

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.

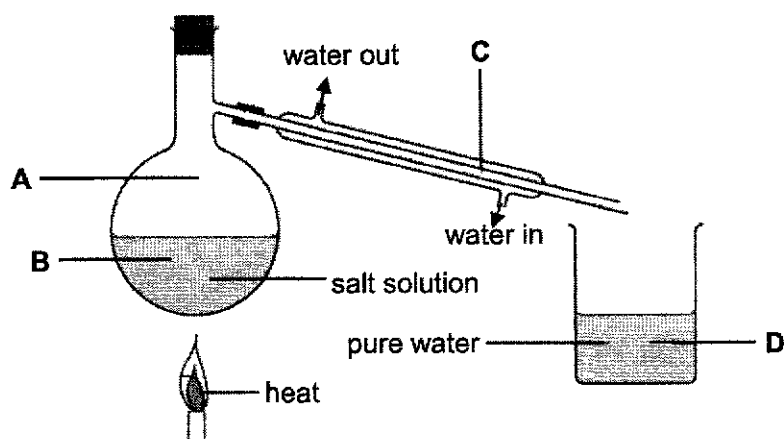
This document consists of **15** printed pages and **1** blank page.

[Turn over

2

- 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

3

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

[Turn over

7 Four particles are shown.



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

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, MgCO₃

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 cm³ of 1.0 mol/dm³ hydrochloric acid.

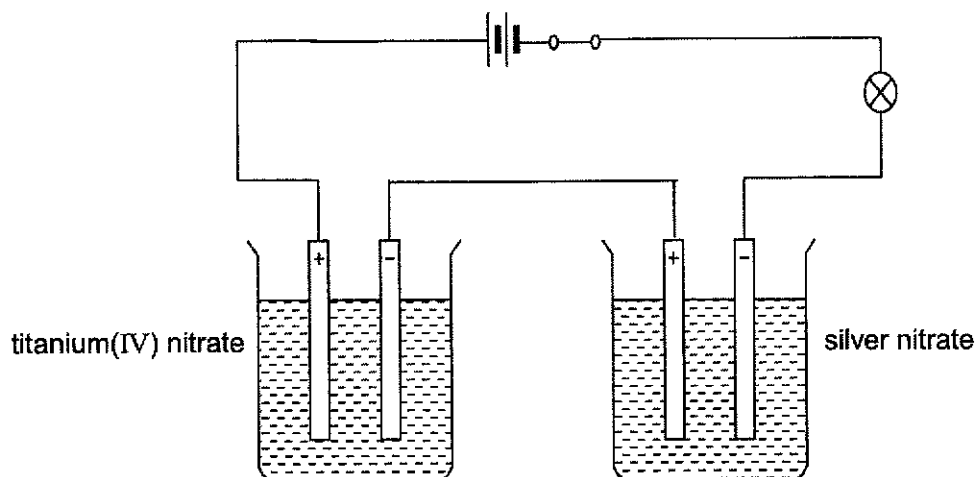
What is the maximum volume of hydrogen evolved at room temperature and pressure?

- A 1.2 dm³ B 2.0 dm³ C 2.4 dm³ D 24 dm³

[Turn over

6

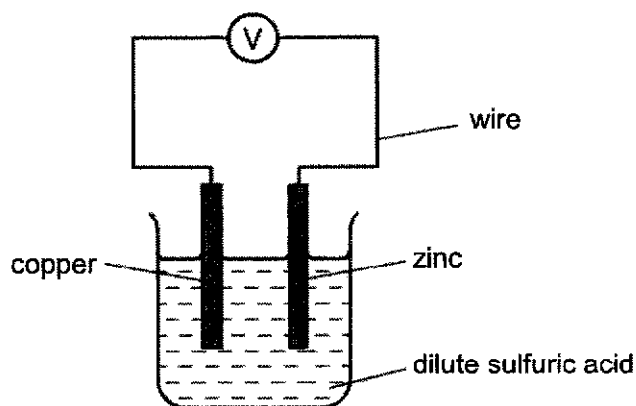
- 14 A current of electricity passes through two cells in series. One cell contains silver nitrate solution and the other contains titanium(IV) nitrate solution.



