JUNYUAN SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2020
SECONDARY FOUR EXPRESS

CANDIDATE NAME

CLASS 4 E

INDEX NUMBER

CHEMISTRY

6092

PAPER 1

2 September 2020

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in soft pencil.
Do not use paper clips, glue or correction fluid.

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 in this booklet.
A copy of the Periodic Table is printed on page 19.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of 19 printed pages.

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1 Which substance would diffuse most quickly?

A carbon dioxide at 0 °C

B carbon dioxide at 25 °C

C neon at 0 °C

D neon at 25 °C

2 A student tested a solution by adding aqueous sodium hydroxide. A precipitate was not seen because the reagent was added too quickly.

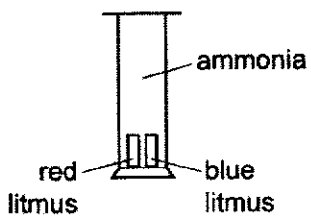
What could not have been present in the solution?

A Al^{3+} **B** Ca^{2+} **C** NH_4^+ **D** Zn^{2+}

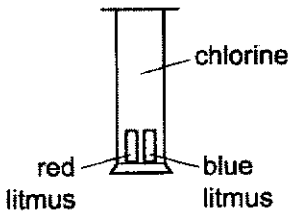
3 Four gas jars each contains one of the gases, ammonia, chlorine and oxygen. A strip of damp blue litmus paper and a strip of damp red litmus paper are placed in each jar.

In which gas jar will both the damp blue litmus paper and the damp red litmus paper change colour?

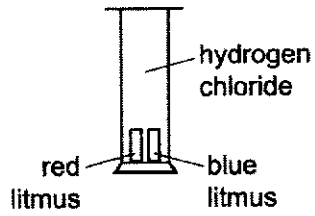
A



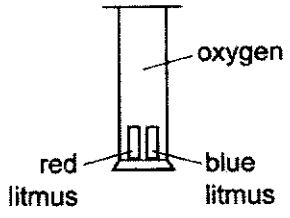
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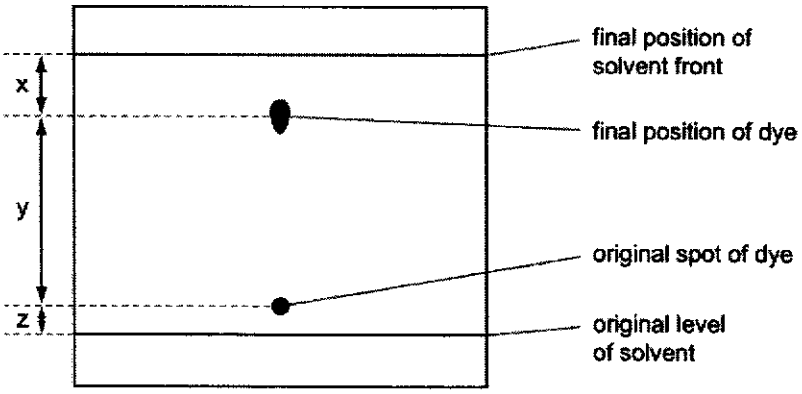
D



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4 The diagram shows the chromatogram obtained by analysis of a single dye.

Three measurements are shown.



How is the R_f value of the dye calculated?

A $\frac{x}{x+y}$ **B** $\frac{y}{x+y}$ **C** $\frac{x}{x+y+z}$ **D** $\frac{y}{x+y+z}$

5 The apparatus shown in Fig. 5.1 can be used to separate pure water from seawater.

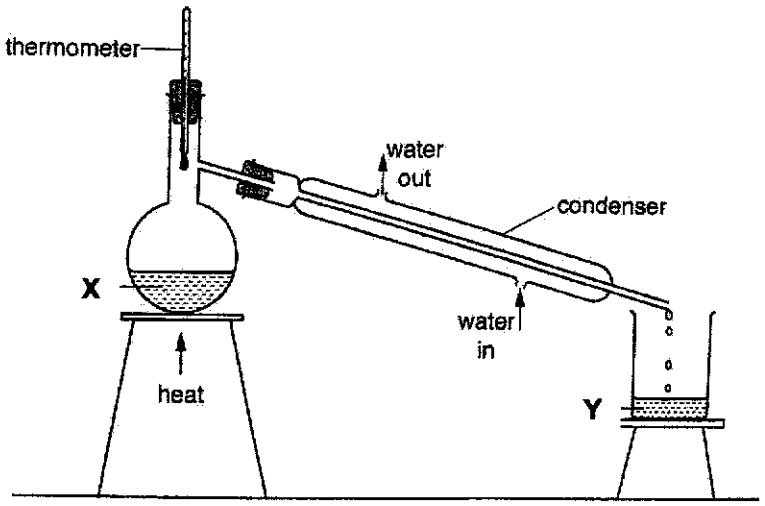


Fig. 5.1

Two samples are taken, one at point X and another at point Y.

Which of the following statements about X and Y is incorrect?

A X and Y can be separated into their components by physical methods.

B When heated to dryness, X leaves a residue while Y does not.

C X boils over a range of temperatures, while Y boils at 100 °C.

D X is a mixture while Y is a compound.

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6 The following statement describes substance X.

A chemical reaction takes place and heat is liberated when this white solid, X is formed.

Which of the following correctly classifies X and explains why X is classified as such?

	classification	explanation
A	element	When decomposition takes place, an element, X, is produced.
B	compound	Bond forming takes place to produce X.
C	mixture	The reactants and the product X, form a mixture.
D	either an element or a compound	A chemical reaction can produce either an element or a compound.

7 The atoms $^{64}_{29}Cu$ and $^{65}_{30}Zn$ have the same

A nucleon number.

B number of electrons.

C number of neutrons.

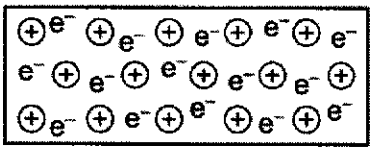
D proton number.

8 Which of the following correctly describes what happens when calcium atoms form calcium ions?

	calcium atoms	ionic equation for the formation
A	gain electrons	$Ca + 2e^- \rightarrow Ca^{2+}$
B	gain electrons	$Ca \rightarrow Ca^{2+} + 2e^-$
C	lose electrons	$Ca + 2e^- \rightarrow Ca^{2+}$
D	lose electrons	$Ca \rightarrow Ca^{2+} + 2e^-$

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9 Element X has a lattice of positive ions and a 'sea of electrons'.



Which property will X have?

A It conducts electricity by the movement of ions and electrons.

B It has a high melting point.

C It is decomposed by an electric current.

D It is not malleable.

10 When a covalent substance in liquid state boils, its molecules become more widely spaced.

Which property of the molecules has the most influence on the amount of energy required to boil a covalent substance?

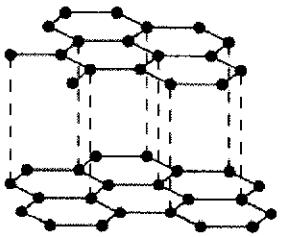
A the forces of attraction between the molecules

B the reactivity of the molecules

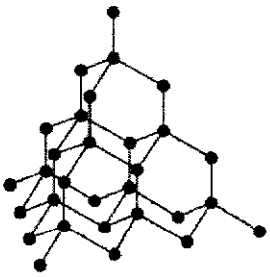
C the shape of the molecules

D the strength of the covalent bonds in the molecules

11 The diagrams show the structures of two forms of carbon.



S



T

Which set of data is correct for these two structures?

	conducts electricity	very hard material	can be used as lubricant
A	T	T	S
B	S	T	S
C	S	S	T
D	T	S	T

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12 Which statement about ionic compounds is correct?

A Ionic compounds conduct electricity when solid because they contain charged particles that can move.

B Ionic compounds consist of a lattice of positive ions and negative ions.

C Most ionic compounds are solids at room temperature because of the strong attraction between electrons and positive ions.

D When molten or in aqueous solution, ionic compounds conduct electricity because they contain electrons that can move.

13 Sulfur and selenium (Se) are in the same group of the Periodic Table.

From this, we would expect selenium to form compounds having the formulae

A SeO, Na_2Se and $NaSeO_4$.

B SeO_2, Na_2Se and $NaSeO_4$.

C SeO_2, Na_2Se and Na_2SeO_4.

D SeO_3, NaSe and $NaSeO_4$.

14 Students give their own special symbols to five non-metallic elements. All five non-metals are in the same group of the Periodic Table. These non-metals exist as coloured elements.

The special symbols are shown in Fig. 14.1. The order of chemical reactivity of these non-meals is also shown.

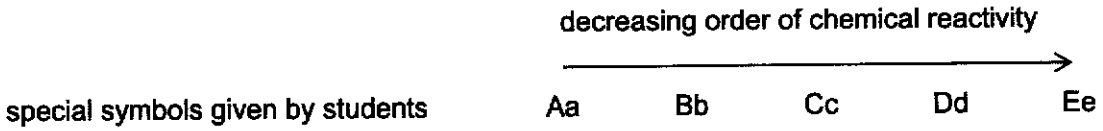


Fig. 14.1

A solution containing Cc ions can be displaced by two of the elements in the Group.

Which of the following correctly shows the ionic equation for one such reaction?

A $Aa(aq) + Cc^-(aq) \rightarrow Aa^-(aq) + Cc(aq)$

B $Bb_2(aq) + 2Cc^-(aq) \rightarrow 2Bb^-(aq) + Cc_2(aq)$

C $Dd(aq) + Cc^-(aq) \rightarrow Dd^-(aq) + Cc(aq)$

D $Ee_2(aq) + 2Cc^-(aq) \rightarrow 2Ee^-(aq) + Cc_2(aq)$

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15 The table shows some of the properties of four elements.

Which element is most likely to be a transition metal?

	melting point / °C	density / g/cm^3	electrical conductivity
A	3550	3.5	poor
B	1860	7.2	good
C	660	2.7	good
D	232	7.3	good

16 The relative formula masses of four compounds are given.

A student has a 1.0 g sample of each compound.

Which sample contains the highest number of moles of oxygen atoms?

	compound	relative formula mass
A	Al_2O_3	102
B	CuO	80
C	H_2SO_4	98
D	HNO_3	63

17 What is the concentration of iodine, I_2, molecules in a solution containing 2.54 g of iodine in 250 cm^3 of solution?

A 0.01 mol/dm^3 **B** 0.02 mol/dm^3 **C** 0.04 mol/dm^3 **D** 0.08 mol/dm^3

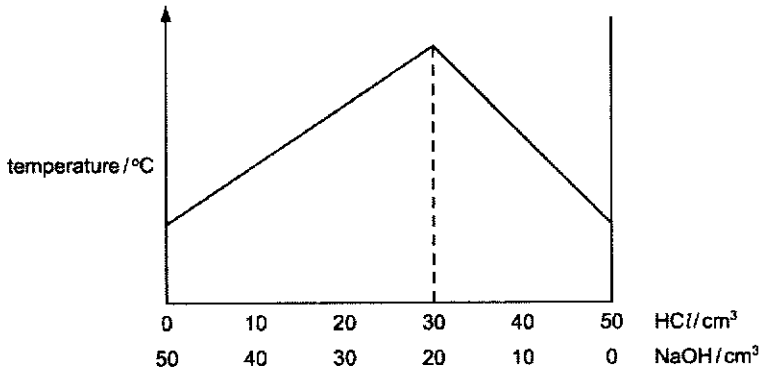
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18 A solution of hydrochloric acid has a concentration of 2 mol/dm^3.

Different volumes of the acid are added to different volumes of aqueous sodium hydroxide.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

The maximum temperature of each mixture is measured. The graph shows the results.



What is the concentration of the aqueous sodium hydroxide?

