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CONVENT OF THE HOLY INFANT JESUS SECONDARY
Preliminary Examination in preparation for
the General Certificate of Education Ordinary Level 2021

CANDIDATE NAME

CLASS

REGISTER NUMBER

CHEMISTRY

6092/01

Paper 1 Multiple Choice

14 September 2021

1 hour

Additional Materials: Multiple Choice Answer Sheet

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 Multiple Choice Answer Sheet provided.

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

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 on the question paper.
A copy of the Periodic Table is printed on page 16.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **15** printed pages and **1** blank page.

[Turn over

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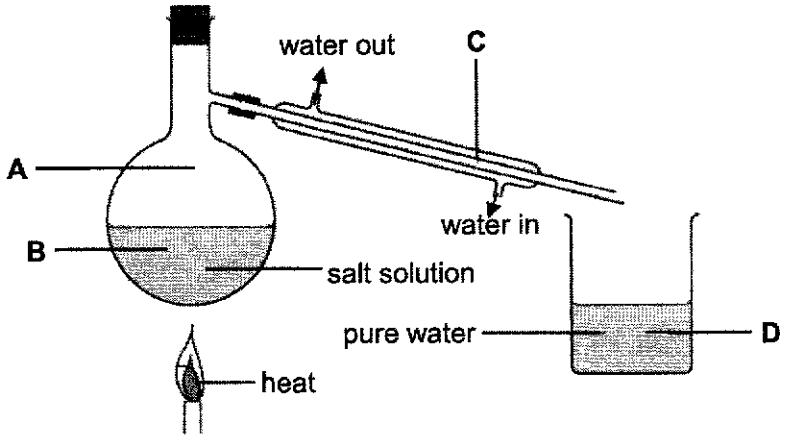
1 The diagram shows how to obtain pure water from salt solution.

Where do water molecules lose energy?



2 A sample of air was passed through aqueous calcium hydroxide followed by concentrated sulfuric acid.

What gases are left in the sample of air?

A nitrogen, carbon dioxide and noble gases

B nitrogen, oxygen and noble gases

C nitrogen, water vapour and carbon dioxide

D oxygen, carbon dioxide and water vapour

3 The rate of diffusion of gas X (M_r = 20) and gas Y (M_r = 44) was compared at 30 °C and 70 °C.

Which would have the fastest rate of diffusion?

A gas X at 30 °C

B gas X at 70 °C

C gas Y at 30 °C

D gas Y at 70 °C

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4 Some students are asked to describe differences between liquids and gases.

Four of their descriptions are:

1 Both liquid and gas particles are disorderly arranged.
2 Gas particles are smaller than liquid particles.
3 Liquid particles vibrate about fixed positions.
4 When a force is applied, gas particles are able to move closer together.

Which descriptions are correct?

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

5 Two different food colourings, X and Y, are tested using chromatography.

The chemist carrying out the experiment forgot to complete her table of results, which is shown.

food colouring	colour of dye	distance travelled by the solvent front / cm	distance travelled by the dye / cm	R_f value
X	green / yellow	.....	green: 3.0 yellow: 3.1	green: 0.81 yellow: 0.83
Y	yellow / orange	3.5	yellow: 3.0 orange: 2.7	yellow: ..... orange: 0.77

Which row identifies the distance travelled by the solvent front for X and the R_f value of the yellow dye in Y?

	the distance travelled by solvent front for X	the R_f value of the yellow dye in Y
A	3.6	0.77
B	3.6	0.81
C	3.7	0.83
D	3.7	0.86

6 Which substance is best used to distinguish between sulfur dioxide gas and chlorine gas?

A aqueous potassium iodide
B dilute hydrochloric acid
C a glowing splint
D sodium nitrate solution

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7 Four particles are shown.

$^{16}_{8}O^{2-}$ $^{17}_{9}F^{-}$ $^{20}_{10}Ne$ $^{23}_{11}Na^{+}$

Which statement about all four particles is correct?

A They have the same number of electrons.

B They have the same number of neutrons.

C They have the same number of protons.

D They have the same number of protons and neutrons.

8 Which statement(s) about isotopes of the same element is/are correct?

1 They are atoms which have the same chemical properties because they have the same number of electrons in their outer shell.

2 They are atoms which have the same number of electrons and neutrons but different number of protons.

3 They are atoms which have the same number of electrons and protons but different number of neutrons.

A 2 only

B 3 only

C 1 and 2 only

D 1 and 3 only

9 The element X and Y form an ionic compound XY_3.

Given that X has 56 particles in the nucleus, which row shows the correct composition of an **ion** of X?

	number of protons	number of neutrons	number of electrons
A	26	30	26
B	26	30	23
C	30	26	26
D	30	26	28

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10 Which statements about sodium nitrate are correct?

1 It is an ionic compound.
2 It is a simple covalent compound.
3 It contains both ionic and covalent bond.
4 Its structure is held together tightly by intermolecular forces of attraction.

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

11 A compound contains oxygen and another element.

Which property of the compound would indicate that the bonds in it are ionic?

A It conducts electricity in solid state.
B It is insoluble in water.
C It has high melting point.
D It has low density.

12 An excess of nitric acid was added separately to the following substances:

reaction 1 36 g of magnesium
reaction 2 40 g of magnesium oxide, MgO
reaction 3 42 g of magnesium carbonate, $MgCO_3$

Which statement about the reaction is correct?

A The mass of magnesium nitrate formed would be the most in reaction 1.
B The mass of magnesium nitrate formed would be the most in reaction 2.
C The mass of magnesium nitrate formed would be the most in reaction 3.
D The mass of magnesium nitrate formed would be the same for all three reaction.

13 An excess of magnesium is added to 100 cm^3 of 1.0 mol/dm^3 hydrochloric acid.

What is the maximum volume of hydrogen evolved at room temperature and pressure?

A 1.2 dm^3 **B** 2.0 dm^3 **C** 2.4 dm^3 **D** 24 dm^3

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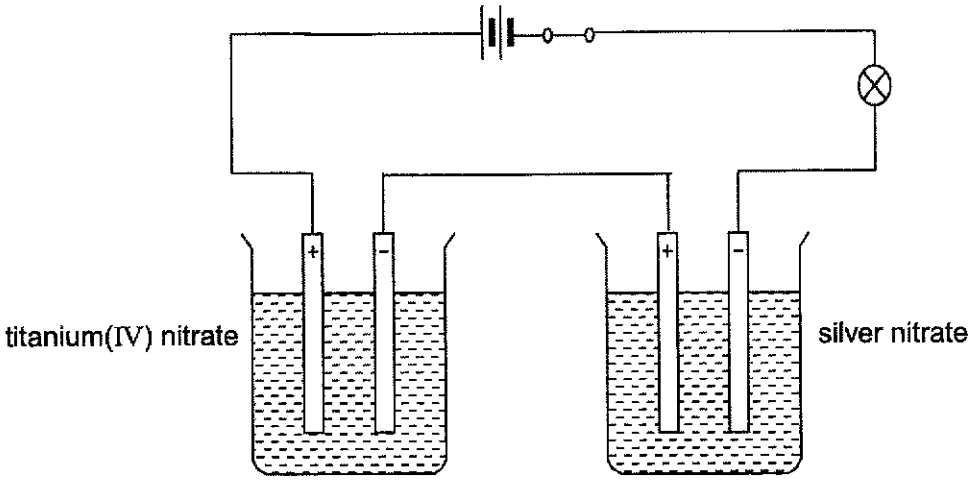
14 A current of electricity passes through two cells in series. One cell contains silver nitrate solution and the other contains titanium(IV) nitrate solution.

