

NAME:

NO:

CLASS:

ADMIRALTY SECONDARY SCHOOL



PRELIMINARY EXAMINATION 2021

SUBJECT : Chemistry
 CODE/PAPER : 6092/1
 LEVEL/STREAM : Secondary 4 Express
 DATE : 30 August 2021
 TIME : 1120h – 1220h
 DURATION : 1 hour

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, class and register number on the Optical Answer Sheet provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

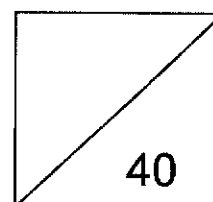
Choose the **one** you consider correct and record your choice in **soft pencil** on the Optical Answer Sheet.

Fill in the Optical Answer Sheet 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 14.

The use of an approved scientific calculator is expected, where appropriate.



DO NOT TURN OVER THIS PAPER UNTIL YOU ARE TOLD TO DO SO.

This question paper consists of **14** printed pages including this cover page.

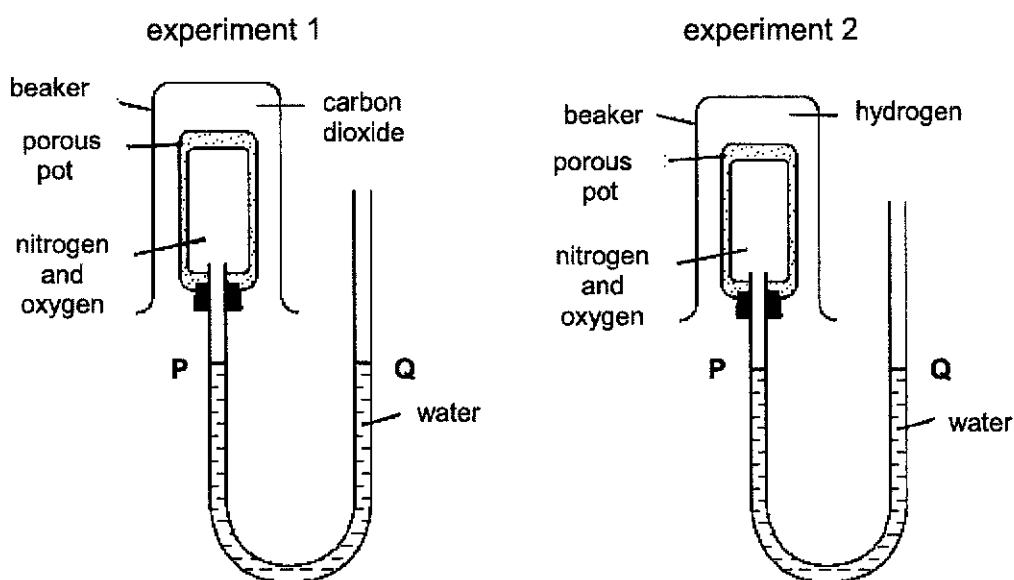
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- 1 Two experimental set-ups used to demonstrate diffusion of gases are shown in the diagrams below. Each porous pot contains a mixture of nitrogen and oxygen.



What changes, if any, to the water levels **P** and **Q**, would you expect to see in both experiments?

	experiment 1	experiment 2
A	P and Q remain the same	P and Q remain the same
B	P and Q remain the same	Q is higher than P
C	P is higher than Q	Q is higher than P
D	Q is higher than P	Q is higher than P

- 2 Which piece of apparatus could be used to determine the end-point of the reaction between hydrochloric acid and potassium hydroxide?

- A** electronic balance **B** gas syringe
C stopwatch **D** thermometer

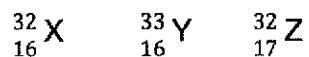
- 3 A new substance was discovered and a series of experiments were conducted on it.

Which observation suggests that the substance **cannot** be an element?

- A** It has a fixed boiling point.
B It dissolves in water to form a yellow-green solution.
C When heated strongly, a brown solid and a yellow gas are produced.
D When heated in air, it can form oxides with two different chemical formulae.

3

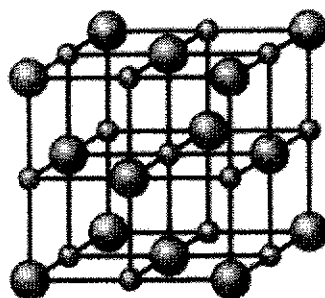
4 Three atoms are shown.



What can be deduced from the proton numbers and nucleon numbers of X, Y and Z?

- A X and Y are the same element.
 - B X and Z are the same element.
 - C Y has more protons than X.
 - D Z has more neutrons than Y.
- 5 Which element has the most number of electrons in the outermost shell of its atoms?
- A argon
 - B boron
 - C chlorine
 - D potassium
- 6 What are isotopes?
- A Atoms of different elements with the same nucleon number but different proton number.
 - B Atoms of the same element with the same nucleon number but different proton number.
 - C Atoms of the same element with the same number of protons but different numbers of neutrons.
 - D Atoms of the same element with the same number of neutrons but different numbers of protons.
- 7 Which of the following substances contains both ionic and covalent bonds?
- A aluminium carbonate
 - B graphite
 - C hydrogen chloride
 - D sodium

- 8 The diagram shows the arrangement of the ions in an ionic lattice.



Which compound would likely have this arrangement?

- A barium fluoride B lithium nitride
C magnesium hydroxide D sodium chloride
- 9 Which ionic equation represents the reaction when calcium carbonate powder is added to hydrochloric acid?

- A $\text{H}^+ (\text{aq}) + \text{OH}^- (\text{aq}) \rightarrow \text{H}_2\text{O} (\text{l})$
B $\text{Ca}^{2+} (\text{aq}) + 2\text{Cl}^- (\text{aq}) \rightarrow \text{CaCl}_2 (\text{s})$
C $2\text{H}^+ (\text{aq}) + \text{CO}_3^{2-} (\text{aq}) \rightarrow \text{CO}_2 (\text{g}) + \text{H}_2\text{O} (\text{l})$
D $\text{CaCO}_3 (\text{s}) + 2\text{H}^+ (\text{aq}) \rightarrow \text{Ca}^{2+} (\text{aq}) + \text{CO}_2 (\text{g}) + \text{H}_2\text{O} (\text{l})$

- 10 Bones contain a complex mixture of calcium salts, protein and other materials. When a bone is strongly heated in a current of air, the only residue is calcium oxide. From a sample of 100 g of bone, 42.0 g of calcium oxide were obtained.

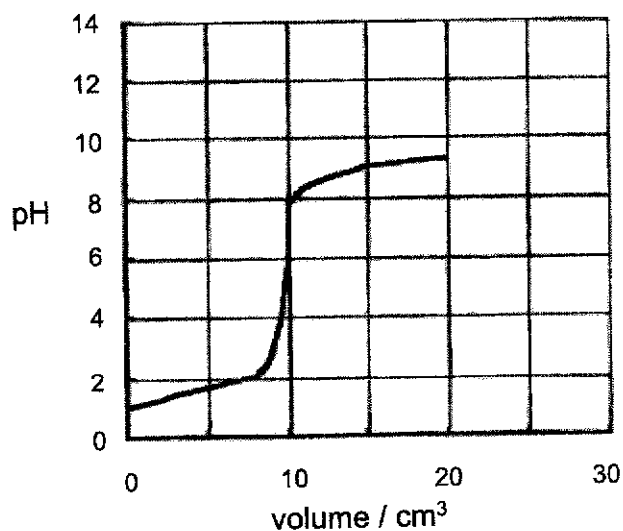
What is the percentage by mass of calcium in the bone?

- A 12.0 % B 30.0 % C 42.0 % D 71.4 %
- 11 Which of the following statements does **not** describe a property of a weak alkali?
- A It has a pH between 8 to 10.
B It forms a salt with sodium metal.
C It is only partially dissociated into ions.
D It turns universal indicator solution blue.

5

- 12 Which chemical is best used to distinguish between calcium chloride and calcium carbonate?
- A aqueous sodium hydroxide
 B dilute hydrochloric acid
 C silver nitrate solution
 D universal indicator solution
- 13 Which of the following is **not** a common use of sulfuric acid?
- A battery acid
 B making of wooden furniture
 C manufacture of detergent
 D manufacture of fertiliser
- 14 In an acid-base titration, a 0.10 mol/dm^3 alkali is added to 10 cm^3 of 0.10 mol/dm^3 dilute acid.

The graph below shows the change in pH during the titration.



Which of the following represents the titration shown in the graph?