A 0.67 mol/dm^3

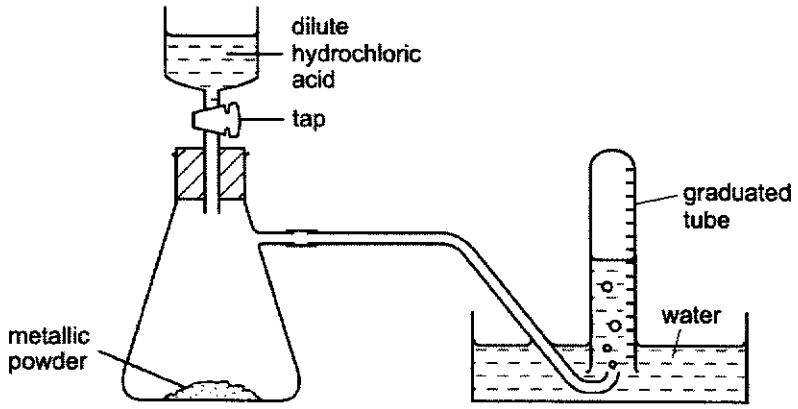
B 1.3 mol/dm^3

C 1.5 mol/dm^3

D 3.0 mol/dm^3

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19 The diagram shows apparatus for measuring the volume of hydrogen given off when an excess of dilute hydrochloric acid is added to powdered metal. The volume of gas is measured at room temperature and pressure.



The experiment is carried out three times, using the same mass of powder each time but with different powders:

- pure magnesium
- pure zinc
- a mixture of magnesium and zinc

Which powder gives the greatest volume of hydrogen and which the least volume?

	greatest volume of H_2	least volume of H_2
A	magnesium	zinc
B	magnesium	the mixture
C	zinc	magnesium
D	zinc	the mixture

20 The following statements about dilute sulfuric acid are all correct.

1 Addition of Universal Indicator shows that the solution has a pH value of less than 7.0.
2 A white precipitate is formed when aqueous barium chloride is added.
3 The solution reacts with copper(II) oxide, forming a blue solution.
4 When electrolysed, hydrogen and oxygen gases are produced.

Which two statements confirm the acidic nature of the solution?

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

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21 A solution of W has the following properties.

- When added in excess to solid ammonium chloride, a gas is given off that turns damp red litmus paper blue.
- When added in excess to a solution of pH 3, the resulting solution has a pH of 13.

What is W?

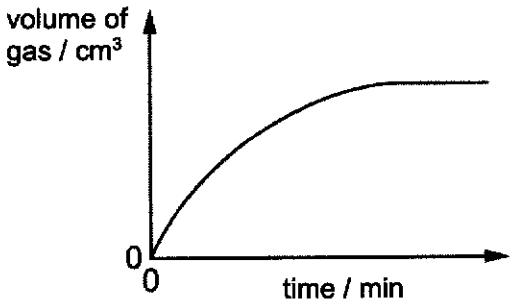
A a strong acid
B a strong base
C a weak acid
D a weak base

22 Which equation describes the most suitable reaction for making lead(II) sulfate?

A $Pb + H_2SO_4 \rightarrow PbSO_4 + H_2$
B $PbCO_3 + H_2SO_4 \rightarrow PbSO_4 + CO_2 + H_2O$
C $Pb(NO_3)_2 + H_2SO_4 \rightarrow PbSO_4 + 2HNO_3$
D $Pb(OH)_2 + H_2SO_4 \rightarrow PbSO_4 + 2H_2O$

23 Excess marble chips were reacted with dilute hydrochloric acid in an experiment. The volume of gas produced was measured at regular time intervals.

The results obtained are plotted in the graph as follows.



The speed of reaction decreases throughout the reaction until it comes to a stop.

Which of the following explains why the speed of reaction decreases?

A Marble chips were completely used up.
B Hydrochloric acid was completely used up.
C The mass of marble chips decreased.
D The concentration of hydrochloric acid decreased.

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24 The following statements describe how the speed of reactions can be increased.

1 increase the amount of kinetic energy reactant particles can possess
2 increase the frequency of effective collisions
3 lower the activation energy of the reaction

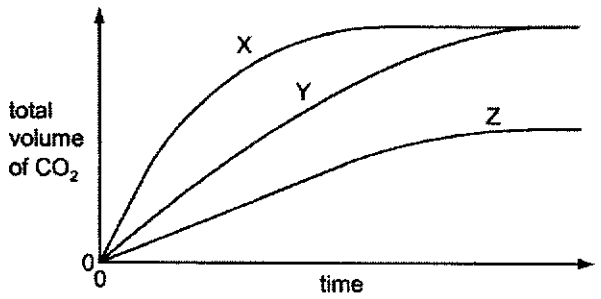
Which statements describe the effect when temperature is increased?

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

25 In experiment 1, an excess of finely powdered marble is added to 20 cm^3 of dilute hydrochloric acid.

In experiment 2, carried out under the same conditions of temperature and pressure, an excess of marble chips is added to 20 cm^3 of dilute hydrochloric acid of the same concentration.

The total volumes of carbon dioxide given off are determined at intervals and plotted against time.

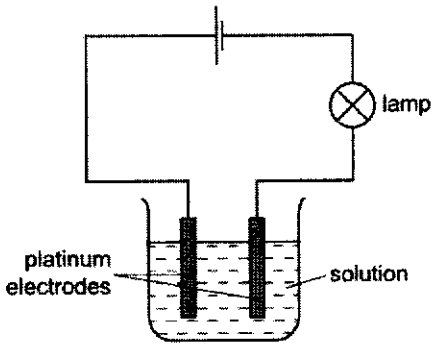


Which pair of curves is obtained in the two experiments?

	experiment 1	experiment 2
A	X	Z
B	X	Y
C	Y	Z
D	Y	X

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26 The diagram shows apparatus used to investigate the conductivity of different solutions.



Which substance, in aqueous solution of concentration 1 mol/dm^3, would cause the lamp to give the brightest light?

A ammonia

B ethanoic acid

C dilute sodium chloride solution

D sulfuric acid

27 The heat-reflecting shields of some space rockets are gold-plated, using electrolysis.

Which electrodes and electrolyte would be used to gold-plate the heat shield?

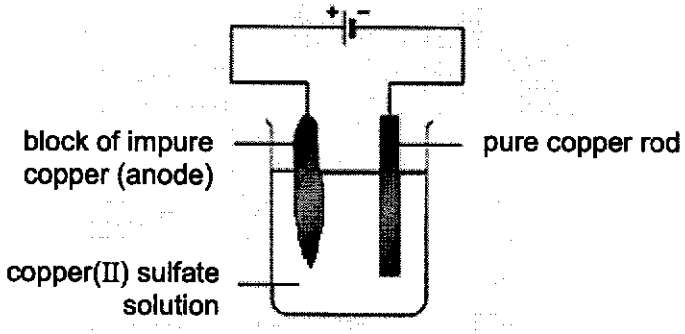
	negative electrode	positive electrode	electrolyte
A	carbon	heat shield	gold compound
B	gold	heat shield	copper compound
C	heat shield	carbon	copper compound
D	heat shield	gold	gold compound

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28 The following set-up shows how a block of impure copper can be purified.

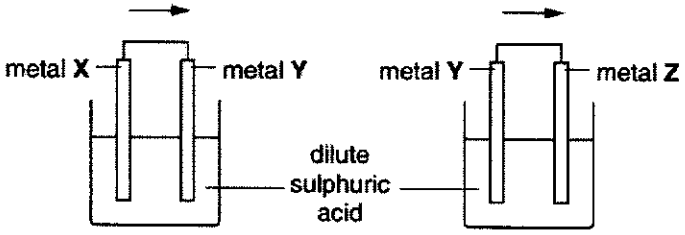


The loss in mass of the anode is 50 g and the gain in mass of the cathode is 45 g.

What is the percentage purity of this sample of copper?

A 10.0 % **B** 11.1 % **C** 90.0 % **D** 95.0 %

29 Two cells were set up as shown in the diagram. The arrow shows the direction of electron flow in the external circuit.

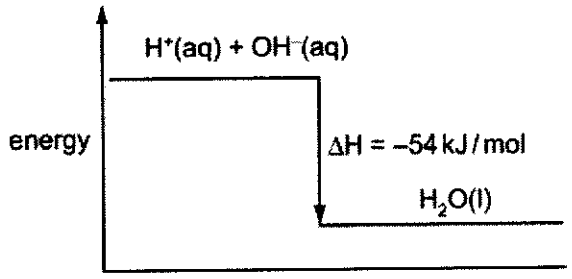


Which set of metals would give the electron flows in the direction shown?

	metal X	metal Y	metal Z
A	Ag	Cu	Zn
B	Ag	Zn	Cu
C	Cu	Zn	Ag
D	Zn	Cu	Ag

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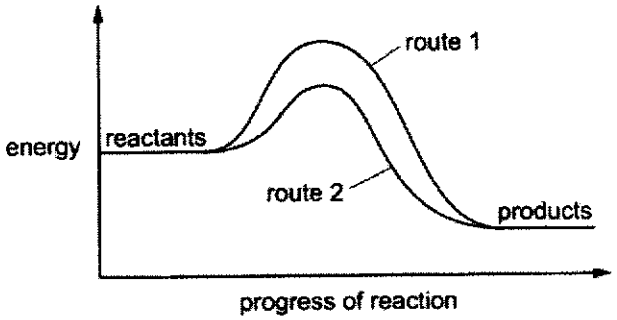
30 The energy diagram for the reaction between sodium hydroxide and hydrochloric acid is shown.



Which quantity of heat is liberated when 100 cm^3 of 1 mol/dm^3 hydrochloric acid reacts with 100 cm^3 of 1 mol/dm^3 sodium hydroxide?

A 0.54 kJ **B** 2.70 kJ **C** 5.40 kJ **D** 10.8 kJ

31 The diagram shows the energy profile for a reaction.



Which statements about this reaction are correct?

1 More energy is absorbed to break the bonds than is released when new bonds are formed.

2 Route 1 and route 2 give the same overall equation for the reaction.

3 Route 2 involves the use of a catalyst.

4 The reaction is exothermic.

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

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32 The equation shows a reversible reaction.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

The forward reaction is endothermic.

Which of these changes will increase the yield of NO_2?

	pressure	temperature
A	decreased	decreased
B	decreased	increased
C	increased	decreased
D	increased	increased

33 Which of the following is not an example of oxidation?

A converting iron(III) salts to iron(II) salts

B converting magnesium atoms into magnesium ions

C dissolving a copper anode during electrolysis

D liberating chlorine from a chloride solution

34 Sulfur dioxide reacts with aqueous bromine according to the following equation.

$$SO_2(g) + Br_2(aq) + 2H_2O(l) \rightarrow H_2SO_4(aq) + 2HBr(aq)$$

Which element has been oxidised?

A bromine

B hydrogen

C oxygen

D sulfur

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35 Some metals and the compounds in their ores are shown.

metal	Al	Ca	Pb	Na	Fe	Mg
compound in their ore	Al_2O_3	$CaCO_3$	PbS	NaCl	Fe_2O_3	$MgCO_3$

Which type of reaction occurs in the extraction of all of these metals from their respective ores?

