1 Bromate ion, bromide ion and hydrogen ions react according to the equation as shown.

$$BrO_3^-(aq) + 5Br^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$$

Some apparatus for measuring the change in the rate of this reaction are suggested.

1 gas syringe
2 balance
3 pH meter

Which apparatus are suitable to measure the rate of this reaction?

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

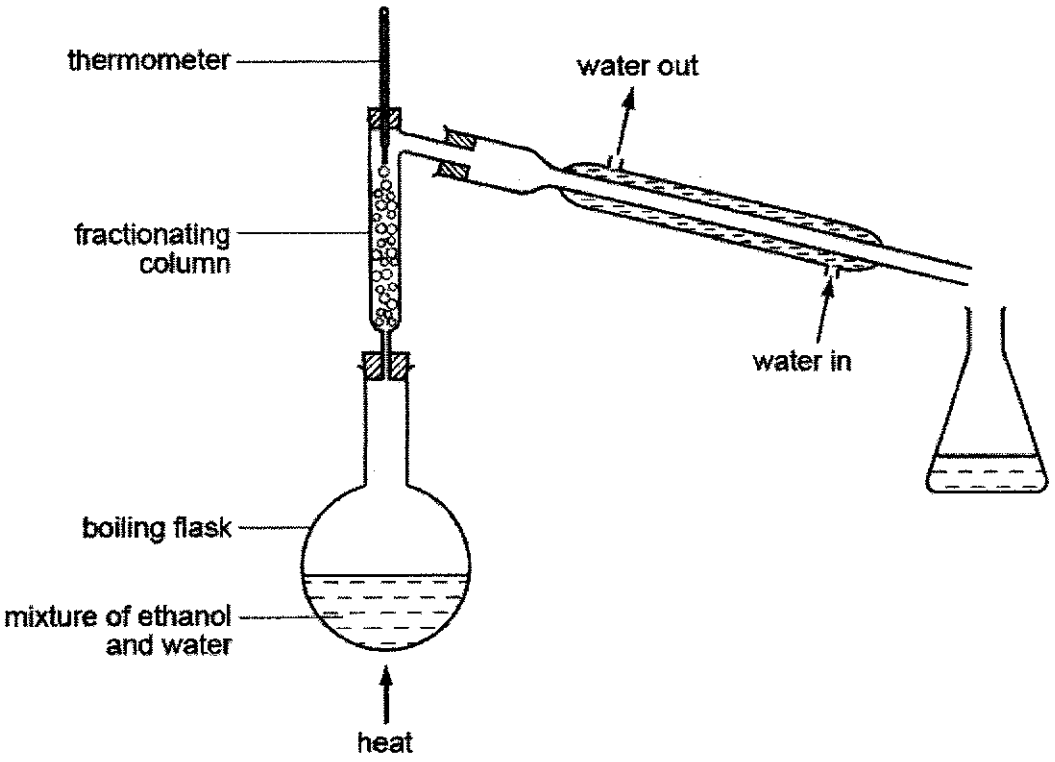
2 A mixture of propane, butane, hydrogen sulfide and carbon dioxide at -30 °C is allowed to cool down gradually to -200 °C.

compound	melting point / °C	boiling point / °C
propane	-188	-42
butane	-135	-1
hydrogen sulfide	-85	-51
carbon dioxide	-78	-78

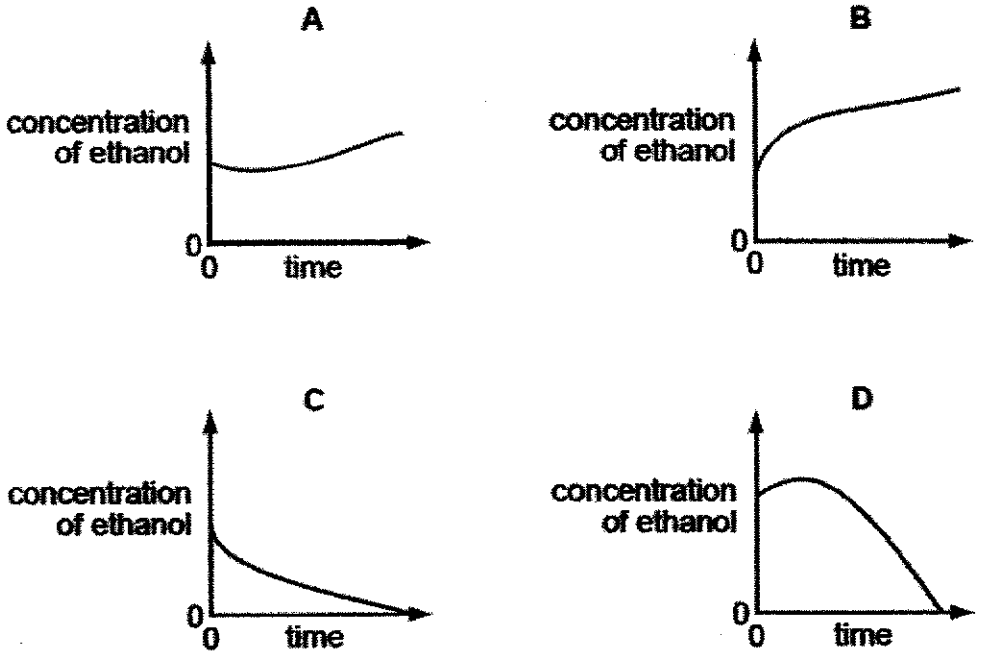
Which compound will solidify first?

A butane
B carbon dioxide
C hydrogen sulfide
D propane

3 The apparatus shown is used to obtain ethanol from a dilute solution of ethanol in water.
[boiling point of ethanol: 78 °C]



Which graph shows the change in concentration of the ethanol in the boiling flask as the distillation proceeds?



4 Which option correctly shows the numbers of particles in $^{34}_{16}S^{2-}$?

	protons	neutrons	electrons
A	16	16	16
B	16	18	18
C	18	16	20
D	20	14	22

5 A sample of oxygen is a mixture of the two isotopes $^{16}_{8}O$ and $^{18}_{8}O$.

The relative atomic mass of carbon is 12.

What are possible values of the relative molecular mass of different molecules of carbon dioxide formed by the combination of carbon and oxygen.

1 44

2 46

3 48

A 1 only

B 1 and 2 only

C 1 and 3 only

D 1, 2 and 3

6 Three elements X, Y and Z have consecutive increasing proton (atomic) numbers. If element Z is a noble gas, how is a stable compound formed between X and Y?

A An atom of X transfers 2 electrons to 1 atom of Y to form XY.

B An atom of X transfers 2 electrons to 2 atoms of Y to form XY_2.

C An atom of X shares 2 electrons with 1 atom of Y to form XY.

D An atom of X shares 2 electrons with 2 atoms of Y to form XY_2.