- A ethanoic acid and aqueous sodium hydroxide
 B ethanoic acid and aqueous ammonia
 C nitric acid and aqueous sodium hydroxide
 D nitric acid and aqueous ammonia

6

15 In which equation does the metal oxide act as an acidic oxide?

- A $\text{K}_2\text{O} (\text{s}) + \text{H}_2\text{O} (\text{l}) \rightarrow 2\text{KOH} (\text{aq})$
- B $\text{Fe}_2\text{O}_3 (\text{g}) + 3\text{CO} (\text{g}) \rightarrow 2\text{Fe} (\text{s}) + 3\text{CO}_2 (\text{g})$
- C $\text{Al}_2\text{O}_3 (\text{s}) + 6\text{HCl} (\text{aq}) \rightarrow 2\text{AlCl}_3 (\text{aq}) + 3\text{H}_2\text{O} (\text{l})$
- D $\text{PbO} (\text{s}) + \text{H}_2\text{O} (\text{l}) + \text{OH}^- (\text{aq}) \rightarrow \text{Pb}(\text{OH})_3^- (\text{aq})$

16 A colourless solution contains two cations. When aqueous ammonia was added to the solution, a white precipitate was formed. When excess aqueous ammonia was added, the white precipitate dissolved to form a colourless solution.

Which of the following is **not** a possible cation in the solution?

- A Ca^{2+}
- B K^+
- C Pb^{2+}
- D Zn^{2+}

17 Zinc sulfate was prepared by reacting sulfuric acid with excess zinc oxide. What is the sequence of steps that needs to be carried out to collect the pure and dry salt after the above reaction?

- A crystallisation \rightarrow filtration
- B distillation \rightarrow crystallisation
- C filtration \rightarrow evaporate to dryness
- D filtration \rightarrow air dry

18 Nitrogen dioxide reacts with water according to the following equation



Which of the following statements correctly describes this reaction?

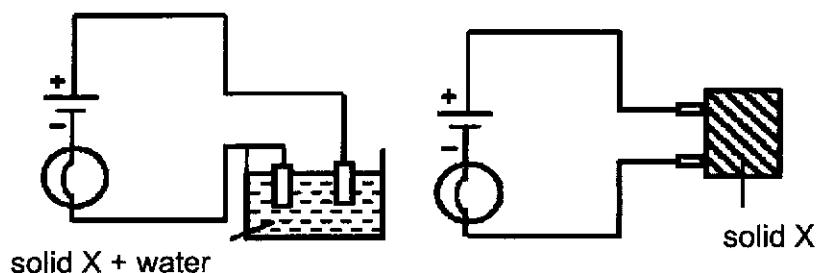
- A NO_2 is reduced to form HNO_3 .
- B The oxidation state of N in HNO_2 is +3.
- C The reaction is a decomposition reaction.
- D Water acts as a catalyst in this reaction.

7

19 Which of the following reactions that takes place in the blast furnace is an acid-base reaction?

- A $C + O_2 \rightarrow CO_2$
 B $CO_2 + C \rightarrow 2CO$
 C $CaO + SiO_2 \rightarrow CaSiO_3$
 D $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

20 Two circuits are shown below. The light bulb lights up in only one of the circuits.

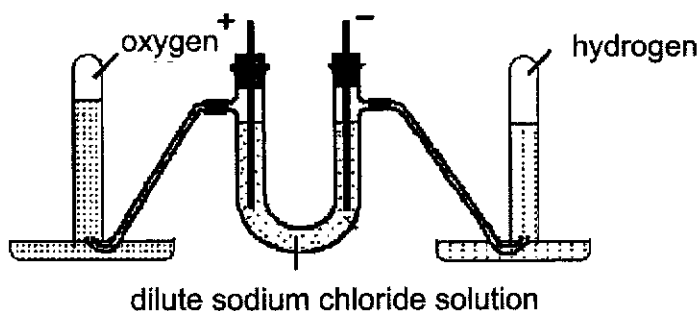


What is the identity of X?

- A barium sulfate
 B magnesium
 C potassium bromide
 D sugar
- 21 In which electrolysis experiment would there be **no** change in pH of the solution when inert electrodes are used?
- A aqueous copper (II) nitrate
 B aqueous silver sulfate
 C concentrated copper (II) chloride solution
 D concentrated potassium bromide solution
- 22 When aqueous copper (II) sulfate is electrolysed using copper electrodes, which observations are correct?

	positive electrode	negative electrode	intensity of blue colour of electrolyte
A	electrode becomes smaller	electrode becomes bigger	constant
B	electrode becomes smaller	gas given off	fades
C	gas given off	electrode becomes bigger	fades
D	gas given off	gas given off	constant

- 23 The diagram shows the electrolysis of dilute sodium chloride solution using inert electrodes.



Given that, at room temperature and pressure, x moles of electrons were passed in the circuit, which of the following statement is correct?

- A $6x \text{ dm}^3$ of oxygen was collected at the anode.
 B $6x \text{ dm}^3$ of hydrogen was collected at the cathode.
 C $12x \text{ dm}^3$ of oxygen was collected at the cathode.
 D $12x \text{ dm}^3$ of hydrogen was collected at the anode.
- 24 Which of the following properties generally decreases when going across a period of the Periodic Table from Group I to Group VII?
- A The acidity of the oxides.
 B The oxidizing ability of the elements.
 C The number of electrons in the valence shell.
 D The tendency of the elements to form positive ions.
- 25 Elements X, Y and Z are in the same period of the Periodic Table.

Solid X conducts electricity.

Oxides of Y reacts with both acid and alkali.

Oxides of Z dissolves in water to form solution with $\text{pH} < 7$.

In which order do the elements appear in the Periodic Table?

- A $X \rightarrow Y \rightarrow Z$
 B $Y \rightarrow X \rightarrow Z$
 C $Z \rightarrow X \rightarrow Y$
 D $Z \rightarrow Y \rightarrow X$

30 Which process removes carbon dioxide from the atmosphere?

- A combustion of carbon-containing fuel
- B flue gas desulfurisation
- C photosynthesis
- D respiration

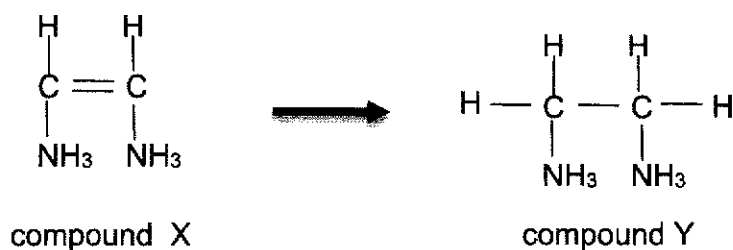
31 The table shows the boiling points of four fractions when crude oil is distilled.

fraction	W	X	Y	Z
boiling point / °C	35 – 75	80 – 145	150 – 250	greater than 250

Which statement regarding the fractions is true?

- A Fraction Y is less flammable than fraction W.
 - B Fraction Y is less viscous than fraction X.
 - C The molecular mass of fraction Z is smaller than that of fraction X.
 - D The molecules in Z have a shorter chain length than those in fraction Y.
- 32 Which statement correctly describes the members of a homologous series?
- A They have the same empirical formula.
 - B They have the same physical properties.
 - C They undergo similar chemical reactions.
 - D The relative molecular masses of consecutive members differ by 12.
- 33 Which statement about vegetable oil and the margarine made from it is correct?
- A Both occur naturally.
 - B Margarine has the higher melting point.
 - C Both are liquids at room temperature and pressure.
 - D Vegetable oil has fewer carbon-carbon double bonds than margarine.

- 34 The following compound X can be converted into the following compound Y.



Which of the following correctly shows the reagents and conditions needed for the conversion?

	reagent	conditions
A	hydrogen	200 °C, nickel catalyst
B	concentrated sulfuric acid	heat
C	steam	300 °C, 60 atm, phosphoric acid
D	monomer	450 °C, iron catalyst

- 35 Which of the following could **not** be produced when methane reacts with fluorine in the presence of ultraviolet light?

- A fluoromethane B hydrogen
C hydrogen fluoride D tetrafluoromethane

- 36 When tetradecane, C₁₄H₃₀, is cracked, only three hydrocarbons are formed. The hydrocarbons are ethene, propane and propene.

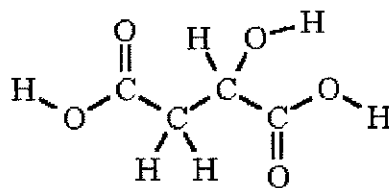
What is the ratio of the hydrocarbons formed?

	ethene	propane	propene
A	1	1	1
B	1	2	2
C	1	3	1
D	4	1	1

- 37 Terylene and nylon are man-made fibres. Which of the following is **not** a typical use of such fibres?

- A clothing
B fishing line
C food product
D parachute

- 38 Apples contain malic acid. The diagram below shows the structural formula of malic acid.

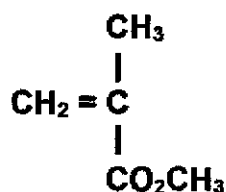


Which of the following salt(s) could be formed upon reacting malic acid with sodium hydroxide?