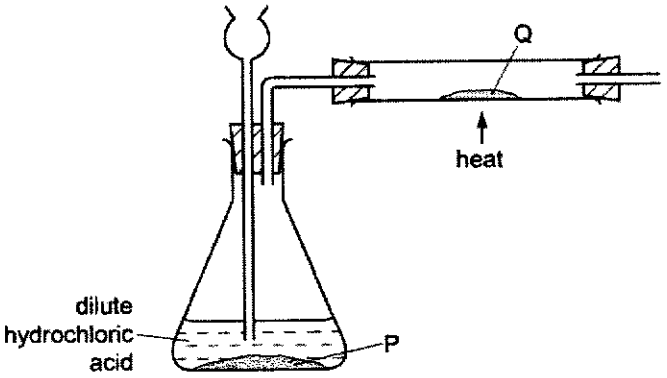
A decomposition by heat

B electrolysis

C precipitation

D reduction

36 The diagram shows the apparatus in an experiment to reduce substance Q with the gas generated in the flask.



What are substances P and Q?

	P	Q
A	copper	copper(II) oxide
B	lead	lead(II) oxide
C	magnesium	zinc oxide
D	zinc	copper(II) oxide

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37 Brass is an alloy.

Which statement about brass is correct?

A It contains a sea of electrons.

B It contains positive and negative ions which are free to move.

C It is a compound of a metal and a non-metal.

D It is a compound of two or more metals.

38 Iron is extracted from its ore haematite, Fe_2O_3, by a reduction process in the blast furnace.

Which equation for reactions in the blast furnace shows the formation of the reducing agent?

A $CaCO_3 \rightarrow CaO + CO_2$

B $CaO + SiO_2 \rightarrow CaSiO_3$

C $CO_2 + C \rightarrow 2CO$

D $C + O_2 \rightarrow CO_2$

39 Cars have catalytic converters fitted to reduce problems caused by some of the exhaust gases. However, cars fitted with catalytic converters still give out environmentally harmful gases.

Which of the following correctly states the harmful gas and the problem the gas causes?

	harmful gas	problem
A	nitrogen dioxide	dissolves in rain to corrode marble buildings
B	nitrogen dioxide	causes breathing problems when inhaled.
C	carbon dioxide	binds with haemoglobin in blood causing respiratory problems
D	carbon dioxide	causes the greenhouse effect leading to global warming

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40 Nitrogen monoxide, NO, damages the ozone layer by reacting with ozone in a two-step reaction.

$NO + O_3 \rightarrow NO_2 + O_2$ step 1

$NO_2 + O_3 \rightarrow NO + 2O_2$ step 2

One nitrogen monoxide molecule can destroy thousands of ozone molecules.

Which statement correctly explains why?

A Nitrogen monoxide in step 1 is easily generated through thunderstorms.

B Nitrogen monoxide, while is used up in step 1, is regenerated in step 2.

C Nitrogen dioxide produced can dissolve in rain to react with thousands of ozone molecules.

D Nitrogen monoxide can react continuously with ozone since the ozone layer consists of thousands of ozone molecules.

End of Paper

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The Periodic Table of Element

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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JUNYUAN SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2020
SECONDARY FOUR EXPRESS

CANDIDATE NAME

CLASS 4 E

INDEX NUMBER

CHEMISTRY

6092 / 02

Paper 2

24 August 2020

1 hour 45 minutes

Candidates answer on the Question Paper.

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 on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough workings.
Do not use paper clips, highlighters, glue or correction fluid.

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

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

Section B
Answer all **three** questions, the last question is in the form either/or.
Write your answers 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 23.

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

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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 Use the list of substances to answer the questions.

ammonia	iodine	copper
hydrochloric acid	calcium chloride	nitrogen
argon	sulfur dioxide	magnesium

Which substance

(a) reacts with gaseous hydrogen chloride to give a white solid?

.....[1]

(b) changes directly into a gas when gently heated?

.....[1]

(c) displaces iron from its salt solution?

.....[1]

(d) exists as a monatomic gas?

.....[1]

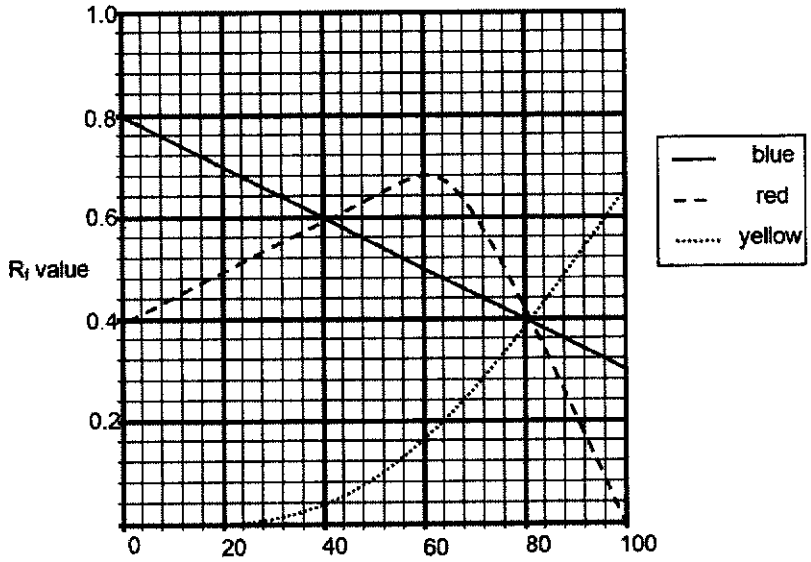
(e) is a colourless solution which can be used to distinguish between aqueous silver nitrate and aqueous zinc nitrate?

.....[1]

[Total: 5]

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A2 A sample of black ink contains a mixture of red, blue and yellow dyes. Usually, the solvent used to separate the dyes in black ink is a mixture of ethanol and water. The coloured dyes have different R_f values in solvents with different proportions of ethanol in the mixture as shown in the graph.



(a) Deduce the R_f value of the blue dye on the chromatogram when the solvent is a mixture of 32 cm^3 of ethanol and 168 cm^3 of water.

R_f value ..... [1]

(b) Based on the graph, justify whether a pure solvent of water is suitable for the separation of the black ink using paper chromatography.

.....

.....

.....[2]

(c) A student carried out chromatography on the black ink using a mixture of ethanol and water as the solvent. He discovered only one spot forming on the resulting chromatogram.

Using evidence from the graph, explain why he cannot conclude that the black ink is a pure substance.

.....

.....

.....[2]

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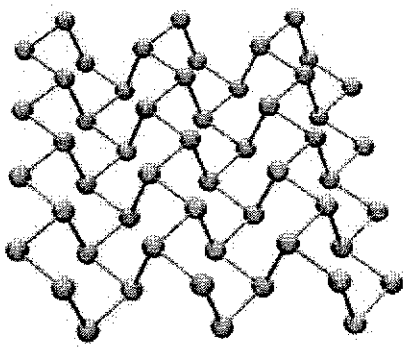
(d) Draw a labelled set up for the separation above.

[2]

[Total: 7]

A3 Elemental phosphorus exists as two forms – white and black phosphorus. The different forms display strikingly different properties.

The table shows the structures and properties of white and black phosphorus.

	white phosphorus	black phosphorus
structure		
properties at room temperature	waxy white solid	black crystalline solid with a greasy touch
melting point / °C	44.2	610

(a) Give one similarity and one difference in the bonding and structure between the two forms of phosphorus.

similarity: .....

.....

difference: .....

.....[2]

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(b) Explain, in terms of bonding, why the melting point of black phosphorus is much higher than the melting point of white phosphorus.

.....

.....

.....

.....

.....[3]

(c) White phosphorus reacts with chlorine to form phosphorus chloride, PCl_3. Draw a 'dot-and-cross' diagram to show the bonding in a molecule of PCl_3.

Show only valence electrons.

[2]

[Total: 7]

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A4 The relative positions of the elements rubidium (Rb), beryllium (Be) and bismuth (Bi) in the reactivity series are shown in the table below.

position in the reactivity series (highest to lowest)
rubidium
sodium
magnesium
beryllium
iron
hydrogen
bismuth
copper
silver

You may assume that these elements do not show variable valencies.

(a) An unknown photograph showing specks of silvery deposits with the caption - "Pure rubidium found on a tiny island in the Pacific Ocean" was posted in the early morning of August 16, 2016, on social media. The post has since gone viral.

Using the information above and your knowledge of metals in the reactivity series, discuss the validity of this post.

.....

.....

.....[2]

(b) Predict, with reasons, the reactions of beryllium with cold water and steam.

.....

.....

.....

.....

.....[4]

(c) Suggest a suitable method to extract bismuth from its ore.

.....[1]

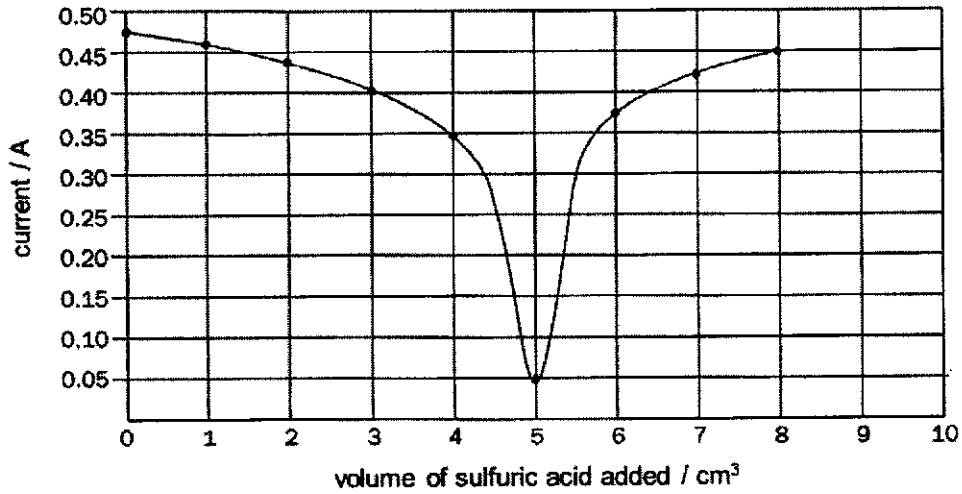
[Total: 7]

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A5 Barium hydroxide reacts with sulfuric acid to form barium sulfate precipitate. The equation for this reaction is as shown.

$$Ba(OH)_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2H_2O(l)$$

In an experiment, 0.500 mol/dm^3 sulfuric acid was gradually added to 25.0 cm^3 of barium hydroxide solution in a conical flask. The mixture was continuously stirred with an iron stirrer covered in plastic. The mixture was connected to an ammeter. The reading was taken after the addition of every 1.00 cm^3 of sulfuric acid. The graph below shows the results obtained from the experiment.



(a) Ignoring the ions contributed by the ionisation of water, state the formulae of the ions present in the conical flask when the following volumes of sulfuric acid were added to the barium hydroxide solution:

(i) 0.00 cm^3 .....

(ii) 8.00 cm^3 ..... [2]

(b) Explain the change in ammeter reading from the start of the experiment to the point when 5.00 cm^3 of acid was added.

.....

.....

.....

.....[3]

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(c) Calculate the concentration, in mol/dm^3, of barium hydroxide solution used.

[2]

(d) Suggest why the iron stirrer was covered in plastic.

.....