7 Which solid contains more than one type of bonding?

A magnesium nitrate

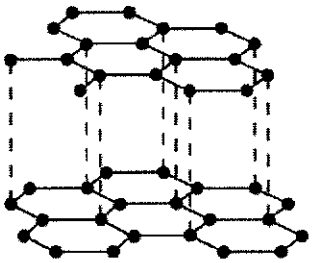
B silicon dioxide

C sodium chloride

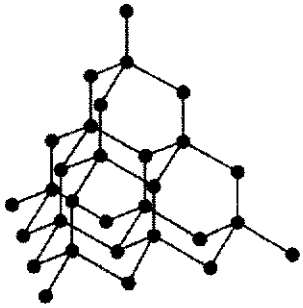
D zinc

8 P, Q and R represent three different structures of an element.

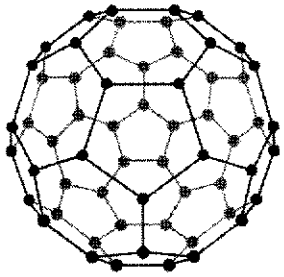
P



Q



R



Which structures are giant covalent?

A P and Q

B P and R

C Q and R

D P, Q and R

9 5.0 g samples of the carbonates of barium, copper, sodium and magnesium are decomposed to form the metal oxides and carbon dioxide.

For which compound is there the greatest loss in mass?

A barium carbonate

B copper(II) carbonate

C magnesium carbonate

D sodium carbonate

10 In an experiment, 8.0 cm^3 of 1.0 mol/dm^3 aqueous copper(II) nitrate was mixed with 6.0 cm^3 of 1.0 mol/dm^3 aqueous potassium carbonate in a beaker.

The reaction can be represented by the equation:

$$Cu(NO_3)_2 + K_2CO_3 \rightarrow CuCO_3 + 2KNO_3$$

What did the reaction vessel contain when the reaction was complete?

A a green precipitate only

B a green precipitate and a blue solution

C a green precipitate and colourless solution

D a blue precipitate and a colourless solution

11 The equation for the combustion of methane is as shown.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

Which statement is **incorrect** for a complete combustion of methane?

A 1 mole of methane will react with 48 dm^3 of oxygen at r.t.p.

B 5 cm^3 of methane will reacts with 10 cm^3 of oxygen at r.t.p.

C 8 g of methane when burnt will form 24 dm^3 of carbon dioxide.

D 8 dm^3 of methane will produce 12 g of water.

12 Ferrite is a ceramic-like material with magnetic properties that are useful in many types of electronic devices. It is made of a mixture of the oxides of calcium and iron. It contains 18.5% calcium and 51.9% iron by mass.

What is the empirical formula of ferrite?

A $CaFe_2O$

B $CaFe_2O_4$

C Ca_2FeO_2

D Ca_4Fe_2O

13 Both hydrochloric acid and ethanoic acid have the same concentration of 0.5 mol/dm^3 . Which methods are suitable to test for their strengths?

1 using a pH meter

2 measuring their electrical conductivity

3 titration using sodium hydroxide solution

A 1 only

B 1 and 2

C 2 and 3

D all of the above

14 An alloy reacts with dilute hydrochloric acid to evolve a gas which extinguishes a lighted splint with a 'pop' sound. A red-brown solid residue remains, which turns into a black solid when heated in air.

Which two metals are present in the alloy?

A silver and zinc

B silver and copper

C iron and copper

D iron and aluminium

15 The equations represent reactions of dilute sulfuric acid.

Which reaction is **not** 'typical' of a dilute acid?

A $CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$

B $2KOH(aq) + H_2SO_4(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$

C $Pb(NO_3)_2(aq) + H_2SO_4(aq) \rightarrow PbSO_4(s) + 2HNO_3(aq)$

D $ZnCO_3(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2O(l) + CO_2(g)$

16 Which oxide is insoluble in aqueous sodium hydroxide?

A Al_2O_3

B MgO

C P_4O_{10}

D SO_2

17 Which row of information correctly displays the reactants used to safely prepare a salt with the highest possible yield?

	reactants	salt to be prepared
A	calcium oxide and sulfuric acid	calcium sulfate
B	copper and hydrochloric acid	copper(II) chloride
C	lithium and hydrochloric acid	lithium chloride
D	zinc oxide and sulfuric acid	zinc sulfate

18 Tests were carried out on an aqueous solution of an unknown compound, P.

The observations were recorded in the table.

test	observation
aqueous sodium hydroxide added	white precipitate, soluble in excess giving a colourless solution
aqueous ammonia	white precipitate, soluble in excess giving a colourless solution
aqueous barium nitrate added, followed by dilute nitric acid	white precipitate formed, white precipitate soluble in dilute nitric acid to form a colourless solution

Which ions are present?

A Al^{3+} and SO_4^{2-}

B Zn^{2+} and SO_4^{2-}

C Al^{3+} and CO_3^{2-}

D Zn^{2+} and CO_3^{2-}

19 In the Haber process, a high yield of ammonia is favoured by high pressure and low temperature. In practice, a high temperature is used.

Which statement best explains the discrepancy in the preferred temperature?

A At low temperature, ammonia decomposes back to its original reactants.

B At low temperature, the activation energy is too low.

C At low temperature, the catalyst is inactive.

D At low temperature, the reaction is too slow.

20 Which reaction is **not** a redox reaction?

A $Mg + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2$

B $2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$

C $SO_2 + NO_2 \rightarrow SO_3 + NO$

D $SO_3 + H_2O \rightarrow H_2SO_4$

21 Hydrogen peroxide (H_2O_2) acts as an oxidising agent in some reactions, but in others, as a reducing agent.

reaction 1: $H_2O_2 + 2KI + H_2SO_4 \rightarrow I_2 + K_2SO_4 + 2H_2O$

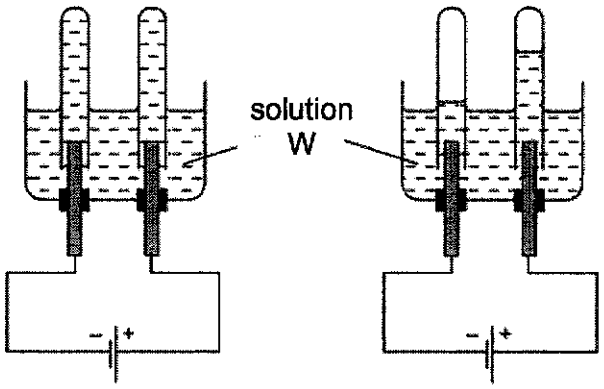
reaction 2: $5H_2O_2 + 2KMnO_4 + 3H_2SO_4 \rightarrow 2MnSO_4 + K_2SO_4 + 5O_2 + 8H_2O$

reaction 3: $H_2O_2 + Ag_2O \rightarrow 2Ag + O_2 + H_2O$

Which row identifies correctly the role of hydrogen peroxide in each reaction?

	reaction 1	reaction 2	reaction 3
A	oxidising agent	reducing agent	oxidising agent
B	oxidising agent	reducing agent	reducing agent
C	reducing agent	oxidising agent	reducing agent
D	reducing agent	oxidising agent	oxidising agent

22 The diagram shows an electrolysis set-up using inert electrodes **before** and **after** the electrolysis.

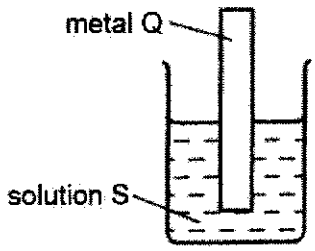


Which could solution W be?

