新加坡 中正中学 CHUNG CHENG HIGH SCHOOL SINGAPORE 义顺

CHUNG CHENG HIGH SCHOOL (YISHUN)

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2024 Preliminary Examination
Secondary Four Express

CANDIDATE NAME			
CLASS		INDEX NUMBER	

CHEMISTRY

6092/01

Paper 1 Multiple Choice

23 August 2024

Additional Materials: OTAS

1 hour

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number in the spaces at the top of this page and on the OTAS provided.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers, **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice **in soft pencil** on the separate OTAS.

Read the instructions on the OTAS very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this question paper.
A copy of the Periodic Table is printed on page **19**.
The use of an approved scientific calculator is expected, where appropriate.

1 In a volumetric experiment involving the addition of hydrochloric acid to 25.0 cm^3 of aqueous sodium hydroxide, it is necessary to determine when the reaction is just complete.

Which piece of apparatus could be used to determine the end-point of the reaction?

A electronic balance

B gas syringe

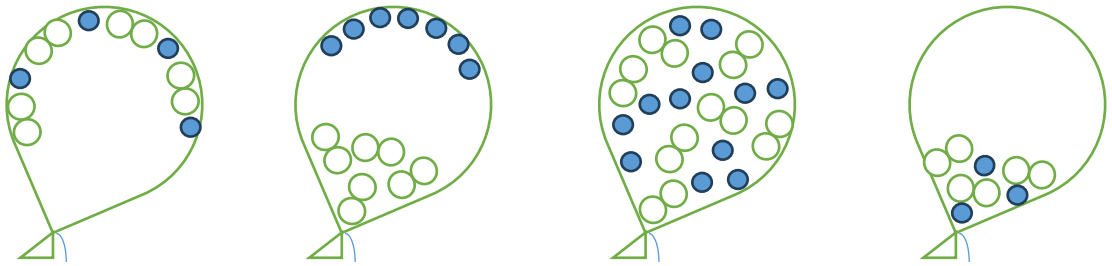
C stopwatch

D thermometer

2 Which diagram shows the arrangement of particles inside a balloon containing helium and oxygen?

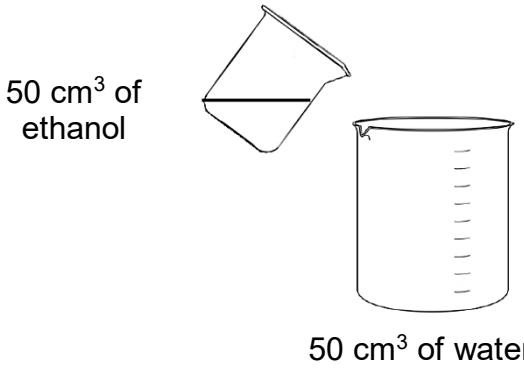
helium

oxygen



A **B** **C** **D**

3 A 50 cm^3 sample of ethanol is mixed with 50 cm^3 of water.



The volume of the mixed ethanol and water is found to be 97 cm^3.

Which statement is the best explanation?

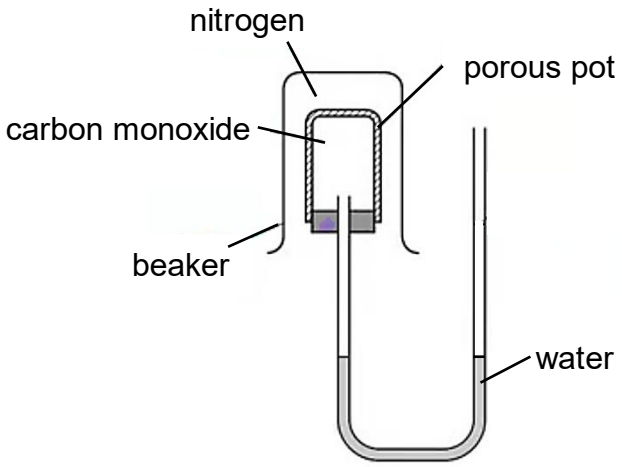
A Some volatile ethanol evaporate.

B The ethanol molecules fit into gaps between water molecules.

C Water and ethanol react to form a soluble salt.

D Water and ethanol react to form a gas which escapes.

4 A beaker of nitrogen was inverted over a porous pot containing carbon monoxide as shown.



The water level did not change.

What is the reason for this?

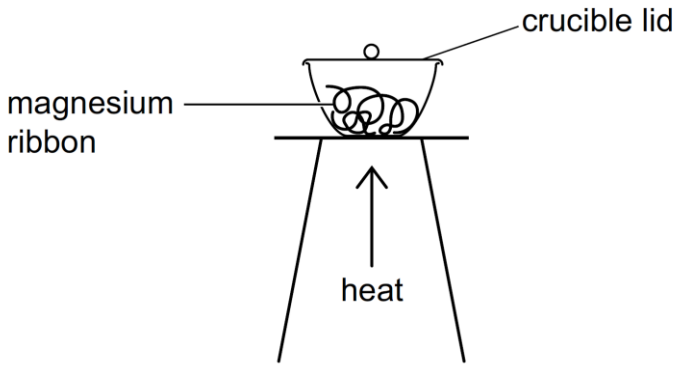
A Both gases are diatomic.

B Nitrogen is an unreactive gas.

C The two gases have the same molecular masses.

D The gas particles are too large to pass through the porous pot.

5 In an experiment to find the formula of magnesium oxide, magnesium metal is heated in a covered crucible.



Why is the crucible covered?

A to prevent air escaping from the crucible

B to prevent magnesium carbonate forming

C to prevent magnesium oxide escaping from the crucible

D to prevent water vapour escaping from the crucible

6 The R_f values of some substances are shown below. The solvent used is ethanol.

substance	R_f value
X	0.20
Y	0.80
Z	0.45

Which of the following **cannot** be concluded from the R_f value of **X**?

A Substance **X** is less soluble in ethanol than **Y** and **Z**.

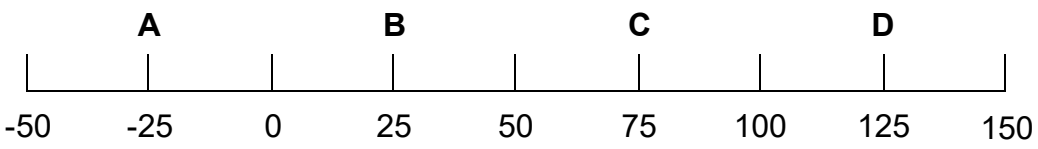
B Substance **X** will have the same R_f value when the solvent is changed to water.

C The distance travelled by **X** is one-fifth the distance travelled by ethanol.

D The distance travelled by **Y** is four times the distance travelled by **X**.

7 Bromine has a melting point of -2 °C and a boiling point of 59 °C.

At which temperature is bromine a liquid?



8 Which group of substances contain an element, a compound and a mixture?

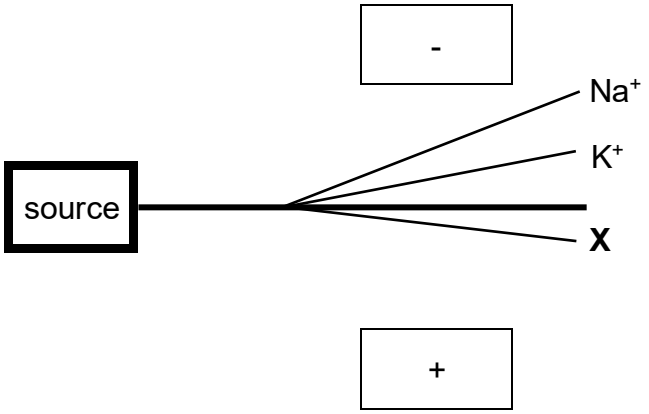
A copper, diamond, sand

B dilute acid, brass, ethanol

C glucose, ammonia, methane

D graphite, polyethene, crude oil

9 In an experiment, a sample was vapourised, ionised and passed through an electric field. Analysis of the deflection occurring at the electric region revealed the following data for the sample.



What is the possible identify of the unknown particle **X**?

A Br^- **B** F^- **C** Li^+ **D** Rb^+

10 The relative atomic mass of naturally occurring chlorine is not a whole number.

What is the reason for this?

A Chlorine is unstable.

B Chlorine atoms can have different number of neutrons.

C Naturally occurring chlorine cannot be obtained pure.

D The mass of the electron has been included.

