FUCHUN SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2020
SECONDARY 4 EXPRESS

NAME	

CENTRE NUMBER	S					INDEX NUMBER				

CLASS:	

CHEMISTRY
Paper 1

6092/01
Max mark: 40
15 September 2020
1 hour

READ THESE INSTRUCTIONS FIRST
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and index number on the Answer Sheet in the spaces provided.
You may use a soft pencil for any diagrams, graph or rough working.

There are forty questions on this section. 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 OTAS provided.

Read the instructions on the 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 booklet.
A copy of the Periodic Table is printed on page 18.
The use of an approved scientific calculator is expected, where appropriate.

Setter: Mdm Yogeswari

This paper consists of **18** printed pages, including the cover page.

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1 An experiment is done to measure the rate of reaction between calcium carbonate and dilute hydrochloric acid. The gas formed is collected in a gas syringe.

Which additional pieces of apparatus are essential to measure how the rate of the reaction changes with temperature and the amount of acid used?

	apparatus to measure temperature	apparatus to measure amount of acid used
A	balance	thermometer
B	measuring cylinder	balance
C	thermometer	measuring cylinder
D	thermometer	beaker

2 After acidification with dilute nitric acid, a colourless solution of X reacts with aqueous silver nitrate to give a white precipitate.

What is X?

A calcium iodide

B copper(II) chloride

C lead(IV) iodide

D sodium chloride

3 Which solution can be used to distinguish between sulfuric acid and nitric acid?

A aqueous barium chloride

B copper(II) carbonate

C aqueous silver nitrate

D aqueous sodium hydroxide

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4 Cobalt is a transition element.

A particle of cobalt contains 24 electrons and has a nucleon number of 60.

Which statement about this particle is correct?

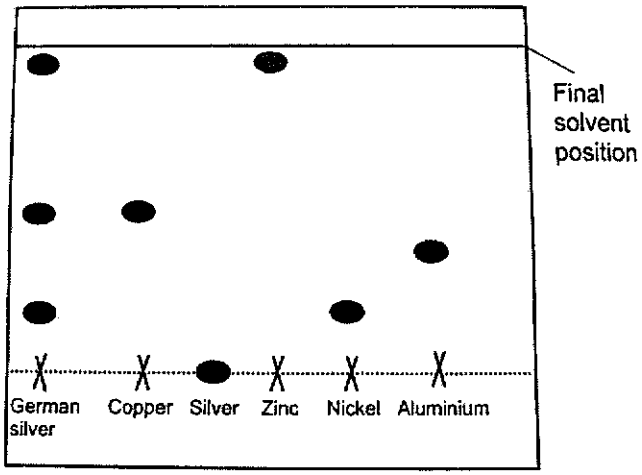
A It forms a 3+ ion.

B It forms a 3- ion.

C It contains 24 neutrons.

D It contains 24 protons.

5 A chromatography was carried out using a drop of solution of an alloy, German silver. The results are shown below:



Which metals do German silver **not** contain?

A copper and nickel

B copper and zinc

C silver and aluminium

D zinc and nickel

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6 Powdered calcium carbonate reacts with dilute hydrochloric acid to produce calcium chloride, water and carbon dioxide.

What is the correct ionic equation, including state symbols, for this reaction?

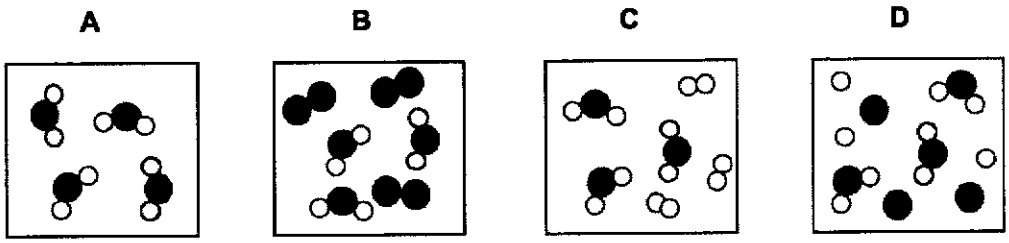
A $CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$

B $Ca^{2+}(aq) + CO_3^{2-}(aq) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + H_2O(l) + CO_2(g)$

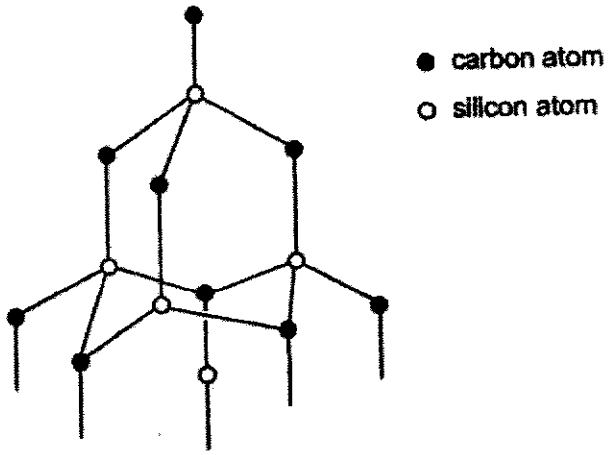
C $CO_3^{2-}(aq) + 2H^+(aq) \rightarrow H_2O(l) + CO_2(g)$

D $CaCO_3(s) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + H_2O(l) + CO_2(g)$

7 20 cm^3 of hydrogen is burnt in 20 cm^3 of oxygen. Which diagram represents the particles that remain in the reaction vessel?



8 The diagram shows the structure of a compound of carbon and silicon, $(SiC)_n$.



What will be a property of (SiC)n?

A acts as a lubricant

B conduct electricity

C insoluble in water

D low melting point

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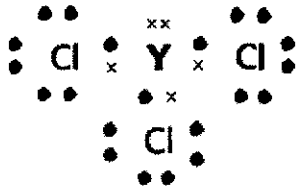
9 The electronic structure of a compound formed between an element **Y** and chlorine is shown below. Only valence electrons are shown.



What is the chemical formula when aluminium combines with element **Y**?

A AlY

B AlY_2

C Al_3Y

D AlY_3

10 In which reaction does the oxidation state of iron remain unchanged?

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

B $2FeCl_2 + Cl_2 \rightarrow 2FeCl_3$

C $Fe + 2FeCl_3 \rightarrow 3FeCl_2$

D $Fe_2O_3 + 6HCl \rightarrow 2FeCl_3 + 3H_2O$

11 Which volume of 0.1 mol/dm^3 hydrochloric acid is required to react completely with 25 cm^3 of 0.2 mol/dm^3 of aqueous sodium carbonate?

A 100 cm^3

B 50 cm^3

C 25 cm^3

D 6.25 cm^3

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12 8 g of X_2O_3, an oxide of element X, contains 5.6 g of X.

How many moles of X does 5.6 g of the element contain?

A $\frac{2.4}{16} \times \frac{2}{3}$

B $\frac{2.4}{16} \times \frac{3}{2}$

C $\frac{8}{16} \times \frac{2}{3}$

D $\frac{8}{16} \times \frac{2}{3}$

13 How many moles of iron can be extracted from 40 g of Fe_2O_3?

A 0.15 mol

B 0.25 mol

C 0.35 mol

D 0.5 mol

14 3.0 dm^3 of sulfur dioxide is reacted with 2.0 dm^3 of oxygen according to the equation below.

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$$

What is the total volume of gas(es) at the end of the reaction? (Assume the reaction goes to completion and the gases are measured at the same temperature and pressure.)

A 2.0 dm^3

B 2.5 dm^3

C 3.0 dm^3

D 3.5 dm^3

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15 Naturally-occurring chlorine has a relative atomic mass of 35.5 and consists entirely of two isotopes of relative atomic masses 35 and 37.

What can be deduced about naturally-occurring chlorine from this information only?

A Chlorine contains two isotopes in different proportions.

B Chlorine has different oxidation states.

C Chlorine isotopes have different number of protons.

D Chlorine isotopes are radioactive.

16 In an electrolysis experiment, the same amount of charge deposited 6 g of zinc and 30 g of manganese.

What was the charge on the manganese ion?

[A_r: Mn, 25; Zn, 30]

A +2

B +3

C +4

D +7

17 In an experiment, 4.0 cm^3 of 1.0 mol/dm^3 copper(II) sulfate solution are mixed with 8.0 cm^3 of 1.0 mol/dm^3 sodium carbonate solution.

What does the reaction vessel contain?

A a green precipitate and a blue solution

B a colourless solution only

C a white precipitate and a colourless solution

D a green precipitate and a colourless solution

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18 Many properties of an element and its compounds can be predicted from the position of the element in the Periodic Table.