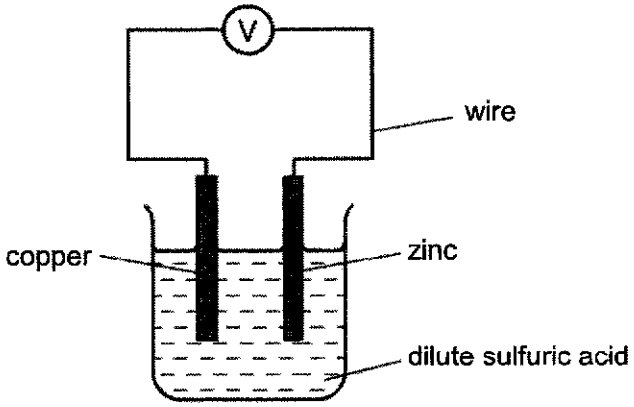


6.0 g of titanium is deposited on the cathode in the cell contains titanium(IV) nitrate solution.
[A_r: Ti, 48, Ag, 108]

What mass of silver is deposited in the cell containing silver nitrate?

A 6.8 g **B** 13.5 g **C** 27.0 g **D** 54.0 g

15 The diagram shows a simple cell.



Which statement about the simple cell is correct?

A Electrons flow from copper along the wire to zinc.

B Copper electrode decreases in size.

C The pH value of the electrolyte increases.

D Reddish-brown solid formed on the zinc electrode.

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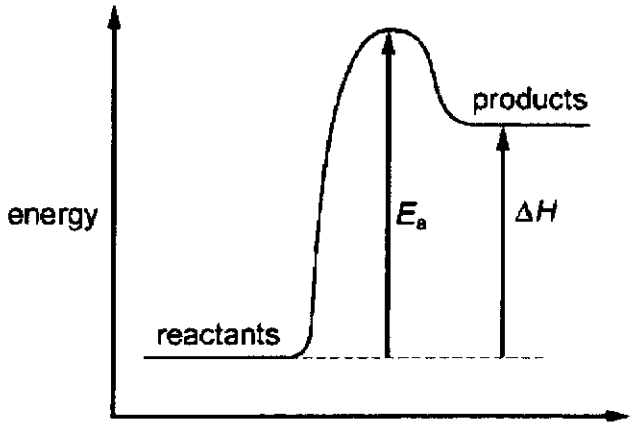
16 The energy profile diagram for a reaction is shown.



Which row is correct?

	sign of E_a	sign of ΔH	overall energy change
A	–	–	exothermic
B	+	+	endothermic
C	+	–	endothermic
D	–	+	exothermic

17 Which is an endothermic process?

A burning of hydrogen
B evaporation of seawater
C neutralisation
D reaction of sodium with water

18 Which row explain why increasing pressure increases the rate of reaction?

	particles collide more often	particles collide with more energy
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

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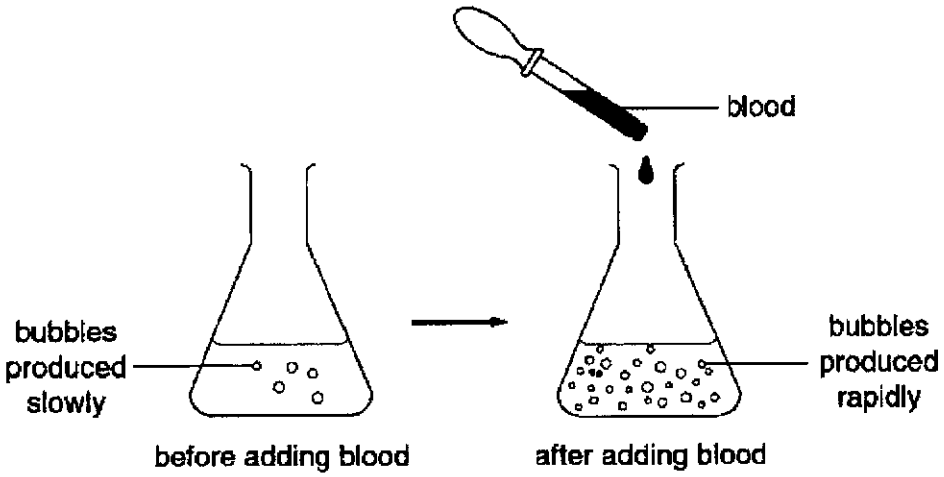
19 A solution of hydrogen peroxide releases oxygen slowly at room temperature.

The diagram show the effect of adding blood to the solution.



What could be the reason for the observed change?

A Blood contains an enzyme.

B Blood contains water.

C Hydrogen peroxide becomes more concentrated.

D Hydrogen peroxide is neutralised by blood.

20 The reaction between iron(II) ions and dichromate(VI) ion is represented by the equation:

$$Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+} \rightarrow 2Cr^{3+} + 7H_2O + 6Fe^{3+}$$

Which statement is correct?

A $Cr_2O_7^{2-}$ is oxidised.

B H_2O is the oxidising agent.

C H^+ is reduced.

D Fe^{2+} is the reducing agent.

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21 Which statement about strong acids are correct?

1 They have high concentration of hydroxide ions.
2 They have a pH value of 1.
3 They completely ionise in water.
4 They turn red litmus paper blue.

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

22 Which substance is able to change the pH of both a dilute acid and an alkali?

A calcium carbonate
B carbon monoxide
C sodium hydroxide
D zinc oxide

23 Which mixture of solids would react with dilute nitric acid to form two different gases?

A copper and magnesium carbonate
B copper(II) carbonate and magnesium oxide
C copper(II) carbonate and magnesium
D copper(II) oxide and magnesium carbonate

24 In an experiment to determine the concentration of hydrochloric acid, a student titrated 25.0 cm^3 of hydrochloric acid with 0.1 mol/dm^3 aqueous sodium hydroxide, using methyl orange as an indicator.

Which step would cause her calculated concentration of hydrochloric acid to be higher than its expected value?

A The burette was rinse with distilled water followed by aqueous sodium hydroxide.
B The conical flask was rinse with distilled water followed by hydrochloric acid.
C The titration reading was taken when methyl orange turns orange.
D Reading the burette at an angle.

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25 The table shows the pH ranges of an indicator, bromothymol blue.

colour of indicator	yellow		green		blue	
pH	4	5	6	7	8	9

The table shows the pH of four solutions.

solution	W	X	Y	Z
pH	3.0	5.0	7.0	9.0

Bromothymol blue was added to a solution in a beaker.

Which description will **not** result in a change in colour of the indicator?

A Indicator was added to solution Z and solution W was added to the mixture until in excess.

B Indicator was added to solution W and solution X was added to the mixture until in excess.

C Indicator was added to solution X and solution Y was added to the mixture until in excess.

D Indicator was added to solution Y and solution Z was added to the mixture until in excess.

26 The presence of nitrates in the soil can be shown by warming the soil with aqueous sodium hydroxide and aluminium foil.

Which observation shows that nitrates are present?

A Effervescence is observed.

B A gas that extinguishes a lighted splint with a 'pop' sound is produced.

C A gas that turns moist red litmus paper blue is produced.

D A white precipitate is seen.

27 Which statement about all alkali metals is correct?

A Their densities are lower than that of water.

B Their reactivity decreases down the group.

C They are strong reducing agents.

D They form insoluble hydroxide on reacting with water.

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28 Sodium, on the left of Period 2 of the Periodic Table, is more metallic than chlorine on the right of this Period.

Which statement explains why?

A Sodium has fewer electron shells than chlorine.

B Sodium has fewer protons than chlorine.

C Sodium has full shells of electrons.

D Sodium has fewer valence electrons than chlorine.

29 A new element, Yr, was discovered with the following properties.

solubility	electrical conductivity	formula of element	bonding in a molecule of the element
insoluble	does not conduct	Yr_2	Yr ≡ Yr

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

A Group III

B Group V

C Group VII

D Group 0

30 Transition elements can have variable oxidation states.

Which pair of compounds show a transition element in two different oxidation states?