.....[1]

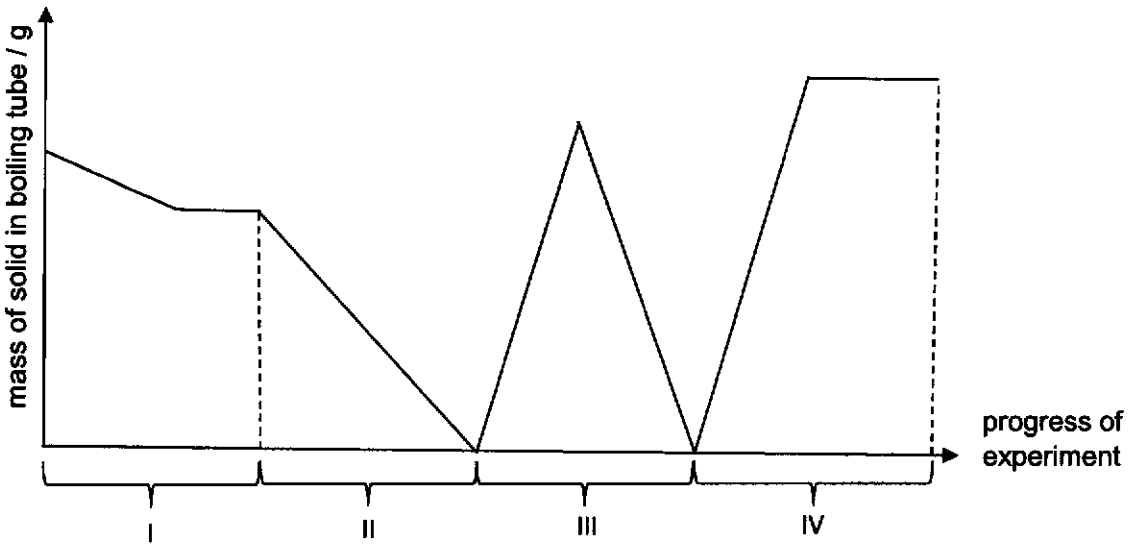
[Total: 8]

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A6 Solid P is a metal carbonate.

The graph shows how the mass of the solid in a boiling tube changes as the experiment progresses.



There are four stages for the experiment.

stages	description
I	solid P is heated strongly with a non-luminous flame to form solid Q.
II	excess dilute hydrochloric acid is added to solid Q.
III	aqueous ammonia is added to the reaction mixture from stage II.
IV	aqueous silver nitrate is added to the reaction mixture from stage III.

(a) Suggest a possible identity of the cation present in solid P.

Explain your answer.

.....

.....

.....[3]

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(b) Do you expect any carbon dioxide to be evolved in stage II?

Explain your answer.

.....

.....[1]

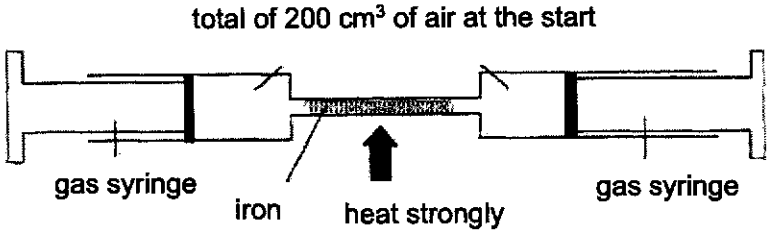
(c) Write the ionic equation for the formation of the solid in stage IV.

.....[2]

[Total: 6]

A7 An experiment was set up to determine the percentage of oxygen in air.

Two gas syringes were connected to a small tube containing excess iron, as shown in the diagram below.



At the start of the experiment, the apparatus contained a total of 200 cm^3 of air.
During heating, the iron reacted with oxygen in the air to form black iron(II) oxide.

$$2Fe(s) + O_2(g) \rightarrow 2FeO(s)$$

The iron was heated until the volume of gas, measured at room temperature and pressure, remained constant.

(a) Explain why it was important to continue heating until the volume of gas remained constant.

.....[1]

(b) The volume of gas left after the reaction was complete was 160 cm^3.

Calculate the percentage of oxygen in the air.

[1]

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(c) Iron(II) oxide can be obtained by the thermal decomposition of iron(II) oxalate.

$$FeC_2O_4(s) \rightarrow FeO(s) + CO_2(g) + CO(g)$$

(i) Determine the oxidation states of carbon in the following substances.

	oxidation state of carbon
FeC_2O_4	
CO_2	
CO	

[2]

(ii) Explain, in terms of oxidation states, why the above reaction is a redox reaction.

.....

.....

.....[2]

[Total: 6]

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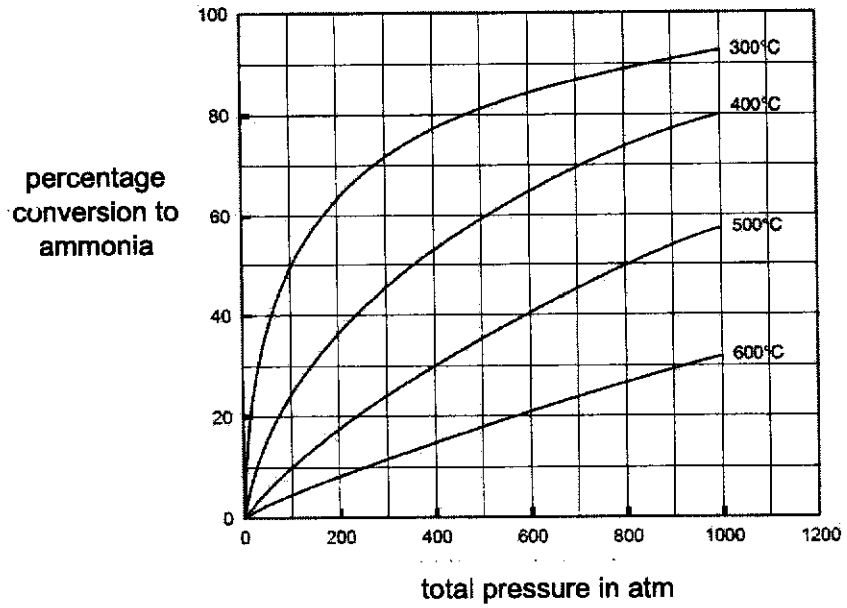
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A8 Ammonia is prepared industrially from hydrogen and nitrogen in the presence of a suitable catalyst according to the equation below.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The graph below shows the variation of the equilibrium yield of ammonia with pressure at different temperatures.



(a) A particular industrial plant uses a pressure of 400 atm and a temperature of 500 °C. From the graph, determine the percentage yield of ammonia under these conditions.

.....[1]

(b) The gases leaving the reactor contain unreacted nitrogen and hydrogen, and about 15% ammonia by volume. Unreacted nitrogen and hydrogen are fed back into the reactor.

Give two reasons why the unreacted gases are fed back into the reactor.

.....

.....

.....[2]

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(c) Temperatures less than 400 °C are not used for this industrial reaction even though such temperatures give a greater equilibrium yield of ammonia.

Suggest why this is so.

.....

.....[1]

[Total: 4]

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SECTION B

Answer all three questions from this section.

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

The total mark for this section is 30.

B9 A fuel cell is a chemical cell in which reactants are continuously supplied to produce electricity.

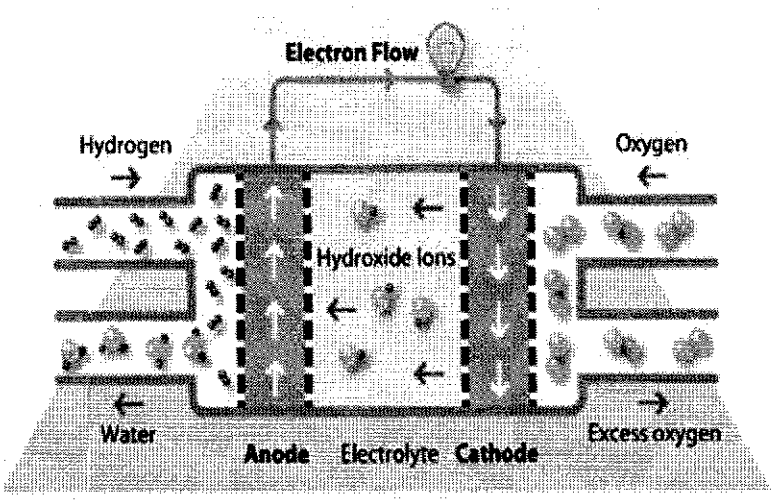
Two such cells are the ***Alkaline Fuel Cell (AFC)*** and the ***Proton Exchange Membrane Fuel Cell (PEMFC)***

Alkaline Fuel Cell

AFCs use an alkaline electrolyte such as potassium hydroxide in water and are generally fuelled with pure hydrogen. Typical operating temperatures are around 70 °C. As a result of the low operating temperature, a variety of non-precious metals can be used as catalysts to speed up the reactions occurring at the anode and cathode.

At the anode, the hydrogen gas reacts with the hydroxide ions to form water. The water then travels through the membrane to the cathode side of the cell where they then react with oxygen to form hydroxide ions. The electrons travel in an external circuit, generating the electrical output of the cell.

AFC cell type is easily poisoned by carbon dioxide (CO_2). In fact, even the small amount of CO_2 in the air can affect this cell's operation, making it necessary to purify both the hydrogen and oxygen used in the cell. This purification process is costly.

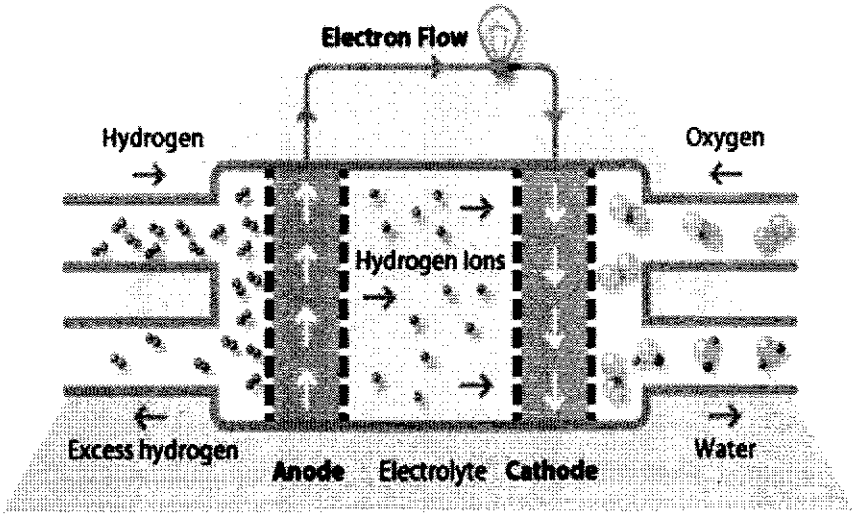


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Proton Exchange Membrane Fuel Cell

The ***PEMFC*** uses a water-based, acidic polymer membrane as its electrolyte, with platinum-based electrodes. PEMFC cells operate at relatively low temperatures (below 100 °C). Due to the use of precious metal-based electrodes, these cells must operate on pure hydrogen.

Hydrogen gas is processed at the anode where electrons are separated to form hydrogen ions on the surface of a platinum-based catalyst. The hydrogen ions pass through the membrane to the cathode side of the cell where they then react with oxygen to form water. The electrons travel in an external circuit, generating the electrical output of the cell



(a) Compare the reactions at the electrodes for ***AFC*** and ***PEMFC***. Complete the table below with the relevant half-equations.

	cathode	anode
AFC		
PEMFC		

[4]

(b) Write the overall equation, with state symbols, for both cells.

.....[2]

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(c) Explain, with reference to the nature of CO_2, why it poisons ***AFC***. Write an equation to support your answer.

.....

.....

.....[2]

(d) Suggest one reason why the operation of ***AFC*** is more economical than that of ***PEMFC***.

.....

.....[1]

(e) Most of the hydrogen produced today is made via steam-methane reforming. In this process, high temperature steam reacts with methane (CH_4), in the presence of a catalyst to produce hydrogen and carbon monoxide.

(i) Hydrogen fuel cells are environmentally-friendly.

Explain why.

.....[1]

(ii) Suggest why some environmentalists argue against the use of hydrogen fuel cells.

.....

