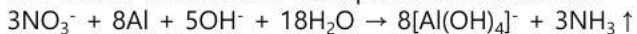
Barium sulfate is highly insoluble in water and forms a solid precipitate, which makes it a reliable indicator of the presence of sulfate ions.

1454. Answer

- ① sodium hydroxide OR potassium hydroxide
- ② aluminium

The test for nitrate ions involves **adding an aqueous solution of sodium hydroxide or potassium hydroxide to the sample, followed by adding a piece of aluminium metal**. The reaction produces ammonia gas if nitrate ions are present.

The overall reaction can be represented as follows:



The ammonia gas produced can be detected by its characteristic pungent smell or by turning damp red litmus paper blue.