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

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

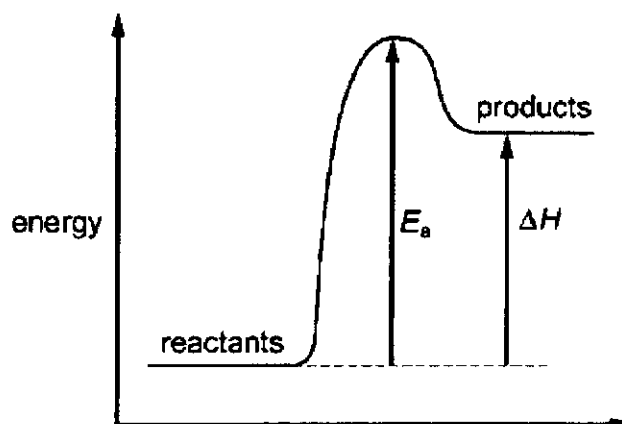
- A 6.8 g B 13.5 g C 27.0 g D 54.0 g
- 15 The diagram shows a simple cell.



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.

- 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

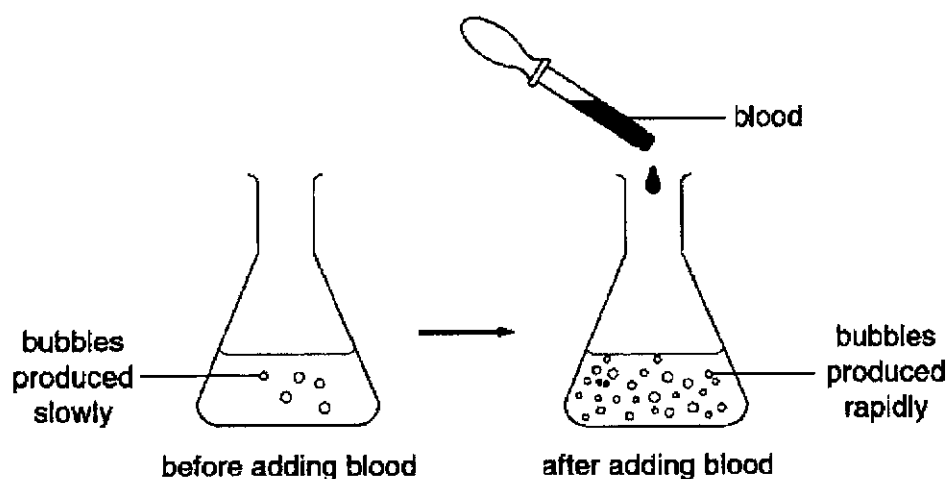
- 18 Which row explain why increasing pressure increases the rate of reaction?

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

[Turn over

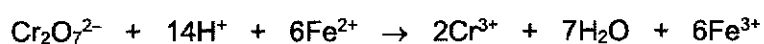
- 19 A solution of hydrogen peroxide releases oxygen slowly at room temperature.

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:



Which statement is correct?

- A $\text{Cr}_2\text{O}_7^{2-}$ is oxidised.
- B H_2O is the oxidising agent.
- C H^+ is reduced.
- D Fe^{2+} is the reducing agent.

- 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 cm³ of hydrochloric acid with 0.1 mol/dm³ 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.

[Turn over

- 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.

- 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 Co₂O₃ and LiCoO₂
 B Cu₂O and CuSO₄
 C K₂CrO₄ and CrO₃
 D NiO and Ni(NO₃)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

[Turn over

- 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		R
B	P		Q
C	Q		P
D	R		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?

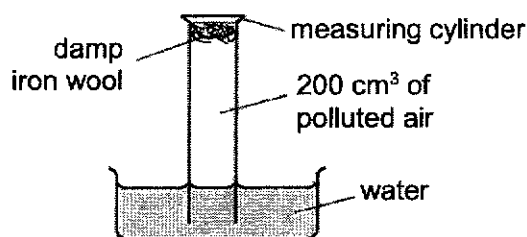
	use of mild steel	use of stainless steel
A	car bodies	cutlery
B	car bodies	electrical wiring
C	cutting tools	cutlery
D	cutting tools	electrical wiring

- 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 cm³ 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 cm³.

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 powdered calcium carbonate?