- I $C_4H_5O_5Na$
- II $C_4H_4O_5Na_2$
- III $C_4H_3O_5Na_3$

- | | | | |
|----------|-----------------|----------|---------------|
| A | II only | B | I and II only |
| C | II and III only | D | I, II and III |

- 39 Bone cement, used in artificial hip and knee replacements, is formed by the polymerisation of methyl methacrylate and the process is highly exothermic.



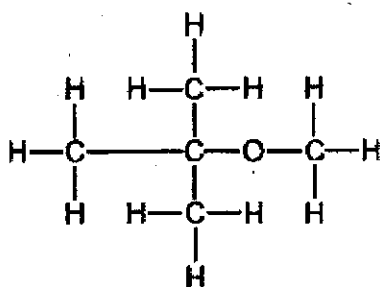
methyl methacrylate

Which statement about bone cement is true?

- A** The empirical formula of bone cement is $C_5H_8O_2$.
- B** Aqueous bromine is decolourised by bone cement.
- C** Water is formed in the polymerisation of methyl methacrylate.
- D** Less energy is released in the formation of C-C bond than the energy absorbed in the breaking of C=C bond.

13

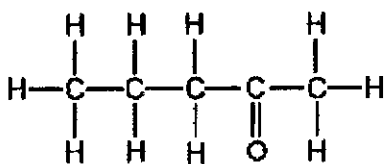
40 The structural formula of compound Z is shown.



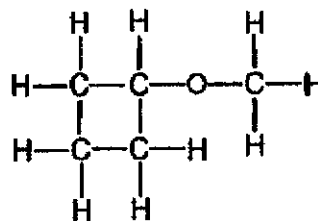
compound Z

Which of the following compound is an isomer of compound Z?

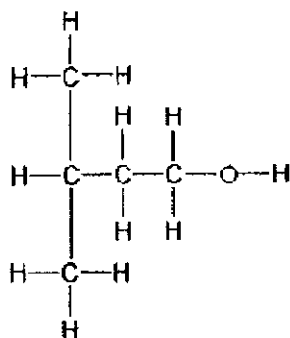
A



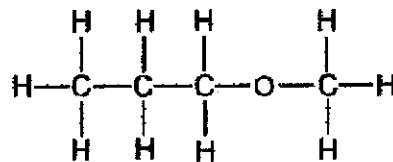
B



C



D



END OF PAPER

The Periodic Table of Elements

Group																																																																										
I	II	III										IV	V	VI	VII	0																																																										
3 Li lithium 7	4 Be beryllium 9	11 Na sodium 23	12 Mg magnesium 24	19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84	37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131	55 Cs caesium 133	56 Ba barium 137	57-71 lanthanoids	58 La lanthanum 139	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium -	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175	87 Fr francium -	88 Ra radium -	89-103 actinoids	89 Ac actinium -	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium -	94 Pu plutonium -	95 Am americium -	96 Cm curium -	97 Bk berkelium -	98 Cf californium -	99 Es einsteinium -	100 Fm fermium -	101 Md mendelevium -	102 No nobelium -	103 Lr lawrencium -

Key
proton (atomic) number
atomic symbol
name
relative atomic mass

1
H
hydrogen
1

lanthanoids

actinoids

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

NAME:

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ADMIRALTY SECONDARY SCHOOL**PRELIMINARY EXAMINATION 2021**

SUBJECT : Chemistry
 CODE/PAPER : 6092/2
 LEVEL/STREAM : Secondary 4 Express
 DATE : 25 August 2021
 TIME : 0800h – 0945h
 DURATION : 1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams, graphs, tables or rough working.

Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

You may lose marks if you do not show your working or if you do not use appropriate units.

Section A

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

Section B

Answer all **three** questions. The last question is in the form of either/or.

Write your answers in the spaces provided on the question paper.

A copy of the Periodic Table is printed on page 21.

The number of marks is given in brackets [] at the end of each question or part question.

For Examiner's Use	
Section A	/ 50
Section B	/ 30
Total	/ 80

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This question paper consists of **21** printed pages including this cover page.

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Section A

Answer all questions.

- 1 The table shows some information about substances A to E.

substance	melting point / °C	boiling point / °C	Does it conduct electricity when it is a solid?	Does it conduct electricity when molten?
A	-71	-62	no	no
B	-8	58	no	no
C	1240	2100	yes	yes
D	1473	1700	no	yes
E	1649	2231	no	no

- (a) Which substance is most likely to be tungsten(VI) oxide?

..... [1]

- (b) Which substance is most likely to be argon?

..... [1]

- (c) Which substance is most likely to be used as a cutting tool?

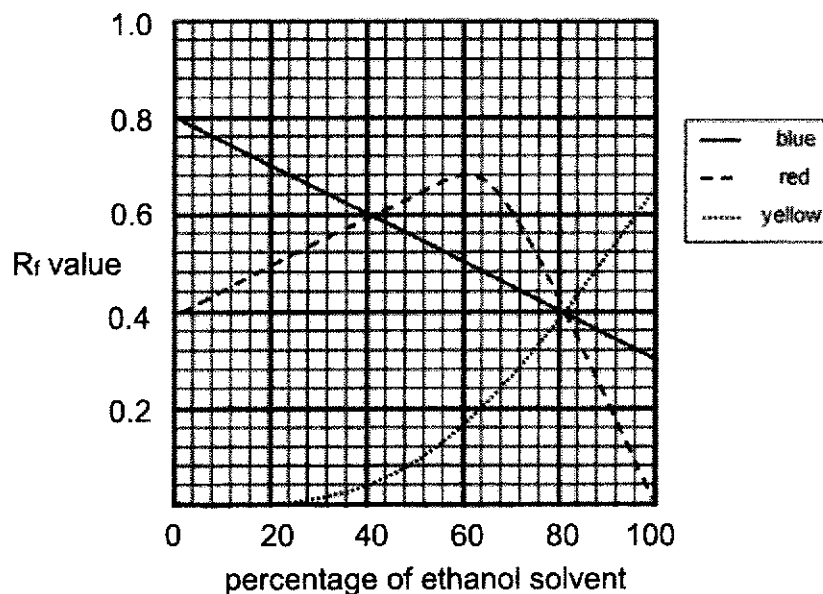
..... [1]

- (d) Draw the heating curve of substance B when the temperature increased from -20 °C to 50 °C.

[2]

3

- 2 A sample of ink contains a mixture of red, blue and yellow dyes. To separate the dyes in the ink, the solvent used is a mixture of water and ethanol. The R_f values of the coloured dyes in solvents with different percentage of ethanol present are shown.



- (a) What is the R_f value of the blue dye when a solvent mixture containing 90 cm³ ethanol and 60 cm³ water is used in the chromatography?

R_f value of the blue dye: [1]

- (b) A mixture of water and ethanol was used to separate a sample of this ink. Only one spot was formed on the chromatogram. Using evidence from the graph, explain why it **cannot** be concluded that the ink sample is a pure substance.

.....

..... [2]

- (c) Suggest a suitable method to separate the water and ethanol solvent mixture.

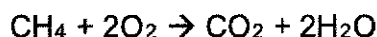
..... [1]

4

- 3 The world is trying to reduce the reliance of fossil fuel by exploring alternative fuels. The table below gives some information about the different fuels explored.

fuel	physical state at room temperature and pressure	enthalpy change of combustion / kJ / mol	products of complete combustion
hydrogen	gas	- 256	H ₂ O only
methanol	liquid	- 715	CO ₂ and H ₂ O
methane	gas	- 890	CO ₂ and H ₂ O

- (a) The complete combustion of methane is represented by the following equation.



- (i) Calculate the mass of methane that needs to be combusted to produce 3115 kJ of heat.

[1]

- (ii) Using ideas about breaking and forming bonds, explain why the enthalpy change for the complete combustion of methane has a negative sign.

.....

 [2]

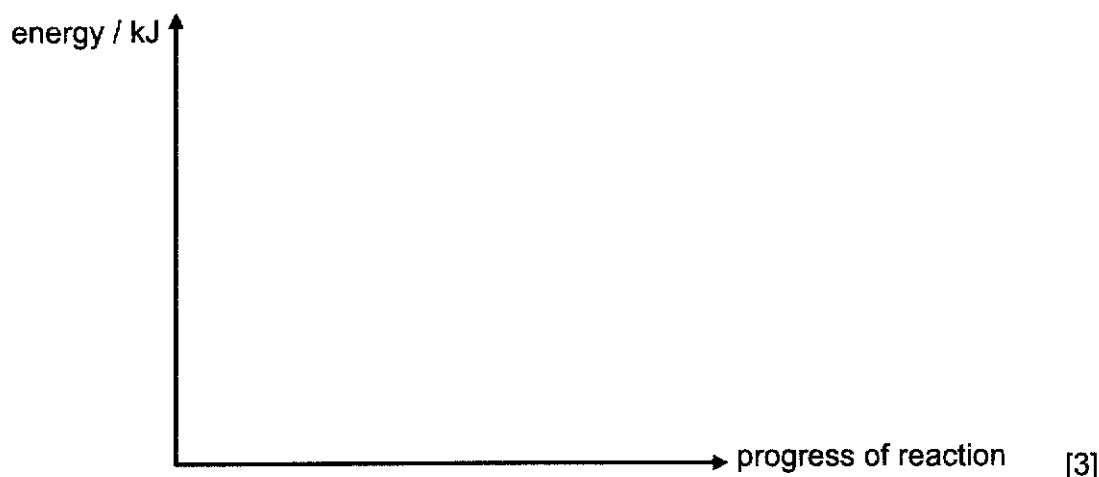
- (b) Using only information from the table, state one advantage and one disadvantage of using methanol as a fuel compared to hydrogen apart from the amount of heat given out.

advantage:

 disadvantage:
 [2]

5

- (c) Draw an energy profile diagram for the complete combustion of hydrogen. Indicate the enthalpy change, ΔH and activation energy, E_a on the diagram clearly.