A Co_2O_3 and $LiCoO_2$

B Cu_2O and $CuSO_4$

C K_2CrO_4 and CrO_3

D NiO and $Ni(NO_3)_2$

31 An inert gas X is used to fill tungsten light bulbs.

Which row correctly describe gas X?

	number of valence electrons in an atom of X	structure of gas X
A	2	single atoms
B	2	diatomic molecules
C	8	single atoms
D	8	diatomic molecules

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32 Which statement about the formation of molten iron from haematite in blast furnace is correct?

A Coke is used as a catalyst.

B Haematite consists of iron(II) oxide.

C Limestone is used to remove alkaline impurities.

D Molten slag is collected above molten iron.

33 The table gives information about the reactivity of three metals, P, Q and R.

metal	reaction with air	reaction with steam	reaction with acid
P	burns with flame	forms an oxide	forms hydrogen
Q	slowly forms an oxide	no reaction	no reaction
R	slowly forms an oxide	no reaction	forms hydrogen

What is the order of reactivity of P, Q and R?

	most reactive ⟶ least reactive		
A	P	Q	R
B	P	R	Q
C	Q	R	P
D	R	P	Q

34 Mild steel and stainless steels are two alloys containing the element iron.

Which row correctly states the use of mild steel and stainless steel?

	use of mild steel	use of stainless steel
A	car bodies	cutlery
B	car bodies	electrical wiring
C	cutting tools	cutlery
D	cutting tools	electrical wiring

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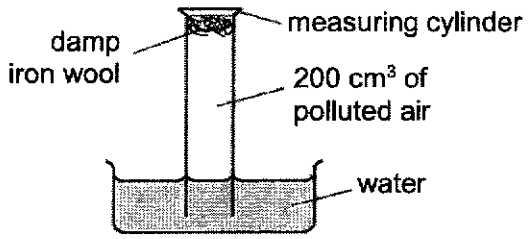
35 Element X displaces element Y from aqueous nitrate of Y. Hot element X does not react with cold water but react with steam to give hydrogen gas. Element Z reacts violently with water.

What could element X, Y and Z be?

	X	Y	Z
A	copper	iron	lithium
B	lead	copper	calcium
C	zinc	iron	sodium
D	magnesium	silver	lithium

36 An experiment to find the percentage of oxygen in 200 cm^3 of polluted air is shown.



The apparatus is left for one week. After this time, the volume of gas in the measuring cylinder is 164 cm^3.

What is the percentage of oxygen, to the nearest whole number, in the polluted air?

A 18% **B** 21% **C** 41% **D** 82%

37 The waste gases from a coal-burning power station are passed through powdered calcium carbonate to reduce air pollutants.

Which waste gas will not be removed by the powered calcium carbonate?

A carbon monoxide

B nitrogen dioxide

C phosphorus(V) oxide

D sulfur dioxide

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38 In the catalytic converter in the exhaust system of a car, harmful gases are converted into carbon dioxide, nitrogen and water.

Which processes take place in the catalytic converter?

1 Carbon monoxide reacts with hydrocarbons.

2 Carbon monoxide reacts with nitrogen monoxide.

3 Platinum and rhodium catalyse the redox reactions.

A 1 and 2 only

B 1 and 3 only

C 2 and 3 only

D 1, 2 and 3

39 One mole of hydrocarbon, X reacts with three moles of bromine to form a saturated organic compound.

What could be the molecular formula of X?

A C_3H_6

B C_4H_6

C C_5H_8

D C_6H_8

40 A food chemist wants to create the scent of pineapples in a product.
An ester with this scent has the formula ethyl butanoate.

Which pair of reactants would produce this ester?

A C_3H_7COOH and C_2H_5OH

B C_4H_9COOH and C_2H_5OH

C C_3H_7COOH and C_3H_7OH

D C_4H_9COOH and C_3H_7OH

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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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CONVENT OF THE HOLY INFANT JESUS SECONDARY
Preliminary Examination in preparation for
the General Certificate of Education Ordinary Level 2021

CANDIDATE NAME

CLASS

REGISTER NUMBER

CHEMISTRY

6092/02

Paper 2

31 August 2021

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer all **three** questions, the last question is in the form either/or.
Answer **all** questions in the spaces provided.

At the end of the examination, fasten all your work securely together.
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 20.

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

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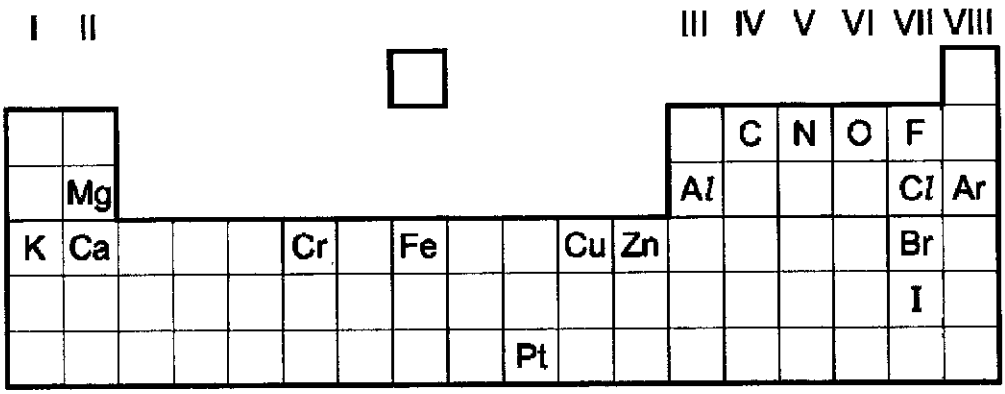
Section A

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

A1 The diagram shows part of the Periodic Table.



Answer the following questions using only the symbols of the elements in the diagram.
Each symbol may be used once, more than once or not at all.

Give the symbol of the element that:

(a) is used as a catalyst for the Haber process,

..... [1]

(b) is used as a catalyst in a catalytic converter,

..... [1]

(c) is used to define the relative atomic mass of elements,

..... [1]

(d) is a solid at room temperature and forms an ionic compound with sodium,

..... [1]

(e) forms an oxide which contributes to acid rain,

..... [1]

(f) forms an aqueous ion that gives a blue precipitate on addition of aqueous sodium hydroxide,

..... [1]

(g) reacts with cold water to form a solution that turns Universal indicator violet.

..... [1]

[Total: 7]

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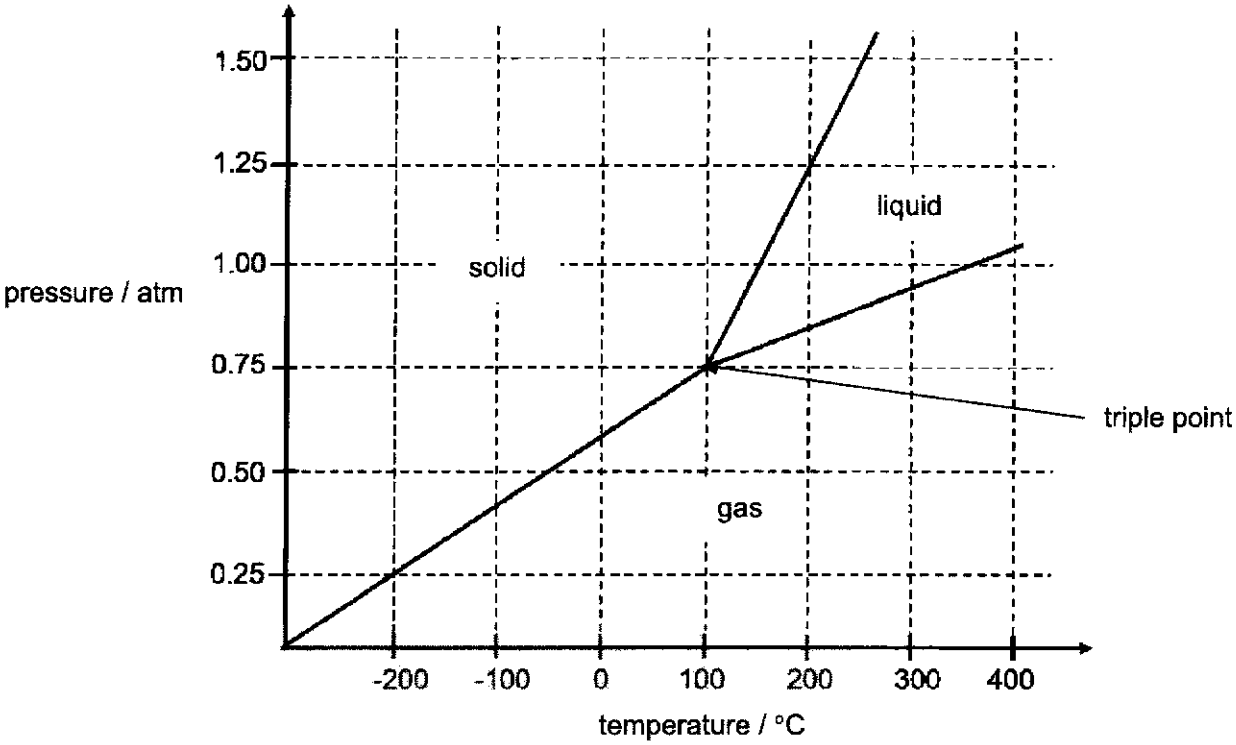
A2 A phase diagram is a graph of the physical states of a substance under different conditions of temperature and pressure. A phase change occurs when we cross the lines on the phase diagram.