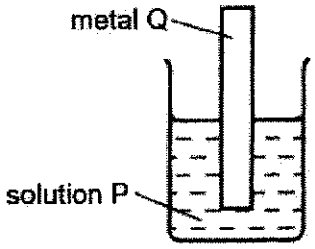
1 aqueous sodium nitrate
2 aqueous copper(II) sulfate
3 concentrated aqueous sodium chloride
4 dilute sulfuric acid

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

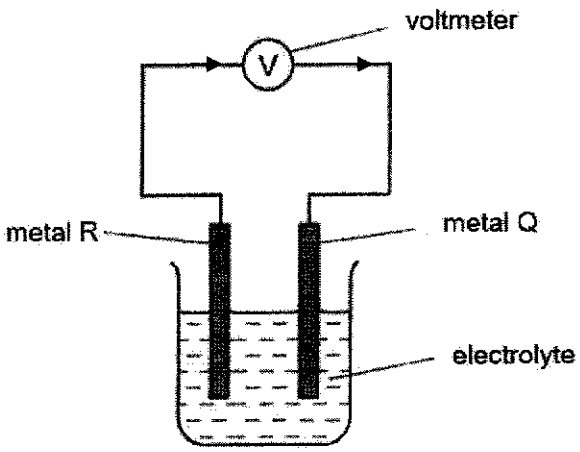
23 Study the set-ups as shown to determine the order of reactivity of four metals, P, Q, R and S.

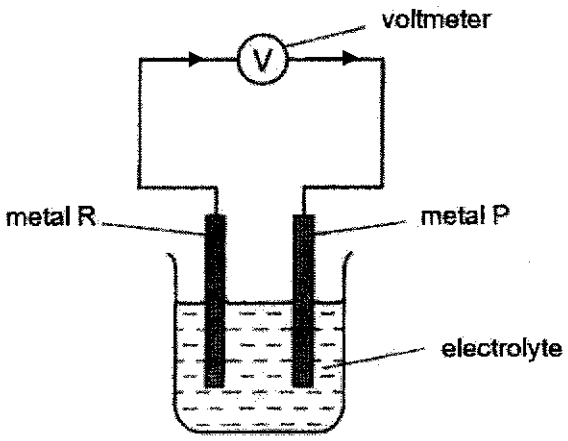


grey solid on metal Q observed in a colourless solution



no visible change observed





If a simple cell was set up between two of the metals, which pair of electrodes will give the largest voltmeter reading?

A metal R and metal Q

B metal R and metal S

C metal R and metal P

D metal P and metal Q

24 Three elements E, F and G belong to the same period in the Periodic Table. The properties of their oxides are as given.

oxide of E:	soluble in both nitric acid and aqueous potassium hydroxide
oxide of F:	insoluble in water and aqueous sodium hydroxide but dissolves readily in nitric acid
oxide of G:	changes acidified potassium manganate(VII) from purple to colourless

What is the arrangement of E, F and G in order of decreasing atomic number in the Periodic Table?

A E, F, G

B F, E, G

C G, F, E

D G, E, F

25 Which statement about catalysts is correct?

A Catalysts are used in industry to reduce energy costs.

B Catalysts are used up during a reaction.

C Manganese dioxide is used as a catalyst in the Haber Process.

D Transition metals do not make good catalysts.

26 The element astatine is below iodine in Group 17 of the Periodic Table.

Which statement describes astatine correctly?

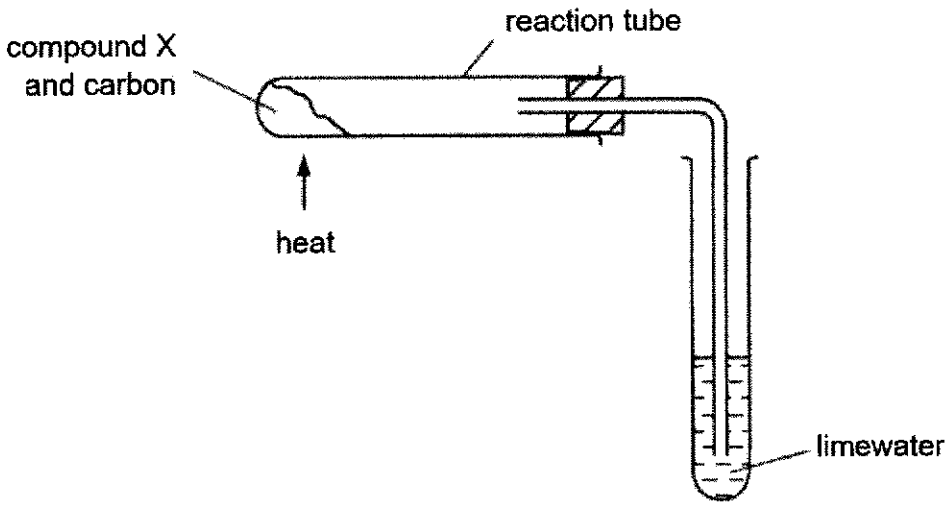
A It forms a covalent compound with potassium.

B It has a high melting point due to strong covalent bonds.

C It is a dark coloured gas at room temperature and pressure.

D It is a weaker oxidising agent than iodine.

27 Compound X is heated with carbon using the apparatus as shown.



A red-brown solid is formed in the reaction tube and white precipitate is seen in limewater.

What is compound X?

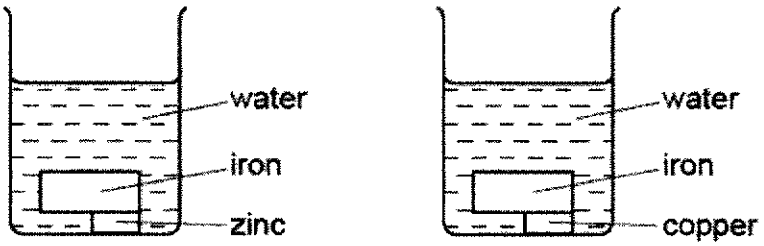
A calcium oxide

B copper(II) oxide

C magnesium oxide

D sodium oxide

28 Two pieces of iron, one with zinc attached and the other with copper attached, are placed separately in water as shown.



beaker X beaker Y

Which statements are correct?

1 The iron in beaker X will not rust.
2 The zinc in beaker X will be oxidised.
3 The water in beaker Y will turn blue.

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

29 The formation of liquid water from hydrogen and oxygen may occur in three stages.

Stage 1 : $2H_2(g) + O_2(g) \rightarrow 4H(g) + 2O(g)$
Stage 2 : $4H(g) + 2O(g) \rightarrow 2H_2O(g)$
Stage 3 : $2H_2O(g) \rightarrow 2H_2O(l)$

Which stages are endothermic?