11 What is the total number of electrons not involved in bonding in an ethyne, C_2H_2, molecule?

H—C≡C—H

A 4 **B** 6 **C** 8 **D** 10

12 The formulae of four covalent molecules are shown.

1 H_2O

2 CO_2

3 CH_3OH

4 CH_3COOH

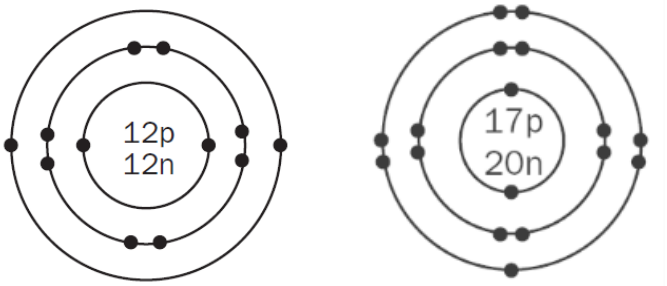
In which pair of molecules does oxygen form at least one double bond in both molecules?

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

13 If one mole of a substance contains ***p*** number of particles, what is the number of gas molecules in a sample of 106.5 g of chlorine gas?

A 0.5 ***p*** **B** 1.0 ***p*** **C** 1.5 ***p*** **D** 2.0 ***p***

14 The diagram below shows the structures of the atoms of two elements.



What is the relative molecular mass of the compound formed by these two elements?

A 46 **B** 61 **C** 85 **D** 98

15 10 g of Z_3O_4 contains 7.5 g of **Z**.

How many moles of **Z** does 7.5 g of the element contain?

A $\frac{2.5}{16} \times \frac{3}{4}$ **B** $\frac{7.5}{16} \times \frac{27}{36}$ **C** $\frac{2.5}{16} \times \frac{4}{3}$ **D** $\frac{10}{16} \times \frac{4}{3}$

16 28 g of gaseous hydrocarbon **X** has a volume of 12 dm^3 at room temperature and pressure.

What is the molecular formula of **X**?

A C_2H_4 **B** C_3H_8 **C** C_4H_8 **D** C_5H_{10}

17 Potassium hydroxide reacts with dilute sulfuric acid to form potassium sulfate and water.

$$2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$$

25 cm^3 of 2.5 mol / dm^3 potassium hydroxide reacted with dilute sulfuric acid to give 0.05 mol of water.

Which of the following volumes and concentrations of dilute sulfuric acid were used?

A 25.0 cm^3 of 2.0 mol / dm^3

B 20.0 cm^3 of 2.5 mol / dm^3

C 12.5 cm^3 of 2.0 mol / dm^3

D 15.0 cm^3 of 2.5 mol / dm^3

18 On heating, ammonium nitrate, NH_4NO_3, decomposes to form dinitrogen oxide and water.

$$NH_4NO_3 \rightarrow N_2O + 2H_2O$$

When 80 g of an impure sample of ammonium nitrate is heated, 27 g of water are formed.

Which expression shows the number of grammes of ammonium nitrate in the impure sample?

A $66 \times \frac{27}{36}$ **B** $80 \times \frac{27}{36}$ **C** $80 \times \frac{27}{18}$ **D** $80 \times \frac{9}{36}$

19 When a strong acid is neutralised by a strong base, the change in heat content is always the same (ΔH = -57.6 kJ).

This is so because

A strong acids and strong bases have the same heat content.

B strong acids and strong bases produces salt and water only.

C strong acids and strong bases have equal strength.

D the reaction involves only H^+ and OH^- ions to produce water.

20 The dissociation constant for an acid indicates the extent to which it dissociates into ions. The higher the dissociation constant, the stronger the acid.

The dissociation constant for some acids is given below along with two possibly correct statements.

acid	dissociation constant
methanoic acid	1.80×10^{-4}
ethanoic acid	1.75×10^{-5}
propanoic acid	1.34×10^{-5}
bromoethanoic acid	1.30×10^{-3}

statement 1: Increasing the length of the carbon chain makes the acid stronger.

statement 2: Replacing a hydrogen by a bromine in ethanoic acid makes the acid stronger.

Based on the data above, which statement(s) is/are correct?

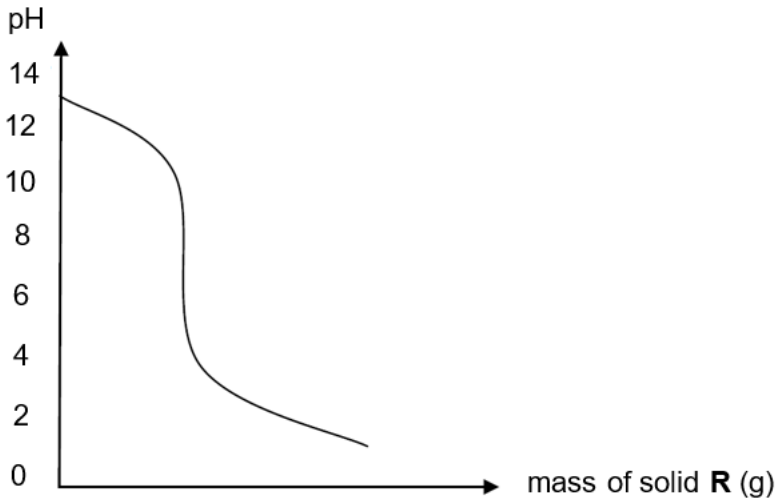
A statement 1 only

B statement 2 only

C neither statement

D both statements

21 Solid **R** is gradually added to aqueous solution **S**. The changes in pH in solution **S** are shown on the graph.

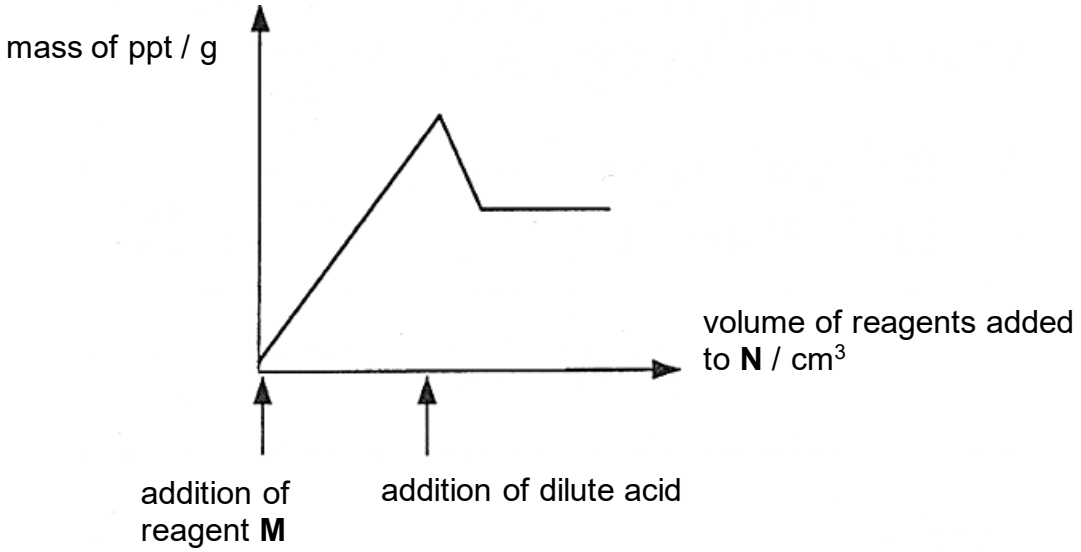


What are **R** and **S**?

	R	**S**
A	insoluble metal oxide	nitric acid
B	soluble metal oxide	hydrochloric acid
C	soluble non-metal oxide	aqueous ammonia
D	soluble non-metal oxide	sodium hydroxide

22 In a quantitative analysis, reagent **M** is gradually added to a salt solution **N** (that contains either one or two different anions), followed by the addition of a dilute acid.