What property could **not** be predicted in this way?

A the acidic and basic nature of its oxide

B the formula of its oxide

C the number of isotopes it has

D its metallic and non-metallic properties

19 Elements **X** and **Y** are in Group VII in the Periodic Table.

X is a liquid at room temperature, **Y** is a solid at room temperature.

Which statements are correct?

1 Atoms of **Y** have more protons than atoms of **X**.

2 Molecules of **Y** have more atoms than molecules of **X**.

3 **Y** displaces **X** from aqueous solutions of X^- ions.

A 1 only

B 2 only

C 3 only

D 1, 2 and 3

20 A dilute aqueous solution of a strong acid, HX, contains molecules of water and the ions H^+ and X^-.

Which statement is true?

A The pH value of the acid is above 7.

B The solution also contains a high concentration of HX molecules.

C The solution also contains OH^- ions.

D The solution contains more H^+ ions than water molecules.

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21 Both magnesium oxide and magnesium carbonate react with sulfuric acid.

In what way are both these reactions the same?

A a gas is set free

B an acid is neutralised by a soluble base

C sulfuric acid is acting as an oxidising agent

D water is a product

22 The oxides of three elements T, U and V are added to the water.

	oxide of T	oxide of U	oxide of V
water added	dissolved to form a solution of pH 2	insoluble	dissolved to form a solution of pH 10

The oxide of U is white in colour.

What could T, U and V be?

	oxide of T	oxide of U	oxide of V
A	calcium	aluminium	sulfur
B	calcium	copper	sulfur
C	sulfur	aluminium	calcium
D	sulfur	copper	calcium

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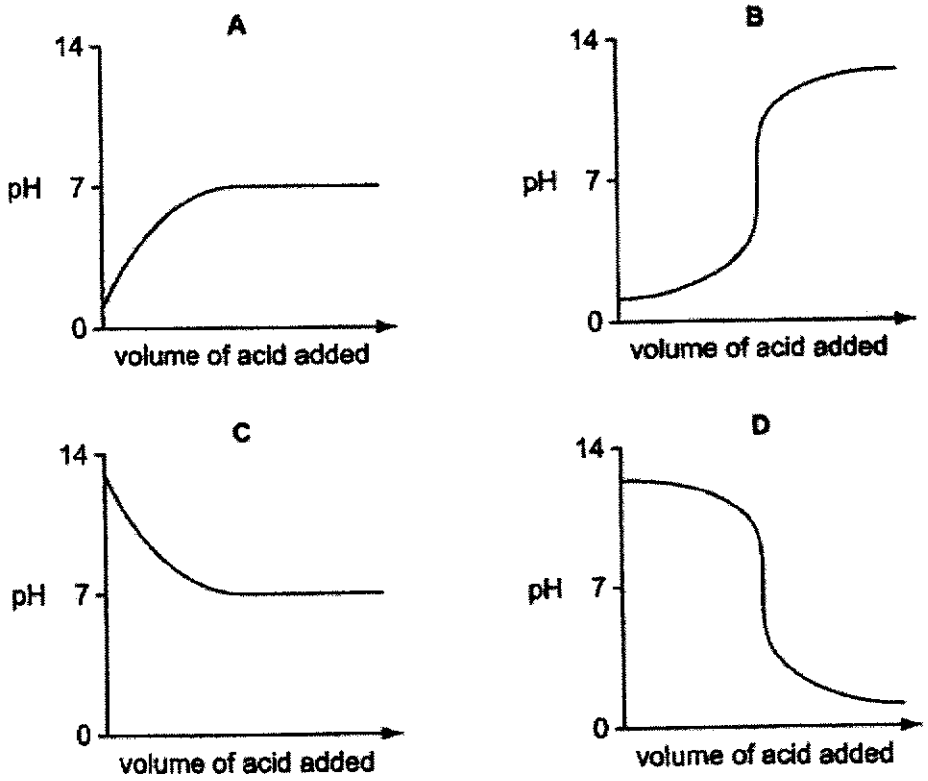
23 Which graph shows the changes in pH as excess of hydrochloric acid is added to aqueous sodium hydroxide?



24 Some statements about acids are given.

1 A 1 mol/dm^3 solution of a strong acid will have lower pH than a 1 mol/dm^3 solution of a weak acid.

2 pH gives a measure of the H^+ concentration in a solution.

3 Universal indicator turns green when placed in a solution of pH 5.

4 When acids react with metals, hydrogen ions lose electrons.

Which statements about acids are correct?

A 1, 2 and 3

B 1 and 2 only

C 1 and 4 only

D 2 and 4 only

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25 Which pairs of statements correctly describe the differences between the conduction of electricity during electrolysis and the the conduction of electricity by metals?

	conduction during electrolysis	conduction by metals
1	The current is due to the movement of both positive and negative ions.	The current is due to the movement of electrons.
2	Charged particles move towards both electrodes.	Charged particles move in one direction only.
3	It results in a chemical change.	It does not result in a chemical change.

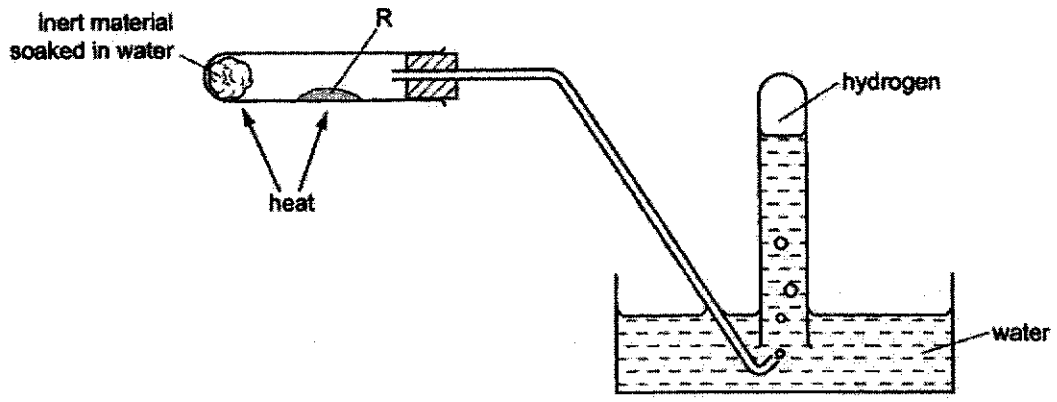
A 1, 2 and 3 are correct

B 1 and 2 only are correct

C 2 and 3 only are correct

D 1 only is correct

26 The diagram shows an experiment to produce and collect hydrogen.



What is R?

A copper(II) oxide

B iron

C lead

D lead(II) oxide

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27 Metal X reacts rapidly with dilute hydrochloric acid. It can be used for the sacrificial protection of underwater pipes.

Metal Y does not corrode easily. It can be used for jewellery.

Metal Z reacts rapidly with water to form hydrogen.

Which method of extraction of the metals from their ores is most likely to be used?

	electrolysis of molten ore	heating with carbon
A	X and Y	Z
B	X and Z	Y
C	Y	X and Z
D	Z	X and Y

28 In the manufacture of the iron by the blast furnace, which are the main gases that escape from the top of the blast furnace?

A carbon monoxide, carbon dioxide and hydrogen

B nitrogen, carbon dioxide, carbon monoxide

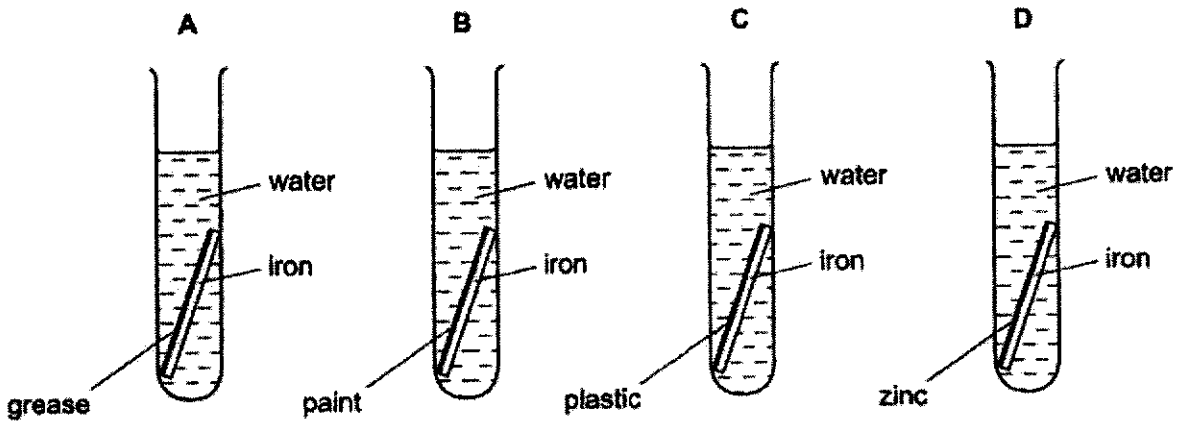
C nitrogen, oxygen, steam

D oxygen, carbon dioxide, sulfur dioxide

29 Four test tubes were set up as shown.

Each piece of iron was protected on one side by a different coating.