- A** carbon monoxide
B nitrogen dioxide
C phosphorus(V) oxide
D sulfur dioxide

[Turn over

- 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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[Turn over

The Periodic Table of Elements

Group																																																																							
I	II	III										IV	V	VI	VII	0																																																							
3 Li lithium 7	4 Be beryllium 9	11 Na sodium 23	12 Mg magnesium 24	19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84	37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium 98	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131	55 Cs caesium 133	56 Ba barium 137	57-71 lanthanoids	58 Fr francium	59 La lanthanum 139	60 Ce cerium 140	61 Pr praseodymium 141	62 Nd neodymium 144	63 Pm promethium	64 Sm samarium 160	65 Eu europium 152	66 Gd gadolinium 157	67 Tb terbium 159	68 Dy dysprosium 163	69 Ho holmium 165	70 Er erbium 167	71 Lu lutetium 175	72 Th thorium 232	73 Ac actinium 231	74 Pa protactinium 231	75 U uranium 238	76 Np neptunium	77 Pu plutonium	78 Am americium	79 Cm curium	80 Bk berkelium	81 Cf californium	82 Es einsteinium	83 Fm fermium	84 Md mendelevium	85 No nobelium	86 Lr lawrencium

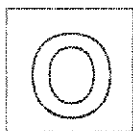
1
H
hydrogen
1

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

lanthanoids

actinoids

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



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Preliminary Examination in preparation for
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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.

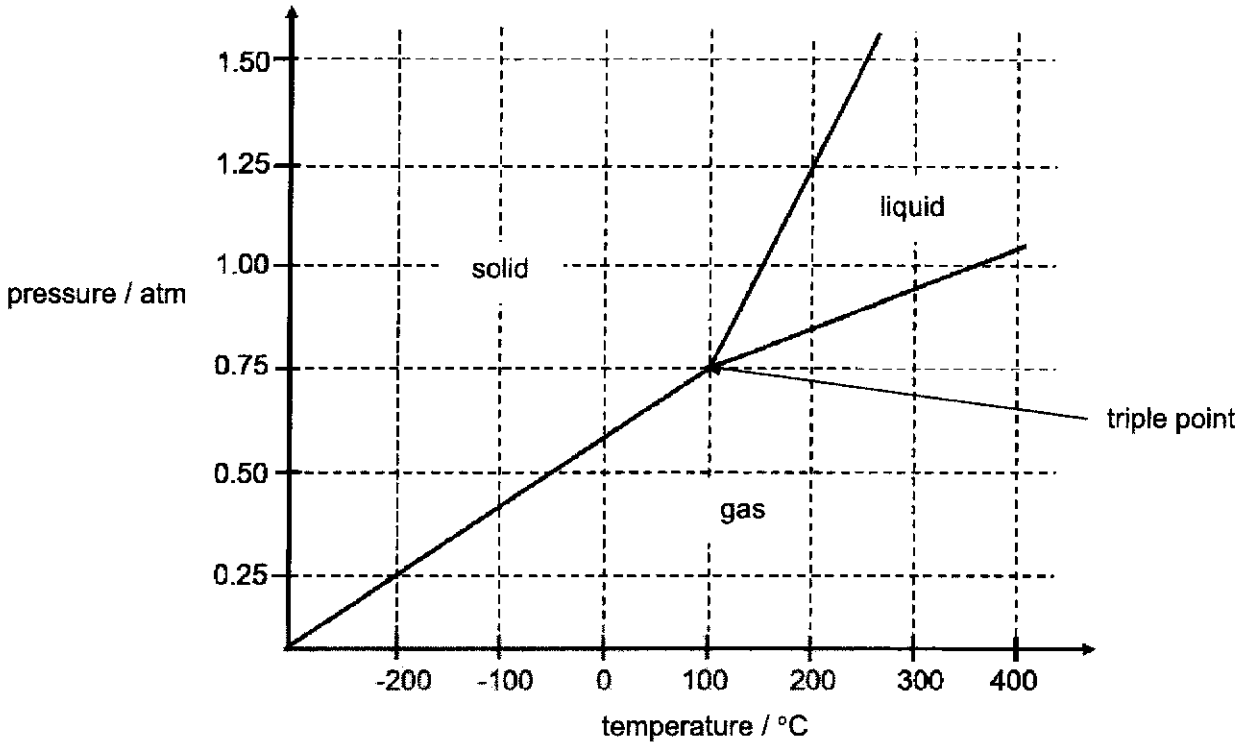
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[Turn over

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?