The graph below shows how the mass of precipitate (ppt) formed changes with the reagents added.



	anion(s) in **N**	reagents (**M** and acid) added
A	CO_3^{2-}	add aqueous silver nitrate, followed by dilute nitric acid
B	Cl^-, CO_3^{2-}	add aqueous barium chloride, followed by dilute hydrochloric acid
C	SO_4^{2-}, CO_3^{2-}	add aqueous silver nitrate, followed by dilute hydrochloric acid
D	SO_4^{2-}, CO_3^{2-}	add aqueous barium chloride, followed by dilute hydrochloric acid

23 Across a period, there is a trend from metallic to non-metallic elements.

This is caused by

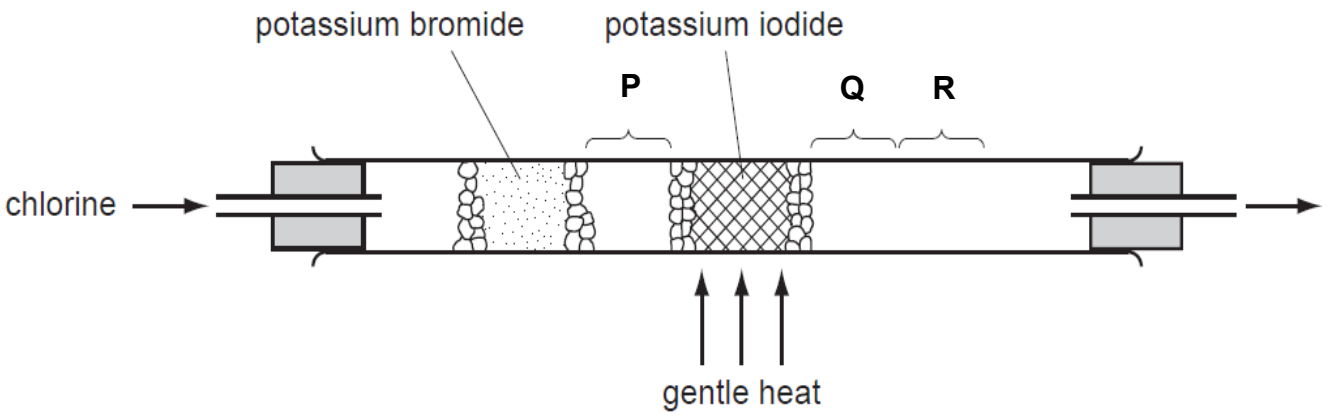
A an increase in number of electrons.

B an increase in number of electrons shells.

C an increase in number of neutrons.

D an increase in number of valency electrons.

24 Using the apparatus shown, chlorine is passed through the tube.



After a short time, coloured substances are seen at **P**, **Q** and **R**.

What are these coloured substances?

	P	Q	R
A	green gas	red brown vapour	violet vapour
B	green gas	violet vapour	black solid
C	red brown vapour	violet vapour	black solid
D	violet vapour	red brown vapour	red brown vapour

25 Which are redox reactions?

1 $2Fe^{2+} + Cl_2 \rightarrow 2Fe^{3+} + 2Cl^-$

2 $H_2SO_4 + Zn \rightarrow ZnSO_4 + H_2$

3 $Pb(NO_3)_2 + 2NaCl \rightarrow PbCl_2 + 2NaNO_3$

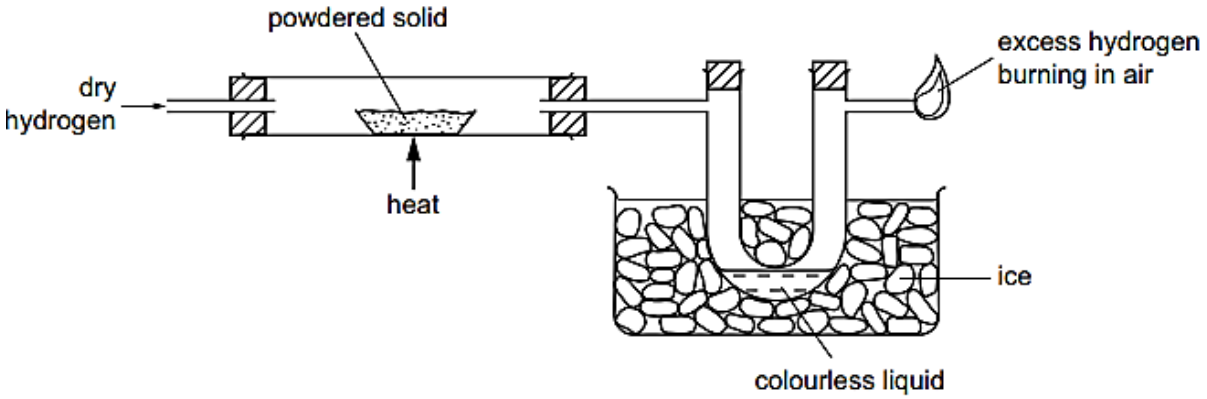
A 1 and 2 only

B 1 and 3 only

C 2 and 3 only

D 1, 2 and 3

26 Dry hydrogen gas is passed over a heated powdered solid and then through a cooled U-tube before excess hydrogen is burned in air.



A colourless liquid collects in the U-tube.

What could the powdered solid be?

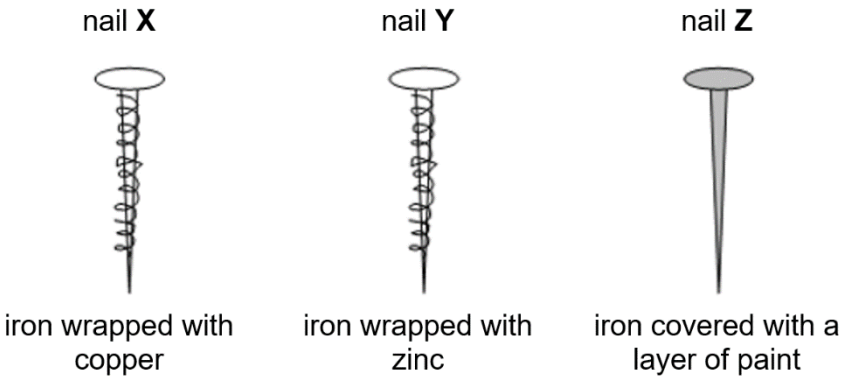
A copper

B copper(II) oxide

C magnesium

D zinc oxide

27 The experiment below investigates the rusting of iron nails.



Which nail(s) will rust?

A **X** only

B **X** and **Y** only

C **Y** only

D none of the nails

28 The equations for the reactions of iron with chlorine and hydrogen chloride are as follow.

$$2Fe + 3Cl_2 \rightarrow 2FeCl_3$$

$$Fe + 2HCl \rightarrow FeCl_2 + H_2$$

Iron and tin react similarly. Tin shows oxidation states of +2 and +4.

A student wrote down the following reactions.

1 $Sn + 2Cl_2 \rightarrow SnCl_4$

2 $Sn + 2HCl \rightarrow SnCl_2 + H_2$

3 $Sn + Cl_2 \rightarrow SnCl_2$

Which of the above reaction(s) would occur with metallic tin?

A 1 only

B 2 only

C 1 and 2 only

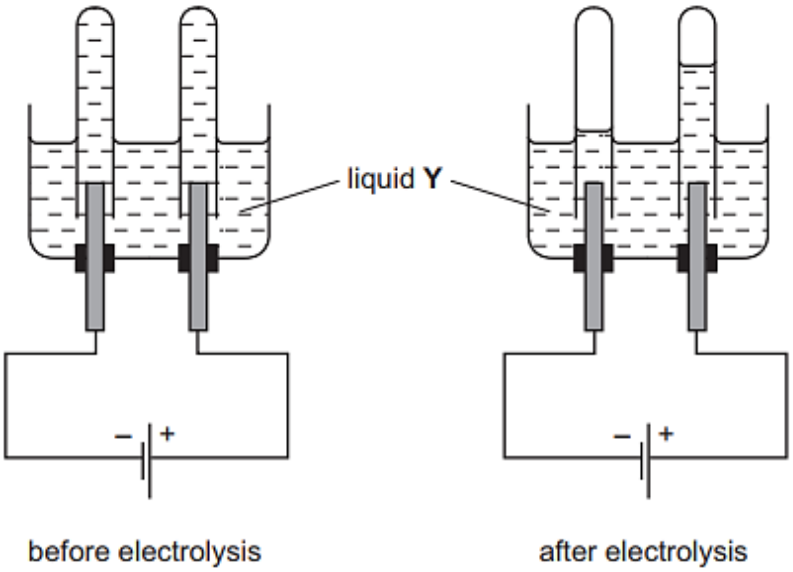
D 1, 2 and 3

29 Aqueous sodium sulfate is electrolysed using carbon electrodes.

Which of the following gives the correct pH values of the solutions around the cathode and the anode during the electrolysis?

	pH of solution around the cathode	pH of solution around the anode
A	12	2
B	2	12
C	12	12
D	2	2

30 The diagrams show an electrolysis set-up using inert electrodes.



Which could be liquid **Y**?