- 4 Duralumin is a mixture of aluminium with copper. It is used mainly in machine parts due to its high strength and hardness compared to aluminium. However, duralumin is more susceptible to corrosion than aluminium.

- (a) State the name given to mixtures such as duralumin.

..... [1]

- (b) Explain why duralumin is harder than aluminium.

.....
 [2]

- (c) Explain why duralumin corrodes more easily than aluminium.

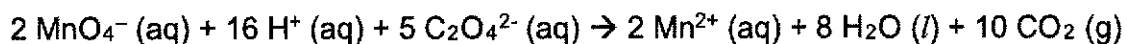
.....
 [2]

- (d) Recycling of metals has been encouraged as a way to produce useful metals instead of extracting them from their ores. Explain why.

.....
 [1]

6

- 5 Acidified potassium manganate(VII) reacts with excess sodium ethanedioate. The ionic equation of the reaction is shown below.



- (a) Describe two observations in this experiment.

.....

..... [2]

- (b) State and explain, in terms of oxidation state, which chemical species is the reducing agent.

.....

.....

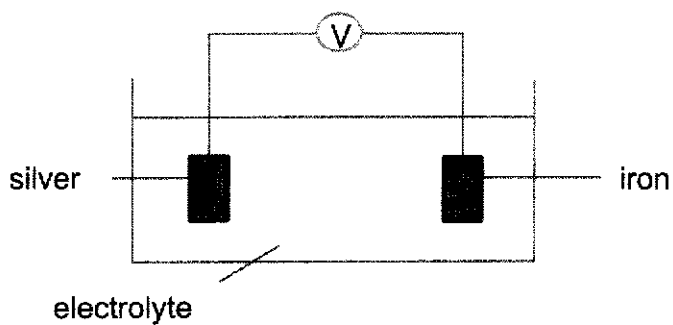
..... [2]

- (c) Calculate the volume of CO_2 produced at r.t.p given that 25.0 cm^3 of 0.5 mol/dm^3 of potassium manganate(VII) was used.

[3]

7

- 6 The diagram shows a simple cell set-up.



Complete the table by filling in the missing information.

electrolyte used	electrodes used	product formed at positive electrode	product formed at negative electrode
aqueous sodium nitrate	silver and iron		
	silver and iron	silver	

[3]

- 7 A colorimeter measures the intensity of light that is absorbed by a coloured solution. The darker the colour of the solution, the more light is absorbed and the higher the reading on the colorimeter.

In experiment 1, fluorine gas was bubbled into aqueous potassium bromide for 6 minutes. The reaction mixture was measured with a colorimeter over time.

- (a) Describe and explain how the colorimeter reading changes as the reaction takes place.

.....

.....

.....

.....

.....

.....

[3]

8

(b) In experiment 2, aqueous potassium bromide was replaced with aqueous potassium chloride of the same concentration.

- (i) Draw a 'dot-and-cross' diagram to show the bonding in potassium chloride. Show only the valence electrons.

[2]

- (ii) State one similarity and one difference in the experimental result between experiments 1 and 2.

Similarity:

.....

Difference:

.....

[2]

9

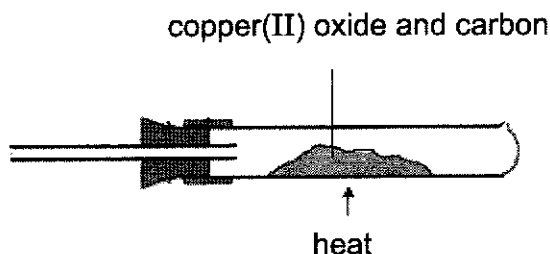
- 8 Hydrated copper(II) sulfate has the chemical formula, $\text{CuSO}_4 \cdot x\text{H}_2\text{O}$ where x can range from 0 to 5. The pentahydrate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) is the most commonly encountered salt.

A sample of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ was heated over time to slowly remove the water of crystallisation. After some time it was noted that the mass of the sample decreased by 15% and $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ was converted to compound P.

- (a) Suggest the chemical formula for compound P.
Show your working clearly. [$M_r \text{CuSO}_4 \cdot 5\text{H}_2\text{O} = 250$]

chemical formula of compound P: [2]

- (b) On further heating of the sample till 950°C , it decomposed to form copper(II) oxide. Copper(II) oxide is then further heated with carbon in a glass tube to produce a gas and molten copper.



- (i) Write an equation for the reaction between copper(II) oxide and carbon.

..... [1]

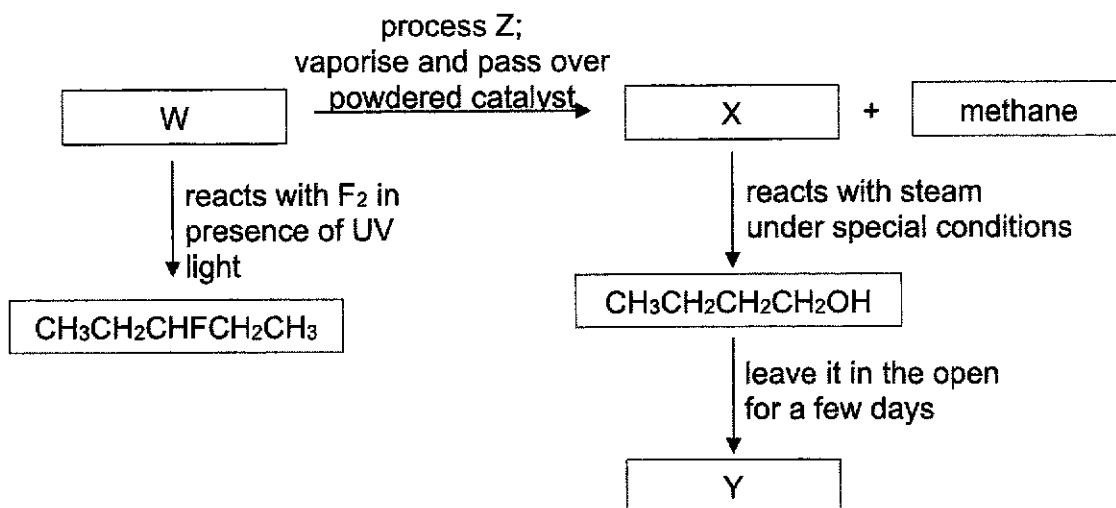
- (ii) Molten copper(II) oxide and copper conduct electricity differently. Describe how they conduct electricity differently.

..... [1]

- (iii) The conduction of electricity can have different effects on copper and on molten copper(II) oxide. Describe the difference.

..... [1]

- 9 The reaction of organic compound W is shown below.



- (a) (i) Name the process Z.

..... [1]

- (ii) Identify compound W.

..... [1]

- (iii) Describe a chemical test to differentiate compound W from X.

.....
.....

..... [2]

- (b) Suggest a way to determine if the reaction of CH₃CH₂CH₂CH₂OH has been completely converted to Y.

.....

..... [1]

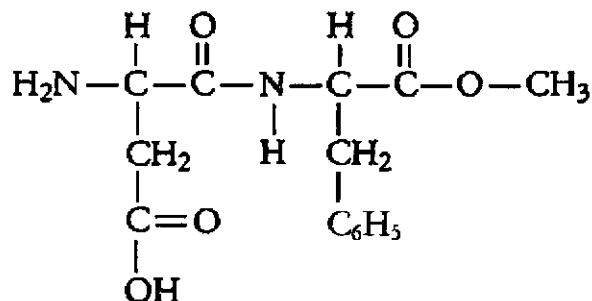
11

Section B

Answer all three questions in this section.

The last question is in the form **either/or** and only one of the alternative should be attempted.

- 10 The structural formula of the artificial sweetener, aspartame, is shown below.



- (a) Name two functional groups present in aspartame.

..... [1]

- (b) Aspartame is hydrolysed in the stomach to produce methanol as well as the amino acids aspartic acid and phenylalanine.