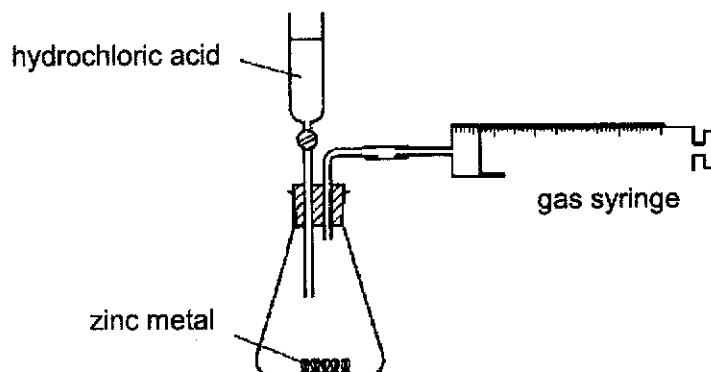
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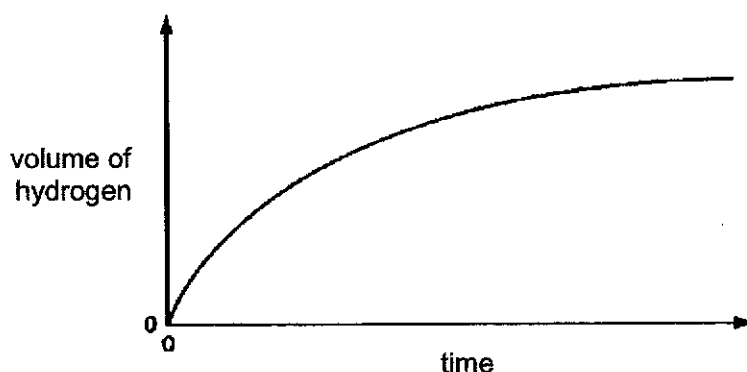
A3 Zinc metal reacts with dilute hydrochloric acid to produce the gas hydrogen.

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]

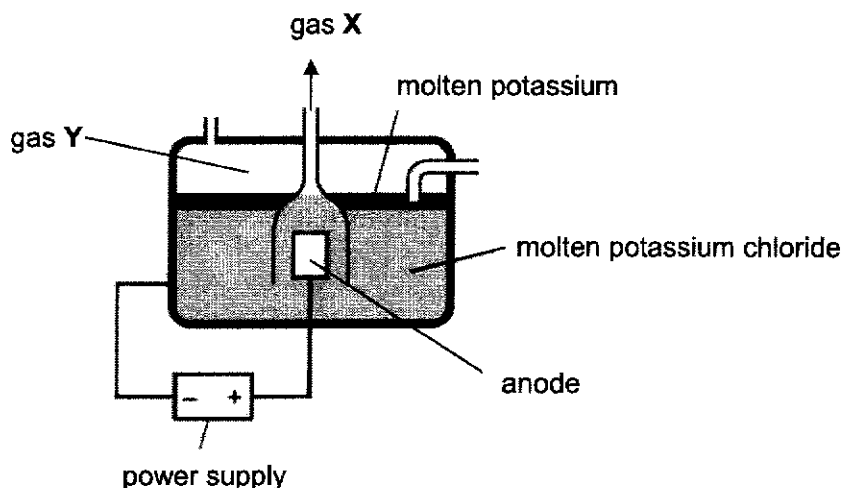
(ii) Why is copper powder more effective as a catalyst than a strip of copper?

..... [1]

[Total: 7]

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

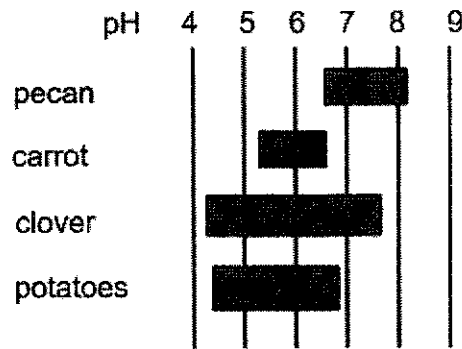
The diagram shows how the process works.