In which test-tube is the iron **least** likely to rust?



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30 Which product is formed at the cathode when molten silver bromide is electrolysed?

A bromide ions

B bromine molecules

C silver ions

D silver atoms

31 Approximately 40% of all iron and steel is produced by recycling.

Which statements are the correct reasons for recycling iron?

1 Iron, when obtained by a recycling process produces less carbon dioxide than the blast furnace process.

2 Scrap steel contains a higher percentage of iron than iron ore.

3 Scrap metal, if not recycled, would cause environmental problems due to its disposal by landfill.

A 1, 2 and 3

B 1 and 2 only

C 1 and 3 only

D 2 and 3 only

32 In which electrolyte would a carbon cathode (negative electrode) increase in mass during electrolysis?

A aqueous copper(II) sulfate

B concentrated hydrochloric acid

C concentrated aqueous sodium chloride

D dilute sulfuric acid

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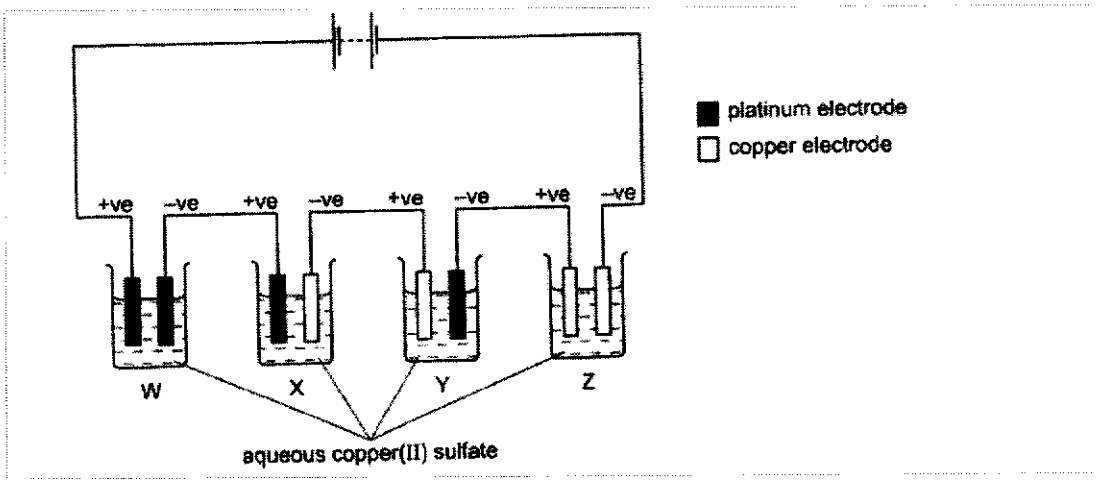
33 The circuit shown below is set up and an electric current is passed through the four cells in series.



In which cells is the intensity of the blue colour unchanged?

A W and Z

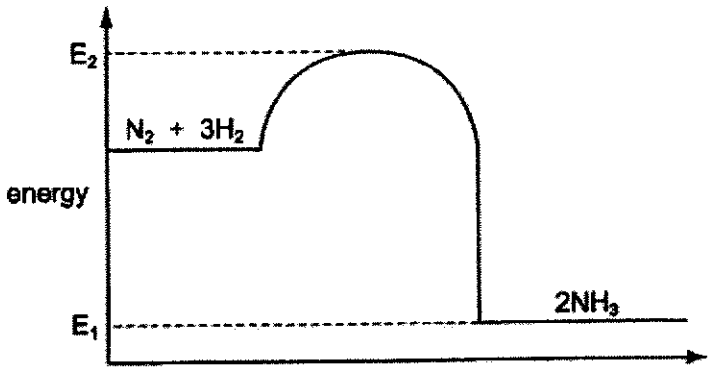
B X and Y

C X and Z

D Y and Z

34 The energy profile diagram for Haber Process is shown below.

$N_2 + 3H_2 \rightleftharpoons 2NH_3$ $\Delta H = -92\,kJ$



What does the energy change E_2-E_1 represent?

A activation energy of the forward reaction

B activation energy of the reverse reaction

C enthalpy change of the forward reaction

D enthalpy change of the reverse reaction

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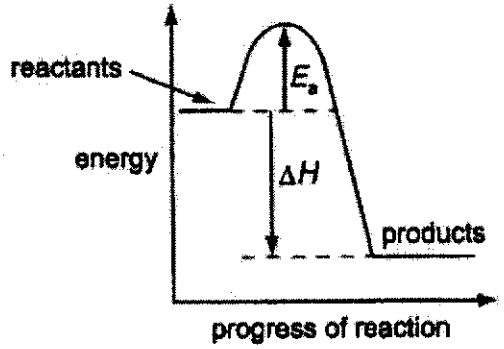
35 The enthalpy diagram shows an uncatalysed exothermic reaction.



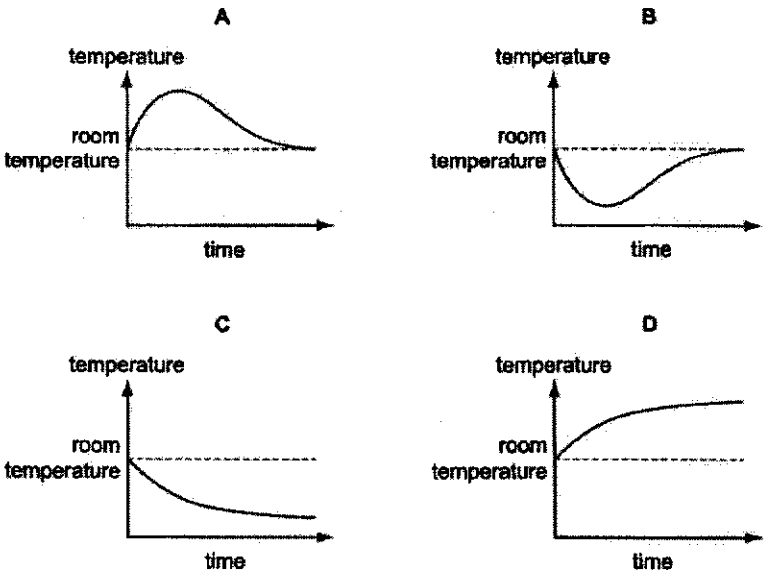
The reaction was repeated in the presence of a catalyst.

What effect does the catalyst have on the activation energy, E_a, and the enthalpy change, ΔH?

	E_a	ΔH
A	decreases	decreases
B	decreases	unchanged
C	increases	unchanged
D	unchanged	decreases

36 Dissolving ammonium nitrate in water is endothermic.

Which graph shows how the temperature alters as the ammonium nitrate is added to the water and then the solution is left to stand for some time?



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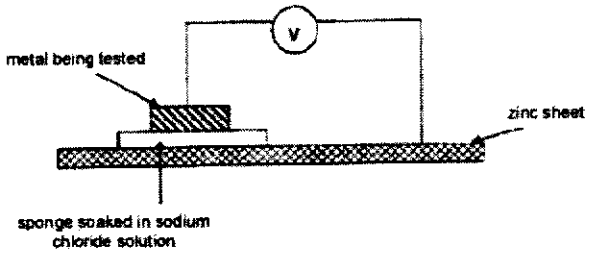
37 An experiment was conducted on three unknown metals P, Q and R. The set-up is shown in the diagram below.



The results are shown in the table.

metal tested	voltage / V	direction of electron flow
P	0.2	zinc to metal P
Q	0.5	metal Q to zinc
R	1.1	zinc to metal R

Arrange the three metals according to their reactivity in the reactivity series, starting with the least reactive metal.