Hydrolysis involves the reaction of an organic compound with water to form two or more new products through breakage of bonds in the organic compound.

Two of the products of hydrolysis of aspartame are shown below:

$\text{H}-\text{O}-\text{CH}_3$	$ \begin{array}{ccccccc} & \text{H} & \text{O} & & & & \\ & & & & & & \\ \text{H} & - \text{N} & - \text{C} & - \text{C} & - \text{OH} \\ & & & & & & \\ & \text{H} & \text{CH}_2 & & & & \\ & & & & & & \\ & & \text{C}_6\text{H}_5 & & & & \end{array} $
methanol	phenylalanine

- (i) Draw the structural formula of aspartic acid.

[1]

- (ii) The full structural formulae of ethanol and propanol are shown below:

name of compound	full structural formula
ethanol	$ \begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array} $
propanol	$ \begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{O}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array} $

Explain why methanol, ethanol and propanol belong to the same homologous series.

.....

 [2]

- (c) When warmed in the presence of concentrated sulfuric acid, methanol reacts with propanoic acid to form water and ester P.

- (i) Name ester P.

..... [1]

- (ii) Esters are commercially used in perfumes for its aromatic property.

State one other commercial use of ester.

..... [1]

- (d) A macromolecule can be formed from phenylalanine undergoing condensation polymerisation as a single monomer.

- (i) Define the term 'macromolecule'.

.....
 [1]

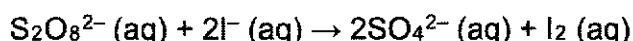
13

- (ii) Draw the structural formula of the polymer formed from the monomer phenylalanine, showing two repeating units.

[1]

11 Reaction Rates

The reaction between colourless peroxodisulfate(VI) ions and iodide ions is represented by the following ionic equation.



The same volume of aqueous $\text{S}_2\text{O}_8^{2-}$ and aqueous I^- are used for each experiment.

The table below shows the results of each experiment when different concentrations of each reactant are used.

experiment	initial concentration / mol/dm ³		initial rate of reaction / mol/dm ³ s
	$\text{S}_2\text{O}_8^{2-}$	I^-	
1	0.008	0.020	1.22×10^{-3}
2	0.016	0.020	2.44×10^{-3}
3	0.032	0.020	4.88×10^{-3}
4	0.008	0.040	2.44×10^{-3}
5	0.008	0.080	4.88×10^{-3}

Order of Reactions

The order of a reaction refers to the power dependence of the rate of reaction on the concentration of each reactant. It is a numerical value.

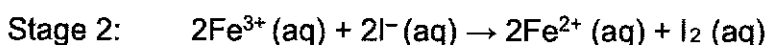
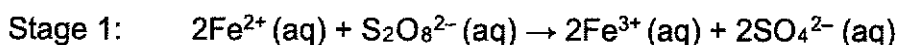
In a zero-order reaction, the concentration of the reactants has no effect on the initial rate of reaction.

In a first-order reaction, the initial reaction rate is directly proportional to the concentration of one of the reactants.

In a second-order reaction, the initial rate of reaction quadruples when the concentration of one of the reactants is doubled.

Increasing the rate of reaction

If a small amount of Fe^{2+} ions is added to the reaction mixture, the rate of reaction will increase. Fe^{2+} will react with the peroxodisulfate(VI) ions, forming Fe^{3+} ions, which will then react with the iodide ions in the following two stages:



15

- (a) (i) Suggest a method to measure the rate of reaction between peroxodisulfate(VI) ions and iodide ions.

..... [1]

- (ii) Two students made comments about the reaction.

Student 1: The reaction is first order with respect to $S_2O_8^{2-}$.

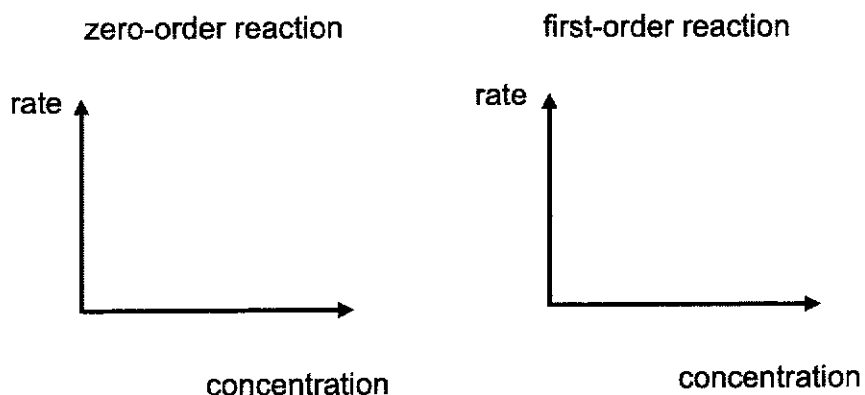
Student 2: The reaction is second order with respect to I^- .

Which student is correct? Show by calculation using information from the table to support your answer.

.....

 [3]

- (iii) Sketch the graphs of rate against concentration of reactant for a zero-order reaction and a first-order reaction.



[2]

16

(iv) Another two similar experiments were carried out.

experiment	concentration of $S_2O_8^{2-}$ / mol/dm^3	concentration of I^- / mol/dm^3	initial rate of reaction / mol/dm^3s
6	0.016	0.040	
7		0.080	9.76×10^{-3}

Predict the initial rate of reaction in experiment 6 and the concentration of $S_2O_8^{2-}$ in experiment 7.

initial rate for experiment 6:

concentration of $S_2O_8^{2-}$ in experiment 7: [2]

(b) (i) Explain the role of Fe^{2+} ions when added into the reaction mixture.

.....

..... [2]

(ii) Suggest a way to remove Fe^{2+} ions from aqueous iodine after Stage 2.

.....

.....

..... [2]

EITHER

- 12 Nickel is a transition element. It is manufactured in a four-stage process from nickel(II) sulfide, NiS.

Stage 1 – nickel(II) sulfide is heated in air to form nickel(II) oxide and sulfur dioxide

Stage 2 – nickel(II) oxide is heated with carbon to give impure nickel

Stage 3 – impure nickel is reacted with carbon monoxide to make nickel tetracarbonyl, Ni(CO)₄

Stage 4 – nickel tetracarbonyl is decomposed to give pure nickel

- (a) (i) Construct the balanced equation for the reaction in stage 1.

..... [1]

- (ii) Calculate the mass of sulfur dioxide that is formed when 182 kg of nickel(II) sulfide is heated in air.

[2]

- (b) Explain why this 4-stage process **cannot** be used to manufacture magnesium.

.....

.....

..... [2]

18

- (c) Nickel tetracarbonyl is a liquid with a boiling point of 43 °C.

Suggest, with a reason, the type of structure and bonding in nickel tetracarbonyl.

.....

.....

..... [2]

- (d) In an experiment, small amounts of three metals were added to three aqueous metal nitrate solutions. The results are shown in the table.

	aqueous zinc nitrate	aqueous nickel(II) nitrate	aqueous copper(II) nitrate
zinc	no reaction	green solution turn colourless and zinc coated with a grey solid	blue solution turn colourless and zinc coated with a pink solid
nickel		no reaction	
copper	no reaction	no reaction	no reaction

Predict the observations when nickel is added to

- (i) zinc nitrate solution

..... [1]

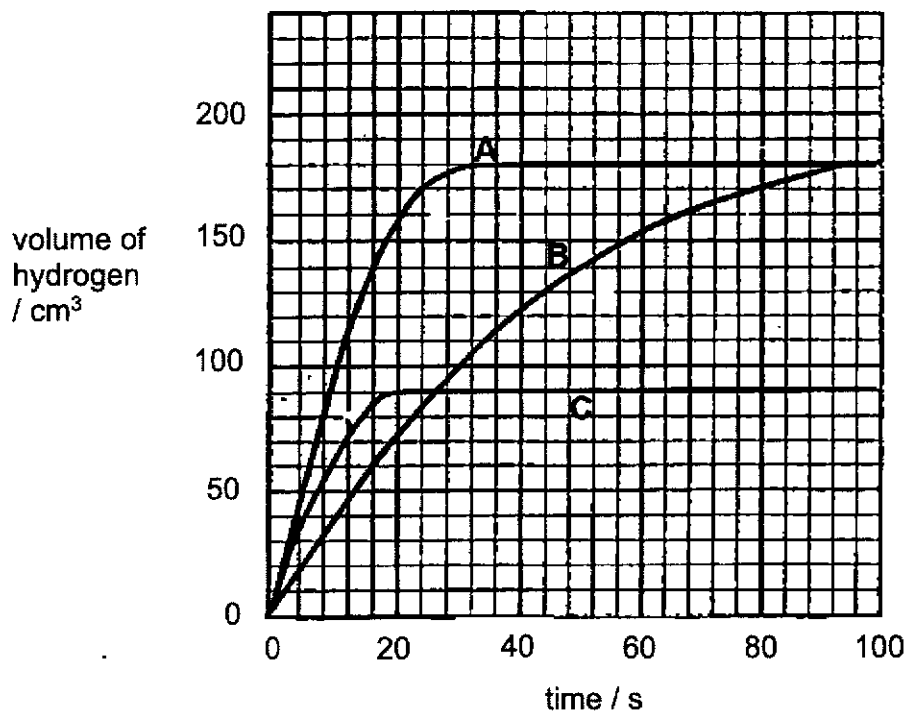
- (ii) copper(II) nitrate solution

.....