The triple point is the point on the phase diagram at which all three distinct phases of matter (solid, liquid and gas) coexist.

The diagram shows the phase diagram for compound **X**.



(a) What is the physical state of compound **X** at room temperature 20 °C, and pressure at 1.00 atm?

..... [1]

(b) What is the melting point of compound **X** at 1.25 atm?

..... [1]

(c) Describe what would happen to the arrangement and movement of the particles in compound **X** when the temperature increase from –200 °C to 50 °C at a constant pressure of 0.50 atm?

.....

.....

.....

.....

..... [3]

[Total: 5]

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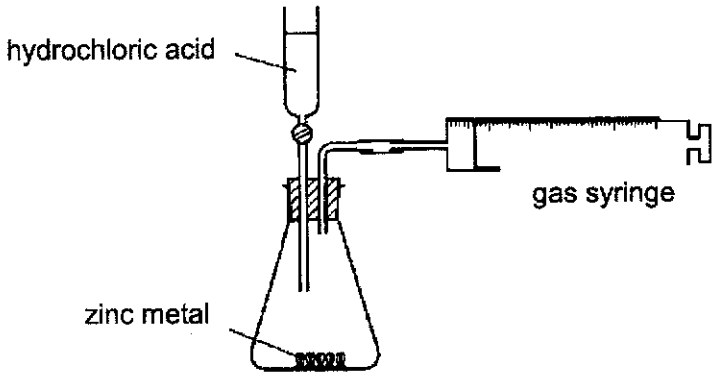
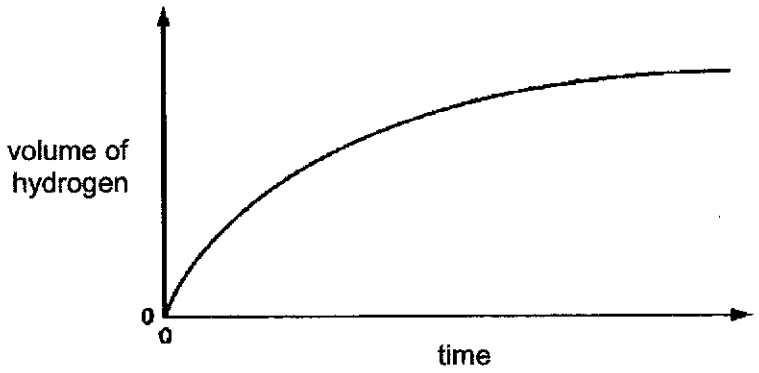
A3 Zinc metal reacts with dilute hydrochloric acid to produce the gas hydrogen.

A student added 1.0 mol/dm^3 hydrochloric acid to zinc in the apparatus shown below. Zinc metal is in excess.

The gas given off was collected and the total volume of gas was measured every minute.



The results of this experiment are shown on the graph below.



(a) Why does the speed of reaction vary with time?

.....

..... [2]

(b) The student repeat the experiment using same volume of 1.0 mol/dm^3 ethanoic acid instead of hydrochloric acid. Sketch the graph for this reaction on the same graph above.

[2]

(c) The reaction is catalysed by copper powder.

(i) How would you show that catalyst is not used up at the end of the reaction?

.....

..... [2]

(ii) Why is copper powder more effective as a catalyst than a strip of copper?

..... [1]

[Total: 7]

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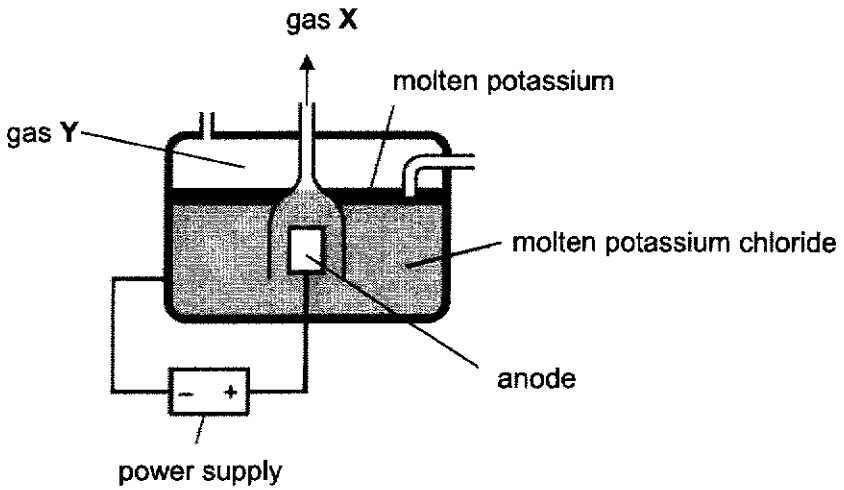
A4 Potassium metal is extracted from molten potassium chloride by electrolysis.

The diagram shows how the process works.



(a) The anode is inert. Suggest a suitable substance that can be used for the anode.

..... [1]

(b) Gas **X** is formed from the electrolysis.

(i) Identify gas **X**.

..... [1]

(ii) Write the ionic half-equation, with state symbols, for the reaction that forms gas **X**.

..... [1]

(c) Describe, with reference to the diagram, how you know that potassium is less dense than molten potassium chloride.

..... [1]

(d) Gas **Y** is pumped into the equipment to remove air before electrolysis begins.

(i) Suggest the identity of gas **Y**.

..... [1]

(ii) Explain why it is important that gas **Y** is present in the equipment.

.....

..... [1]

[Total: 6]

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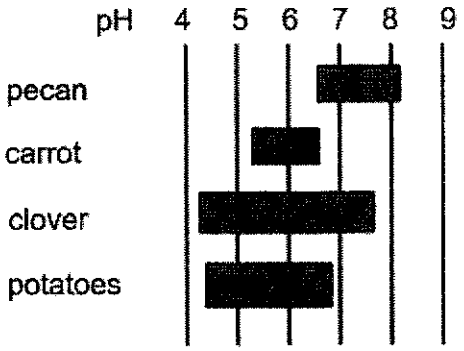
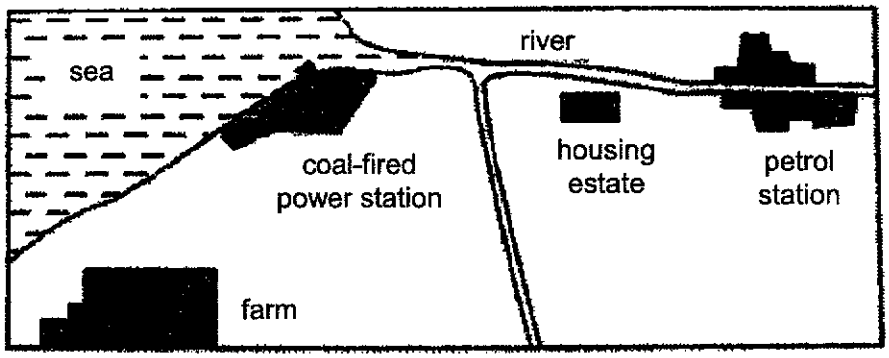
A5 The diagram shows the best pH ranges for growing different plants.