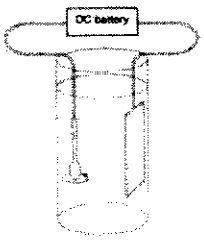
A P, Q, R

B P, R, Q

C Q, P, R

D R, P, Q

38 The following diagram shows the setup used to electroplate an iron spoon with chromium.



Which row correctly states the cathode, the electrolyte used, as well as the reaction which takes place at the anode?

	cathode used	electrolyte used	reaction at anode
A	spoon	aqueous chromium(III) nitrate	$Cr^{3+} + 3e \rightarrow Cr$
B	spoon	aqueous chromium(III) nitrate	$Cr \rightarrow Cr^{3+} + 3e$
C	chromium	aqueous iron(III) nitrate	$Cr^{3+} + 3e \rightarrow Cr$
D	chromium	aqueous chromium(III) nitrate	$Cr \rightarrow Cr^{3+} + 3e$

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39 Which change will increase the speed of the reaction between 1 mol of each of two gases?

A a decrease in the surface area of the catalyst

B a decrease in temperature

C a decrease in the volume of the reaction flask

D an increase in the volume of the reaction flask

40 A student performs two reactions.

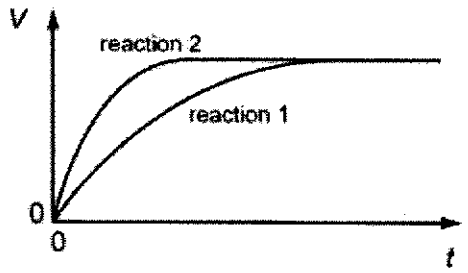
reaction 1: 10 g of magnesium ribbon with excess 2.0 mol/dm^3 dilute hydrochloric acid

reaction 2: 5 g of magnesium powder with excess 2.0 mol/dm^3 dilute hydrochloric acid

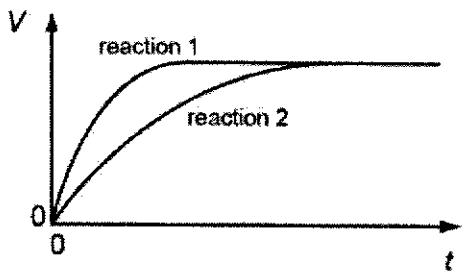
In both reactions, the volume of hydrogen produced, *V*, is measured against time, *t*.

Which set of graphs is correct for both reactions?

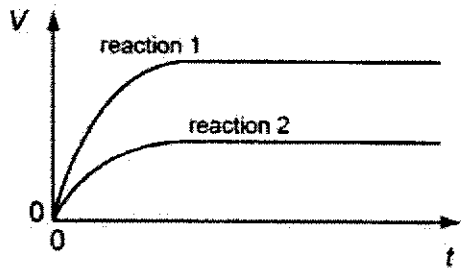
A



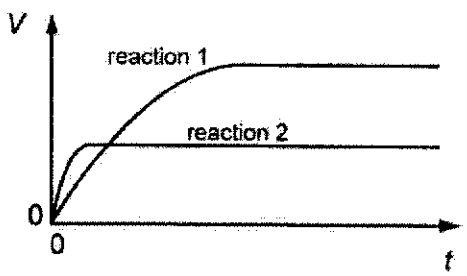
B



C



D



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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
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 –	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	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89 – 103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

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 –	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 –	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 –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

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NAME	

CENTRE NUMBER	S					INDEX NUMBER				

CLASS:	

CHEMISTRY
Paper 2

6092/02
Max mark: 80
14 September 2020
1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class in the spaces provided at the top of this page.
Write in dark blue or black pen in the spaces provided on the Question Paper.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A

Answer **all** the questions in the spaces provided.
The number of marks is given in brackets [ ] at the end of each question or part-question.

Section B

Answer **all** three questions, the last question is in the form either/or.
Write your answers in the spaces provided.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 21.

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

For Examiner's Use	
Section A	
Section B	
Total	

Setter: Mdm Yogeswari

This paper consists of **21** printed pages, including the cover page.

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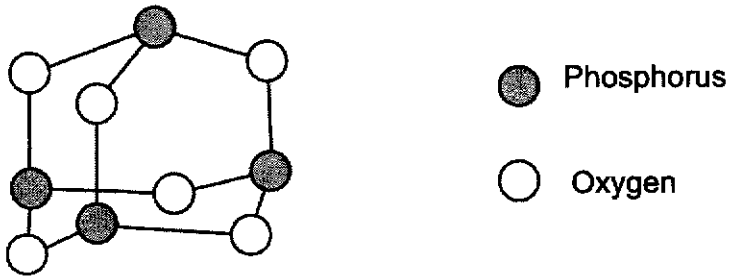
Section A
Answer **all** the questions in the spaces provided.
The total mark for this section is 50.

A1 Phosphorus is a non-metal. This diagram shows the structure of one molecule of phosphorus(III) oxide.



(a) **(i)** Give the molecular formula of phosphorus(III) oxide.

.....[1]

(ii) Give the empirical formula of phosphorus(III) oxide.

.....[1]

(b) Explain why phosphorus(III) oxide has the properties given below.

Property 1 Phosphorus(III) oxide is acidic.

explanation.....

.....

Property 2 Phosphorus(III) oxide has a low melting point.

explanation.....

.....

Property 3 Phosphorus(III) oxide will not conduct electricity when molten.

explanation.....

.....[3]

[Total: 5]

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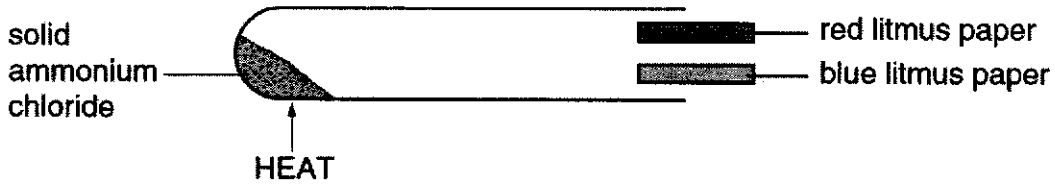
A2 The table shows some information about three gases.

name of gas	formula	relative molecular mass
chlorine		71
ammonia		17
	HC*l*	

(a) Complete the table by filling in the boxes. [3]

(b) A student heated some solid ammonium chloride, NH_4Cl, in a test-tube. Ammonia and one other gas were formed. He tested the gases coming out of the tube with litmus paper.



The red litmus quickly turned blue. A few seconds later, both pieces of litmus paper turned red.

(i) Identify the gas that turned red litmus paper blue.

.....[1]

(ii) Identify the gas that turned blue litmus paper red.

.....[1]

(iii) Explain why the two gases travelled along the test-tube at different speeds. Use information from the table.

.....

.....[2]

[Total: 7]

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A3 Flerovium, F*l*, atomic number 114, was first made in research laboratories in 1998.

(a) Flevorium was made by bombarding atoms of Plutonium, Pu, atomic number 94, with atoms of element **Z**.

- The nucleus of one atom of Plutonium combined with the nucleus of one atom of element **Z**.
- This formed the nucleus of one atom of Flevorium.

Suggest the identity of element **Z**.

.....[1]

(b) To which period of the Periodic Table does Flevorium belong?

.....[1]

(c) Predict the number of outer shell electrons in an atom of Flevorium.

.....[1]

(d) Two isotopes of Flevorium ^{286}Fl and ^{289}Fl are discovered. Complete the table below to show the number of protons, neutrons and electrons in atoms of the isotopes shown.

isotope	number of protons	number of neutrons	number of electrons
^{286}Fl			
^{289}Fl			

[2]

(e) Only a relatively small number of atoms of Flevorium have been made in the laboratory and the properties of Flevorium have not yet been investigated.
It has been suggested that Flevorium is a typical metal.

(i) Suggest two physical properties of Flevorium.

1. .....

2. .....[2]

(ii) Suggest one chemical property of flevorium oxide.

.....[1]

[Total: 8]

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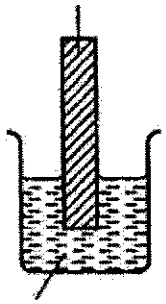
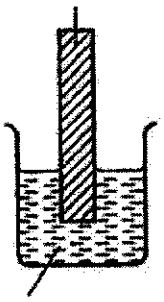
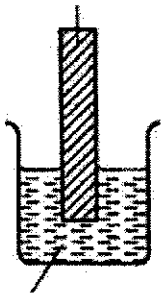
A4 Three experiments are carried out to find the order of reactivity of three metals.