1 aqueous sodium nitrate
2 aqueous copper(II) sulfate
3 concentrated aqueous sodium chloride
4 dilute sulfuric acid

A 1 only
B 1 and 4 only
C 2 and 4 only
D 2, 3 and 4 only

31 How is the electrical energy is produced in a simple cell?

A formation of covalent bonds between atoms
B positive and negative ions coming together
C transfer of electrons from the positive terminal to the negative terminal
D transfer of electrons from a more reactive element to a less reactive element

32 The bond energies of three different bonds are as shown in the table.

bond	bond energy (kJ / mol)
F – F	158
H – H	436
H – F	556

Which statement can be deduced from the information provided above?

A Hydrogen fluoride molecules are the least stable compared to hydrogen and fluorine molecules.

B Hydrogen gas is more reactive than fluorine gas.

C The bond in the fluorine molecule is the strongest compared to hydrogen and hydrogen fluoride molecules.

D The energy produced when forming 1 mole of hydrogen fluoride from its elements is 259 kJ.

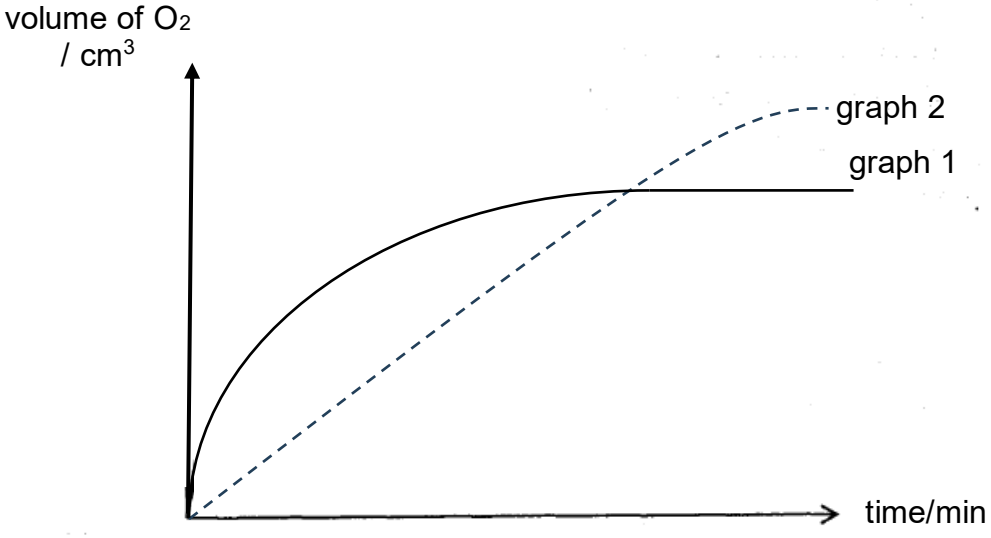
33 In each of five different experiments, the same mass of magnesium reacts with the same volume of an excess of sulfuric acid.

Which set of conditions will result in the magnesium being used up the fastest?

	form of magnesium	concentration of acid (mol/dm^3)	pressure (atm)
A	ribbon	1	1
B	powder	0.5	2
C	ribbon	0.5	2
D	powder	1	1

34 Graph 1 was obtained by observing the decomposition of 100 cm^3 of 1 mol / dm^3 aqueous hydrogen peroxide, catalysed by manganese(IV) oxide.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$



What change has been made to the conditions to produce graph 2?

A adding some 0.1 mol / dm^3 aqueous hydrogen peroxide

B lowering the temperature

C using a better catalyst

D using less manganese(IV) oxide

35 In the presence of sunlight, methane gas and chlorine gas are mixed in a container.

After some time, which of the following compounds may be present in the container?

1 CH_3Cl

2 CCl_4

3 H_2

4 HCl

A 1 and 2 only

B 3 and 4 only

C 1, 2 and 4 only

D 1, 2, 3 and 4

36 Olive oil is said to be healthier as it contains unsaturated fatty acids.

Which of the following is a straight chain mono-unsaturated fat found in olive oil?

A $C_{14}H_{29}COOH$

B $C_{15}H_{31}COOH$

C $C_{16}H_{33}COOH$

D $C_{17}H_{33}COOH$

37 The list shows reactions in which ethanol is either a reactant or a product.

1 combustion of ethanol

2 fermentation of glucose

3 conversion of ethene to ethanol

4 oxidation of ethanol to ethanoic acid

In which reaction(s) is/are water also either a reactant or a product?

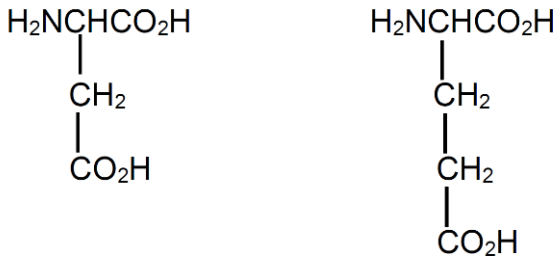
A 1, 2 and 4 only

B 1, 3 and 4 only

C 2, 3 and 4 only

D 3 only

38 The diagram below shows the structural formula of aspartic acid and glutamic acid.



aspartic acid glutamic acid

Aspartic acid and glutamic acid can react with each other to form amide linkages.

What is the maximum number of different organic compounds that can be formed when one molecule of aspartic acid reacts with one molecule of glutamic acid?

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

39 Which statement correctly describes physical and chemical method of recycling plastics?

A Melting small pieces of poly(ethene) waste into pellets is a chemical method, while depolymerisation of plastic waste into chemical feedstock is a physical method.

B Melting small pieces of poly(ethene) waste into pellets is a physical method, while cracking plastic waste into fuel is a chemical method.

C Depolymerisation of plastic waste into chemical feedstock is a physical method, while melting small pieces of poly(ethene) waste into pellets is a chemical method.

D Cracking plastic waste into fuel is a physical method, while melting small pieces of poly(ethene) waste into pellets is a chemical method.

40 Which atmospheric pollutants, emitted by internal combustion engines, are reacted together to convert them to less harmful products?

A carbon monoxide and nitrogen dioxide

B carbon monoxide and unburned hydrocarbons

C nitrogen dioxide and sulfur dioxide

D sulfur dioxide and unburned hydrocarbons

Section A

Answer **all** questions.

1 Use the list of substances to answer the question.

iron(II) nitrate	**zinc phosphate**	**iron(III) sulfate**
copper(II) chloride	**ammonium carbonate**	**calcium iodide**

(a) Which two substances contain both ionic and covalent bonds?

……[1]

(b) Which substance will slowly turn brown if left standing in air?

……[1]

(c) Which substance is a white solid at room temperature?

……[1]

(d) Which substance will give out two different gases on heating?

……[1]

(e) Which substance will not form any precipitate with aqueous sodium hydroxide?

……[1]

(f) Which substance will react with aqueous ammonia to form a dark blue solution?

……[1]

(g) Which substance will react with acidified aqueous silver nitrate to form a yellow precipitate?

……[1]

(h) Which substance will be reduced by aluminium in the presence of aqueous sodium hydroxide?

……[1]

[Total: 8]

2 Table 2.1 shows some information about three particles, **A**, **B** and **C**.

Table 2.1

particle	**A**	**B**	**C**
nucleon number	1	2	3
number of protons	1	1	1
number of electrons	1	2	0

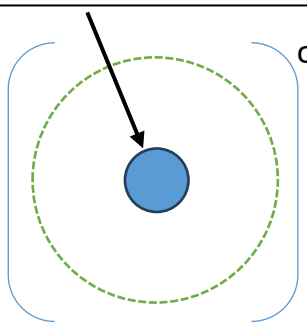
(a) Complete the diagrams of the three particles to show:

- the numbers of neutron and proton in the nucleus
- the arrangement of the electrons
- the charge on each particle.

A nucleus contains …..

……

……

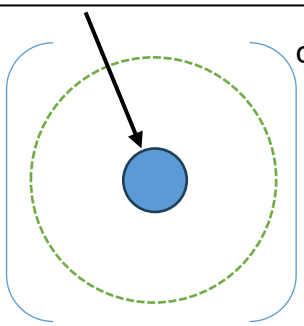


charge: …….

B nucleus contains …..