(a) Which two plants grow best in acidic conditions only?

..... [1]

(b) The diagram shows the map of a village. A farmer moved to the village recently and planted pecan and clover in her farm that has soil of pH 7.5.



(i) Initially, both pecan and clover plants grew well. However, after a few months, the farmer noticed that the pecan plants are dying but not the clover plants.

Suggest a reason for this observation.

.....

.....

.....

.....

..... [3]

(ii) Describe what the farmer can do to stop the pecan plants from dying.

Give a reason to support your idea.

.....

..... [2]

[Total: 6]

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A6 Chlorine, bromine and iodine are found in Group VII of the Periodic Table.

(a) Chlorine can be made in the laboratory by warming sodium hypochlorite with dilute hydrochloric acid.

$$NaOCl(s) + 2HCl(aq) \rightarrow Cl_2(g) + NaCl(aq) + H_2O(l)$$

A 4.47 g sample of sodium hypochlorite is added to 20.0 cm^3 of 4.00 mol/dm^3 hydrochloric acid.

Use calculations to decide which reagent, NaOC*l* or HC*l*, is in excess in this reaction.

Show your working and explain your answer.

excess reagent: .....

reason .....

.....

..... [4]

(b) $^{129}_{53}I$ is an isotope of iodine.

(i) Complete the table to show the number of each type of sub-atomic particles in an **ion** of $^{129}_{53}I$.

particles	number
protons	
electrons	
neutrons	

[2]

(ii) An oxide of iodine has a formula, I_2O_5.

Predict and explain the effect of adding Universal Indicator to an aqueous of solution this oxide.

effect on Universal Indicator .....

explanation ..... [2]

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(c) A student investigate the displacement reaction of halogen.

She added bromine water into separate test-tubes containing colourless solution of aqueous potassium chloride and aqueous potassium iodide respectively.

Table 4.1 shows her results.

Table 4.1

solution	observation upon addition of bromine water
potassium chloride	colourless solution turns brown
potassium iodide	colourless solution turns dark brown

The student makes this conclusion:

'Displacement reaction occurs in both potassium chloride and potassium iodide experiment because a new brown product is formed.'

Do you agree with the student? Use your knowledge of reactivity of halogens to explain your answer.

.....

.....

.....

.....

.....

..... [3]

[Total: 11]

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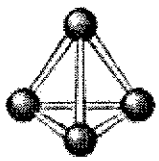
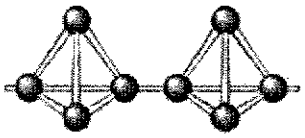
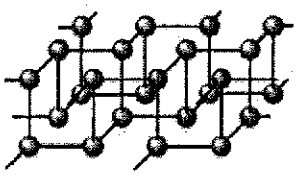
A7 **(a)** Phosphorus can exist in several allotropes that exhibit very different properties.

The boxes show the structures and melting points of the allotropes, white phosphorus, red phosphorus and black phosphorus.

white phosphorus	red phosphorus
	
melting point: 44.1 °C	**melting point:** 590 °C

black phosphorus



melting point: 416 °C

Compare the bonding and structure of the three allotropes.

.....

.....

.....

.....

.....

..... [4]

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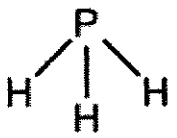
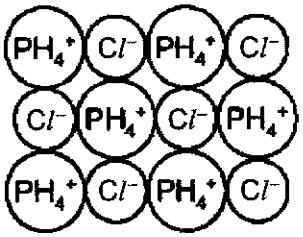
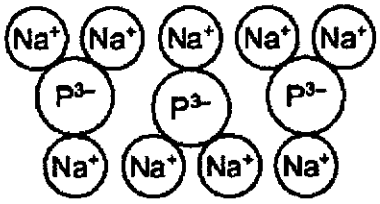
(b) The structures of some substances containing phosphorus are shown.



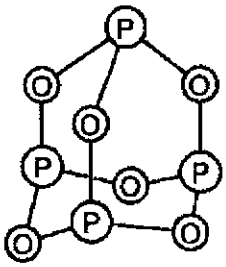
phosphine



phosphonium chloride



sodium phosphide



phosphorus trioxide

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

[2]

(ii) Using your understanding of bonding and structure, indicate if these statements are true or false.

Put a tick (✓) in one box in each row.

	true	false
Phosphonium iodide is a gas at room temperature.		
Sodium phosphide is very soluble in water.		
Phosphine has a lower melting point than phosphorus trioxide.		
Phosphorus trioxide has good electrical conductivity in any state.		

[2]

[Total: 8]

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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.

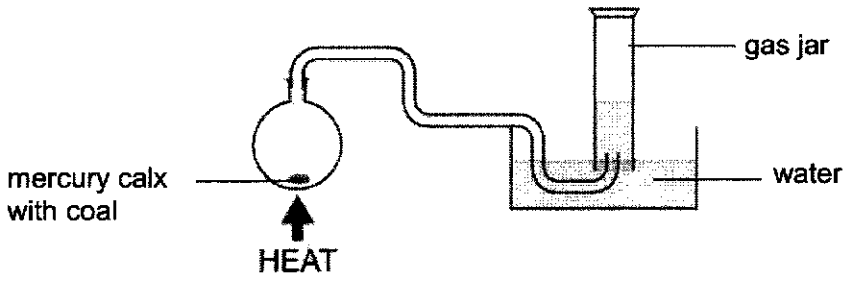
B8 Changing Chemistry from Qualitative to Quantitative Science

Oxygen Theory of Combustion

Antoine-Laurent de Lavoisier (1743 – 1794) was a French chemist who is most famous for changing chemistry from a qualitative to a quantitative science.

Lavoisier understood that elements combined with something in the air leading to a gain in their weight. In 1772, he conducted his first experiments on combustion. Lavoisier started by using mercury. When heated, mercury formed mercury red balls he called mercury calx. Then, he tried to perform some experiments on mercury calx to analyse it.

In his first experiment, Lavoisier placed an ounce of mercury calx and grains of coal in a round-bottomed flask with the neck of the flask extending into a tube. This mixture was heated as shown below. The end of the tube from the flask was placed into a tub of water with the opening of the tube directly underneath a semi-submerged gas jar. As gas is produced in the flask. The gas travels through the tube and into the gas jar, and the water level decreased. It was also noticed that the grains of coal had completely disappeared.



According to his scientific observations, Lavoisier suggested a colourless gas was released. The most important property of this gas was that a candle extinguished in its presence almost instantaneously. He called this gas "fixed air".

In his second experiment, Lavoisier decide to repeat the same experiment but this time, without the coal. It took him several hours more before the mercury calx shows signs of reaction. However, this time the gas released caused candles to burn with a very intense flame-brighter than in normal air. He named this gas "respirable air".

After analysing the results of both experiments, Lavoisier concluded that "fixed air" was composed of "respirable air" and coal.