.....[1]

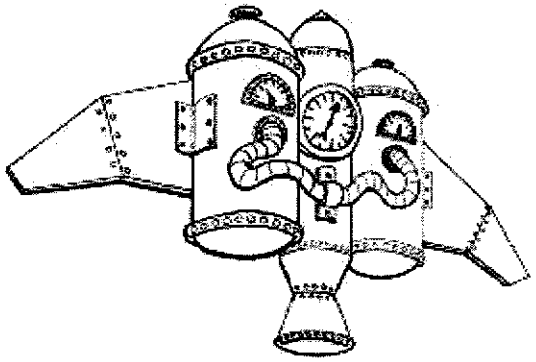
[Total: 11]

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B10 Rocket belts, also known as jetpacks, can be used to lift people into the air and transport them over short distances.

The picture below shows a rocket belt, usually strapped onto a person's back.



Rocket belts contain concentrated hydrogen peroxide solution as a fuel. An exothermic change occurs when the hydrogen peroxide decomposes rapidly to form oxygen and water.

This rapid release of oxygen from the rocket belt lifts the person off the ground.

(a) Write a balanced chemical equation for the decomposition of hydrogen peroxide in the rocket belt.

.....[1]

(b) Explain why the decomposition of hydrogen peroxide is exothermic, in terms of the energy changes that take place during bond breaking and bond forming.

.....

.....

.....[2]

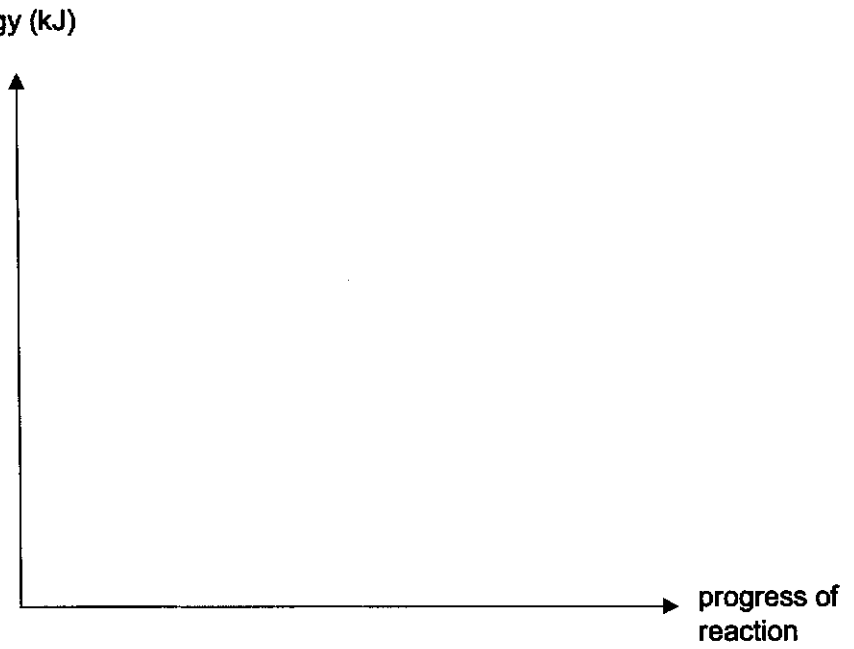
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(c) The decomposition of hydrogen peroxide is very slow at room temperature.

In a rocket belt, silver powder is present to speed up this decomposition reaction.

The silver powder remains unchanged at the end of the reaction.

(i) Draw an energy profile diagram below to show how the silver powder speeds up the decomposition of hydrogen peroxide.



[3]

(ii) Explain the shape of the energy profile diagram.

.....

.....

.....

.....[2]

(iii) Suggest another way to increase the rate of decomposition of hydrogen peroxide in the rocket belt.

.....

.....[1]

[Total: 9]

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EITHER

B11 Nickel is a transition element. It is manufactured in a four-stage process from nickel(II) sulfide, NiS.

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

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

Stage 3 - impure nickel is reacted with carbon monoxide to make nickel tetracarbonyl, $Ni(CO)_4$

Stage 4 - nickel tetracarbonyl is decomposed to give pure nickel

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

.....[1]

(ii) Calculate the volume of sulfur dioxide formed if 182 kg of nickel(II) sulfide is used.

volume of sulfur dioxide = ... dm^3 [2]

(b) In terms of structure and bonding, explain why pure nickel is a good electrical conductor.

.....

.....

.....[2]

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

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

Predict the observations when nickel is added to separate solutions of zinc nitrate and copper(II) nitrate.

with zinc nitrate

.....

.....

with copper(II) nitrate

.....

.....[3]

(d) Explain why this four-stage process cannot be used to manufacture magnesium.

.....

.....

.....[2]

[Total: 10]

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OR

B11 Cleaning solutions usually contain the acid salt, sodium dihydrogen phosphate. It is known as an 'acid salt' as it can behave as both an acid and a salt. This salt can be made by reacting sodium hydroxide with phosphoric acid, H_3PO_4.

Sodium dihydrogen phosphate contains the anion, $H_2PO_4^-$.

(a) Write an equation, with state symbols, for the formation of sodium dihydrogen phosphate.

.....[2]

(b) The table shows information about other acidic compounds.

name	pH of a 1.0 mol/dm^3 solution
phosphoric acid	4.7
sodium dihydrogen phosphate	4.5
ethanoic acid	3.8
sulfuric acid	1.0

(i) Identify a strong acid and a weak acid.

Explain your reasoning.

.....

.....

.....

.....

.....

.....[3]

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(ii) Describe an experiment, other than measuring pH, that you could carry out to show that the named acids in **(b)(i)** is a strong acid and weak acid respectively.

State what measurements you would make and what results you would expect. Include in your answers two variables to be kept constant.

You may include diagrams in your answer.

.....

.....

.....

.....

.....

.....

.....

.....[5]

[Total: 10]

End of paper

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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89 – 103 actinoids	104 Rf Rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

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

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

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JUNYUAN SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2020
SECONDARY FOUR EXPRESS

CANDIDATE NAME

CLASS 4 E

INDEX NUMBER

CHEMISTRY

6092

PAPER 1

2 September 2020

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in soft pencil.
Do not use paper clips, glue or correction fluid.

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 in this booklet.
A copy of the Periodic Table is printed on page 19.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of 19 printed pages.

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1 Which substance would diffuse most quickly?

A carbon dioxide at 0 °C

B carbon dioxide at 25 °C

C neon at 0 °C

D neon at 25 °C

2 A student tested a solution by adding aqueous sodium hydroxide. A precipitate was not seen because the reagent was added too quickly.

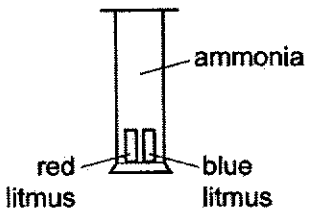
What could not have been present in the solution?

A Al^{3+} **B** Ca^{2+} **C** NH_4^+ **D** Zn^{2+}

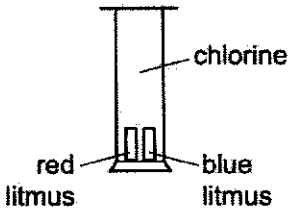
3 Four gas jars each contains one of the gases, ammonia, chlorine and oxygen. A strip of damp blue litmus paper and a strip of damp red litmus paper are placed in each jar.

In which gas jar will both the damp blue litmus paper and the damp red litmus paper change colour?

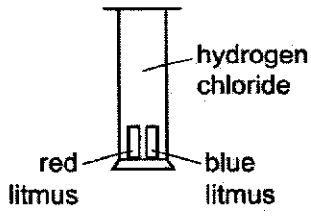
A



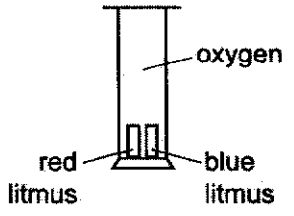
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C



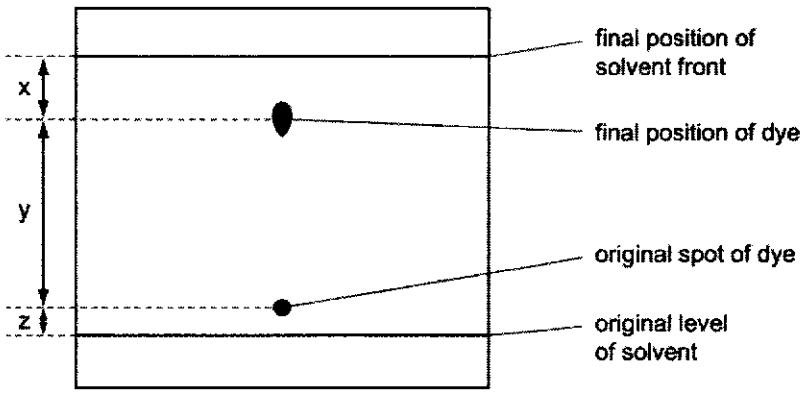
D



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4 The diagram shows the chromatogram obtained by analysis of a single dye.

Three measurements are shown.



How is the R_f value of the dye calculated?

A $\frac{x}{x+y}$ **B** $\frac{y}{x+y}$ **C** $\frac{x}{x+y+z}$ **D** $\frac{y}{x+y+z}$

5 The apparatus shown in Fig. 5.1 can be used to separate pure water from seawater.

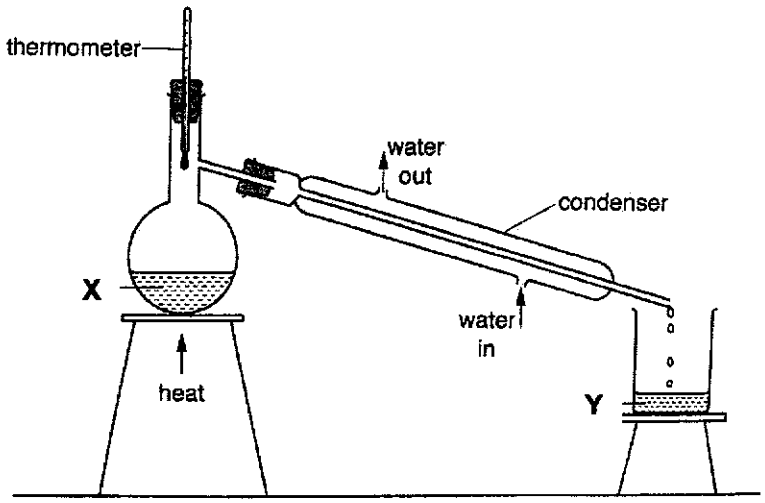


Fig. 5.1

Two samples are taken, one at point X and another at point Y.

Which of the following statements about X and Y is incorrect?

A X and Y can be separated into their components by physical methods.

B When heated to dryness, X leaves a residue while Y does not.

C X boils over a range of temperatures, while Y boils at 100 °C.

D X is a mixture while Y is a compound.

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6 The following statement describes substance X.

A chemical reaction takes place and heat is liberated when this white solid, X is formed.

Which of the following correctly classifies X and explains why X is classified as such?

	classification	explanation
A	element	When decomposition takes place, an element, X, is produced.
B	compound	Bond forming takes place to produce X.
C	mixture	The reactants and the product X, form a mixture.
D	either an element or a compound	A chemical reaction can produce either an element or a compound.

7 The atoms $^{64}_{29}Cu$ and $^{65}_{30}Zn$ have the same

A nucleon number.

B number of electrons.

C number of neutrons.

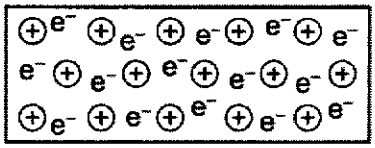
D proton number.