……

……

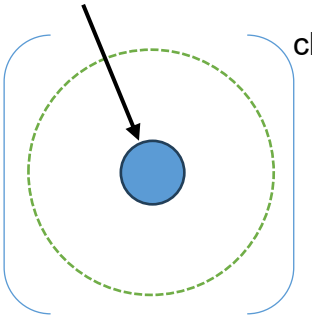


charge: …….

C nucleus contains …..

……

……



charge: …….

[3]

(b) Particle **A, B** and **C** belong to the same element.

Do you agree with the statement? Explain your reasoning.

……

……[1]

(c) Particle **A** reacts with magnesium to form a solid at room temperature.

Draw a 'dot-and-cross' diagram to show the bonding in the solid.

Show outer electrons only.

[2]

(d) Particle **A** react with nitrogen to form a gas at room temperature.

Draw a 'dot-and-cross' diagram to show the bonding in the gas.

Show outer electrons only.

[2]

[Total: 8]

3 Rocks such as quartz are made of covalently bonded compounds of silicon and oxygen.

Other types of rock are made of ionic silicate compounds. These contain metal ions ionically bonded to silicate ions.

Table 3.1 below shows some naturally occurring silicates and the silicate ions present.

Table 3.1

name of silicate compound	formula	metal ion(s)	silicate ion
phenacite	Be_2SiO_4	Be^{2+}	SiO_4^{4-}
anorthite	$CaAl_2Si_2O_8$		
microcline	$KAlSi_3O_8$	K^+, Al^{3+}	$Si_3O_8^{4-}$

(a) Typically, quartz contains 46.7 % silicon and 53.3 % oxygen by mass.

Show that the empirical formula of quartz is SiO_2.

[2]

(b) Explain in terms of structure and bonding, why quartz is resistant to scratching.

……

……

……[2]

(c) Complete **Table 3.1** to show the formulae and charges of the ions present in anorthite. [2]

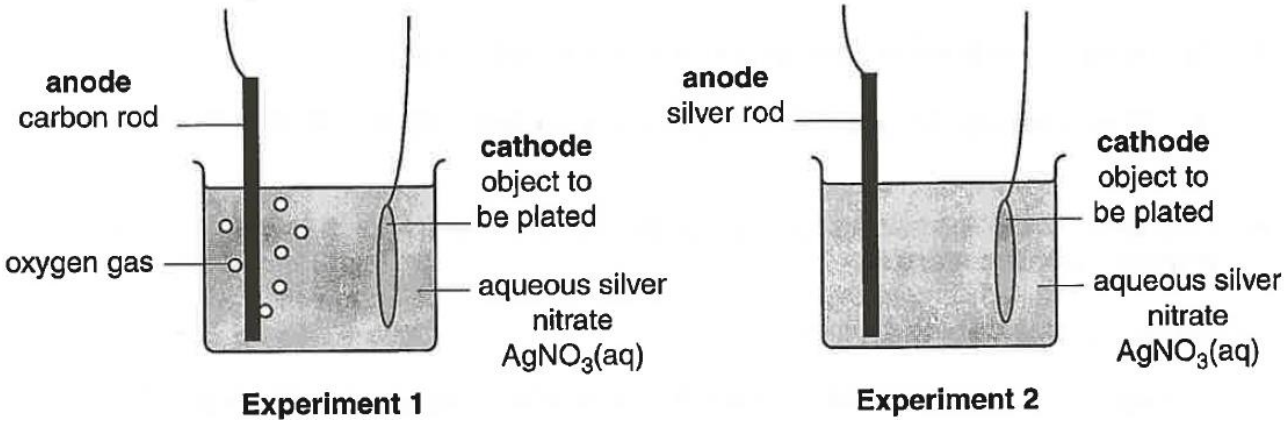
(d) Beryllium and silicon can both be extracted from the mineral phenacite.

Show by calculation that 1 kg of phenacite contains a larger mass of silicon than beryllium but a larger number of moles of beryllium atoms than silicon atoms.

[4]

[Total: 10]

4 A student sets up two different experiments for electroplating an object with silver.



He measures the masses of each electrode at the start and at the end of the experiment.

Table 4.1 shows his results.

Table 4.1

	at the start		at the end	
mass of electrode	anode	cathode	anode	cathode
experiment 1 / g	3.50	3.50	3.50	6.20
experiment 2 / g	3.50	3.50	0.80	6.20

(a) Write equations for the reactions that happen at the anode and cathode for experiment 1. Include state symbols.

at the anode:

at the cathode:

[3]

(b) **(i)** Explain why the mass of anode electrode in experiment 2 decreases by the end of the experiment but not for experiment 1.

……

……[2]

(ii) Explain why after sometime, bubbles will be observed at the cathode for both experiment 1 and 2. Include a suitable equation to support your answer.

……

……[2]

(c) At the beginning of each experiment, the student removes a sample of the electrolyte aqueous silver nitrate and puts in a test-tube.

The student then adds a few drops of aqueous magnesium chloride.

Using an ionic equation, describe and explain what the student sees.

……

……[3]

[Total: 10]

5 Ethanol is manufactured by reacting ethene with steam at high temperature and pressure in the presence of an acid catalyst. The reaction is reversible and the formation of the ethanol is exothermic.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g) \qquad \Delta H = -45 \text{ kJ / mol}$$

(a) Calculate the volume of steam needed to completely react with 56 dm^3 of ethene.

[1]

(b) Complete the energy profile diagram for the **reverse** reaction.

Your diagram should include

- the reactants and products
- the activation energy
- the enthalpy change of the reaction and its value

[3]

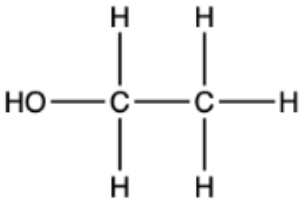
(c) High pressure will increase the rate of reaction and favour the forward reaction, thus increasing the yield of ethanol in a shorter time span.

However, at higher pressure, an addition polymer is formed and clogged up the reactor.

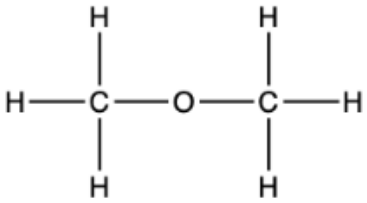
Name and draw two repeating units of the addition polymer formed. .

……..……..…[2]

(d) Two isomers of ethanol are shown below.



ethan-1-ol



dimethyl ether

Explain why they are isomers.

……..……

……..……

……..……..…[2]

(e) The same products are formed when both isomers are completely combusted.

Write a chemical reaction to show the complete combustion of both isomers.

……..……..…[1]

(f) Explain in terms of bond breaking and bond forming, why the enthalpy change of combustion for the two isomers are different.

……..……

……..……

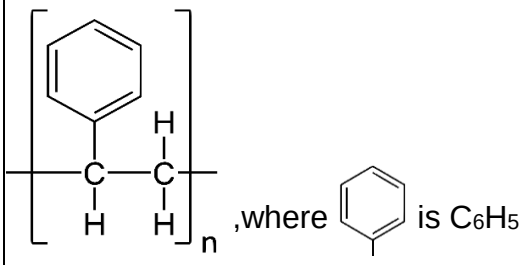
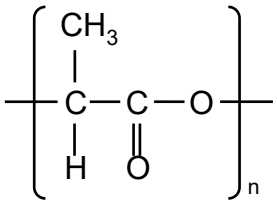
……..……

……..……..…[2]

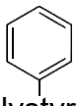
[Total: 11]

6 Table 6.1 gives some information on two polymers commonly used in disposable food containers are given below.

Table 6.1

name	expanded polystyrene (styrofoam)	polylactic acid (PLA)
structural formula	 ,where is C_6H_5	
source	crude oil	plants
relative molecular mass	13300 – 18700	5700 – 14400
density	0.011 – 0.028 g / cm^3	1.21 – 1.43 g / cm^3
glass transition temperature	100 – 128 °C	52 – 63 °C
end of life	• x years, still decaying	• biodegradable under industrial composting condition • chemically recycled to monomer by thermal depolymerisation or hydrolysis

The glass transition temperature is defined as the temperature where the polymer changes from a rigid glassy material to a soft, but not melted, material.

(a) Given the relative molecular mass of  is 77, determine the range of the average number of repeating units in polystyrene.

[3]

(b) Polystyrene is an addition polymer. Polylactic acid is a condensation polymer.

Explain, using the structure of polylactic acid, why polylactic acid is a condensation polymer.