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

30 Which is the overall equation for the reactions that take place in a hydrogen fuel cell?

A $H_2 \rightarrow 2H^+ + 2e^-$

B $2H_2 + O_2 \rightarrow 2H_2O$

C $2H_2O \rightarrow 2H_2 + O_2$

D $2H^+ + 2e^- \rightarrow H_2$

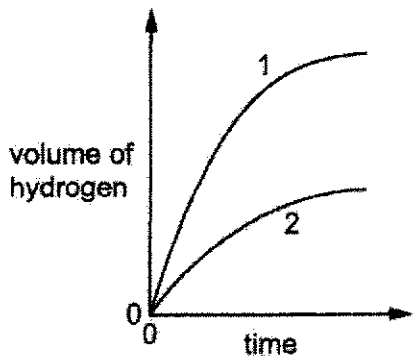
31 A student performs two reactions.

Reaction 1: 10 g of magnesium ribbon with 0.5 dm^3 of 2.0 mol/dm^3 dilute hydrochloric acid
Reaction 2: 5 g of magnesium powder with 0.5 dm^3 of 3.0 mol/dm^3 dilute hydrochloric acid

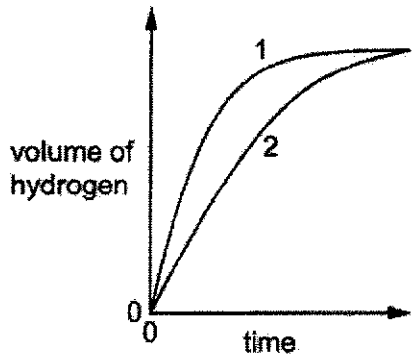
In both experiments, the volume of hydrogen produced is measured against time and the results are plotted graphically.

Which graph is correct?

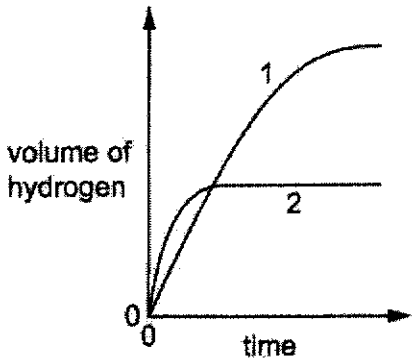
A



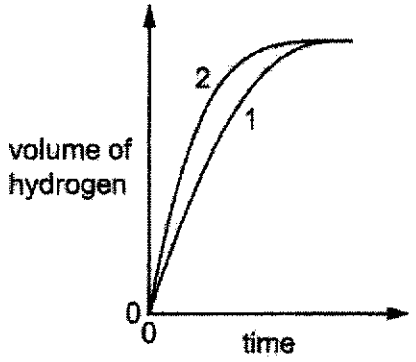
B



C



D



32 Powdered manganese(IV) oxide acts as a catalyst in the decomposition of aqueous hydrogen peroxide.

Which statement explains why the rate of production of oxygen decreases during the reaction?

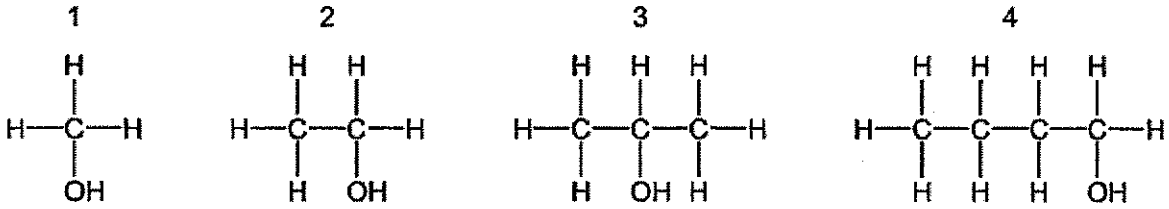
A The concentration of aqueous hydrogen peroxide decreases.

B The mass of manganese(IV) oxide decreases.

C The surface of manganese(IV) oxide decreases.

D The temperature of aqueous hydrogen peroxide decreases.

33 The structures of four alcohols are as shown.



Which statement is correct?

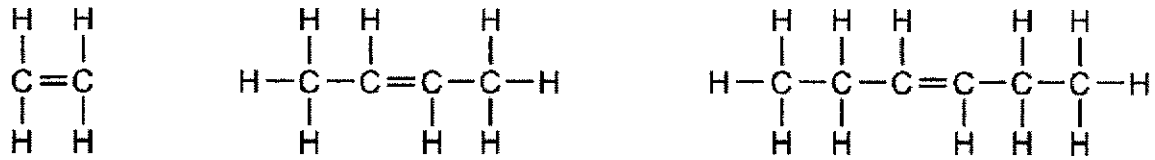
A Alcohol 1 can be made by the addition of steam to an alkene.

B Alcohol 2 is a product of fermentation.

C Alcohol 3 can undergo oxidation to form $C_3H_7CO_2H$.

D Alcohol 4 has only one other isomer.

34 The structures of three compounds are as shown.



Why do these compounds all belong to the same homologous series?

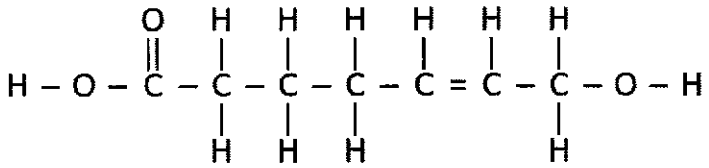
A They are all saturated.

B They are all hydrocarbons.

C They all contain the same functional group.

D They all contain an even number of carbon atoms.

35 The diagram shows the structure of a compound Z.



Which prediction about its properties is **not** likely to be correct?

A It can react with zinc to liberate hydrogen gas.

B It can turn acidified potassium iodide solution from colourless to brown.

C It can undergo addition polymerisation.

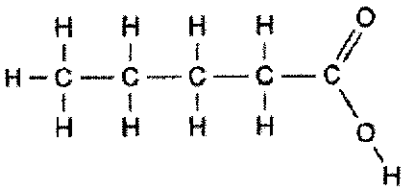
D It can undergo condensation polymerisation by itself.

36 The ester, $CH_3CO_2CH_2CH(CH_3)CH_2CH_3$, has an odour of bananas.

Which set of reagents could be used to prepare this ester in the laboratory?

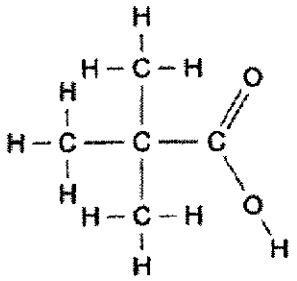
	reagent 1	reagent 2
A	$CH_3CH_2CH_2CH(CH_3)CH_2CO_2H$	CH_3OH
B	$CH_3CH_2CH(CH_3)CH_2OH$	CH_3CO_2H
C	$CH_3CH_2CH(CH_3)CH_2CO_2H$	CH_3OH
D	$CH_3CH_2CH(CH_3)CH_2OH$	$CH_3CH_2CO_2H$

37 The molecular formula of an organic acid is as shown.

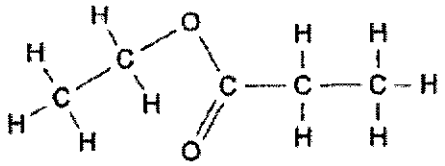


Which structure is **not** an isomer of this acid?