8 Which of the following correctly describes what happens when calcium atoms form calcium ions?

	calcium atoms	ionic equation for the formation
A	gain electrons	$Ca + 2e^- \rightarrow Ca^{2+}$
B	gain electrons	$Ca \rightarrow Ca^{2+} + 2e^-$
C	lose electrons	$Ca + 2e^- \rightarrow Ca^{2+}$
D	lose electrons	$Ca \rightarrow Ca^{2+} + 2e^-$

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9 Element X has a lattice of positive ions and a 'sea of electrons'.



Which property will X have?

A It conducts electricity by the movement of ions and electrons.

B It has a high melting point.

C It is decomposed by an electric current.

D It is not malleable.

10 When a covalent substance in liquid state boils, its molecules become more widely spaced.

Which property of the molecules has the most influence on the amount of energy required to boil a covalent substance?

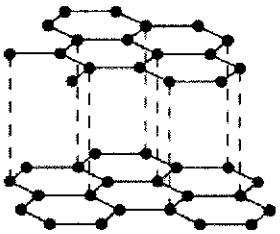
A the forces of attraction between the molecules

B the reactivity of the molecules

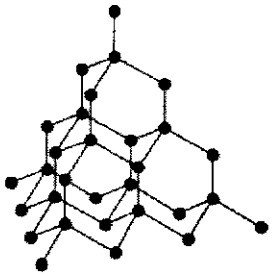
C the shape of the molecules

D the strength of the covalent bonds in the molecules

11 The diagrams show the structures of two forms of carbon.



S



T

Which set of data is correct for these two structures?

	conducts electricity	very hard material	can be used as lubricant
A	T	T	S
B	S	T	S
C	S	S	T
D	T	S	T

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12 Which statement about ionic compounds is correct?

A Ionic compounds conduct electricity when solid because they contain charged particles that can move.

B Ionic compounds consist of a lattice of positive ions and negative ions.

C Most ionic compounds are solids at room temperature because of the strong attraction between electrons and positive ions.

D When molten or in aqueous solution, ionic compounds conduct electricity because they contain electrons that can move.

13 Sulfur and selenium (Se) are in the same group of the Periodic Table.

From this, we would expect selenium to form compounds having the formulae

A SeO, Na_2Se and $NaSeO_4$.

B SeO_2, Na_2Se and $NaSeO_4$.

C SeO_2, Na_2Se and Na_2SeO_4.

D SeO_3, NaSe and $NaSeO_4$.

14 Students give their own special symbols to five non-metallic elements. All five non-metals are in the same group of the Periodic Table. These non-metals exist as coloured elements.

The special symbols are shown in Fig. 14.1. The order of chemical reactivity of these non-meals is also shown.

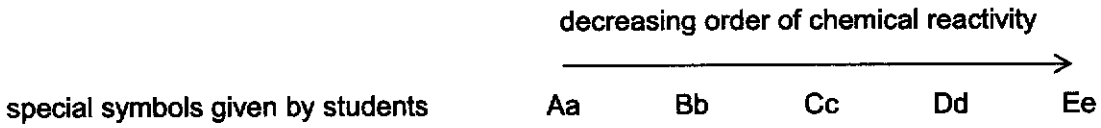


Fig. 14.1

A solution containing Cc ions can be displaced by two of the elements in the Group.

Which of the following correctly shows the ionic equation for one such reaction?

A $Aa(aq) + Cc^-(aq) \rightarrow Aa^-(aq) + Cc(aq)$

B $Bb_2(aq) + 2Cc^-(aq) \rightarrow 2Bb^-(aq) + Cc_2(aq)$

C $Dd(aq) + Cc^-(aq) \rightarrow Dd^-(aq) + Cc(aq)$

D $Ee_2(aq) + 2Cc^-(aq) \rightarrow 2Ee^-(aq) + Cc_2(aq)$

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15 The table shows some of the properties of four elements.

Which element is most likely to be a transition metal?

	melting point / °C	density / g/cm^3	electrical conductivity
A	3550	3.5	poor
B	1860	7.2	good
C	660	2.7	good
D	232	7.3	good

16 The relative formula masses of four compounds are given.

A student has a 1.0 g sample of each compound.

Which sample contains the highest number of moles of oxygen atoms?

	compound	relative formula mass
A	Al_2O_3	102
B	CuO	80
C	H_2SO_4	98
D	HNO_3	63

17 What is the concentration of iodine, I_2, molecules in a solution containing 2.54 g of iodine in 250 cm^3 of solution?

A 0.01 mol/dm^3 **B** 0.02 mol/dm^3 **C** 0.04 mol/dm^3 **D** 0.08 mol/dm^3

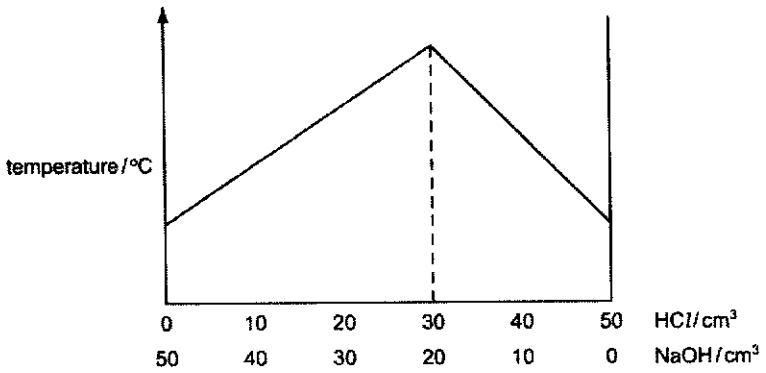
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18 A solution of hydrochloric acid has a concentration of 2 mol/dm^3.

Different volumes of the acid are added to different volumes of aqueous sodium hydroxide.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

The maximum temperature of each mixture is measured. The graph shows the results.



What is the concentration of the aqueous sodium hydroxide?

A 0.67 mol/dm^3

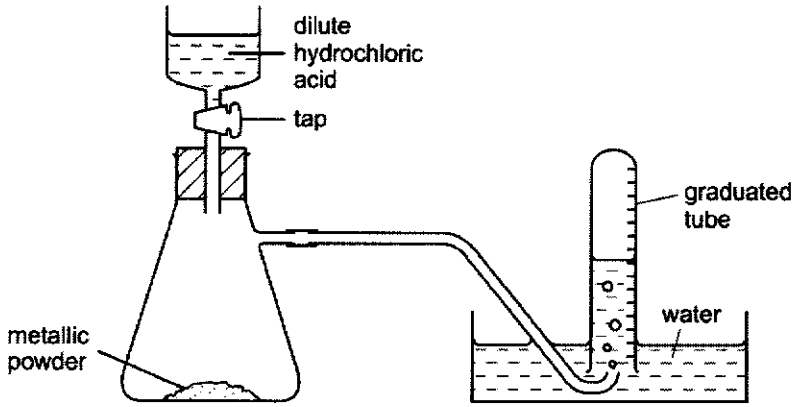
B 1.3 mol/dm^3

C 1.5 mol/dm^3

D 3.0 mol/dm^3

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19 The diagram shows apparatus for measuring the volume of hydrogen given off when an excess of dilute hydrochloric acid is added to powdered metal. The volume of gas is measured at room temperature and pressure.



The experiment is carried out three times, using the same mass of powder each time but with different powders:

- pure magnesium
- pure zinc
- a mixture of magnesium and zinc

Which powder gives the greatest volume of hydrogen and which the least volume?

	greatest volume of H_2	least volume of H_2
A	magnesium	zinc
B	magnesium	the mixture
C	zinc	magnesium
D	zinc	the mixture

20 The following statements about dilute sulfuric acid are all correct.

1 Addition of Universal Indicator shows that the solution has a pH value of less than 7.0.
2 A white precipitate is formed when aqueous barium chloride is added.
3 The solution reacts with copper(II) oxide, forming a blue solution.
4 When electrolysed, hydrogen and oxygen gases are produced.

Which two statements confirm the acidic nature of the solution?

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

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21 A solution of W has the following properties.

- When added in excess to solid ammonium chloride, a gas is given off that turns damp red litmus paper blue.
- When added in excess to a solution of pH 3, the resulting solution has a pH of 13.

What is W?

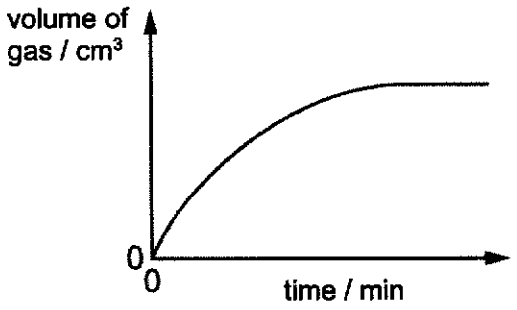
A a strong acid
B a strong base
C a weak acid
D a weak base

22 Which equation describes the most suitable reaction for making lead(II) sulfate?

A $Pb + H_2SO_4 \rightarrow PbSO_4 + H_2$
B $PbCO_3 + H_2SO_4 \rightarrow PbSO_4 + CO_2 + H_2O$
C $Pb(NO_3)_2 + H_2SO_4 \rightarrow PbSO_4 + 2HNO_3$
D $Pb(OH)_2 + H_2SO_4 \rightarrow PbSO_4 + 2H_2O$

23 Excess marble chips were reacted with dilute hydrochloric acid in an experiment. The volume of gas produced was measured at regular time intervals.

The results obtained are plotted in the graph as follows.



The speed of reaction decreases throughout the reaction until it comes to a stop.

Which of the following explains why the speed of reaction decreases?

A Marble chips were completely used up.
B Hydrochloric acid was completely used up.
C The mass of marble chips decreased.
D The concentration of hydrochloric acid decreased.

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24 The following statements describe how the speed of reactions can be increased.

1 increase the amount of kinetic energy reactant particles can possess
2 increase the frequency of effective collisions
3 lower the activation energy of the reaction

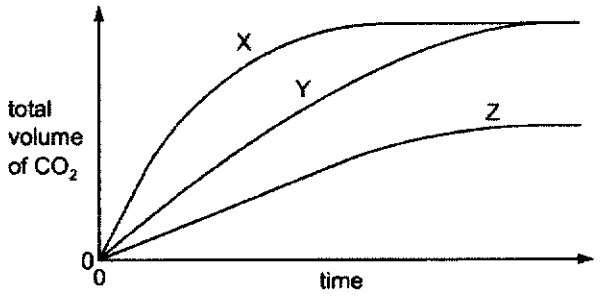
Which statements describe the effect when temperature is increased?

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

25 In experiment 1, an excess of finely powdered marble is added to 20 cm^3 of dilute hydrochloric acid.

In experiment 2, carried out under the same conditions of temperature and pressure, an excess of marble chips is added to 20 cm^3 of dilute hydrochloric acid of the same concentration.

The total volumes of carbon dioxide given off are determined at intervals and plotted against time.

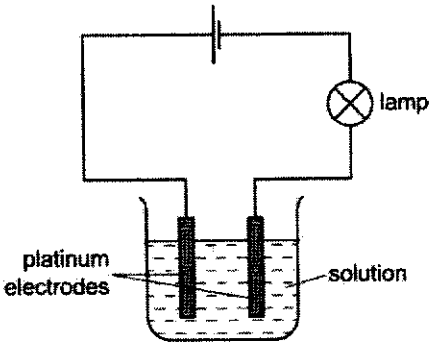


Which pair of curves is obtained in the two experiments?

	experiment 1	experiment 2
A	X	Z
B	X	Y
C	Y	Z
D	Y	X

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26 The diagram shows apparatus used to investigate the conductivity of different solutions.



Which substance, in aqueous solution of concentration 1 mol/dm^3, would cause the lamp to give the brightest light?