The metals used were zinc, tin and unknown metal **X**.

experiment 1	experiment 2	experiment 3
zinc  tin(II) chloride	tin  metal **X** sulfate	metal **X**  zinc sulfate

		experiment 1	experiment 2	experiment 3
colour of metal	start	silver grey	silver grey	orange brown
	end	silver-grey with crystals formed on surface	brown coating on surface	
colour of solution	start	colourless	blue	colourless
	end	colourless	paler blue	

(a) Suggest the name of metal **X**.

.....[1]

(b) Complete the table to show the colour of the metal and the solution at the end of experiment 3. [2]

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(c) Give the order of reactivity of the three metals.

most reactive .....

.....

least reactive .....

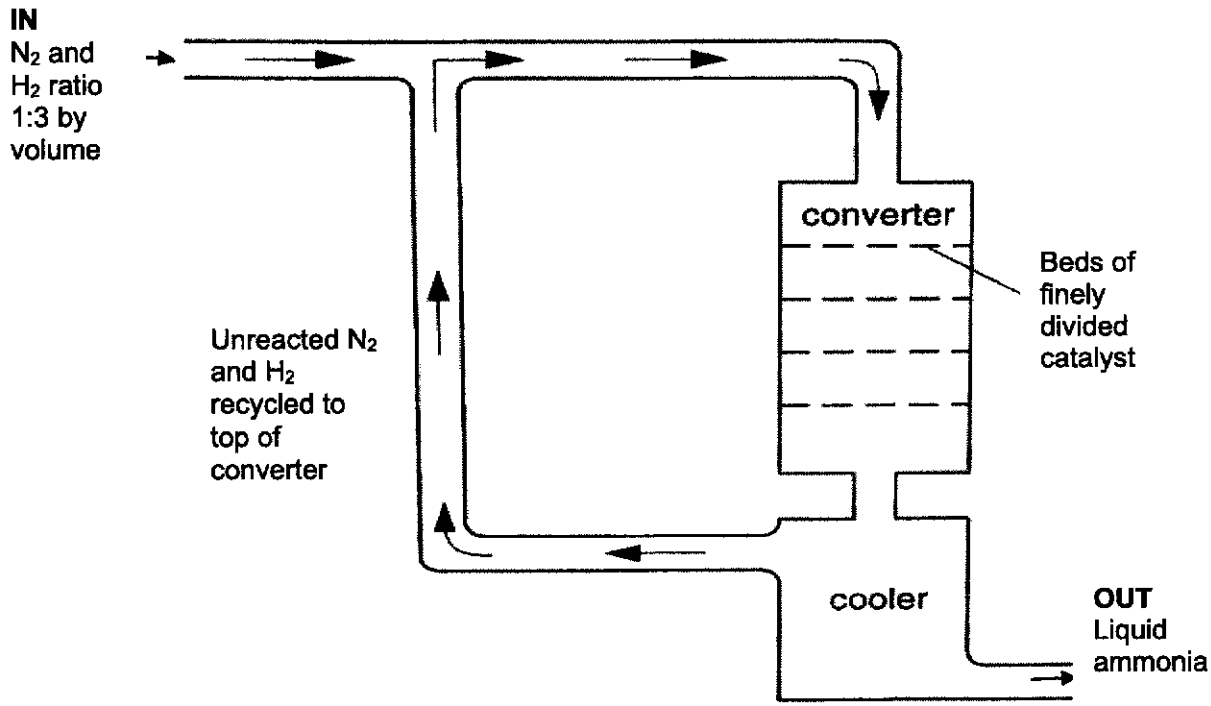
[1]

(d) Write an ionic equation, with state symbols, for the reaction in experiment 1.

.....[1]

[Total: 5]

A5 The diagram below shows some information about the Haber process for making ammonia.



(a) Explain why the gases are mixed in a 1:3 ratio. Include an equation in your answer.

.....

.....

.....[2]

(b) Name the catalyst used in the process.

.....[1]

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(c) When the mixture of nitrogen, hydrogen and ammonia enters the cooler, the ammonia turns into a liquid but the other gases do not.

What does this tell you about the boiling point of ammonia?

.....[1]

(d) Give a reason, other than cost, why the unreacted nitrogen and hydrogen are recycled.

.....

.....[1]

(e) The Haber process is carried out at 450°C and 200 atm pressure. Studies have shown that a higher pressure and lower temperature can produce a better yield of ammonia.

(i) Explain in terms of collision theory, how a higher pressure can produce a reasonable yield of ammonia, within a shorter span of time.

.....

.....[2]

(ii) Studies have shown that lowering the temperature can increase the yield of ammonia. Explain in terms of energy of reacting particles why this condition is not favored.

.....

.....[2]

(f) Calculate the maximum mass of ammonia that can be made form 3 tonnes of hydrogen.

[1 tonne = 100000 g] [2]

[Total: 11]

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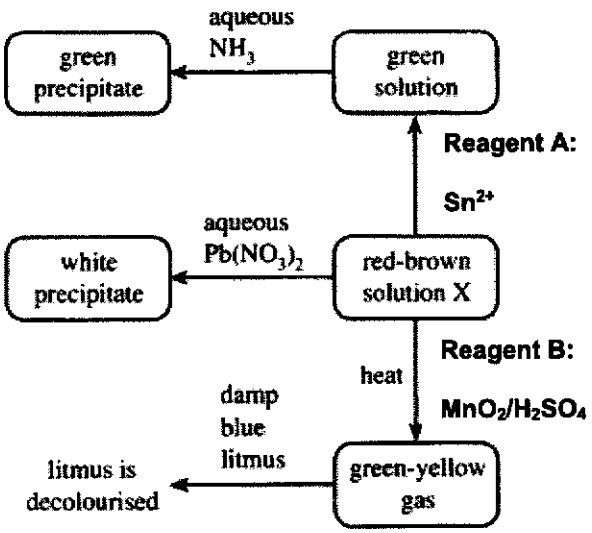
A6 Study the reactions scheme below and answer the following questions.



(a) Name the green-yellow gas.

.....

[1]

(b) Name the green precipitate and state its chemical formula.

name: .....

chemical formula: .....

[2]

(c) Identify the red brown solution.

.....

[1]

(d) Identify the green solution.

.....

[1]

(e) What is the role of reagent **A** and of reagent **B**?

Reagent **A**: .....

Reagent **B**:.....

[2]

[Total: 7]

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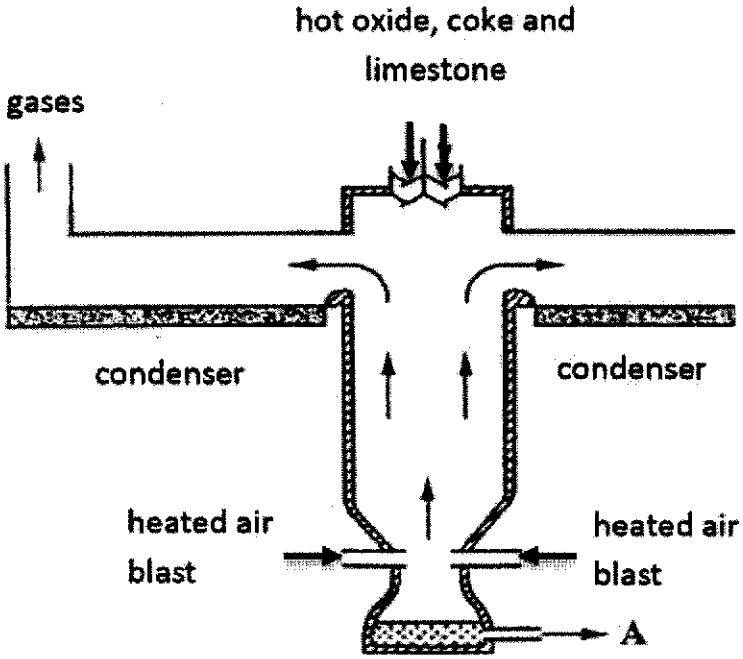
A7 Zinc is manufactured from the ore zinc blende, which contains zinc sulfide (ZnS) and impurities including sand. The ore is heated in air to produce zinc oxide and sulfur dioxide. The zinc oxide can then be heated with coke and limestone in a blast furnace, a simplified diagram of which is shown below.



The zinc distils off and is collected.

(a) Name a metal manufactured by a similar method to that used for zinc.

.....[1]

(b) Construct a chemical equation for the heating of zinc sulfide in air.

.....[1]

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(c) Describe one environmental problem caused by sulfur dioxide produced in this process if it is allowed to escape into the atmosphere.

.....

.....[1]

(d) Suggest a reason for adding limestone to the furnace.

.....[1]

(e) State two reasons other than cost that supports the reasons for recycling zinc rather than extracting the metal from its ore.