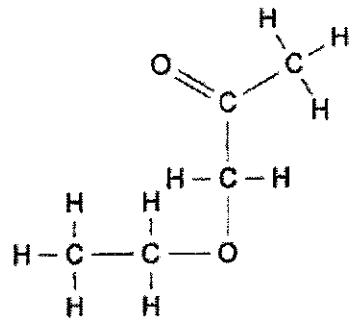
A



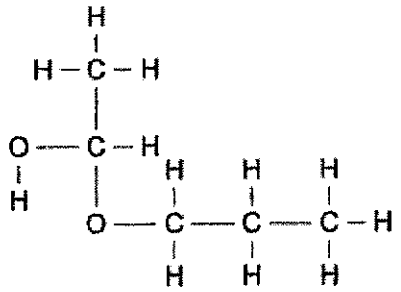
B



C

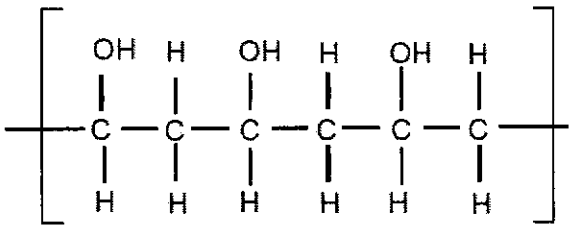


D

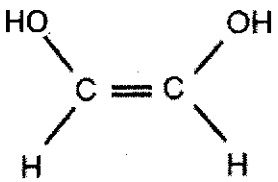


38 Polyethenol is a new plastic which is water soluble. This plastic is useful in hospitals for keeping soiled laundry and thereby preventing infection. The dirty laundry is then placed in the wash and the bag dissolves letting the washing out.

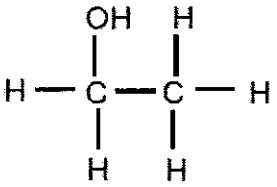
The structure of polyethenol is as shown.



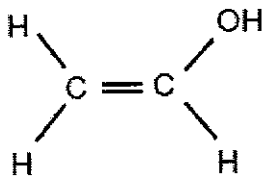
What is the monomer unit for this polymer?



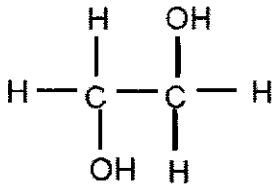
A



B



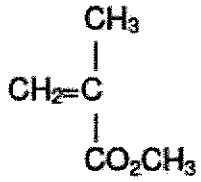
C



D

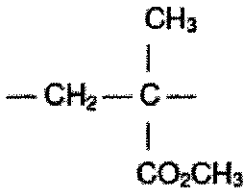
39 In an artificial hip joint, bone cement is used to attach the poly(ethene) cup for the joint to the pelvic girdle. Bone cement is formed by the polymerisation of methyl 2-methylpropenoate. The process is highly exothermic.

The structure of methyl 2-methlypropenoate is as shown.



Which statements are correct about this polymerisation?

1 The repeat unit of the polymer is



2 The formation of the cement occurs by addition polymerisation.

3 Less energy is released in making the C – C bonds than absorbed in breaking a C = C bond.

A 1 and 2 only

B 2 and 3 only

C 1 and 3 only

D 1, 2 and 3

40 To reduce atmospheric pollution, the waste gases from a coal-burning power station are passed through powdered calcium carbonate.

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

A carbon dioxide

B nitrogen monoxide

C phosphorus oxide

D sulfur dioxide

The Periodic Table of Elements

Group																	
1	2											13	14	15	16	17	18
							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	3	4	5	6	7	8	9	10	11	12	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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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.).
The Avogadro constant, $L = 6.02 \times 10^{23}\ mol^{-1}$.

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SWISS COTTAGE SECONDARY SCHOOL

SECONDARY FOUR O LEVEL
PRELIMINARY EXAMINATION
PURE CHEMISTRY
Paper 1 MCQ

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

SWISS COTTAGE SECONDARY SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION

O

Name

Academic Class: 4 A

Form Class / Index Number

Form Class: 4 S

CHEMISTRY

6092/02

Paper 2

Wednesday 28 August 2024

1 hour 45 minutes

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name 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.
Write your answers in the spaces provided on the Question Paper.

Section B
Answer **one** question.
Write your answers in the spaces provided on the Question Paper.

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 24.

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

For Examiner's Use	
Section A	/ 70
Section B	/ 10
Total	/ 80

This document consists of **23** printed pages and **1** blank page.

[Turn over

Section A

Answer **all** questions.

A1 Use the list of elements to answer the questions.

zinc	**argon**	**fluorine**	**copper**
hydrogen	**sodium**	**silicon**	**carbon**

Each element may be used once, more than once or not at all.

(a) Name the element that forms an amphoteric oxide.

.....[1]

(b) Name the element that can form ions with more than one oxidation state.

.....[1]

(c) Name the element that can form a neutral oxide.

.....[1]

(d) Name the element that is unreactive.

.....[1]

(e) Name the element that is a good oxidising agent.

.....[1]

(f) Name the element that forms an oxide with a giant covalent structure.

.....[1]

[Total: 6]

A2 **(a)** Fig. 2.1 and Fig. 2.2 show some properties of Group 17 elements, the halogens.

Fig. 2.1 shows the atomic radii and Fig. 2.2 shows the electronegativity of the Group 17 elements.

Electronegativity is a measure of the tendency of an atom to attract a bonding pair of electrons. It is usually measured on the Pauling scale, on which the most electronegative element (fluorine) is given an electronegativity of 4.0.

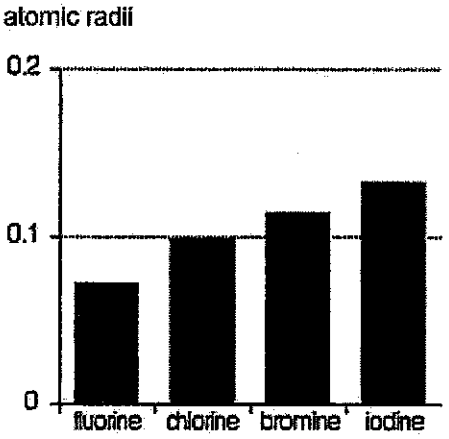

Fig. 2.1

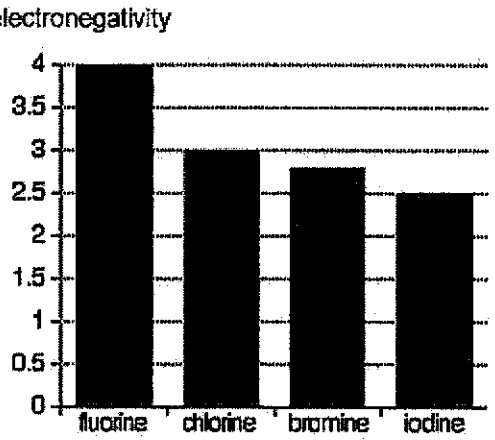

Fig. 2.2

(i) Use Fig. 2.1 to describe and explain the trend in atomic radii for halogens down the group.

.....

.....

.....[1]

(ii) Use Fig. 2.1 and Fig. 2.2 to state and explain the relationship between atomic radii and electronegativity of the halogens.

.....

.....