..... [2]

OR

- 12 In experiment 1, 0.488 g of zinc was reacted with two acids, hydrochloric acid and sulfuric acid separately. The volume and concentration of the acids used were both 20.0 cm^3 and 2.00 mol/dm^3 . The curves A and B shown in the graph below show the results of the reactions.



In experiment 2, a similar reaction with an unknown mass of zinc and 20.0 cm^3 of a 2.00 mol/dm^3 acid was conducted. Curve C shows the result of the reaction.

- (a) Explain, with relevant calculations, why the same volume of gas was produced for both curves A and B.

.....

.....

..... [3]

- (b) Between curves A and B, identify the curve for the reaction that used sulfuric acid. Explain your choice.

.....

 [2]

- (c) Given that either sulfuric acid or hydrochloric acid was used to obtain curve C,

- (i) identify the acid used and state your reasoning.

..... [1]

- (ii) calculate the mass of zinc used.

[1]

- (d) Experiment 2 was repeated using the same mass of zinc and the same volume and concentration of the acid, but this time, a small amount of copper(II) sulfate crystals were added to the reaction mixture.

Effervescence was observed and a brown deposit was formed. The volume of hydrogen collected was slightly less than in experiment 2.

With the aid of an equation, explain why less hydrogen was collected.

.....

 [3]

The Periodic Table of Elements

		Group																																																																																																																																								
I	II	III	IV	V	VI	VII						0																																																																																																																														
3 Li lithium 7	4 Be beryllium 9	11 Na sodium 23	12 Mg magnesium 24	13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40	19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84	37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium 101	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131	55 Cs caesium 133	56 Ba barium 137	57-71 lanthanoids	58 Fr francium 137	87 Fr francium 137	88 Ra radium 137	89-103 actinoids	86 Rn radon 131	85 At astatine 127	84 Po polonium 127	83 Bi bismuth 209	82 Pb lead 207	81 Tl thallium 204	80 Hg mercury 201	79 Au gold 197	78 Pt platinum 195	77 Ir iridium 192	76 Os osmium 190	75 Re rhenium 186	74 W tungsten 184	73 Ta tantalum 181	72 Hf hafnium 178	71 La lanthanum 139	70 Lu lutetium 175	69 Tm thulium 169	68 Er erbium 167	67 Ho holmium 165	66 Dy dysprosium 163	65 Tb terbium 159	64 Gd gadolinium 157	63 Eu europium 152	62 Sm samarium 150	61 Pm promethium 147	60 Nd neodymium 144	59 Pr praseodymium 141	58 Ce cerium 140	57 La lanthanum 139	56 Lu lutetium 175	55 Xe xenon 131	54 I iodine 127	53 Te tellurium 128	52 Sb antimony 122	51 Sn tin 119	50 In indium 115	49 Cd cadmium 112	48 Ag silver 108	47 Pd palladium 106	46 Rh rhodium 103	45 Ru ruthenium 101	44 Tc technetium 101	43 Mo molybdenum 96	42 Nb niobium 93	41 Zr zirconium 91	40 Y yttrium 89	39 Sr strontium 88	38 Rb rubidium 85	37 K potassium 39	36 Kr krypton 84	35 Br bromine 80	34 Se selenium 79	33 As arsenic 75	32 Ge germanium 73	31 Ga gallium 70	30 Zn zinc 65	29 Cu copper 64	28 Ni nickel 59	27 Co cobalt 59	26 Fe iron 56	25 Mn manganese 55	24 Cr chromium 52	23 V vanadium 51	22 Ti titanium 48	21 Sc scandium 45	20 Ca calcium 40	19 K potassium 39	18 Ar argon 40	17 Cl chlorine 35.5	16 S sulfur 32	15 P phosphorus 31	14 Si silicon 28	13 Al aluminium 27	12 Mg magnesium 24	11 Na sodium 23	10 Ne neon 20	9 F fluorine 19	8 O oxygen 16	7 N nitrogen 14	6 C carbon 12	5 B boron 11	4 He helium 4	3 Li lithium 7	2 He helium 4	1 H hydrogen 1

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium 147	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium 232	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium 237	94 Pu plutonium 244	95 Am americium 243	96 Cm curium 247	97 Bk berkelium 247	98 Cf californium 251	99 Es einsteinium 252	100 Fm fermium 257	101 Md mendelevium 258	102 No nobelium 259	103 Lr lawrencium 260

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

END OF PAPER

Admiralty Secondary School
 Marking Scheme
 4E Pure Chemistry (Paper 1 and 2)
 PRELIMINARY EXAMINATION 2021

PAPER 1 [40 marks]

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

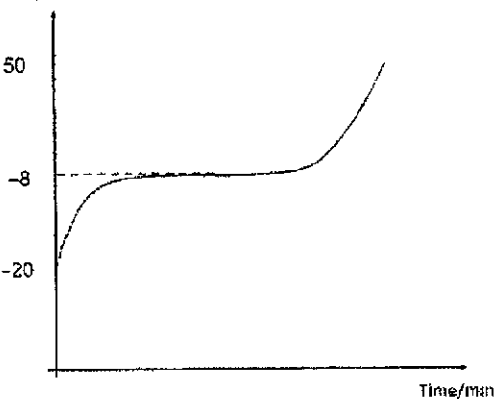
11	12	13	14	15	16	17	18	19	20
B	B	B	D	D	C	C	B	C	C

21	22	23	24	25	26	27	28	29	30
C	A	A	D	A	C	B	C	B	C

31	32	33	34	35	36	37	38	39	40
A	C	B	A	B	D	C	B	A	C

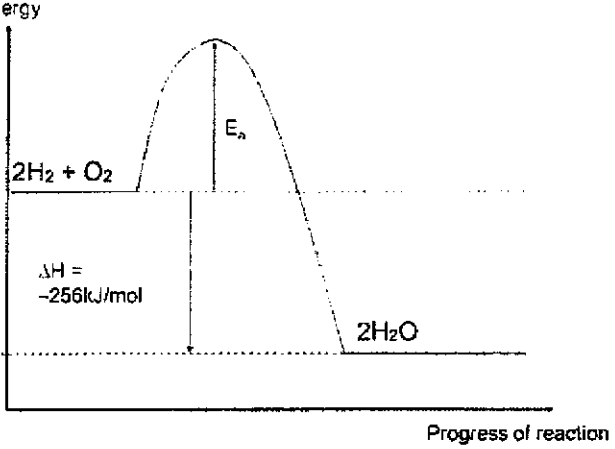
PAPER 2 SECTION A [50 marks]

Qn.	Description	Mark	Remarks
1a	D	1	
b	A	1	
c	E	1	

d	 <p>1m: correct shape 1m: correct labelling of axes and values</p>	2	
---	---	---	--

Qn.	Description	Mark	Remarks
2a	0.50	1	
b	<p>The sample could be a mixture of three dyes if the solvent used is 80% ethanol.</p> <p>This is because only one spot will be observed as all three dyes have the same R_f value of 0.4</p>	1 1	
c	Fractional distillation		A: simple distillation

Qn.	Description	Mark	Remarks
3ai	<p>No of moles of methane = $3115/890$ = 3.5 mol</p> <p>Mass of methane = 3.5×16 = 56g</p>	1	
aii	The energy taken in to break 4 mol C-H bond and 2 mol O=O bond is less than the energy give out in the bond formation of 2 mol C=O bond and 4 mol O-H bond. Hence the reaction is exothermic and has a negative sign for enthalpy change.	2	<p>1m: compare energy taken in and given out</p> <p>1m: relate energy taken in to that of bond breaking of the reactants and energy given out as bond forming of products</p>

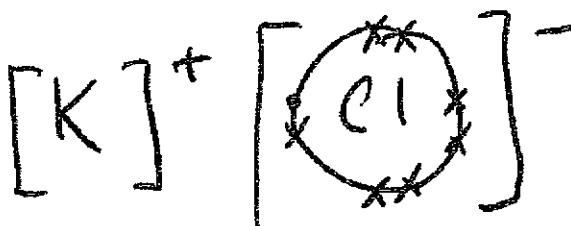
b	<p>Advantage: Methanol is a liquid while hydrogen is a gas at rtp. <u>Easier to transport methanol</u> as transporting hydrogen would require use of pressurised tanks</p> <p>Disadvantage: Burning methanol releases carbon dioxide which is a greenhouse gas. While burning hydrogen produces only water which is non-pollutive</p>	1	
c	 <p>[1 mark for correct shape of graph, 1 mark for correct labelling of reactant and product, 1 mark for correct labelling of enthalpy change and activation energy]</p>	3	