- (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]

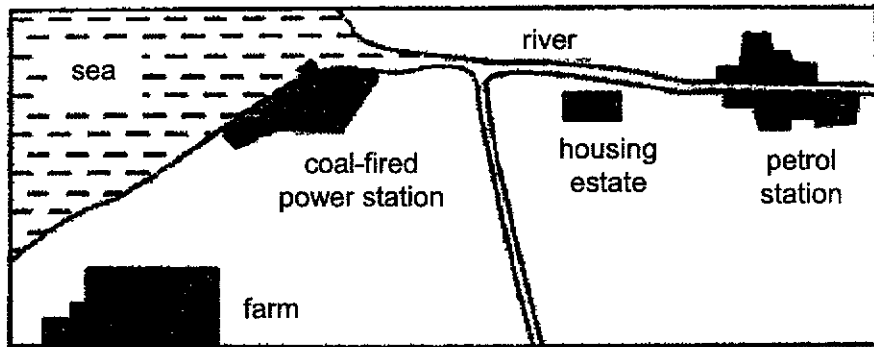
A5 The diagram shows the best pH ranges for growing different plants.



(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]

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.



A 4.47 g sample of sodium hypochlorite is added to 20.0 cm³ of 4.00 mol/dm³ hydrochloric acid.

Use calculations to decide which reagent, NaOCl or HCl, is in excess in this reaction.

Show your working and explain your answer.

excess reagent:

reason

.....

..... [4]

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

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

particles	number
protons	
electrons	
neutrons	

[2]

- (ii) An oxide of iodine has a formula, I₂O₅.

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

effect on Universal Indicator

explanation [2]

- (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.

.....

.....

.....

.....

.....

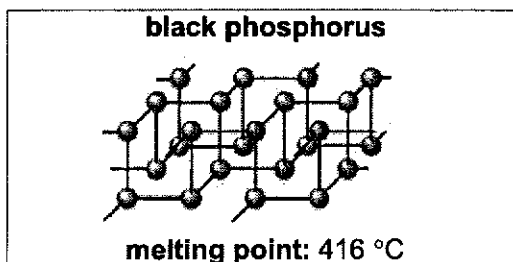
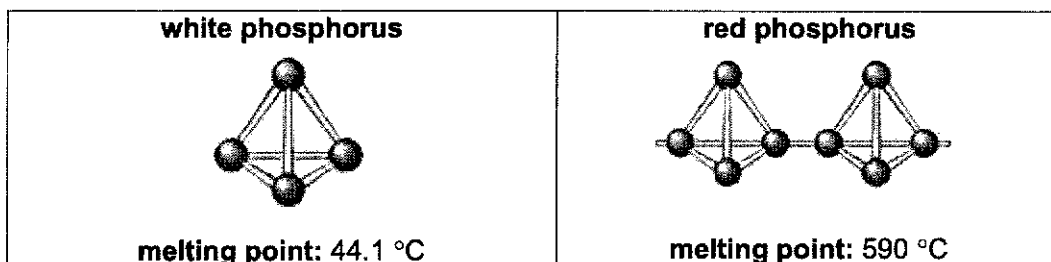
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..... [3]

[Total: 11]

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.



Compare the bonding and structure of the three allotropes.

.....

.....

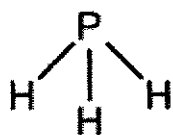
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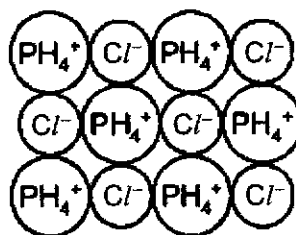
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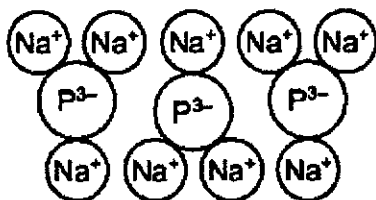
- (b) The structures of some substances containing phosphorus are shown.



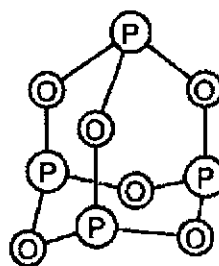
phosphine



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]

CANDIDATE
NAME

CLASS

REGISTER
NUMBER
Section B

Answer all three questions in this section.