……

……

……[2]

(c) Draw the full structural formula of the monomer when polylactic acid is depolymerised.

[2]

(d) Describe chemical tests and the expected results if polylactic acid has fully depolymerised.

……

……

……

……[2]

(e) Environmentalists have argued for the use of polylactic acid as the material to make disposable food containers instead of polystyrene because it is renewable. However, many companies continue to use polystyrene.

(i) Explain why environmentalists think that polylactic acid is "*renewable"*.

……

……[1]

(ii) Use the information given in table 6.1 to suggest why "*many companies continue to use polystyrene"*.

……

……[1]

[Total: 11]

7 Standard Electrode Potentials ($E^{\ominus}$ Values)

Standard Electrode Potentials or $E^{\ominus}$ values show how likely an element or ion is to be reduced by gaining electrons.

Table 7.1 below shows the ionic half equations of selected reactions and the $E^{\ominus}$ values for each of the reactions. All ionic states refer to aqueous ions, but other state symbols have been omitted.

Table 7.1

reaction	$E^{\ominus}$/V
$2H^+ + 2e^- \rightleftharpoons H_2$	0.00
$O_2 + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+1.23
$Li^+ + e^- \rightleftharpoons Li$	-3.05
$Na^+ + e^- \rightleftharpoons Na$	-2.71
$K^+ + e^- \rightleftharpoons K$	-2.92
$Rb^+ + e^- \rightleftharpoons Rb$	-2.93
$Ag^+ + e^- \rightleftharpoons Ag$	+0.80
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+0.34
$F_2 + 2e^- \rightleftharpoons 2F^-$	+2.87
$Cl_2 + 2e^- \rightleftharpoons 2Cl^-$	+1.36
$Br_2 + 2e^- \rightleftharpoons 2Br^-$	+1.07
$I_2 + 2e^- \rightleftharpoons 2I^-$	+0.54
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+1.49

(https://chemistrytalk.org/standard-reduction-potentials-made-easy/)

The $E^{\ominus}$ values refer to the forward reaction. The larger the value, the more likely the forward reaction will occur.

$E^{\ominus}$ values are also a powerful theoretical tool for predicting the likelihood of a chemical reaction occurring (spontaneity of a reaction), regardless of whether the reaction involves metals, ions, or other species.

Consider the two ionic half equations,

equation 1: $Ag^+ + e^- \rightarrow Ag$ $E^{\ominus} = +0.80$ V

equation 2: $Cu^{2+} + 2e^- \rightarrow Cu$ $E^{\ominus} = +0.34$ V

Equation 1 is more likely to happen than equation 2 since it has a larger $E^{\ominus}$ value.

To predict if a reaction between the two species will occur, the ionic half equation with the lower $E^{\ominus}$ value must be reversed, together with the $E^{\ominus}$ value. For example, +0.34 V becomes -0.34 V.

The sum of the $E^{\ominus}$ values of the two equations gives the overall $E^{\ominus}$ value.

$$\text{Overall } E^{\ominus} \text{ value} = +0.80 + (-0.34) = +0.46 \text{ V}$$

Since the overall $E^{\ominus}$ value is larger than 0.00 V, the reaction is spontaneous.

Hence, overall chemical equation for the reaction:

$$2Ag^{+} + Cu \rightarrow Cu^{2+} + 2Ag$$

Stoichiometric coefficients are **not factored** in for $E^{\ominus}$ value calculations.

(a) Use the information in Table 7.1 to suggest the most spontaneous reaction.

……..……..….[1]

(b) Explain in terms of atomic structure, why fluorine is the strongest oxidising agent among all halogens.

……..……

……..……

……..…[2]

(c) In the reaction between silver ion and copper.

$$2Ag^{+} + Cu \rightarrow Cu^{2+} + 2Ag$$

Copper acts as a reducing agent.

Use ideas about oxidation state **and** electron transfer to explain why the above statement is true.

……..……

……..……

……..……

……..…[2]

(d) A student suggested that since reactivity decrease down Group 1 element, the reducing power of the element also decrease down the group.

Do you agree with him?

Explain your reasoning.

……..……

……..……

……..……

……..…[2]

(e) A student wants to find out whether the reaction between hydrogen and oxygen is spontaneous or non-spontaneous.

(i) Using the ionic half equations, write an overall equation for a reaction between hydrogen and oxygen.

……..[1]

(ii) Use $E^{\ominus}$ values to show whether the reaction between hydrogen and oxygen is spontaneous or non-spontaneous.

[3]

(f) Suggest an advantage of using $E^{\ominus}$ values in predicting the spontaneity of a reaction.

……..……

……..…[1]

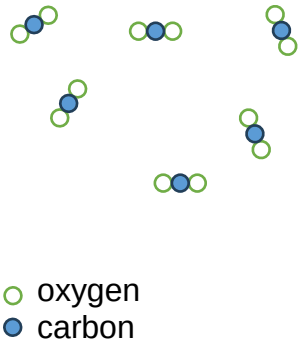
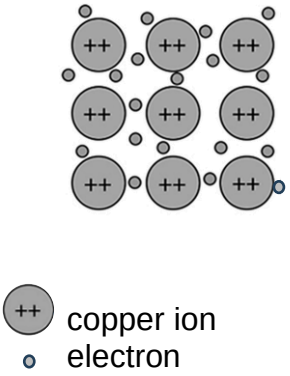
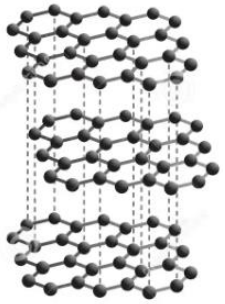
[Total: 12]

Section B

Answer **one** question from this section.

8 Table 8.1 shows the structures and electrical conductivities of three substances, carbon dioxide, copper and graphite.

Table 8.1

substance	carbon dioxide	copper	graphite
structure			
electrical conductivity	low	high	high

(a) Compare the bonding and structures of the three substances.

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.....

..... [5]

(b) Explain why the electrical conductivities of the three substances differ.

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……

…… [3]

(c) A sample of copper was burnt in air to form copper(II) oxide.

The black powdery copper(II) oxide was accidentally mixed with some graphite powder.

Describe briefly how pure and dry graphite powder can be obtained from the mixture.

……

……

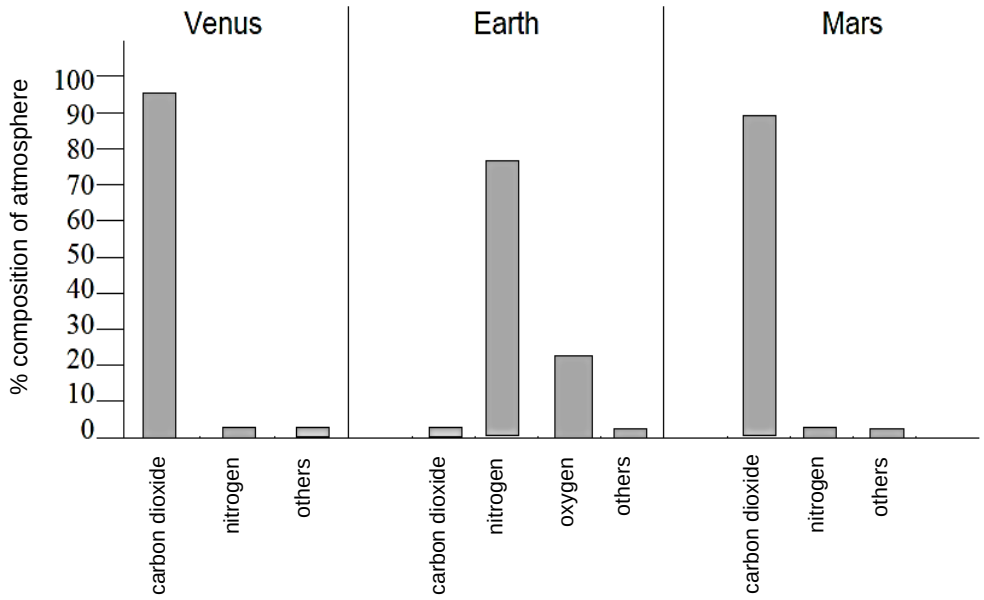
……

…… [2]

[Total: 10]

9 Figure 9.1 shows the composition of the atmosphere on Venus, Earth and Mars.

Figure 9.1



(a) Earth lies between Venus and Mars. The composition of gases in the three atmospheres is expected to follow a trend. However, it was found that Earth's atmosphere deviates from the trend.