Qn.	Description	Mark	Remarks
4a	Alloy	1	
b	<p>Aluminium consists of aluminiums atoms arranged in orderly layers. These layers can slide easily when a force is applied.</p> <p>While duralumin contains atoms of different sizes that disrupt the orderly arrangement of the atoms. Hence the atoms cannot slide over each other easily when a force is applied. Hence it is harder.</p> <p>1m: describe correctly the arrangement of atoms in aluminium and duralumin.</p> <p>1m: describe correctly the ease of atoms sliding over each other when a force is applied.</p>	2	

c	Aluminium is more reactive than copper.	1	
	Hence it acts as a sacrificial metal protection for copper and corrode much easily.	1	
d	To conserve metal as it is a finite resource	1	A: any other plausible reason
	or To reduce pollution as extraction of metal might produce harmful waste products		

Qn.	Description	Mark	Remarks
5a	1. Purple solution turned colourless.	1	
	2. Effervescence observed.	1	
b	$C_2O_4^{2-}$ is the reducing agent.	1	
	$C_2O_4^{2-}$ is oxidised to form CO_2 . <u>The oxidation state of C increases from +3 in $C_2O_4^{2-}$ to +4 in CO_2.</u>	1	
c	No. of moles of $KMnO_4$ used = $25/1000 \times 0.5$ = 0.0125 mol	1	
	No. of moles of CO_2 produced = $0.0125 \times (10/2)$ = 0.0625 mol	1	
	Volume of CO_2 produced = 0.0625×24 = 1.50 dm^3	1	

Qn.	Description				Mark	Remarks
6	electrolyte used	electrodes used	product formed at positive electrode	product formed at negative electrode	3	
	aqueous sodium nitrate	silver and iron	hydrogen	iron ions		
	any silver salt solution	silver and iron	silver	iron ions		
	1m. electrolyte 1m. product at positive electrode 1m. product at negative electrode					

Qn.	Description	Mark	Remarks
7a	<u>Reading increase over time</u> as more bromine is formed.	1	
	Fluorine is more reactive than bromine, hence fluorine displaces bromine from potassium bromide solution to form bromine and potassium fluoride solution.	1	
	<u>Solution turns from colourless to reddish brown over time</u> causing the reading to increase	1	
bi	 <p>1m: cation 1m: anion</p>	2	
bii	Similarity: reading increases over time	1	
	Difference: reading is higher in experiment 1 than in experiment 2	1	

Qn.	Description	Mark	Remarks
8a	From graph, % mass loss = 15% Mass loss = $250 \times 15\%$ = <u>37.5</u> ≈ mass of 2 mol of water molecules Chemical formula of P : <u>CuSO₄.3H₂O</u>	1 1	
bi	$2\text{CuO} + \text{C} \rightarrow 2\text{Cu} + \text{CO}_2$	1	
bii	Molten R conducts electricity with free mobile ions while molten S conducts electricity with <u>mobile/ delocalised electrons</u> .	1	
biii	S will <u>remain unchanged</u> while R will be <u>electrolysed/ decomposed</u> .	1	

Qn.	Description	Mark	Remarks
9ai	Cracking	1	
aii	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$		
aiii	Add <u>aqueous bromine</u> to both W and X. If reddish brown aqueous bromine turns from <u>brown to colourless rapidly</u> , sample is X, If aqueous bromine <u>remains reddish brown</u> , sample is W.	1 1	
b	By adding acidified potassium manganate (VII) to mixture. If it remains purple, it means all have been converted. Or By checking whether the substance boils at the fixed boiling point of butanoic acid.	1	

PAPER 2 SECTION B [30 marks]

Qn.	Description	Mark	Remarks
10a	<ul style="list-style-type: none"> • Carboxylic acid • Amide • Ester • Amine <p>Any two of the above.</p>	1	
bi	$\begin{array}{c} \text{O} \quad \quad \text{NH} \\ \parallel \quad \quad \\ \text{OH}-\text{C}-\text{CH}_2-\text{C}-\text{COOH} \\ \quad \quad \quad \\ \quad \quad \quad \text{H} \end{array}$	1	
bii	<ul style="list-style-type: none"> • They have the same general formula, $\text{C}_n\text{H}_{2n+1}\text{OH}$. • They contain the same $-\text{O}-\text{H}$ functional group • Each successive member of the series differ by a $-\text{CH}_2$ unit. <p>Any two of the above.</p>	2	
ci	Methyl propanoate	1	
cii	<ul style="list-style-type: none"> • Used in flavourings • Used as solvents <p>Any one above</p>	1	
di	Macromolecules are large molecules built up from small units/molecules	1	
dii		1	

Qn.	Description	Mark	Remarks
11ai	<p>1. Measure the change in colour of the solution due to the formation of I₂ over time</p> <p>or</p> <p>2. Measure the change in electrical conductivity of solution over time</p>	1	
aii	<p>Student 1 is correct.</p> <p>Comparing experiment 1 & 2, when the concentration of S₂O₈²⁻ is doubled, the initial rate of reaction also doubles.</p> $\frac{2.44 \times 10^{-3}}{1.22 \times 10^{-3}} = 2$ <p>Comparing experiment 4 & 5 / 1 & 4, when the concentration of I⁻ is doubled, the initial rate of reaction is doubled</p> $\frac{4.88 \times 10^{-3}}{2.44 \times 10^{-3}} = 2$	<p>1</p> <p>1</p> <p>1 (for both calculations)</p>	
aiii	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>Zero order</p> </div> <div style="text-align: center;"> <p>First order</p> </div> </div>	2 (1m for each correct graph)	
aiv	<p>Initial rate of reaction : $4.88 \times 10^{-3} \text{ mol/dm}^3\text{s}$</p> <p>Concentration of S₂O₈²⁻ : 0.016 mol/dm^3</p>	<p>1</p> <p>1</p>	
bi	<p>Fe²⁺ acts as a catalyst.</p> <p>It speeds up the rate of reaction (by providing an alternative pathway with lower activation energy) and remain chemically unchanged at the end of the reaction.</p>	<p>1</p> <p>1</p>	

bii	1. Add sodium hydroxide/potassium hydroxide to precipitate out the insoluble iron (II) hydroxide	1	
	2. filter to remove the iron (II) hydroxide precipitate.	1	

EITHER

Qn.	Description	Mark	Remarks
12ai	$2\text{NiS} + 3\text{O}_2 \rightarrow 2\text{NiO} + 2\text{SO}_2$	1	
ai	no. of moles of NiS = $\frac{182000}{59+32} = 2000$ mol	1	
	$2000 \times (32 + 16 \times 2) = 128$ kg	1	
b	magnesium is more reactive than carbon ;	1	
	thus manufacture by <u>electrolysis</u> (of its ore) instead of reduction by carbon;	1	
ci	simple covalent molecule/ simple molecular structure with	1	
	It has a low boiling point which is probably due to the need for little amount of energy to overcome the weak intermolecular forces of attraction between the molecules.	1	
cii	no visible change	1	
d	blue solution turned green	1	
	nickel coated with pink solid	1	

OR

Qn.	Description	Mark	Remarks
12a	$\text{Zn} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2$ $\text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$	1	
	No. of moles of zinc used = $0.488/65$ = 0.00751 mol		

	<p>No. of moles of acid used $= 2.0 \times 20.0/1000$ $= 0.04 \text{ mol}$</p> <p><u>Zinc is the limiting reagent</u> in both reactions and will produce the same volume (180 cm^3) of hydrogen</p>	1 1	
b	<p>A is the reaction with sulfuric acid</p> <p>Curve A has a steeper gradient than curve B which means experiment A has a faster rate of reaction.</p> <p>Given the acid concentration is the same, since sulfuric acid is dibasic while hydrochloric acid is monobasic, the <u>concentration of H^+ present in sulfuric acid is twice as much as in hydrochloric acid</u>. Hence rate is faster for reaction with sulfuric acid.</p>	1 1	
ci	<p>Sulfuric acid</p> <p>Curve C shows the <u>same initial gradient as curve A</u> which means they have the same initial rate of reaction</p>	1	
cii	<p>No. of moles of hydrogen $= 90/24000$ $= 0.00375 \text{ mol}$</p> <p>mass of zinc $= 0.00375 \times 65 = 0.244 \text{ g}$;</p> <p>Or</p> <p>half the volume of hydrogen, therefore half the mass of zinc so $0.488/2 = 0.244 \text{ g}$;</p>	1	
d	<p>$\text{Zn(s)} + \text{CuSO}_4(\text{aq}) \rightarrow \text{ZnSO}_4(\text{aq}) + \text{Cu(s)}$</p> <p>OR</p>	1	