A ammonia

B ethanoic acid

C dilute sodium chloride solution

D sulfuric acid

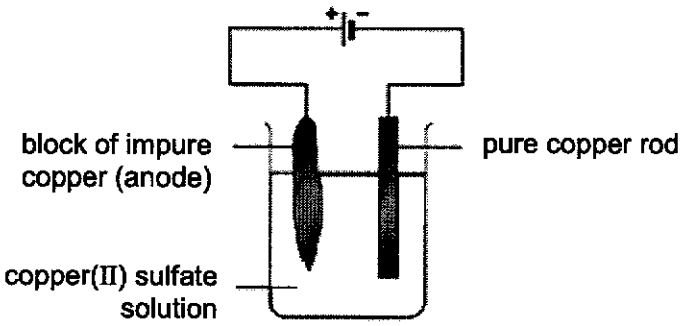
27 The heat-reflecting shields of some space rockets are gold-plated, using electrolysis.

Which electrodes and electrolyte would be used to gold-plate the heat shield?

	negative electrode	positive electrode	electrolyte
A	carbon	heat shield	gold compound
B	gold	heat shield	copper compound
C	heat shield	carbon	copper compound
D	heat shield	gold	gold compound

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28 The following set-up shows how a block of impure copper can be purified.

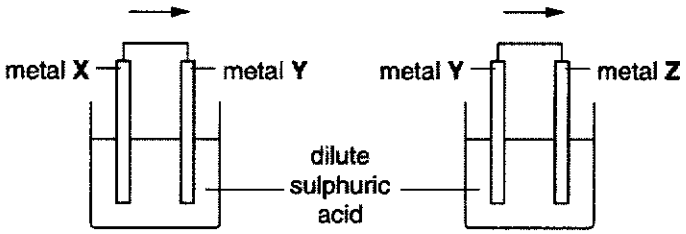


The loss in mass of the anode is 50 g and the gain in mass of the cathode is 45 g.

What is the percentage purity of this sample of copper?

A 10.0 % **B** 11.1 % **C** 90.0 % **D** 95.0 %

29 Two cells were set up as shown in the diagram. The arrow shows the direction of electron flow in the external circuit.

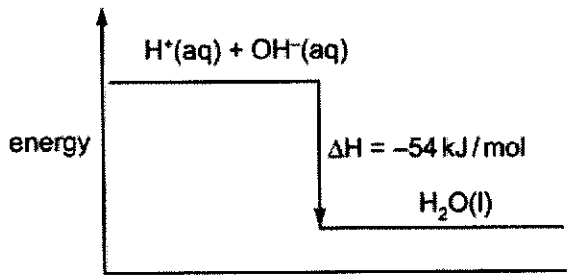


Which set of metals would give the electron flows in the direction shown?

	metal X	metal Y	metal Z
A	Ag	Cu	Zn
B	Ag	Zn	Cu
C	Cu	Zn	Ag
D	Zn	Cu	Ag

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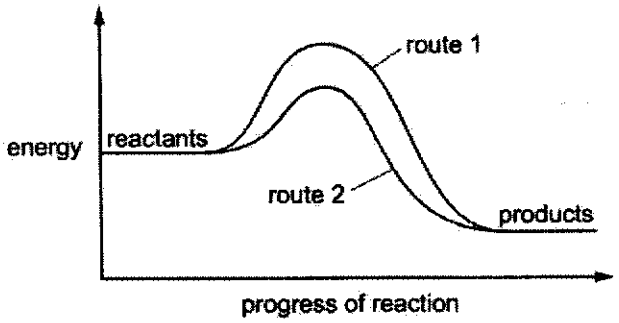
30 The energy diagram for the reaction between sodium hydroxide and hydrochloric acid is shown.



Which quantity of heat is liberated when 100 cm^3 of 1 mol/dm^3 hydrochloric acid reacts with 100 cm^3 of 1 mol/dm^3 sodium hydroxide?

A 0.54 kJ **B** 2.70 kJ **C** 5.40 kJ **D** 10.8 kJ

31 The diagram shows the energy profile for a reaction.



Which statements about this reaction are correct?

1 More energy is absorbed to break the bonds than is released when new bonds are formed.

2 Route 1 and route 2 give the same overall equation for the reaction.

3 Route 2 involves the use of a catalyst.

4 The reaction is exothermic.

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

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32 The equation shows a reversible reaction.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

The forward reaction is endothermic.

Which of these changes will increase the yield of NO_2?

	pressure	temperature
A	decreased	decreased
B	decreased	increased
C	increased	decreased
D	increased	increased

33 Which of the following is not an example of oxidation?

A converting iron(III) salts to iron(II) salts

B converting magnesium atoms into magnesium ions

C dissolving a copper anode during electrolysis

D liberating chlorine from a chloride solution

34 Sulfur dioxide reacts with aqueous bromine according to the following equation.

$$SO_2(g) + Br_2(aq) + 2H_2O(l) \rightarrow H_2SO_4(aq) + 2HBr(aq)$$

Which element has been oxidised?

A bromine

B hydrogen

C oxygen

D sulfur

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35 Some metals and the compounds in their ores are shown.

metal	Al	Ca	Pb	Na	Fe	Mg
compound in their ore	Al_2O_3	$CaCO_3$	PbS	NaCl	Fe_2O_3	$MgCO_3$

Which type of reaction occurs in the extraction of all of these metals from their respective ores?

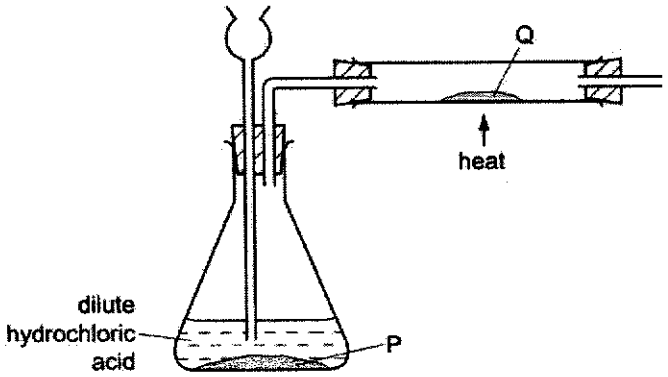
A decomposition by heat

B electrolysis

C precipitation

D reduction

36 The diagram shows the apparatus in an experiment to reduce substance Q with the gas generated in the flask.



What are substances P and Q?

	P	Q
A	copper	copper(II) oxide
B	lead	lead(II) oxide
C	magnesium	zinc oxide
D	zinc	copper(II) oxide

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37 Brass is an alloy.

Which statement about brass is correct?

A It contains a sea of electrons.

B It contains positive and negative ions which are free to move.

C It is a compound of a metal and a non-metal.

D It is a compound of two or more metals.

38 Iron is extracted from its ore haematite, Fe_2O_3, by a reduction process in the blast furnace.

Which equation for reactions in the blast furnace shows the formation of the reducing agent?

A $CaCO_3 \rightarrow CaO + CO_2$

B $CaO + SiO_2 \rightarrow CaSiO_3$

C $CO_2 + C \rightarrow 2CO$

D $C + O_2 \rightarrow CO_2$

39 Cars have catalytic converters fitted to reduce problems caused by some of the exhaust gases. However, cars fitted with catalytic converters still give out environmentally harmful gases.

Which of the following correctly states the harmful gas and the problem the gas causes?

	harmful gas	problem
A	nitrogen dioxide	dissolves in rain to corrode marble buildings
B	nitrogen dioxide	causes breathing problems when inhaled.
C	carbon dioxide	binds with haemoglobin in blood causing respiratory problems
D	carbon dioxide	causes the greenhouse effect leading to global warming

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40 Nitrogen monoxide, NO, damages the ozone layer by reacting with ozone in a two-step reaction.

$$NO + O_3 \rightarrow NO_2 + O_2 \qquad \text{step 1}$$
$$NO_2 + O_3 \rightarrow NO + 2O_2 \qquad \text{step 2}$$

One nitrogen monoxide molecule can destroy thousands of ozone molecules.

Which statement correctly explains why?

A Nitrogen monoxide in step 1 is easily generated through thunderstorms.

B Nitrogen monoxide, while is used up in step 1, is regenerated in step 2.

C Nitrogen dioxide produced can dissolve in rain to react with thousands of ozone molecules.

D Nitrogen monoxide can react continuously with ozone since the ozone layer consists of thousands of ozone molecules.

End of Paper

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The Periodic Table of Element

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 –		

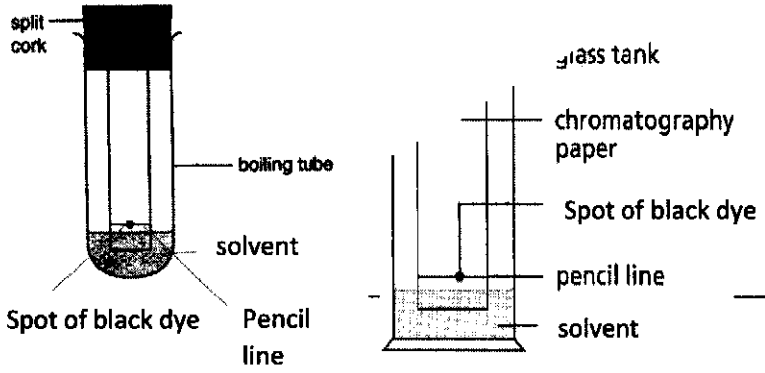
lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
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.).

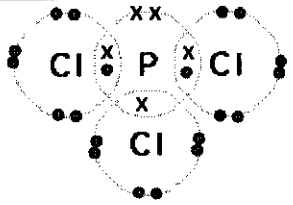
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Question	Suggested answer	Mark allocation	Remarks
1a	Ammonia	1	1e was especially badly done
b	Iodine	1	
c	Magnesium	1	
d	Argon	1	
e	Hydrochloric acid/calcium chloride	1	
2a	0.72	1	Surprisingly, a considerable number of students got this wrong
2b	A pure solvent of water is suitable for the separation of the black ink. This is because, the Rf values shows that the blue ink will travel further up the chromatogram than the red ink, While the yellow ink will remain insoluble at the original spot. Hence, all three components would be separated.	1 1	All students wrote that it is not suitable. Students need to read question carefully – since they are alredy told that there are only 3 dyes present in the black ink, and since two of them are soluble in pure water (with different solubilities), this means that separation is possible.
2c	When the solvent used **is about 80% ethanol**, **all the 3 dyes will give the same R_f value as they have the same solubilities / travel the same distance**. Hence, it will appear as only spot.	1 1	Generally well done. Vague response – meet at one point
2d		1m for correct set up (spot above solvent, stopper/lid) 1m for correct labelling (minimally	Although students were not penalized, need to highlight that since ethanol, a volatile solvent, is used, a lid needs to be used to prevent it from evaporating. Need to highlight that solvent front is NOT THE SAME as start line.

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		solvent, spot on pencil line)	
3a	Similarity – both are made of phosphorus **atoms covalently bonded** together / both involve each phosphorus atom being bonded to 3 other atoms. Difference – white phosphorus has a **simple molecular structure** while black phosphorus has a **giant molecular / covalent structure**.	1 1	Many wrote that black phosphorus has a simple molecular structure. Need to highlight that students need to name the type of bond – stating 'held together by strong bonds' is insufficient
3b	In black phosphorus, a **large amount of energy** is needed to **break the extensive network of strong covalent bonds**. This accounts for its high melting point. However, in white phosphorus, a **small amount of energy** is needed to overcome the **weak intermolecular forces of attraction** between the molecules. Hence, it has a much lower melting point.	1 1m 1m for comparing the relative amount of energies needed.	Got ecf from 3a. Some students panicked and forgot the bonds/forces of attraction that needs to be overcome during melting.
3c	 Key: ▪ : electrons of Cl X : electrons of P	1m for correct bonding and arrangement of atoms	A handful of students separated the unbonded electrons in phosphorus.