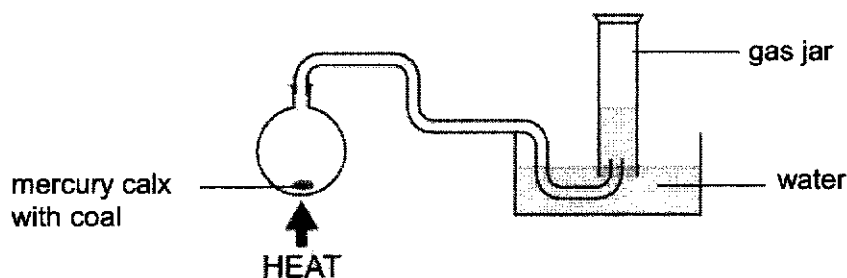
The last question is in the form of an either/or and only one of the alternatives should be attempted.

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 decided 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”.

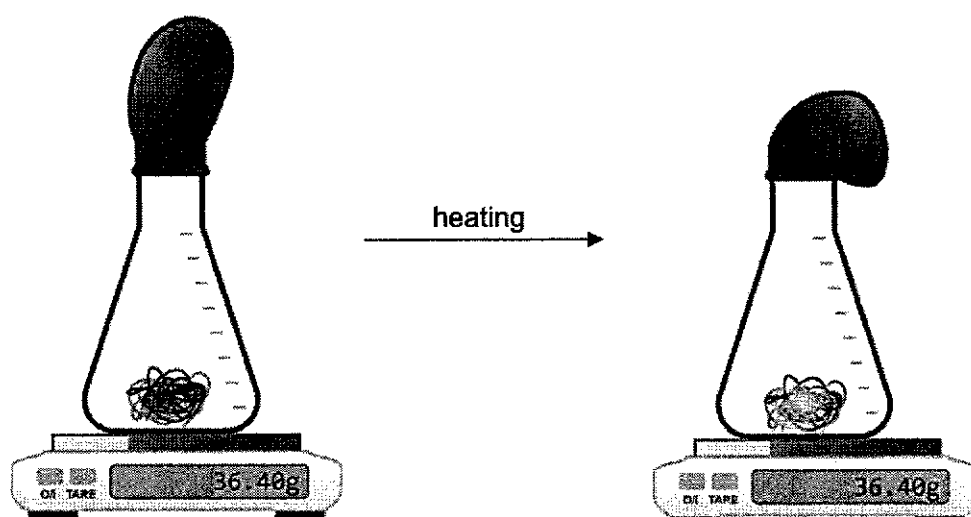
After analysing the results of both experiments, Lavoisier concluded that “fixed air” was composed of “respirable air” and coal.

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:

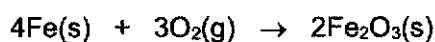


Table 1 shows some data from the experiment.

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>

(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]

- (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]

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]

ETHER

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 cm³ of 1.0 mol/dm³ aqueous lead(II) nitrate, 20 cm³ of 1.0 mol/dm³ 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?

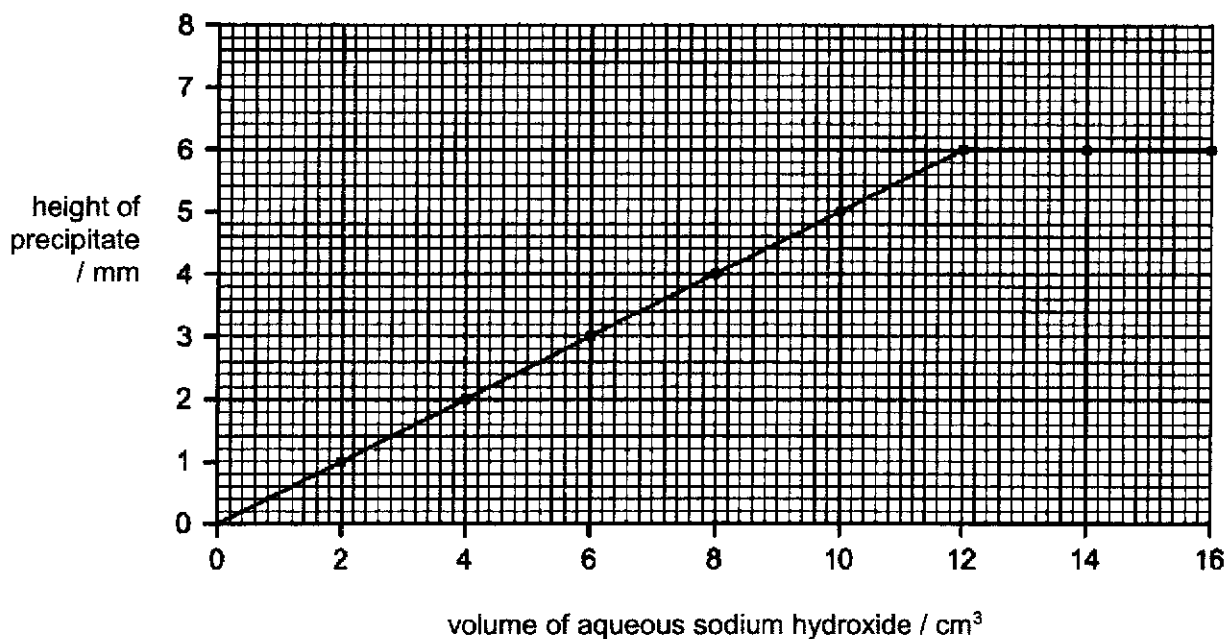
Give a reason for your answer.