1. .....

2. .....[2]

(f) Explain why bars of zinc fixed to the ship's hull prevents the steel body of the ship from rusting.

.....[1]

[Total: 7]

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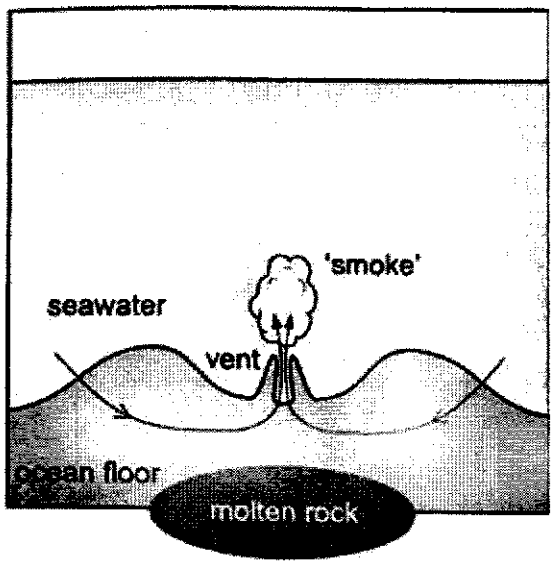
Section B

Answer all **three** questions in this section.
The last question is in the form of an either/or and only one of the alternatives should be attempted.

B8 A series of chemical reactions happen in hydrothermal vents that are found on the ocean floor.

	normal seawater	hydrothermal vent water
temperature / °C	2	350
pH	7.8	4.3
concentration of ions / $\times 10^{-3}$ mol dm^{-3}		
Cl^-	531	539
Na^+	450	419
Mg^{2+}	51.2	0.0
SO_4^{2-}	27.1	0.0
HCO_3^-	2.3	5.7
Ca^{2+}	9.9	15.1
K^+	9.5	22.5
Fe^{2+}	0.0	1.62
Mn^{2+}	0.0	0.93
Zn^{2+}	0.0	0.10
Cu^{2+}	0.0	0.03
NH_4^+	0.0	0.03
concentration of gases / $\times 10^{-3}$ mol dm^{-3}		
O_2	0.1	0.0
H_2S	0.0	7.1
H_2	0.0	1.7
CH_4	0.0	0.1
He	0.0	2×10^{-6}

Seawater flows through the rocks in the ocean floor and is heated by molten rock below the surface. It then flows back out into the ocean through the hydrothermal vent, producing a cloud of smoke consisting of precipitated solids. The chemical composition of the water coming out from the vents is different from normal seawater. The table shows a typical composition of both types of water.



The discovery of life in deep oceans was a surprise to the scientific community as it was assumed that food energy resources would be scarce in an environment without sunlight to support photosynthesis. Researchers soon discovered that the organisms responsible for this biological abundance do not need photosynthesis, but instead are able to obtain energy from chemical reactions through a process known as chemosynthesis.

The hydrothermal vent water is chemical rich and boiling hot. Saturated with toxic chemicals and heavy metals, it is more acidic than vinegar and are deadly to most marine animals.

This noxious brew is paradise to the bacteria that coats the rocks around the vent in thick orange and white mats. The bacteria absorb hydrogen sulfide streaming from the vents, and oxidise it to sulfur.

Reaction 1: $2H_2S + O_2 \rightarrow 2S + 2H_2O$ $\quad \Delta H = -1124$ kJ/mol

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They use the chemical energy released during oxidation to combine carbon, hydrogen, and oxygen into sugar molecules in a process known as *chemosynthesis*.

- ***Chemosynthesis***:

$$18H_2S + 6CO_2 + 3O_2 \rightarrow C_6H_{12}O_6 + 18S + 12\ H_2O$$

Chemosynthesis is the use of energy released by inorganic chemical reactions to produce food. It is analogous to the more familiar process *of photosynthesis*.

- ***Photosynthesis***:

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

Plants use energy form the sun to convert carbon dioxide and water to form glucose (sugar) and oxygen.

In photosynthesis, plants grow in sunlight, capturing solar energy to make organic matter. In chemosynthesis, bacteria grow in mineral-rich water, harnessing chemical energy to make organic material.

From this simple reaction, an entire ecosystem grows. Snails, clams, mussels, and a host of other grazing animals feed on the bacterial mats. Crabs and shrimp eat the grazers, and then are hunted by larger crabs, fish, and octopi.

Chemosynthesis can sustain life in absolute darkness.

(a) **(i)** State which ions are removed from the seawater by the hydrothermal vent.

.....[1]

(ii) State which metal ions have been added to the water by the process.

.....[1]

(b) **(i)** Explain Reaction 1 is a redox reaction in terms of gain and loss of hydrogen atoms.

.....

.....

.....

.....

..... [3]

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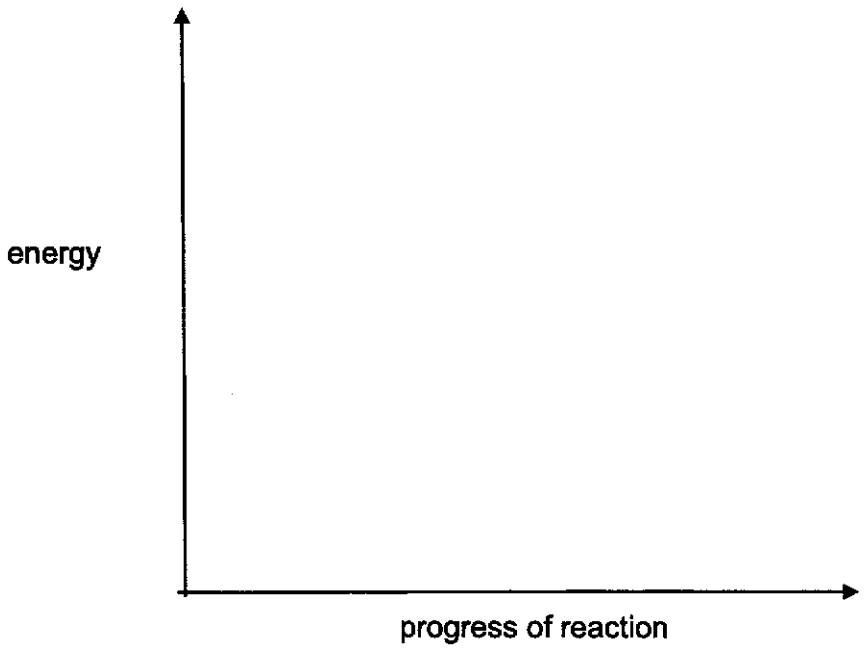
(ii) Draw the energy profile diagram for Reaction 1.

Label clearly the **reaction enthaply change** and the **activation energy**.

Your diagram should also include the **reactants** and **products** of the reaction.



[3]

(c) Chemosynthesis and photosynthesis are important chemical reactions that sustain life on Earth. Fill in the blanks in the table below which compares both processes.

Chemosynthesis	Photosynthesis
Uses .....energy	Uses .....energy
By products : Glucose and	By products : Glucose and .....
.....is oxidised to form	.....is oxidised to form .....
.....is reduced to form	.....is reduced to form .....

[4]

[Total: 12]

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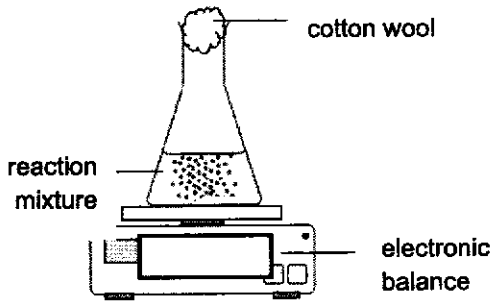
B9 In an experiment, aqueous sodium carbonate was reacted with dilute sulfuric acid completely. The reaction can be represented by the following chemical equation.

$$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + CO_2 + H_2O$$

The set-up is shown below.



The rate of reaction was investigated by recording the mass of the reaction mixture at suitable time intervals.