.....[1]

(iii) Predict and explain the electronegativity value of astatine, the next member of Group 17 element.

.....

.....[1]

(b) Table 2.1 shows the melting points and boiling points of Group 1 elements, together with the atomic radii.

Table 2.1

	element	melting point / °C	boiling point / °C	atomic radii / pm
Group 1	lithium	180	1330	145
	sodium	98	890	180
	potassium	64	774	220
	rubidium	39	688	235

(i) State the trend observed in the melting and boiling points of Group 1 elements.

.....

.....[1]

(ii) Explain, in terms of bonding, the trend observed in **(b)(i)**.

.....

.....

.....

.....

.....[2]

[Total: 6]

A3 Table 3.1 shows some properties of oxyacids of chlorine.

Table 3.1

name of acid	chemical formula	reaction with magnesium (all acids have the same concentration)	oxidation state of chlorine
hypochlorous acid	HC*l*O	only a few bubbles seen	
chlorous acid	HC*l*O_2	reacts readily	
chloric acid	HC*l*O_3	vigorous	
perchloric acid	HC*l*O_4	very vigorous	

(a) Suggest why these acids are known as oxyacids.

.....

.....

.....[1]

(b) Complete Table 3.1 by filling in the oxidation states of chlorine. [2]

(c) State the relationship between the oxidation state of chlorine and the strength of the acids.

Explain your reasoning using the information in Table 3.1.

.....

.....

.....

.....[2]

(d) Identify the acid with the lowest electrical conductivity.

Explain your answer.

.....

.....[1]

[Total: 6]

A4 **(a)** Ammonia is produced by nitrogen gas and hydrogen gas during the Haber process.

(i) Since nitrogen is the most abundant gas in air, explain why air is **not** used as a raw material during the Haber process.

.....

.....

.....

.....[1]

(ii) Concentrated aqueous ammonia is used to make fertilisers such as ammonium sulfate, $(NH_4)_2SO_4$. Aqueous ammonia reacts with dilute sulfuric acid to form ammonium sulfate, $(NH_4)_2SO_4$.

$$2NH_3(aq) + H_2SO_4(aq) \rightarrow (NH_4)_2SO_4(aq)$$

A student titrates 20.0 cm^3 of aqueous ammonia with 0.150 mol/dm^3 sulfuric acid. 10.50 cm^3 of sulfuric acid is required to neutralise the aqueous ammonia. Calculate the concentration, in mol/dm^3 , of the aqueous ammonia.

[2]

(b) Table 4.1 shows some fertilisers that are necessary for healthy plant growth. Some of the elements needed by plants are nitrogen, potassium and phosphate.

Table 4.1

type of fertiliser	chemicals commonly used	
potassium-based fertilisers	potassium chloride	KCl
nitrogen-based fertilisers	ammonium nitrate	NH_4NO_3
	urea	$CO(NH_2)_2$
phosphate fertilisers	calcium dihydrogen phosphate	$Ca(H_2PO_4)_2$
	calcium sulfate	$CaSO_4$

Calculate the percentage by mass of nitrogen in ammonium nitrate and urea to determine which fertiliser would give more nitrogen per kg.

[2]

(c) A chemical company makes salts for use in fertilisers.

To make calcium sulfate, the company started with limestone, which is calcium carbonate. Briefly describe how pure calcium sulfate can be made from calcium carbonate.

.....

.....

.....

.....

.....

.....[2]

[Total: 7]

A5 A mixture of grey powder and white crystals undergoes a series of reactions as shown in Fig. 5.1.

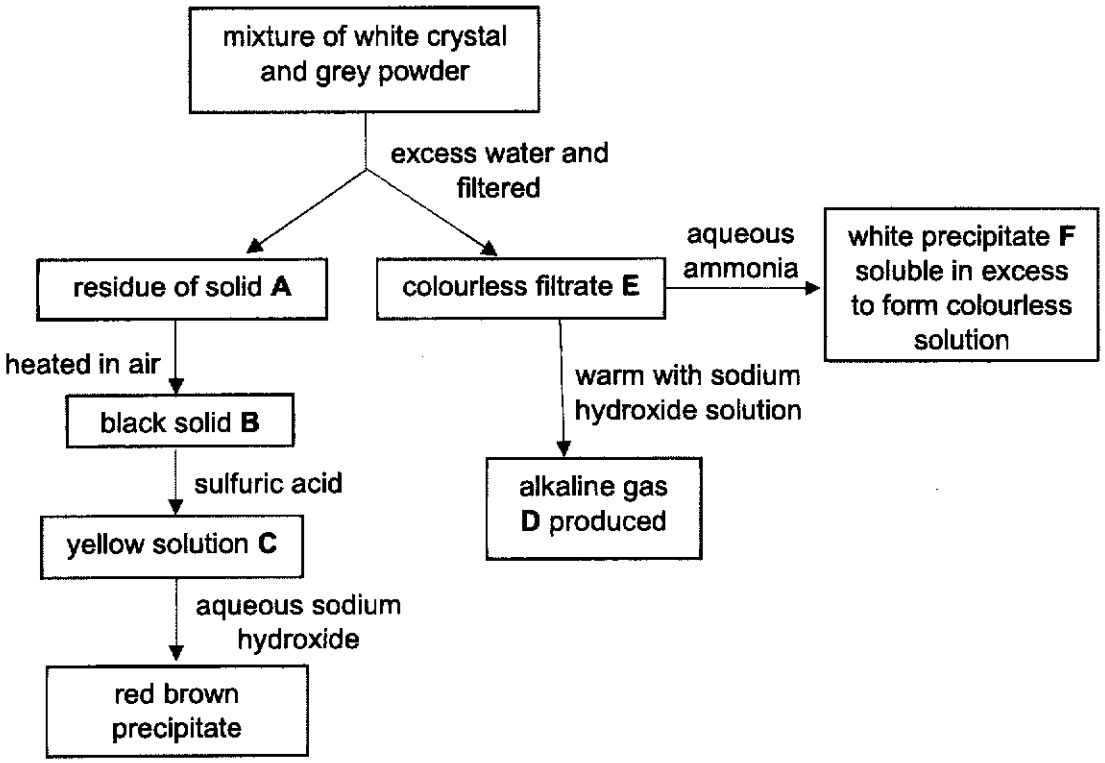

Fig. 5.1

(a) Identify substances **A**, **B**, **C** and **D**.

A .....

B .....

C .....

D ..... [4]

(b) There are two cations present in filtrate **E**. Give the formulae of the two cations present in filtrate **E**.

.....[1]

(c) Write the ionic equation for the formation of precipitate F.

.....[1]

(d) To test for the anion present in filtrate **E**, a student added acidified silver nitrate solution to a sample of **E**. No visible change was observed. What can be concluded from this statement?

.....[1]

[Total: 7]

A6 Many metal carbonates thermally decompose to form carbon dioxide and metal oxide. Four 2.00 g samples of carbonates are heated strongly until there is no further change in their masses.
Table 6.1 shows the mass of solid remaining at the end of the heating.

Table 6.1

metal carbonate	mass before heating / g	mass after heating / g
calcium carbonate	2.00	1.12
copper(II) carbonate	2.00	1.29
magnesium carbonate	2.00	0.95
zinc carbonate	2.00	1.35

(a) Calculate the percentage yield of carbon dioxide formed when 2.00 g of zinc carbonate is heated.