Predict the composition of Earth's atmosphere based on this trend.

……

……

…… [2]

(b) How does the atmosphere on Venus differ from the atmosphere on Earth?

……

……

……

……

……

…… [3]

(c) Venus is often called Earth's twin since it has almost the same size and density as Earth. Initially, Earth's atmosphere was similar to that of Venus.

Suggest and explain what caused the composition of Earth's atmosphere to change. Include the processes involved and giving chemical equations for any reactions.

……

……

……

……

……

……

……

……

……

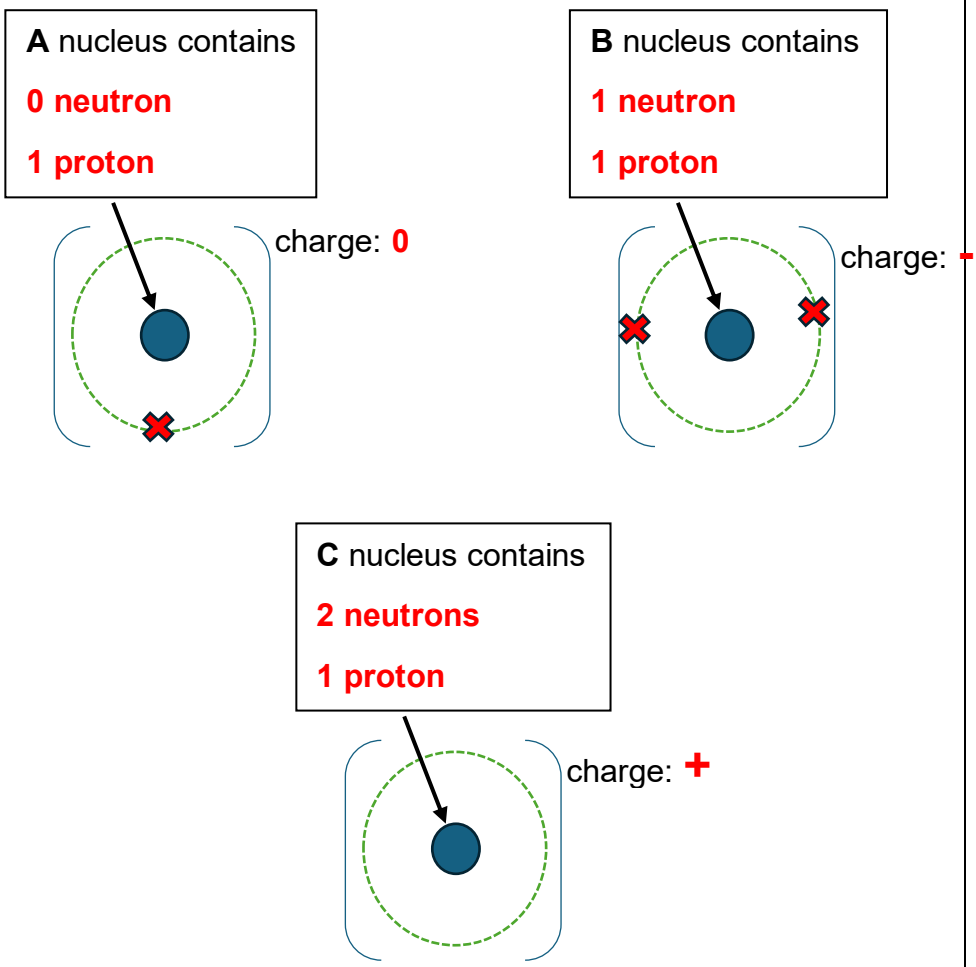
…… [5]

[Total: 10]

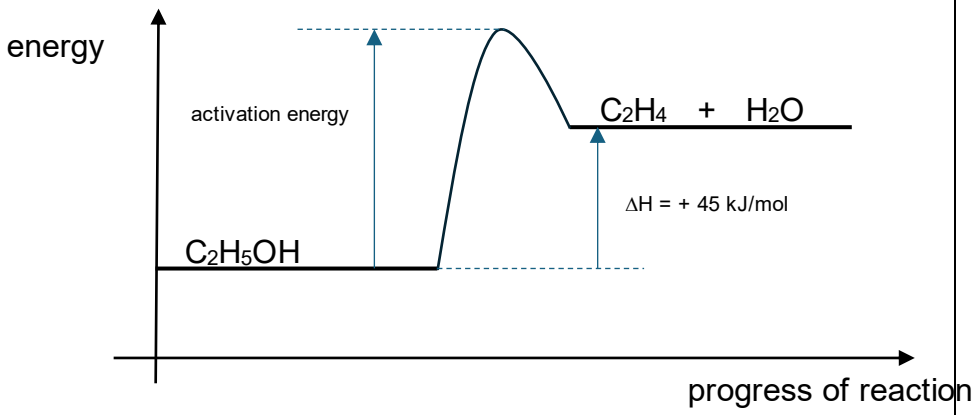
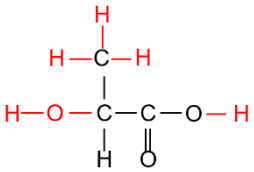
2024 CCHY Chem Prelim P1
Suggested Answers

1	D	**21**	D
2	C	**22**	D
3	B	**23**	D
4	C	**24**	C
5	C	**25**	A
6	B	**26**	B
7	B	**27**	A
8	D	**28**	C
9	A	**29**	A
10	B	**30**	B
11	A	**31**	D
12	C	**32**	D
13	C	**33**	D
14	D	**34**	A
15	A	**35**	C
16	C	**36**	D
17	C	**37**	B
18	B	**38**	D
19	D	**39**	B
20	B	**40**	A

2024 CCHY S4 Chemistry Preliminary Examination P2 Marking Scheme

Qn	Marking point	Marks
1(a)	iron(II) nitrate / zinc carbonate / iron(III) sulfate / ammonium carbonate	1
(b)	iron(II) nitrate	1
(c)	ammonium carbonate/ zinc phosphate/ calcium iodide	1
(d)	ammonium carbonate	1
(e)	ammonium carbonate	1
(f)	copper(II) chloride	1
(g)	calcium iodide	1
(h)	iron(II) nitrate	1
	Total	**8**
2(a)		3 1 mark for each correct particle
(b)	Yes All three particles have the same number of proton (1)	1
(c)	Dot and cross diagram of MgH_2 • Correct ions • Correct charges • Correct ratio - [1] for every error	2
(d)	Dot and cross diagram of NH_3 • Correct ratio • Correct number of shared electrons • Correct number of lone pair electrons - [1] for every error	2
	Total	**8**

<table>
<tr><th>Qn</th><th>Marking point</th><th>Marks</th></tr>
<tr><td>3(a)</td><td>divide by relative atomic mass / calculated mole ratio</td><td>1</td></tr>
<tr><td></td><td>divide by smallest number to get ratio</td><td>1</td></tr>
<tr><td>(b)</td><td>A large amount of force (reject energy)</td><td>1</td></tr>
<tr><td></td><td>is needed to break the strong covalent bonds between the Si and O atoms throughout the entire structure.</td><td>1</td></tr>
<tr><td>(c)</td><td><table><tr><th>name of silicate compound</th><th>formula</th><th>metal ion(s)</th><th>silicate ion</th></tr><tr><td>phenacite</td><td>Be_2SiO_4</td><td>Be^{2+}</td><td>SiO_4^{4-}</td></tr><tr><td>anorthite</td><td>$CaAl_2Si_2O_8$</td><td>Ca^{2+} , Al^{3+}</td><td>$Si_2O_8^{8-}$</td></tr><tr><td>microcline</td><td>$KAlSi_3O_8$</td><td>K^+, Al^{3+}</td><td>$Si_3O_8^{4-}$</td></tr></table></td><td>2
1 mark for each blank</td></tr>
<tr><td>(d)</td><td>mass of beryllium in 1 kg of phenacite = (2 x 9)/(2x9 + 28 + 4x16) x 1000</td><td></td></tr>
<tr><td></td><td>= (18/110) x 1000
= 163.6 g or 164 g</td><td>1</td></tr>
<tr><td></td><td>No. of mole of beryllium = 163.6/9
= 18.2 mole</td><td>1</td></tr>
<tr><td></td><td>mass of silicon in 1 kg of phenacite = (28)/(2x9 + 28 + 4x16) x 1000</td><td></td></tr>
<tr><td></td><td>= (28/110) x 1000
= 254.5 g or 255 g</td><td>1</td></tr>
<tr><td></td><td>No. of mole of silicon = 254.5/28
= 9.10 mole</td><td>1</td></tr>
<tr><td></td><td>Total</td><td>10</td></tr>
<tr><td>4(a)</td><td>anode: $4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4\ e^-$</td><td>1</td></tr>
<tr><td></td><td>cathode: $Ag^+(aq) + e^- \rightarrow Ag(s)$</td><td>1</td></tr>
<tr><td></td><td>Correct state symbols</td><td>1</td></tr>
<tr><td>(b)(i)</td><td>In Experiment 2: Silver electrode is active electrode and hence oxidises to form silver ions.</td><td>1</td></tr>
<tr><td></td><td>In Experiment 1: Carbon electrode is inert and cannot oxidise. Hence, no change in mass.</td><td>1</td></tr>
<tr><td></td><td>Idea of active vs inert</td><td>Max 1</td></tr>
<tr><td>(b)(ii)</td><td>All silver ions are discharged. Hence, hydrogen ions are discharged to form hydrogen gas.</td><td>1</td></tr>
<tr><td></td><td>$2H^+ + 2e^- \rightarrow H_2$</td><td>1</td></tr>
<tr><td>(c)</td><td>[Describe] white ppt</td><td>1</td></tr>
<tr><td></td><td>[Explain] Magnesium chloride reacts with silver nitrate to form white ppt of/insoluble silver chloride</td><td>1</td></tr>
<tr><td></td><td>$Ag^+ + Cl^- \rightarrow AgCl$</td><td>1</td></tr>
<tr><td></td><td>Total</td><td>10</td></tr>
<tr><td>5(a)</td><td>$56/2 = 28\ dm^3$</td><td>1</td></tr>
<tr><td>(b)</td><td></td><td>3</td></tr>
</table>