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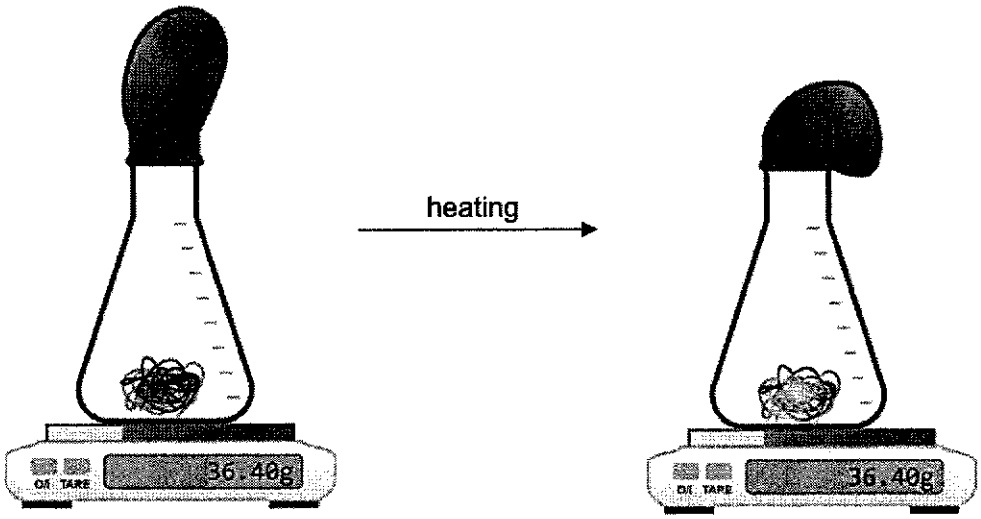
Law of Conservation of Mass

In 1789, Lavoisier discovered that mass is neither created nor destroyed in chemical reaction. He found that when a metal oxide is heated, its mass decreases and the oxygen released has the same mass as the mass lost by the metal oxide and vice versa. Lavoisier carefully measured the mass of reactants and products in many different chemical reactions. He carried out the reactions inside a sealed jar and in every case, the total mass of the jar and its contents was carefully measured.

One of the reactions that he did was to heat up a ball of grey steel wool. He used a balloon to seal up the conical flask and weigh the conical flask and its content before heating and after heating as shown below.

During heating, the steel wool glows with a bright flame. After heating, a reddish-brown solid was left inside the conical flask and the balloon was flaccid.



During the reaction, the iron in steel reacts with oxygen in the air inside the conical flask as follows:

$$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$$

Table 1 shows some data from the experiment.

Table 1

Mass of steel wool before heating	6.00 g
Mass of reddish-brown solid after heating	8.40 g

Source:

1. *https://flexbooks.ck12.org/cbook/ck-12-middle-school-physical-science-flexbook-2.0/section/5.18/primary/lesson/conservation-of-mass-in-chemical-reactions-ms-ps*
2. *http://www.chm.bris.ac.uk/webprojects2001/hossain/combustion.htm*

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(a) A calx is what we call a metal oxide today. Mercury calx is mercury(II) oxide.

Lavoisier's second experiment of mercury calx took longer than his first experiment.

Suggest a reason for this observation.

.....

.....

.....

..... [2]

(b) In the two experiments that Lavoisier performed on mercury calx, the gas that was produced in each experiment was different.

Write the chemical equations for the production of the gases.

experiment 1: .....

experiment 2: ..... [2]

(c) State the evidence to help Lavoisier conclude that "fixed air" was composed of "respirable air" and coal.

.....

.....

.....

..... [2]

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(d) When Lavoisier carried out the experiment with steel wool,

(i) how can he tell that oxygen is used up in the reaction?

.....

..... [1]

(ii) how can he tell that a new product is formed?

.....

..... [1]

(iii) what evidence is there to confirm that mass is neither created nor destroyed in this chemical reaction?

.....

..... [1]

(e) Use the data from the **Table 1** for this question.

Steel is an alloy of iron and carbon.

Calculate the percentage mass of carbon in the steel wool.

percentage mass of carbon ..... % [3]

[Total: 12]

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B9 **(a)** Both iron and steel have some typical metallic properties.

(i) Explain why both iron and steel have high melting points.
Refer to their bonding in your answer.

.....

.....

..... [2]

(ii) Explain why, when a force is applied to a piece of steel, it cannot be bent as easily as iron.

.....

.....

..... [2]

(b) Steel may be coated with another metal, zinc, or with a plastic.

(i) Suggest a property of the plastic that makes it suitable for this purpose.

..... [1]

(ii) Explain why the steel will rust when the protective coating of plastic is broken.

.....

..... [1]

(iii) When the protective layer of zinc is broken, the steel still does not rust.

Suggest an explanation.

.....

.....

..... [2]

[Total: 8]

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B10 Precipitation reaction involves mixing two solutions to form an insoluble solid that separates out from the reaction mixture.

(a) Preparation of insoluble lead(II) chloride is described below.

To 10 cm^3 of 1.0 mol/dm^3 aqueous lead(II) nitrate, 20 cm^3 of 1.0 mol/dm^3 aqueous sodium chloride is added. The mixture is filtered and the precipitate washed with deionised water to remove impurities. The precipitate is allowed to dry on pieces of filter paper.

(i) Write the chemical equation, with state symbols, for the reaction between lead(II) nitrate and sodium chloride.

..... [2]

(ii) Why is the volume of sodium chloride solution double that of the lead(II) nitrate solution.

.....

..... [1]

(iii) Suggest the name of an impurity that could be present on the precipitate.

..... [1]

(b) A student makes use of precipitation reaction to help determine whether aqueous chlorine or aqueous iodine is a more powerful oxidising agent.

To two test-tubes containing a solution of iron(II) ion, the student added aqueous chlorine and aqueous iodine separately. Aqueous sodium hydroxide is then added to each test-tube. The results are given in the table below.

	test tube with aqueous chlorine	test tube with aqueous iodine
after addition of a few drops of aqueous sodium hydroxide	reddish-brown precipitate formed	green precipitate formed.

(i) Name the reddish-brown precipitate.

..... [1]

(ii) Based on the results, which is a more powerful oxidising agent?

Give a reason for your answer.

.....

.....

.....

..... [2]

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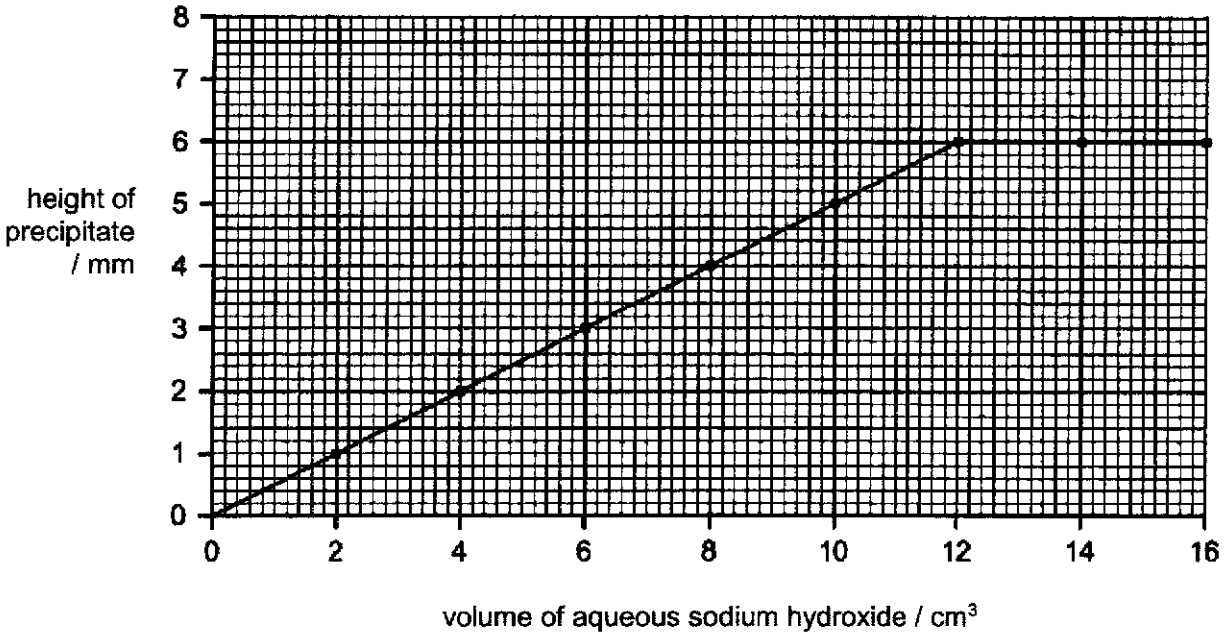
(c) 2.0 cm^3 portions of 1.0 mol/dm^3 aqueous sodium hydroxide were added to 4.0 cm^3 of 1.0 mol/dm^3 aqueous iron(III) nitrate. When the precipitate had settled, its height was measured.