[3]

(b) Explain why the mass of carbon dioxide formed is different for each metal carbonate.

.....

.....[1]

(c) In two separate experiments, hydrogen was passed over heated aluminium oxide and heated copper(II) oxide.
Describe the observation, if any, you would expect to see in each experiment. Explain your reasoning.

.....

.....

.....

.....[2]

[Total: 6]

A7 A student electrolysed aqueous copper(II) sulfate using the set-ups shown in Fig. 7.1. The electrodes used in each apparatus are made of the same material. However, the electrodes used in experiment 1 and 2 are made of different materials

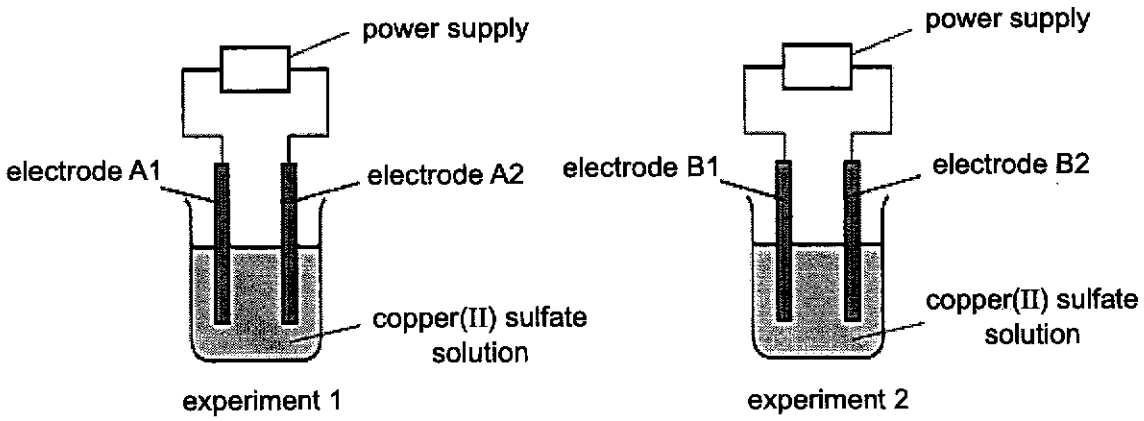

Fig. 7.1

He recorded the observations in Table 7.1.

Table 7.1

experiment 1	experiment 2
mass of electrode A1 has increased	mass of electrode B1 has increased
mass of electrode A2 remains the same	mass of electrode B2 has decreased
effervescence observed at electrode A2	no effervescence observed at electrode B2

(a) State which electrode is the cathode in each experiment.

experiment 1 : ..... experiment 2 : ..... [1]

(b) Explain, with an appropriate equation, the increase in mass at electrodes A1 and B1.

.....

.....

.....

.....[2]

(c) Write the half-equations of the reactions taking place at electrode A2.

.....[1]

(d) Universal Indicator is added to the solution after the electrolysis in experiment 1.

Predict the pH and colour of the Universal Indicator in experiment 1.

colour of Universal Indicator in experiment 1 .....

pH of electrolyte in experiment 1 .....

Explain your reasoning.

.....

.....

.....

.....[3]

[Total: 7]

A8 Fig. 8.1 shows the apparatus used to investigate the relative reactivity of metals, **A**, **B**, **C** and **D**. The metal strips and copper were first cleaned with sandpaper. The metal strips were connected in turn with the copper strip and the voltage was recorded.

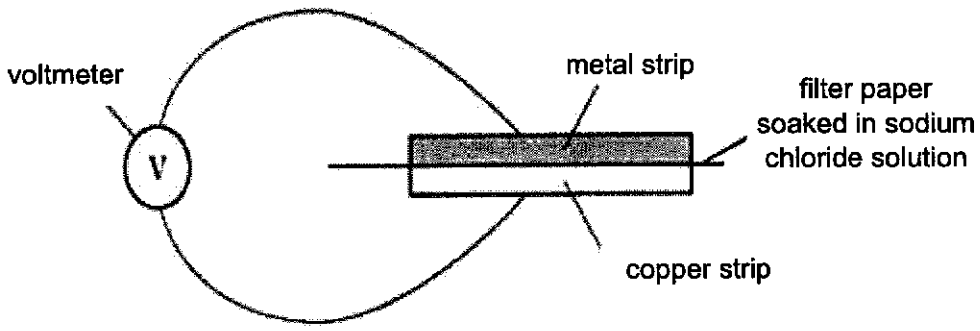

Fig. 8.1

Table 8.1 shows the results.

Table 8.1

metal strip	direction of electron flow	voltage / V
A	from copper to metal **A**	0.78
B	from metal **B** to copper	2.22
C	from metal **C** to copper	1.39
D	from metal **D** to copper	0.28

(a) Use the results in Table 8.1 to deduce the order of reactivity of these four metals and copper.

..... most reactive

.....

.....

.....

..... least reactive [2]

(b) Given that metal **C** is an element in Group 2 of the Periodic Table and does not react readily with water, describe two observations you would expect to see if metal **C** were added to copper(II) sulfate solution.

observation 1: .....

.....

observation 2: .....

.....[2]

(c) Predict and explain the voltage reading if the experiment with metal **A** and copper were repeated using a piece of filter paper soaked in ethanol instead of sodium chloride solution.

voltage reading = ...

.....

.....[1]

[Total: 5]

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Name: _____ ( ) Class: **4S / 4A**

Preliminary Examination 2024
6092 CHEMISTRY
Secondary Four

A9 In Singapore's residential homes, there are two types of supplied gas: piped gas or liquidfied petroleum gas.

Piped gas comprises hydrogen gas and is delivered straight to your kitchen through built-in pipes whenever you turn on the gas stove, whereas liquidfied petroleum gas comprises mainly propane and butane gas, and comes in gas cylinders.

(a) One mole of hydrogen gas gives out 247.5 kJ of energy when combusted. Write a chemical equation for the combustion of hydrogen gas and its enthalpy change of reaction in kJ/mol.

.....[2]

(b) The enthalpy change for the combustion of one mole of propane is – 2025 kJ/mol.

$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g) \quad \Delta H = -2025$ kJ/mol

(i) Explain, in terms of bond forming and bond breaking, why the combustion of propane is exothermic.