Qn	Marking point	Marks
	 [1] Endo profile complete with reactant and products [1] E_a and [1] ΔH = + 45 kJ/mol	
(c)	Poly(ethene) / polyethene	1
	2 repeating units shown, reject with n	1
(d)	They have the same molecular formula of C_2H_6O	1
	But the atoms are arranged differently	1
(e)	$C_2H_6O + 3O_2 \rightarrow 2CO_2 + 3H_2O$	1
(f)	Enthalpy change = energy absorbed + (- energy released)	
	Different amount of energy is absorbed to break the different bonds in the 2 isomers,	1
	But the same amount of energy is released when the same number and types of bonds were formed in the products.	1
	Hence the net energy, enthalpy change, is different	
	Total	**11**
6(a)	Mr of one repeat unit: 77 + 2(12) + 3(1) = 104	1
	M_r: 13300 – 18700	
	Lower range: 13300 / 104 = 128 Upper range: 18700 / 104 = 179	1
	Range: 128 to 179	1
(b)	Polylactic acid is a large molecule made up of many repeating units	1
	which contains the ester linkages.	1
(c)	 [1] alcohol [1] carboxylic acid -[1] if not all bonds are shown	2
(d)	Indicator with corresponding results for the carboxyl test (accept other acid-rxns test with the corresponding results)	1
	Acidified purple $KMnO_4$ decolourised for alcohol test	1
(e)(i)	Polylactic acid comes from plants, which can be grown and replenished, without severely depleting any other natural resources. **Key idea of renewable**	1
(ii)	• Polylactic acid has a higher density (**1.21-1.43 g/cm^3**) as compared to polystyrene (**0.011-0.028 g/cm^3**), hence a cup with the same volume will **weigh more**.	1

<table>
<tr><th>Qn</th><th>Marking point</th><th>Marks</th></tr>
<tr><td></td><td>• Polylactic acid has a lower glass transition temperature (52-63 °C) as compared to polystyrene (100-128 °C), hence it cannot be used to contain hot drinks/food.

Any one</td><td></td></tr>
<tr><td></td><td>Total</td><td>11</td></tr>
<tr><td>7(a)</td><td>$F_2 + 2e^- \rightarrow 2F^-$</td><td>1</td></tr>
<tr><td>(b)</td><td>As it has a smallest atomic size compared to other halogens, thus, there is a strongest pull from the nucleus.</td><td>1</td></tr>
<tr><td></td><td>It can attract electrons most easily to form the stable F^-</td><td>1</td></tr>
<tr><td>(c)</td><td>Cu reduces Ag^+ to Ag by donating electron to Ag^+</td><td>1</td></tr>
<tr><td></td><td>Reducing the O.S of Ag from +1 to 0</td><td>1</td></tr>
<tr><td>(d)</td><td>Disagree to the statement.</td><td></td></tr>
<tr><td></td><td>Reactivity increases down group 1 and hence, reducing power should increase</td><td>1</td></tr>
<tr><td></td><td>Based on data, Li has the highest $E^{\ominus}$ compared to Rb, hence, it has the strongest reducing power (most easily donating e).</td><td>1</td></tr>
<tr><td></td><td>Agree to 2nd part of statement but disagree to first part of statement</td><td></td></tr>
<tr><td>Alternative to (d)</td><td>Reactivity increases down group 1.</td><td>1</td></tr>
<tr><td></td><td>Based on data, Li has the highest $E^{\ominus}$ compared to Rb, hence, it has the strongest reducing power (most easily donating e), Rb has the lowest reducing power (least easily donating e).</td><td>1</td></tr>
<tr><td>(e)(i)</td><td>$H_2 + 2e^- \rightleftharpoons 2H^-$ $\quad E^{\ominus} = 0.00$ V</td><td></td></tr>
<tr><td></td><td>$O_2 + 4H^+ + 4e^- \rightleftharpoons 2H_2O$ $\quad E^{\ominus} = +1.23$ V</td><td></td></tr>
<tr><td></td><td>$2H_2 + O_2 \rightarrow 2H_2O$</td><td>1</td></tr>
<tr><td>(ii)</td><td>Overall $E^{\ominus} = 0.00 + (+1.23)$</td><td>1</td></tr>
<tr><td></td><td>= +1.23 V</td><td>1</td></tr>
<tr><td></td><td>+1.23 V > 0, hence it is spontaneous</td><td>1</td></tr>
<tr><td>(f)</td><td>Advantage (any of the suggested answer or logical answer):
• No need to memorise the reactivity series
• Can be for ions or other species not only for metals</td><td>1</td></tr>
<tr><td></td><td>Total</td><td>12</td></tr>
<tr><td>8(a)</td><td>
<table>
<tr><th>carbon dioxide</th><th>copper</th><th>graphite</th></tr>
<tr><td>simple molecular structure

• with strong covalent bonds between the C and O atoms in each discrete molecule

• but with weak forces of attraction between them.</td><td>giant metallic structure

• with strong metallic bonds between the positive metal ions and the mobile sea of electrons, throughout the structure.</td><td>giant molecular structure

• with strong covalent bonds between the C atoms, on a hexagonal plane,

• but week forces of attraction between the layers of C atoms</td></tr>
</table>
[1] for each point.
</td><td>5</td></tr>
</table>

Qn	Marking point	Marks
(b)	CO_2 does not conduct electricity as it does not have any mobile electrons or ion to be the charge carrier	1
	Copper conducts electricity well as the mobile sea of electrons carry electric current.	1
	Graphite conducts well as each C atom in the hexagonal plane is only bonded to 3 other C atoms, leaving 1 electron free per C atom. These free electrons carry electric current.	1
(c)	Add **excess** acid	1
	Stir to dissolve the CuO	
	Filter to obtain the graphite powder as the residue	1
	Wash and dry the graphite powder	
	Total	**10**
9(a)	~90% CO_2	1
	<5% N_2 and other gases / No O_2	1
(b)	*Always remember to compare the extreme like most and least, before comparing the intermediate.* **Most:** Venus has ~95% CO_2 but Earth has <5% CO_2 (based on data, do not penalise if cited as 0.03% or 3%)	1
	Least: Venus has <5% N_2 but Earth has ~80% N_2	1
	Intermediate: Venus has no O_2, but Earth has ~20% O_2	1
(c)	Plants appeared on Earth first	
	Plants absorb CO_2 during photosynthesis to make food and give out O_2	1
	$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$	1
	Resulted in the drastic decrease in $\%CO_2$	
	Animals then appeared on Earth	
	Animals take in O_2 during respiration and give out CO_2	1
	$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$	1
	Name of processes (photosynthesis and respiration) are given	1
	Total	**10**