.....

 [2]

- (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]

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?

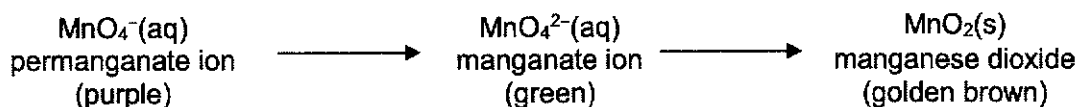
..... [1]

- (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.



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.

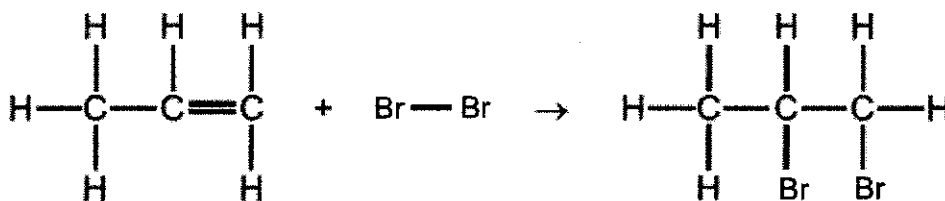


Complete the balancing of the ionic half-equation for this reaction. [1]

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

..... [1]

(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

The Periodic Table of Elements

		Group																										
I	II	III	IV	V	VI	VII	0																					
3 Li lithium 7	4 Be beryllium 9	11 Na sodium 23	12 Mg magnesium 24	<div style="border: 1px solid black; padding: 5px; margin: 5px auto; width: fit-content;"> <p>Key</p> <p>proton (atomic) number</p> <p>atomic symbol</p> <p>name</p> <p>relative atomic mass</p> </div> <div style="border: 1px solid black; padding: 5px; margin: 5px auto; width: fit-content;"> <p>1</p> <p>H</p> <p>hydrogen</p> <p>1</p> </div>											2 He helium 4													
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	117 Ts tennessine	118 Og oganeson	119 Nh nihonium	120 Dh dubnium											
		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												
		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												

CHIJSec/2021/OLevelPrelim/6092/02

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


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		

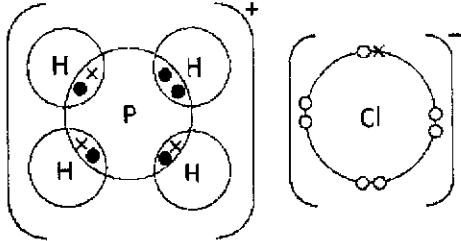
Qn No	Answer	Marks	Total	Comment
A2	(a)	solid	1	5 Quite well done.
	(b)	200 °C	1	
	(c)	<ul style="list-style-type: none"> At -200 °C, particles are closely packed in an orderly manner, vibrating about fixed position. When temperature increase, particles gain (heat)energy and move faster. At -50 °C, particles 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	