The experiment was repeated using different volumes of aqueous sodium hydroxide. The results are shown on the following graph.



(i) Write the ionic equation for the reaction of aqueous iron(III) nitrate with aqueous sodium hydroxide.

..... [1]

(ii) On the same grid, sketch the graph that would have been obtained if 4.0 cm^3 of 1.0 mol/dm^3 zinc nitrate had been used instead of iron(III) nitrate, assuming that the maximum height of precipitate obtained is the same in both cases.

[2]

[Total: 10]

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OR

B10 **(a)** Some elements in Period 4 and some of their common oxidation states are shown below.

element	potassium	calcium	gallium	bromine	krypton
oxidation state	+1	+2	+3	−1	0

(i) What does it mean when the only oxidation state of an element is zero?

..... [1]

(ii) From Group I to III, oxidation states are positive and increases. Explain why.

..... [1]

(b) Manganese is a transition element. Transition elements have variable oxidation states. To investigate the variable oxidation states, a student added potassium permanganate solution to a mixture of glucose solution and sodium hydroxide.

During the reaction, manganese goes through a number of different oxidation states, each of which has a different colour.

MnO_4^-(aq) permanganate ion (purple) → MnO_4^{2-}(aq) manganate ion (green) → MnO_2(s) manganese dioxide (golden brown)

The student wrote this observation for the reaction.

> The colour change of the solution runs from purple to blue to green to orange-yellow and finally a suspension is obtained.

(i) Complete the table by filling in the missing oxidation state of manganese in permanganate ion and manganate ion.

substance	permanganate ion	manganate ion	manganese dioxide
oxidation state			+4

[1]

(ii) Is manganese being oxidised or reduced in the reaction performed by the student? Use oxidation states to explain your answer.

.....

..... [1]

(iii) The ionic half-equation for the reaction of manganate ion to form manganese dioxide is shown below.

$$MnO_4^{2-} + \ldots\ldots H_2O + \ldots\ldots e^- \rightarrow MnO_2 + \ldots\ldots OH^-$$

Complete the balancing of the ionic half-equation for this reaction. [1]

(iv) Explain why a suspension is obtained at the end of the reaction.

..... [1]

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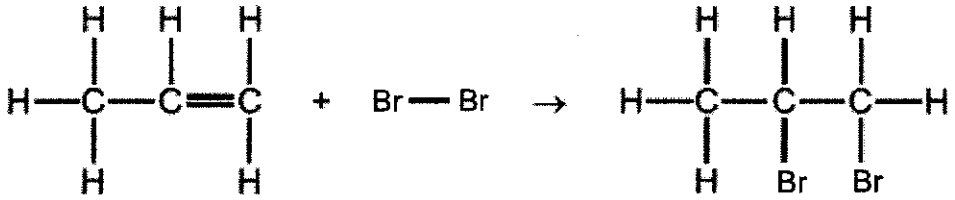
(c) Bromine reacts with propene as follows:



Bond energy is the amount of energy, in kJ, which must be supplied to break one mole of the bond.

Table 2 shows some of the bond energies involved.

Table 2

bond	bond energy in kJ/mol
H – H	436
H – Br	366
C – H	413
C – C	346
C = C	610
Br – Br	193

(a) Use the data in **Table 2**, calculate the overall enthalpy change of the reaction. You must show your calculations.

[3]

(b) Hence, state whether the reaction is endothermic or exothermic. Give a reason for your answer.

.....

..... [1]

[Total: 10]

End of Paper

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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		Key: proton (atomic) number / atomic symbol / name / relative atomic mass									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 –		

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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CHIJ SECONDARY (TOA PAYOH)

Preliminary Examination_2021

Sec 4E Chemistry 6092 **Mark Scheme & Comments**

Updated on 20/09/2021

Paper 1

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

Paper 2
Section A (50 marks)

Qn No		Answer	Marks	Total	Comment
A1	(a)	Fe	1	7	
	(b)	Pt	1		
	(c)	C	1		
	(d)	I	1		
	(e)	N	1		
	(f)	Cu	1		
	(g)	K or Ca	1		

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Qn No		Answer	Marks	Total	Comment
A2	(a)	solid	1	5	Quite well done.
	(b)	200 °C	1		Quite well done.
	(c)	• At –200 °C, particles are **closely packed in an orderly manner, vibrating about fixed position.** • When temperature increase, particles **gain (heat)energy and move faster.** • **At –50 °C,** particles have enough energy to **overcome forces of attraction** / break away (from their fixed position) • Particles are now spread **far part and moving about in any direction.** [4 points – 3m ; 3 points – 2m; 2 point – 1m]	3		• Answer required both description of arrangement and movement. • Answer requires identifying the sublimation point of –50°C.

Qn No		Answer	Marks	Total	Comment
A3	(a)	• Less reactants / reactants are used up [1] • Frequency / number of effective collision decreases [1]	2	7	Not well done. This question is NOT about limiting reagent.
	(b)	• Gentle initial slope / below the original graph [1] • Same final point [1]	2		
	(ci)	• Weigh / measure the mass of the copper powder **before and after** the experiment. [1] • The mass of copper powder **remains the same.** [1]	2		
	(cii)	Larger (total) surface area	1		Well done.

Qn No		Answer	Marks	Total	Comment
A4	(a)	Graphite OR platinum	1	6	
	(bi)	Chlorine.	1		
	(bii)	$2Cl^-(l) \rightarrow Cl_2(g) + 2e^-$	1		Not well done. State symbol for chloride ion is (l) because it is in molten state.
	(c)	Potassium floats on top of potassium chloride	1		Well done.
	(d)	Any noble gas (Helium / Argon / Neon) Provides an **inert atmosphere** that **prevents oxidation** / reaction with oxygen of the potassium metal	1 1		Accept: inert gases / unreactive gases

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Qn No		Answer	Marks	Total	Comment
A5	(a)	Carrots and potatoes	1	6	
	(b) (i)	**Sulfur dioxide** released from the power station [1] Dissolves in rain water **to form acid rain** which make the soil too acidic / pH less than 6.5. [1] Pecan cannot grow well in soil less than pH 6.5, however clover can grow well in soil less than pH 6.5. [1]	3		REJECT: carbon dioxide. ACCEPT: Other ways soil can get acidic (acidic seawater deep into soil) Required to mention the soil is too acidic (pH6.5) for pecan.
	(b) (ii)	Farmer can add quicklime (calcium oxide) / slaked lime (calcium hydroxide) to treat the soil. [1] Excess acids will be **neutralised** causing the pH of the soil to raise. [1]	2		ACCEPT: calcium carbonate. Required to mention "neutralize".