	$\text{Zn(s)} + \text{Cu}^{2+}(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{Cu(s)}$ <p>zinc displaces copper from copper(II) sulfate to produce brown copper deposit</p> <p>less zinc reacts with acid to produce less hydrogen ;</p>	1 1	
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Admiralty Secondary School
Marking Scheme
4E Pure Chemistry (Paper 3)
PRELIMINARY EXAMINATION 2021

Qn	Indicative material	Mark	Total
1(a)	<p>full set of data (5 time taken values) + correct trend (increasing)</p> <p>accurate calculation of average speed of reaction</p> <p>all time taken recorded to nearest second</p> <p>accurate calculated speed to 3 s.f.</p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p>	[4]
1(b)	<p>axis labels + units</p> <p>appropriate scale (<i>y-axis to cover at least 2/3 of paper</i>)</p> <p>all points correctly plotted</p> <p>best fit line (0,0 is not a data point)</p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p>	[4]
1(c)	<p>Trend: The larger the volume of P used, the higher the average speed of reaction.</p> <p>Explain: Larger volume of P, higher concentration of P, more P particles per unit volume</p> <p>Higher frequency of collision and <u>higher frequency of effective collision</u>, hence higher speed of reaction.</p>	<p>1</p> <p>1</p> <p>1</p>	[3]
1(d)	<p>No of moles of P to use $= (0.18 \times 25) / 1000$ $= 0.00450 \text{ mol}$</p> <p>Volume of P to draw from $0.2 \text{ mol/dm}^3 \text{ P}$ $= (1000 \times 0.0045) / 0.2$ $= 22.5 \text{ cm}^3$</p>	<p>1</p> <p>1</p>	[2]
1(e)	<p>value from graph AND indication shown</p> <p>to determine from $x = 22.5 \text{ cm}^3$ allow ECF from 1(d)</p>	<p>1</p>	[1]
1(f)	<p>Change to the experiments</p> <ul style="list-style-type: none"> • Use burette/pipette • Repeat each set of experiment a few times and find average of time taken <p>Explanation (to match change suggested)</p> <ul style="list-style-type: none"> • More accurate (than measuring cylinder) 	<p>1</p> <p>1</p>	[2]

1(g)	<ul style="list-style-type: none"> • To reduce the human reaction time error • Start from origin • Steeper gradient • [if original best fit line does not pass through origin, can accept line where all the y-values are higher than the original best fit line, even if gradient seems to be the same] 	1													
1(h)	<p><u>Procedures</u></p> <ol style="list-style-type: none"> 1. Perform the procedures detailed in Experiment 1. This time round, use a thermometer to measure the temperature of solution P before adding to Q. Record the temperature, T_0, to the nearest $^{\circ}\text{C}$. [1] 2. Repeat Step 1 for four more times with the temperature of solution P at T_0+10, T_0+20, T_0+30 and T_0+40 respectively. [1] 3. Record the temperature of P, to the nearest $^{\circ}\text{C}$, and time taken, to the nearest second, for mixture to turn blue-black <p><u>Results</u></p> <table border="1" data-bbox="331 1003 1094 1301"> <thead> <tr> <th>Temperature of solution P / $^{\circ}\text{C}$</th> <th>Time taken / s</th> </tr> </thead> <tbody> <tr> <td>$T_0 =$</td> <td></td> </tr> <tr> <td>$T_0 + 10 =$</td> <td></td> </tr> <tr> <td>$T_0 + 20 =$</td> <td></td> </tr> <tr> <td>$T_0 + 30 =$</td> <td></td> </tr> <tr> <td>$T_0 + 40 =$</td> <td></td> </tr> </tbody> </table> <p>[1]</p> <p><u>Data Processing</u></p> <p>If the time-taken for the blue-black colour to appear for every increase in 10°C of solution P is halved, then the suggestion is confirmed. [1]</p> <p><u>Assumptions</u></p> <ol style="list-style-type: none"> 1. Solution P is stable to heating and will react with Q normally 2. The temperature difference between each successive mixture when P is added to Q is approximately 10°C even though solution Q and the starch solution is not heated. <p>1 mark awarded for any one of the above two points.</p>	Temperature of solution P / $^{\circ}\text{C}$	Time taken / s	$T_0 =$		$T_0 + 10 =$		$T_0 + 20 =$		$T_0 + 30 =$		$T_0 + 40 =$			[5]
Temperature of solution P / $^{\circ}\text{C}$	Time taken / s														
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$T_0 + 20 =$															
$T_0 + 30 =$															
$T_0 + 40 =$															

Note: Supervisors are asked to carry out the following experiment to ensure that results fall within the required limits.

To 10.0 cm³ of Q, add 2 cm³ of starch solution and then add 25cm³ of P.

The time taken for the mixture to turn blue-black should be within 15-25 s.

To adjust the time taken, increase or decrease the concentration of P.

Setter's results for Question 1:

experiment	volume of Q / cm^3	volume of starch / cm^3	volume of P / cm^3	volume of water / cm^3	time taken / s	$\frac{1}{\text{time taken}} / \text{s}^{-1}$
1	10	2	25	0	19	0.0526
2	10	2	20	5	26	0.0385
3	10	2	15	10	32	0.0313
4	10	2	10	15	63	0.0159
5	10	2	5	20	138	0.00724

Qn	Indicative material	Mark	Total	
2(a)	Test		[12]	
	Test 1 Place 2 cm ³ of R in a test tube and add equal volume of aqueous silver nitrate	Yellow/pale yellow ppt formed.		1
	Add dilute nitric acid to the mixture.	No changed is observed.		1
	Test 2 Place 1 cm ³ of R in a test tube and add an equal volume of aqueous copper(II) sulfate.	(Colourless solution turned brown.) A pale brown ppt is produced. $2KI(aq) + CuSO_4(aq) \rightarrow 2CuI(s) + I_2(aq) + K_2SO_4$		1
	Add aqueous sodium thiosulfate to the mixture until no further change take place.	Brown ppt (turned to <i>white ppt</i>) and soluble in excess to form colourless solution { $Na_2S_2O_3$ – reducing agent } $I_2(\text{brown soln}) \rightarrow I^-(\text{colourless solution})$		1
Test 3 Place 2 cm ³ of R in a test tube and add an equal volume of dilute sulfuric acid and a few drops of S.	Colourless solution turned reddish brown/brown	1		
Add an excess of solution S to the mixture and allow to stand for a few minutes	The brown solution turns dark brown/ black ppt formed. $2KI(aq) + H_2SO_4(aq) + H_2O_2 \rightarrow I_2(aq) + K_2SO_4(aq) + H_2O(l)$	1		
Test 4 Place 2 cm ³ of acidified potassium manganate(VI) solution in a test tube and add equal volume of S. Leave the mixture to stand for a few minutes.	Purple acidified potassium manganate (VII) solution turned from purple to colourless. Effervescence observed. (Colourless gas produced relights the glowing splint. Gas is oxygen.)	1 1		
Test 5	Colourless/Light green solution turns to pale yellow or orange or	1		

	<p>To 1 cm³ of aqueous iron(II) sulfate add an equal volume of S. Leave the mixture to stand for a few minutes, shaking occasionally.</p> <p>To the mixture, add sodium hydroxide until no further change is seen.</p>	<p>brown solution/ On standing brown ppt formed</p> <p>(Effervescence observed. The gas produced relights the glowing splint. Gas is oxygen.)</p> <p>Reddish brown ppt formed</p> <p>Effervescence observed.</p> <p>The gas produced relights the glowing splint. Gas is oxygen.</p>	<p>1</p> <p>1</p> <p>1</p>	
2(b)	<p>Anion R is <u>iodide ion, I⁻ ion</u></p> <p>Reasoning: In Test 1, a yellow precipitate of silver iodide is formed with silver nitrate solution.</p> <p><i>The precipitate is insoluble in dilute nitric acid.</i></p> $Ag^+(aq) + I^-(aq) \rightarrow AgI(s)$		<p>1</p> <p>1</p>	[2]
2(c)	<p>Chemical property of solution R is a reducing agent</p> <p>Reasoning: In Test 3, colourless solution of iodide ion is oxidized to brown iodine solution.</p>		<p>1</p> <p>1</p>	[2]
2(d)	<p>Chemical property of solution S is an oxidizing/reducing agent.</p> <p>Reasoning:</p> <ul style="list-style-type: none"> Reducing agent: In Test 4, purple acidified potassium manganate (VII) solution is reduced to colourless Mn²⁺ solution. Oxidising agent: Test 3, colourless I⁻ solution is oxidized to brown I₂ or Test 5, the pale green Fe²⁺ solution is oxidized to yellow Fe³⁺ solution. 		<p>1</p> <p>1</p>	[2]