Qn No	Answer	Marks	Total	Comment
A3	(a)	<ul style="list-style-type: none"> 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)	<ul style="list-style-type: none"> Gentle initial slope / below the original graph [1] Same final point [1] 	2	
	(ci)	<ul style="list-style-type: none"> 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 Not well done. State symbol for chloride ion is (l) because it is in molten state.
	(bi)	Chlorine.	1	
	(bii)	$2Cl^{-}(l) \rightarrow Cl_2(g) + 2e^{-}$	1	
	(c)	Potassium floats on top of potassium chloride	1	
	(d)	Any noble gas (Helium / Argon / Neon) Provides an inert atmosphere that prevents oxidation / reaction with oxygen of the potassium metal	1 1	

Qn No	Answer	Marks	Total	Comment	
A5	(a)	Carrots and potatoes	1	6	
	(b)	Sulfur dioxide released from the power station [1]	3		REJECT: carbon dioxide.
	(i)	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]			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)	Farmer can add quicklime (calcium oxide) / slaked lime (calcium hydroxide) to treat the soil. [1]	2	ACCEPT: calcium carbonate.		
(ii)	Excess acids will be neutralised causing the pH of the soil to raise. [1]		Required to mention "neutralize".		

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

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)	 <ul style="list-style-type: none"> • 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] <p>[3 points – 2m ; 2 points – 1m]</p>	2		Common error is the diagram for phosphonium ion.
	(bii)	False; True; True; False	2		Quite well done.

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)	$2\text{HgO} + \text{C} \rightarrow 2\text{Hg} + \text{CO}_2$ (Gas is carbon dioxide) Accept: $\text{HgO} + \text{C} \rightarrow \text{Hg} + \text{CO}$ (Gas is carbon monoxide) [1] AND $2\text{HgO} \rightarrow 2\text{Hg} + \text{O}_2$ 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.	

(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)	<p>Mass of oxygen in iron(III) oxide $= 8.40 - 6 = 2.4\text{g}$ [1]</p> <p>Number of moles of oxygen atom $= 2.4 / 16 = 0.15\text{ mol}$</p> <p>Number of moles of iron atom present $= 0.15 / 3 \times 2 = 0.1\text{ mol}$ [1]</p> <p>Mass of iron present $= 0.1 \times 56 = 5.6\text{g}$</p> <p>Mass of carbon $= 6.0 - 5.6$ $= 0.4\text{ g}$</p> <p>Percentage mass of carbon $= (0.4/6.0) \times 100\%$ $= \underline{6.66\% (3sf)}$ [1]</p>	3	ALLOW $4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$ Mass of oxygen used $= 8.40 - 6 = 2.4\text{g}$ [1] Number of moles of oxygen gas $= 2.4 / 2(16) = 0.075\text{ mol}$ Number of moles of iron reacted $4 / 3 \times 0.075 = 0.1\text{ mol}$ [1] Mass of iron present $= 0.1 \times 56 = 5.6\text{g}$ Mass of carbon $= 6.0 - 5.6$ $= 0.4\text{ g}$ Percentage mass of carbon $= (0.4/6.0) \times 100\%$ $= 6.66\% (3sf)$ [1]

Qn No	Answer	Marks	Total	Comment	
B9	(a) (i)	<ul style="list-style-type: none"> 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)	<ul style="list-style-type: none"> Atoms of different size disrupt the regular arrangement of the atoms [1] Atoms cannot slide over each 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)	<ul style="list-style-type: none"> 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	

Qn No	Answer	Marks	Total	Comment	
B1 0 Eit he r	(a) (i)	$\text{Pb}(\text{NO}_3)_2(\text{aq}) + 2\text{NaCl}(\text{aq}) \rightarrow \text{PbCl}_2(\text{s}) + 2\text{NaNO}_3(\text{aq})$ [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)	$\text{Fe}^{3+} + 3\text{OH}^- \rightarrow \text{Fe}(\text{OH})_3$	1		
	(c) (ii)	Peak at 8 cm ³ of NaOH [1] Drop to zero mm [1]	2	Very poorly answered	

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	10	ALLOW -does not form ions -belong to Group O/VIII/monatomic -unreactive
	(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)	$\text{MnO}_4^{2-} + 2\text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{MnO}_2 + 4\text{OH}^-$	1		
	(biv)	Manganese dioxide is displaced from the solution / precipitated out of the solution as a solid	1		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		