Qn No		Answer	Marks	Total	Comment
A6	(a)	Mr of NaOC*l* = 23 + 16 + 35.5 = 74.5 No. of mol NaOC*l* = 4.47 / 74.5 = 0.06 mol No. of mole of HC*l* = (20/1000) x 4 = 0.08 mol Excess is NaOCl (no marks) Because 0.08 mol of HCl only need 0.04 mol of NaOCl but there is 0.06 mol of NaOCl.	1 1 1 1	11	
	(bi)	particles / number protons: **53** electrons: **54** neutrons: **76** 3 correct – 2 marks 2 correct – 1 mark	2		
	(bii)	(Green to)red / pink / orange / yellow Iodine is a **non-metal,** it will form **acidic oxide**	1 1		
	(c)	Do not agree with student (no marks) Displacement reaction occurs with potassium iodide as **bromine is more reactive than iodine.** Displacement reaction did not occur in potassium **chloride as chlorine is more reactive than bromine.** Brown colour for potassium chloride is due to bromine, reddish-brown colour for potassium bromide is due to iodine.	1 1 1		

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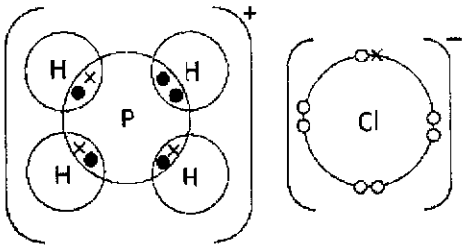
Qn No		Answer	Marks	Total	Comment
A7	(a)	In all allotrope, each phosphorous atom **is covalently bonded to other phosphorus atom.** White phosphorus has a **simple molecular structures**; with **(weak) intermolecular forces of attraction** between molecules. Red phosphorus and black phosphorus has **a giant molecular structures**;	1 1 1 1	8	ACCEPT: Mention of covalent bond. REFECT: Simple covalent bond / Giant lattice structure.
	(bi)	 • Correct number of shared electrons between phosphorus and hydrogen and correct charge [1] • Correct number of valence electrons (2 symbols) for chloride ion and correct charge [1] [3 points – 2m ; 2 points – 1m]	2		Common error is the diagram for phosphonium ion.
	(bii)	False; True: True: False	2		Quite well done.

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Section B (30 marks)

Qn No		Answer	Marks	Total	Comment
B8	(a)	In the first experiment, **coal acts as a reducing agent** to reduce mercury(II) oxide to mercury. [1] In the second experiment, **a lot of energy is** required to break the bond between mercury and oxygen. / **decomposition reaction requires a lot of energy** [1]	2	12	NOT coal acts as a catalyst as different products were produced in the 2 experiments.
	(b)	$2HgO + C \rightarrow 2Hg + CO_2$ (Gas is carbon dioxide) Accept: $HgO + C \rightarrow Hg + CO$ (Gas is carbon monoxide) [1] **AND** $2HgO \rightarrow 2Hg + O_2$ Gas is oxygen. [1]	2		
	(c)	In the first experiment, the coal had completely disappeared and that "fixed air" had been produced [1] In the second experiment **without coal**, only "respirable air" was produced [1]	2		REJECT Explanation NOTE: Evidence is required NOT Only difference between the product of the 2 gases is the presence of carbon. Therefore fixed air is composed of respirable air and coal
	(di)	The balloon reduces/decreases in size.	1		ALLOW: deflate, balloon becomes flaccid.

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	(dii)	The **reddish-brown product** is **different colour** than the grey steel wool / bright light is produced indicating a chemical reaction has occur	1		ALLOW:
	(diii)	The mass of the system before the reaction is the same as after the reaction.	1		ALLOW: total mass remains the same/ is constant throughout the experiment
	(e)	Mass of oxygen in iron(III) oxide = 8.40 – 6 = 2.4g [1] Number of moles of oxygen atom = 2.4 / 16 = 0.15 mol Number of moles of iron atom present = 0.15 / 3 x 2 =0.1 mol [1] Mass of iron present = 0.1 x 56 = 5.6g Mass of carbon = 6.0 – 5.6 = 0.4 g Percentage mass of carbon = (0.4/6.0) x 100% **= 6.66% (3sf)** [1]	3		ALLOW $4Fe + 3O_2 \rightarrow 2Fe_2O_3$ Mass of oxygen used = 8.40 – 6 = 2.4g [1] Number of moles of oxygen gas = 2.4 / 2(16) = 0.075 mol Number of moles of iron reacted 4 / 3 x 0.075 =0.1 mol [1] Mass of iron present = 0.1 x 56 = 5.6g Mass of carbon = 6.0 – 5.6 = 0.4 g Percentage mass of carbon = (0.4/6.0) x 100% = 6.66% (3sf) [1]

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Qn No		Answer	Marks	Total	Comment
B9	(a) (i)	• Strong electrostatic forces of attraction / metallic bonding between positive metal ions and 'sea of mobile electrons' [1] • Large amount of energy required to break / overcome these strong bonds [1]	2	8	Reject; Both steel and iron are metallically bonded. Metallically-no such word
	(a) (ii)	• Atoms of different size disrupt the regular arrangement of the atoms [1] • Atoms cannot slide over reach other easily (when a force is applied) [1]	2		Reject: Atoms cannot slide over each other
	(b) (i)	Waterproof / impervious / flexible	1		Reject: 1) resistant (able to resist the penetration of water to some degree not entirely) 2) plastic will not react chemically with oxygen and water,
	(b) (ii)	Exposure to water and oxygen (air)	1		Allow steel reacts with water and oxygen
	(b) (iii)	• Zinc more reactive than iron / zinc forms ions more readily than iron • Oxygen and water reacts with zinc not iron (idea of sacrificial protection)	2		Allow: 1)Zinc corrode in place of iron 2) zinc oxidise in place of steel Reject: Zinc is more reactive. Note; must mention zinc is more reactive than iron **Reject** zinc is more reactive than steel.. **MISTAKE** Zinc oxidise to form a layer ooide(zinc oxide to prevent steel from coming in contact with the moisture

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Qn No		Answer	Marks	Total	Comment
B10 Either	(a) (i)	$Pb(NO_3)_2(aq) + 2NaCl(aq) \rightarrow PbCl_2(s) + 2NaNO_3(aq)$ [1] balanced chemical equation [1] correct state symbols	2	10	
	(a) (ii)	Mole ratio Pb^{2+}: Cl^- is 1:2 [1] Answer must mention moles [accept argument based on charges or number of ions]	1		
	(a) (iii)	Sodium nitrate / sodium chloride / lead(II)nitrate	1		
	(b) (i)	Iron(III) hydroxide	1		
	(b) (ii)	Aqueous chlorine (no marks) When aqueous chlorine is added to iron(II) solution, the iron(II) ion is oxidised to iron(III) ion. [1] When aqueous iodine is added to iron(II) solution, the iron(II) ion remains the same. [1]	2		ALLOW When aqueous iodine was added, there was no change in oxidation state,
	(c) (i)	$Fe^{3+} + 3OH^- \rightarrow Fe(OH)_3$	1		
	(c) (ii)	Peak at 8 cm^3 of NaOH [1] Drop to zero mm [1]	2		Very poorly answered

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Qn No		Answer	Marks	Total	Comment
B10 OR	**(ai)**	Does not form compounds / does not accept and does not lose electrons / has full outer shell / it is a noble gas	1		**ALLOW** -does not form ions -belong to Group O/VIII/monqtomic -unreqctive
	(aii)	Number of electrons **lost is more** across Group I to III.	1		
	(bi)	permanganate ion: +7 manganate ion: +6	1		
	(bii)	Reduced (no marks). The oxidation state of manganese **decreases from +7** in permanganate ion to **+4** in manganese dioxide.	1		
	(biii)	MnO_4^{2-} + $\underline{2H_2O}$ + $\underline{2e^-}$ → MnO_2 + $\underline{4OH^-}$	1		
	(biv)	Manganese dioxide is displaced from the solution / precipitated out of the solution as **a solid**	1	**10**	Allow Manganese dioxide is a solid/ **precipitate**.
	(c) (i)	Energy absorbed for bond breaking = 610 + 193 = 803 kJ [1] Energy given out for bond forming = 346 + (366 x 2) = 1078 kJ [1] Enthalpy change of reaction = 803 – 1078 = **– 275 kJ [1]**	3		1 mark deducted if did not explain / write Energy absorbed for bond breaking Energy given out for bond forming
	(c) (ii)	(ECF from ci) Reaction is exothermic (no marks) as enthalpy change is negative OR more energy is given out for bond forming than taken in for bond breaking.(1)	1		

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