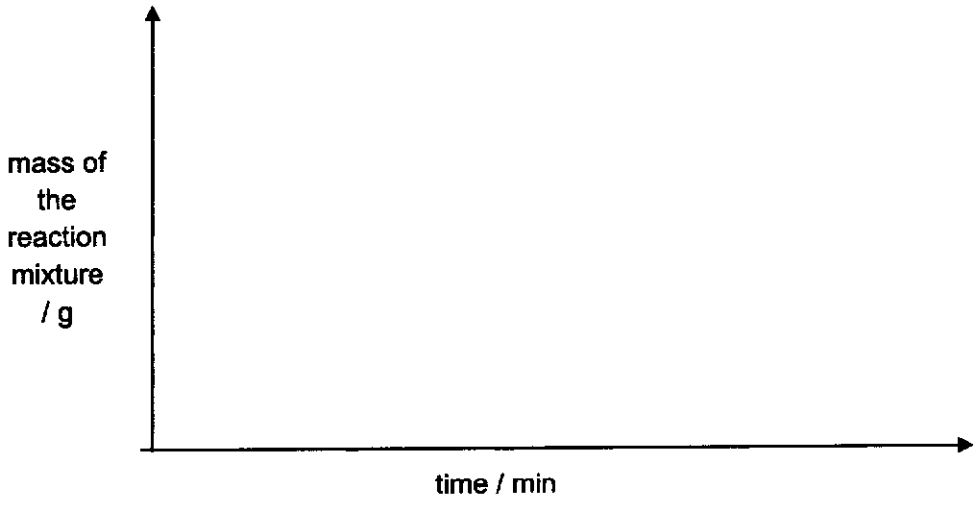
(a) The experiment was first performed using a sample of sodium carbonate solution that was prepared by dissolving 2.5 g of solid sodium carbonate in 200 cm^3 of water.

(i) Calculate the concentration of the sodium carbonate solution in mol/dm^3.

[Relative atomic masses: A_r: C, 12; Na, 23; O, 16]

[2]

(ii) Sketch a graph to show how the mass of the reaction mixture changes with time.



[1]

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(b) The experiment was repeated by using sodium carbonate solution with a concentration of 1.0 mol/dm^3. All other variables were kept constant.

(i) Describe how the rate of the reaction would be different. Explain your answer.

.....

.....

.....

..... [2]

(ii) On the same axes in **(a)(ii)**, sketch the graph you would expect for this second experiment. Label the graph as **G**. [1]

(c) The rate of reaction in this experiment can also be obtained by measuring the volume of gas produced per unit time. Draw a **labelled diagram** to illustrate the apparatus and set-up required for this experiment.

[2]

[Total: 8]

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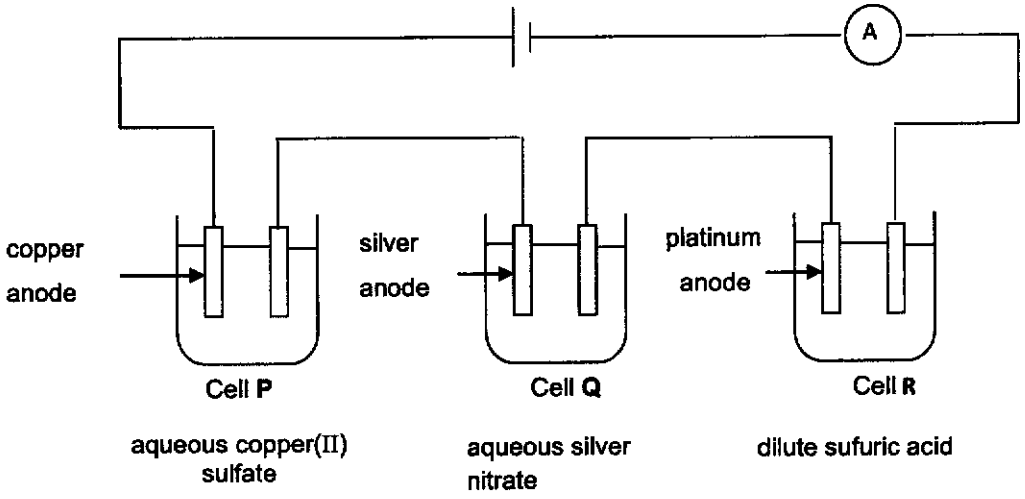
Either

B10 Most experiments involving electrolysis use inert electrodes, which do not take part in the reactions. However, in some experiments the electrodes do take part in the reactions.

A student passed an electric current into three cells containing different solutions for 10 minutes, using the apparatus shown.



The student weighed the **anode** of each cell before and after the experiment and worked out the decrease in mass. The table shows the results of his experiment.

Cell	Decrease in mass / g
P	0.81
Q	2.70
R	0.00

(a) Write the *ionic* equation for the reaction that occurred at the anode of each cell.

P : .....

Q : .....

R : .....

[3]

(b) **(i)** Calculate the number of moles of copper and silver lost at the respective anodes during the experiment. [2]

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(ii) Suggest an explanation for the difference in the number of moles of copper and silver lost when the same conditions are used

.....

.....

..... [2]

(c) (i) The student repeated the experiment but this time, he modified the apparatus by replacing the platinum **anode** in Cell **R** with lead.
His results showed that there was an initial increase in mass at the lead anode. However, the electrolysis stopped shortly, within 10 minutes of the experiment. Explain why these observations were made.

.....

.....

..... [2]

(d) If an iron object is placed in Cell **Q**, a silver coating forms on the iron.
If a gold object is placed in Cell **Q**, no reaction happens.
Explain why.

.....

.....[1]

[Total: 10]

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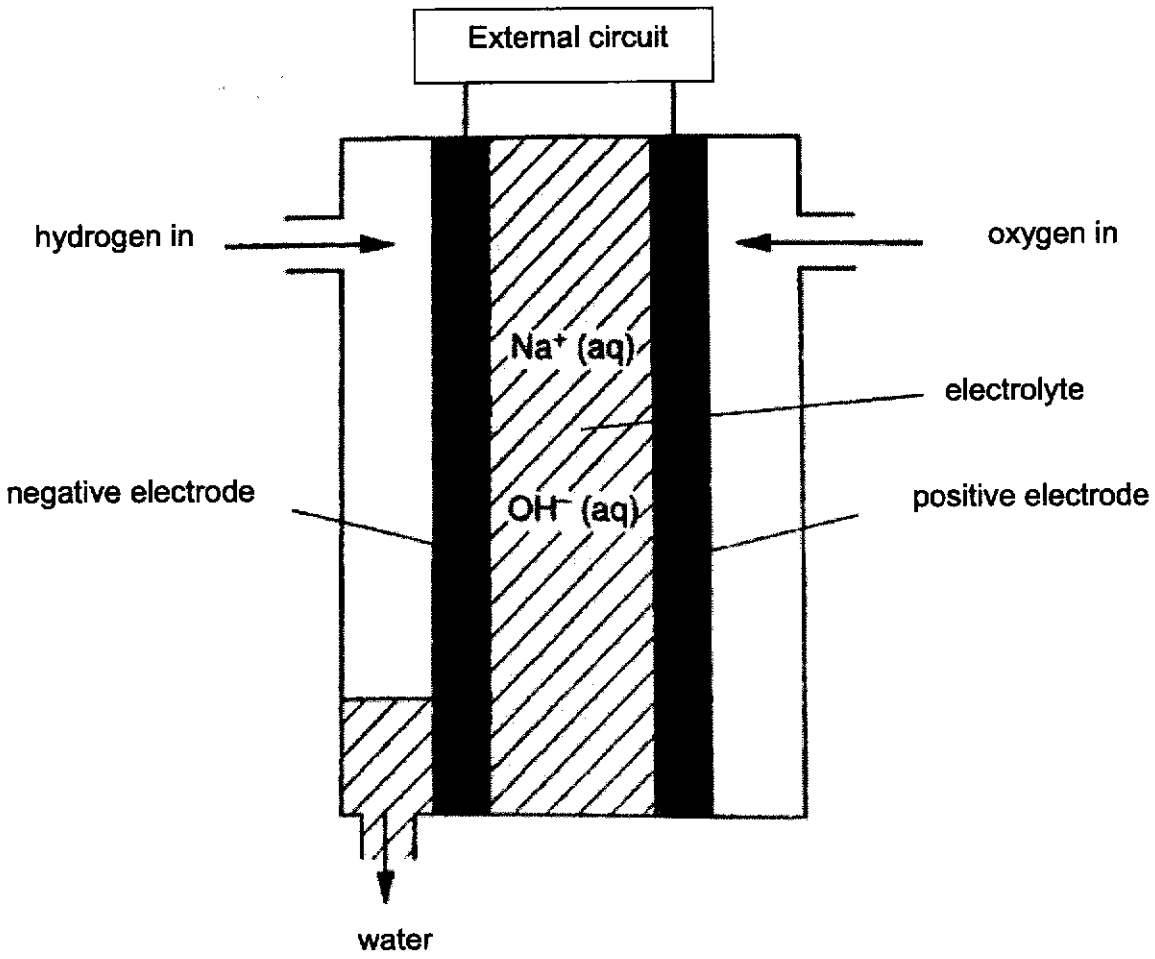
Or

B10 The NASA space shuttle uses fuel cells to generate electricity. The diagram below shows hydrogen and oxygen fuel cell.