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		1m for correct arrangement of electrons (-1m for drawing all electron shells)	
4a	This post is not valid. Sodium will **react in air/water** since it is very reactive. Hence, since **rubidium is even more reactive than sodium, the possibility of it reacting in air/water is higher**. Therefore, it cannot be found as silvery deposits. OR Rubidium is on top of the series. Hence it is **higly reactive**. It would have **reacted with other elements in the air/environment** to form a compound, and cannot exist uncombined as an element.	1m for explaining that it will react in air 1m for drawing comparison with sodium 1 1	Generally well done
4b	Magnesium **reacts very slowly with cold water while iron does not react with cold water**. Since beryllium is in between these two metals, it might **not even react / react extremely slowly** (slower than Mg) **with cold water** Magnesium reacts **violently with steam whereas iron reacts slowly with steam.** Since beryllium is between these two metals, it might react **quickly/rapidly/slowly** (slower than Mg) with steam.	1 1 1 1	Poorly done. Need to highlight that the question's intent is for them to explain the vigour of the reaction, and also that they need to draw comparisons with magnesium and iron, since these two are the located the closes with beryllium.
4c	Heating bismuth oxide with coke (carbon) / hydrogen		Some wrote 'electrolysis'
5a(I)	Ba^{2+}, OH^-	1	To go through 5a and 5b in detail since it was very badly done. Even for 5a, many students stated the formula of the substance though they have been clearly
5a(II)	H^+, SO_4^{2-}	1	
5b	At the start of the experiment, the **ammeter reading was the highest** as there was **highest number of ions present** (concentration of ions is at its maximum) to **carry a current**.	1	

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	As sulfuric acid is added, the **ammeter reading drops as the Ba^{2+} ions were used up** to form solid $BaSO_4$. Therefore, there are **fewer mobile ions present to carry a current**. When 5.00 cm^3 of sulfuric acid is added, **all the Ba^{2+} ions have reacted** to form solid barium sulfate, which is poor electrical conductor.	1 1	asked for formula of the ions. Many failed to interpret the curve correctly.
5c	No. of moles of sulfuric acid needed for complete reaction = 0.500 x 0.005 = 0.0025 Concentration = 0.0025 / 0.025 = 0.1 mol/dm^3 OR M_1V_1 / M_2V_2 = na/nb M_1 x 25 / (**0.5 x 5**) = 1/1 M_1 = **0.1 mol/dm^3**	1 1 1 1	Generally well done.
5d	Plastic **prevents the iron from coming into contact with oxygen and water**, preventing rusting.	1	Generally well done. Vague response will be to just state that iron will react with the **mixture.**
6a	Zn^{2+} or Cu^{2+} (zinc or copper(II) ions) As aqueous ammonia is added, a **precipitate of the metal hydroxide forms**, and mass of solid increases. When aqueous ammonia is added in **excess, the precipitate dissolves and the mass of solid decreases**.	1 1 1	Very poorly done. Need to highlight to students that since question is asking them to identify cation, they need to zoom in straight to the cations test.
6b	No. The reaction of the **metal oxide obtained from stage I** with hydrochloric acid will not produce carbon dioxide.	1	Many failed to give the proper explanation, just stating that there is 'no more carbonate left.'

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<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>6c</td><td>$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$</td><td>1m for correct balanced equation, 1m for correct state symbols</td><td>Poorly done. Tried to award ecf but tough..</td></tr>
<tr><td>7a</td><td>This is to ensure that all of the oxygen has reacted.</td><td>1</td><td>Generally well done. Vague responses will include 'ensuring that all reactants has reacted'.</td></tr>
<tr><td>b</td><td>Volume of oxygen = 200 – 160 = 40 cm^3

% of oxygen = 40 / 200 x 100% = 20%</td><td>1</td><td></td></tr>
<tr><td>c(i)</td><td><table><tr><td></td><td>oxidation state of carbon</td></tr><tr><td>FeC_2O_4</td><td>+3</td></tr><tr><td>CO_2</td><td>+4</td></tr><tr><td>CO</td><td>+2</td></tr></table></td><td>1m for FeC_2O_4
1m for the other 2 substances</td><td>Very poorly done for FeC_2O_4</td></tr>
<tr><td>c(ii)</td><td>The oxidation state of C has increased from +3 (in FeC_2O_4) to +4 (in CO_2).

The oxidation state of C has also decreased from +3 ((in FeC_2O_4) to +2 (in CO).

Since both oxidation and reduction happens at the same time, this is a redox reaction.</td><td>1

1</td><td>Decent</td></tr>
<tr><td>8a</td><td>30%</td><td>1</td><td>Well done</td></tr>
</table>

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<table>
<tr><td>8b</td><td>This is to increase the yield of hydrogen and nitrogen into ammonia.
This also helps to save cost and/or prevent wastage.</td><td>1

1</td><td>Well done</td></tr>
<tr><td>8c</td><td>When the temperature is too low, the speed of reaction will be too slow.</td><td>1</td><td>Well done</td></tr>
<tr><td>9a</td><td><table>
<tr><td></td><td>cathode</td><td>anode</td></tr>
<tr><td>AFC</td><td>$O_2(g) + 2H_2O(l) + 4e \rightarrow 4OH^-(aq)$</td><td>$H_2(g) + 2OH^-(aq) \rightarrow 2H_2O(l) + 2e$</td></tr>
<tr><td>PEMFC</td><td>$4H^+(aq) + O_2(g) + 4e \rightarrow 2H_2O(l)$</td><td>$H_2(g) \rightarrow 2H^+(aq) + 2e$</td></tr>
</table></td><td>1 each</td><td>Extremely poorly done. Really need to teach students to read and process passage</td></tr>
<tr><td>9b</td><td>$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$</td><td>1 for correct balanced equation, 1 for state symbols</td><td>Poorly done</td></tr>
<tr><td>9c</td><td>Carbon dioxide, being an acidic oxide, reacts with the electrolyte potassium hydroxide.

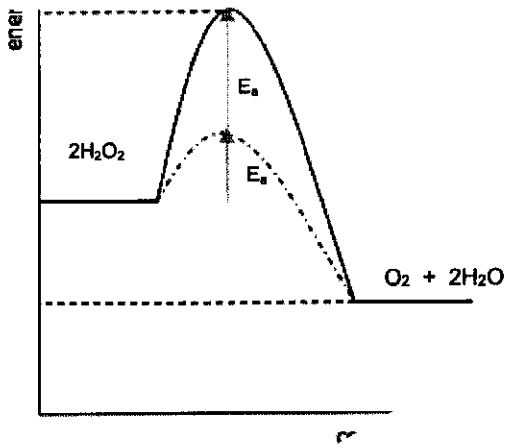
$CO_2 + 2KOH \rightarrow K_2CO_3 + H_2O$</td><td>1

1</td><td>Even though many were able to state that carbon dioxide is an acidic oxide, many failed to write the correct equation; instead they wrote the equation for the formation of carbonic acid, which doesn't explain why carbon dioxide poisons the electrolyte at all.</td></tr>
<tr><td>9d</td><td>The operation of AFC requires non-precious metal as catalyst in contrast to PEMFC which requires expensive platinum catalysts and precious metal-based electrodes as well.</td><td>1</td><td>Well done.</td></tr>
</table>

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9e(i)	They produce **only water as the waste product.**	1	Many wrote 'they do not produce greenhouse gases'; there are many other ways that a fuel can pollute the environment.
9e(ii)	Methane is used in the production of hydrogen. If methane leaks into the atmosphere, it can **trap heat** and cause **greenhouse effect.** OR Carbon monoxide, which is produced, is toxic as it binds to the haemoglobin, resulting in it being unable to bind to oxygen, which may lead to breathing difficulties that may result in death.	 1	Students need to discuss the impact. For CO, many just stated that it is a toxic gas without explaining its impact.
10a	$2H_2O_2 \rightarrow O_2 + 2H_2O$	1	Many did not know the formula of hydrogen peroxide!
10b	**More energy is released to form** O=O bonds and O-H bonds than **the energy taken in to break** O-H bonds and O-O bonds. OR **Less energy is taken in to break** O-H bonds and O-O bonds than the **energy released to form** O=O bonds and O-H bonds.	1 1 1	Many did not split up the atoms. For e,g 'H-O-H bonds'.

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10c(i)		1m for correct shape of energy profile diagram, 1m for labelling the activation energy on both energy profile diagrams, 1m for correctly labelling the reactants and products	Generally well done.
10c(ii)	The catalyst **lowers** the activation energy of the reaction and this **increases** the number of particles having energy **higher than or equal to the new activation energy**. Hence, **the frequency of effective collisions increases**, thereby speeding up the reaction.	1 1	Many failed to realise that since this is a part question, their answer needs to be linked to c(i).
10c(iii)	increase the concentration of the hydrogen peroxide	1	Many wrote 'increase temperature' without considering the feasibility of it in this context.
EITHER 11a(i)	$2NiS + 3O_2 \rightarrow 2NiO + 2SO_2$	1	A few did not balance correctly.
11a(ii)	No. of moles of NiS = 182 000 / 91 = 2000 No. of moles of SO_2 formed = 2000 Volume = 2000 x 24 dm^3 = 48 000 dm^3	1 1	Many did not convert the mass to grams! Ecf awarded (grudgingly)

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11b	Metals consist of a lattice **of positive ions** that are surrounded by a sea of mobile **delocalized free moving electrons**. This **sea of mobile electrons** can **move** to carry the charge of an electric current when a potential difference is applied.	1 1	Well done. Those who did not get the full marks did not explain metal structure.
11c	No visible reaction Blue solution turns green Nickel gets coated with a pink solid	1 1 1	Many wrote 'blue solution turns colourless'
11d	Magnesium is **more reactive than nickel**/carbon Its **oxide cannot be reduced by carbon to form magnesium**; however, nickel(II) oxide can be reduced by carbon in stage 2. OR Magnesium can only be obtained by electrolysis	1 1	Need to highlight to students that they need to compare magnesium to either Ni or C.
OR **11a**	$NaOH(aq) + H_3PO_4(aq) \rightarrow NaH_2PO_4(aq) + H_2O(l)$	1m for correct equation, 1m for correct state symbols	Not many attempted this question.
11b(i)	Strong acid – sulfuric acid Weak acid – phosphoric acid / sodium dihydrogen phosphate / ethanoic acid Sulfuric acid is a strong acid as it undergoes **complete ionisation in water** that results in a **high concentration of hydrogen ions**, thereby resulting in a low pH. Phosphoric acid / sodium dihydrogen phosphate / ethanoic acid is a weak acid as it undergoes **partial ionisation in water** to form a **low concentration of hydrogen ions**, thereby resulting in a relatively high pH.	1m for correctly stating the types of ionisation that strong and weak acids undergo 1m for stating that ionization takes place in water 1m for stating the relative concentrations of hydrogen ions formed	Many missed out 'in water'

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(ii)	Place the chosen acids of **same, known volume** and **same, known concentration** into separately into a conical flask. Add a **known mass** of zinc carbonate / zinc (any plausible carbonate or metal) into the acids. Immediately attach a well-oiled gas syringe to the flask to collect the carbon dioxide gas / hydrogen gas formed. Stop the experiment for both acids at the same time. Record the volume of gas produced. The strong acid will give a higher volume of gas whereas the weak acid will give a lower volume of gas. (other accepted methods – measuring current, measuring speed of reactions, measuring mass loss)	1 1 1 1 1m for stating at least 2 variables that are kept constant	Setup: 1 Reagents: 1 Measurements: 1 Conclusion: 1 Variables kept constant: 1 Correct approach – 1m Correct measurements/observation – 1m Correct variable fixed – 1m Correct conclusion – 1m Those who attempted this did quite well.

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