(a) Complete the table below for the reactions that happen in the fuel cell. [2]

electrode	**Ionic equation for reaction at the electrode**
positive	
negative	

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(b) The overall equation in the fuel cell is the reaction between hydrogen and oxygen to form water. A fuel cell uses 240 dm^3 of hydrogen. Calculate the volume of oxygen needed, and the mass of water formed. All gas volume are measured at to room temperature and pressure.

[2]

(c) Car manufacturers are also exploring the use of fuel cells for cars.

Two possible fuels for use in fuel cells that manufacturers are considering are hydrogen and octane, C_8H_{18}.

fuel	**boiling point/ °C**	**Density at room temperature and pressure in g/dm^3**	**Enthalpy change when 1 mole of fuel is completely burned in kJ/ mol**	**Enthalpy change when 1 kg of fuel is completely burned in kJ/ kg**
hydrogen	-252	0.083	-286	
octane	128	0.703	-5075	

The table gives the values for the energy change of combustion for each fuel in kJ/mol.

Complete the table by calculating the enthalpy change when 1 kg of each fuel is completely burned.

Use the space below to show your working. [2]

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(d) Use the information in the table to evaluate the use of hydrogen and octane as fuels. Your answer should consider

- ease of storage;
- the energy content of the fuels. [3]

.....

.....

.....

.....

.....

.....

(e) Some people think that hydrogen is a completely non-polluting fuel.
Explain why this is incorrect.

.....

.....[1]

[Total: 10]

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
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 –	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	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89 – 103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

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 –	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 –	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 –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

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Fuchun Secondary School

Secondary 4 Express

Chemistry (6092)

Prelim Examination P1 & P2 2020

Marking Scheme

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

Section A	Answer	Marks	
1ai	P_4O_6	1	
1aii	P_2O_3	1	
1b	property 1: It is a non metallic oxide property 2: It is a covalent molecule which has **weak intermolecular forces of attraction between the molecules which** requires little energy. property 3:It **does not have mobile ions or electrons** to carry electric charge.	1 1 1	
2a	Chlorine: Cl_2 Ammonia: NH_3 Hydrogen chloride - 36.5	•√√√ 3 √√ 2	
2bi	ammonia	1	
2bii	hydrogen chloride	1	
2biii	ammonia with a **smaller molecular mass** of 17 **diffuses faster** than hydrogen chloride whose molecular mass is 36.5.(must quote values)	2	
3a	calcium	1	
3b	7		
3c	4		
3d	114, 172, 114 114, 175, 114	1 1	
3ei	malleable/durable, conductor of electricity, high mpt/bpt, high density, shiny (any two)	1	

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3eii	It reacts with acids to form salt and water.	1	
4 a	copper	1	
4b	colour of metal: orange brown colour of solution: colourless	1 1	
4c	most reactive: zinc tin least reactive: metal x/copper	1	
4d	$Zn(s) + Sn^{2+}(aq) \rightarrow Sn(s) + Zn^{2+}(aq)$	1	
5a	$\mathbf{N_2 + 3H_2 \rightarrow 2NH_3}$ According to the eqn, **1 mole of hydrogen reacts with 3 moles of nitrogen.** Since 1 mol of any gas occupies $24dm^3$ at rtp, the mole ratio is equal to the volume ratio.	1 1	
5b	iron	1	
5c	higher than nitrogen and hydrogen	1	
5d	to increase the yield of ammonia	2	
5ei	higher pressure leads to **more successful collisons per unit time** leading **to faster rate of reaction** which will produce a higher yield of ammonia	1 1	
5eii	At lower temperature, **proportion of particles with energy greater or equal to Ea will be lesser**, leading to **lesser successful collisions** per unit time and cause a **slower rate** of reaction.	1 1	
5f	no of moles of hydrogen : 3/2 mole = 1.5×10^6 mole no of moles of ammonia: $(1.5 \times 10^6 / 3) \times 2 = 1.0 \times 10^6$ mole mass of ammonia : $1 \times 10^6 \times 17 = 17$ tonnes	1 1	
6a	chlorine	1	
6b	$Fe(OH)_2$, iron (II) hydroxide	1, 1	
6c	$FeCl_3$ (Iron (III) chloride)	1	
6d	Iron (II) chloride, $FeCl_2$	1	
6e	A: reducing agent B: oxidising agent	1 1	
7a	iron	1	
7b	$ZnS + O_2 \rightarrow ZnO + SO_2$	1	
7c	It dissolves in rainwater to form acid rain which might increase the acidity of soil and destroy crops	1	
7d	to remove acidic impuriites	1	

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7e	Metal ores are finite resources. Fewer landfills needed to dispose off scrap metal	1 1	
7f	zinc is more reactive than iron and will provide sacrificial protection/ corrodes in place.	1	
	Section B		
8ai	Mg^{2+}, SO_4^{2-}	1	
8aii	Fe^{2+}, Mn^{2+}, Zn^{2+}, Cu^{2+}	1	
8bi	H_2S is **oxidised** to S as it **loses hydrogen.** O_2 is **reduced** to H_2O as **it gains oxygen** oxidised – loses hydrogen/ reduced – gain of H 2m correct species 1m	3	
8bii	energy profile diagram of exothermic reaction enthalpy -1m activation energy 1m correct reactants/products and energy levels-1m	3	
8c	Chemosynthesis uses chemical energy by products: Glucose and sulfur H_2S oxidized to S CO_2 reduced to glucose photosynthesis uses light energy by products: glucose and oxygen water is oxidized to oxygen carbon dioxide is reduced to glucose	1 1 1 1 1	
9ai	no of moles of sodium carbonate= 2.5/106= 0.02358 moles concentration in mol/dm^3 = 0.02358/200 x 1000=0.1 mol/dm^3	1 1	
9aii	downward curve should not reach zero	1	

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9bi	When the concentration of sodium carbonate increases, the **frequency of successful collisons per unit time increases**. The **rate of reaction increases.**	1 1	
9bii	new curve should be shifted inwards and labelled	1	
9c	must draw conical flask set up must draw collection of gas by gas syringe/ stopwatch to take time	1 1	
either 10a	P: $Cu \rightarrow Cu^{2+} + 2e$ Q: $Ag \rightarrow Ag^{+} + e$ R: $4OH^{-} \rightarrow 2H_2O + O_2 + 4e$	1 1 1	
10bi	No of moles of Cu lost = 0.81/64 = 0.127 No of moles of Ag lost = 2.70/108 = 0.25	1 1	
10bii	for every **1 mole of electrons, 1 mole of silver** is discharged to become silver ions but **only ½ mole of copper** is discharged. or The ratio of Ag : Cu in terms of electrons given off is 2 : 1	1 1 1 1	
10ci	Initial increase is because the lead form lead sulfate layer when lead reacted with the sulfuric acid formed. the insoluble layer then prevents further reaction of the anode so the electrolysis stopped.	1 1	
10d	Iron is more reactive than silver so it displaces silver from its salt solution. gold is less reactive than silver so no displacement	1	
either			
10a	positive: $0_2 + 2H_20 + 4e \rightarrow 4OH^{-}$ negative: $2H_2 + 4\ OH^{-} \rightarrow 4\ H_2O + 4e$	1 1	
10b	$2H_2 + O_2 \rightarrow 2H_2O$ no of moles of hydrogen= 240/24= 10moles no of moles of oxygen = 5 moles vol of oxygen = 5 x 24dm^3 =120 dm^3 no of moles of water= 10 moles mass of water formed= 10 x 18= 180g	 1 1	

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10c	Mass/Mr = 1000g/2 = 500mol Ikg of hydrogen =- 286 kJ/mol x 500 mol = -143000KJ of energy For Octane 1000g/ 114 = 8.772 mol 1 kg of octane = 8.772 x -5075KJ= -44518KJ of energy	1 1	
10d	hydrogen is a gas and octane is a liquid at rt. So it is more difficult to store and transport hydrogen ags than liquid octane needed. hydrogen has a higher energy output compared to octane. But larger volumes of hydrogen are needed compared to octane.	1 1 1	
10e	Hydrogen is produced by the cracking of alkanes which requires the usage of fossil fuels that might cause the release of carbon dixoide when they undergo combustion. Carbon dioxide is a greenhouse gas that can cause global warming that leads to climate change.	1	

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