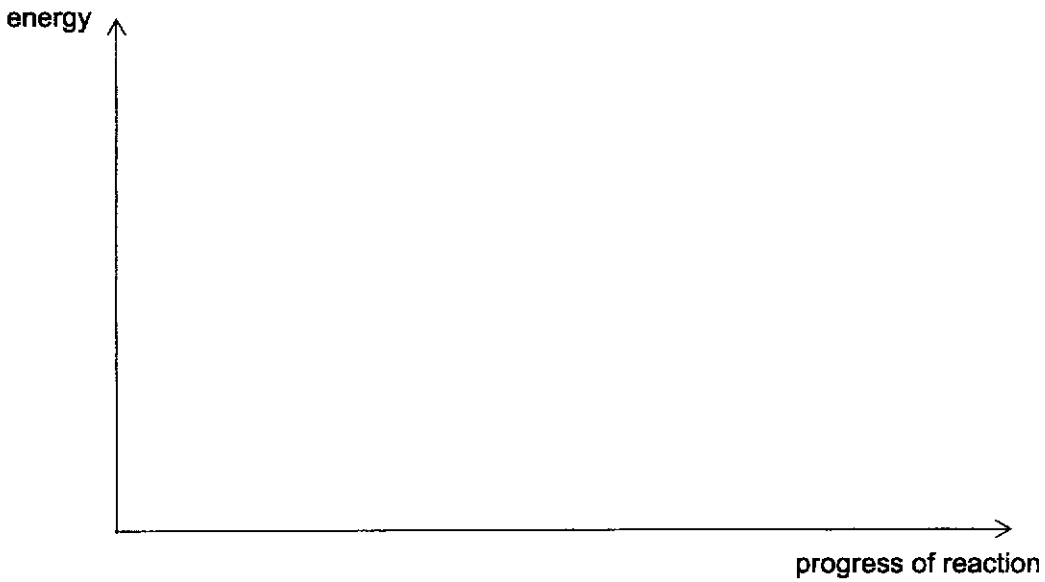
.....

.....

.....

.....[2]

(ii) Draw the energy profile diagram for the combustion of propane.



[2]

(c) Suggest one advantage for using each type of gas.

piped gas: .....

.....[1]

liquidfied petroleum gas: .....

.....[1]

[Total: 8]

A10 Co-ordinate Bonds

In 1913, the Bohr model was introduced to explain the structure of an atom. Based on the Bohr model, an atom consists of a small, dense nucleus surrounded by electrons in fixed orbits.

The Bohr model also shows the formation of a simple covalent bond as the sharing of a pair of valence electrons from two atoms. A co-ordinate bond is a covalent bond in which both electrons come from the same atom.

An example of a co-ordinate bond can be found in the ammonium cation. Ammonium ion is formed when ammonia gas reacts with hydrogen chloride. During the reaction the H^+ ion will attach to ammonia forming ammonium ion while the electron from hydrogen remains on the chlorine atom to form a chloride ion.

$$NH_3 + HCl \rightarrow NH_4Cl$$

The co-ordinate bond is represented by an arrow in the structural formula, pointing from the atom that contributes the pair of electrons to the other atom. The structural formula of ammonium cation is as shown in Fig. 10.1.

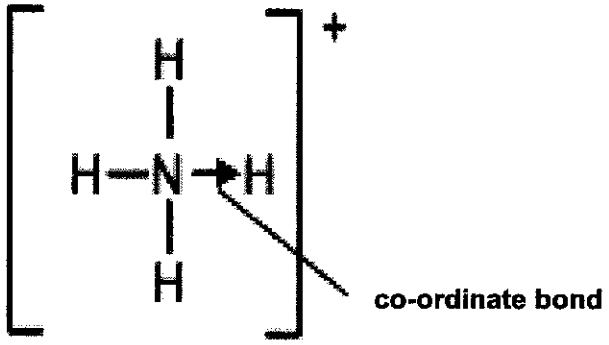


Fig. 10.1

Ligand Exchange Reactions

Ligands are ions or molecules that bind to a central metal atom to form a complex metal ion. The ligand shares one of its electron pair with the central metal atom, forming a co-ordinate bond.

In general, the cations involved in qualitative analysis are considered as complex metal ions. For example, in a beaker containing $CuSO_4$ solution, water acts as a ligand, sharing one electron pair with Cu^{2+} ion, forming a complex ion of copper(II) with molecular formula $[Cu(H_2O)_6]^{2+}$. The structural formula of $[Cu(H_2O)_6]^{2+}$ is as shown in Fig. 10.2 .

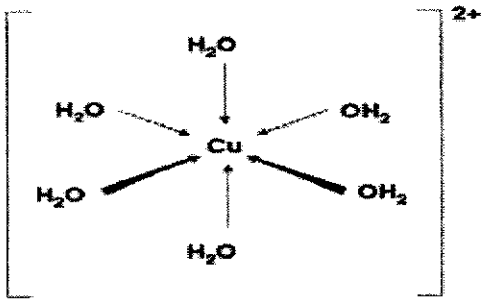


Fig. 10.2

When a small volume of aqueous sodium hydroxide is added to a solution of copper(II) ions, a complex, light blue precipitate of $Cu(H_2O)_4(OH)_2$ is formed. The molecular formula of the precipitate remains the same when excess aqueous sodium hydroxide is added.

When a small volume of aqueous ammonia is added to a solution of copper(II) ions, $Cu(H_2O)_4(OH)_2$ is formed, containing four H_2O ligands and two OH^- ligands. When aqueous ammonia is added in excess, four ammonia ligands replaces two OH^- ligands and two H_2O ligands.

(a) **(i)** Draw the dot-and-cross diagram of ammonium chloride, showing only the outer shell electrons.

[2]

(ii) Given that there is only one co-ordinate bond formed from the reaction between ammonia and boron trifluoride, draw the structural formula of the product, NH_3BF_3.

[1]

(b) **(i)** Describe the observations when aqueous ammonia is added to a solution of copper(II) ions until there are no further changes.

.....

.....

.....

.....[2]

(ii) Suggest the molecular formula of the complex ion of copper(II) after adding excess aqueous ammonia.

.....[1]

(iii) Draw the structural formula of the complex ion of copper(II) after adding excess aqueous ammonia.

[2]

(c) **(i)** Suggest the molecular formula of the complex ion of iron(II) after adding excess aqueous ammonia.

.....[1]

(ii) With reference to the complex ions of both metals, explain the difference in observations when excess aqueous ammonia is added to copper(II) and iron(II) solutions in separate test tubes.

.....

.....

.....[1]

(iii) Green precipitate formed after adding aqueous sodium hydroxide to iron(II) solution. After a while, It was observed that the surface of the green precipitate in the test tube turns red-brown. Explain the observation.

.....

.....

.....[2]

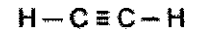
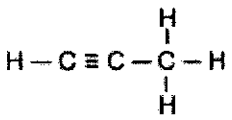
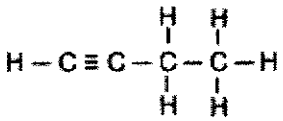
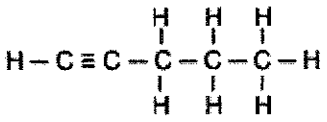
[Total: 12]

Section B

Answer **one** question from this section.

B11 Alkenes and alkynes are two homologous series of hydrocarbons. These hydrocarbons are sometimes obtained from the fractional distillation of crude oil. Table 11.1 shows the structural formulae of the first four members of alkynes.

Table 11.1

alkyne	structural formula
ethyne	
propyne	
but-1-yne	
pent-1-yne	

(a) Ethyne and propyne are unsaturated hydrocarbons. Both have the same general formula.

(i) Explain what is meant by '*ethyne and propyne are unsaturated hydrocarbon*'.

.....

.....[2]

(ii) Deduce the general formula of alkynes.

.....[1]

(iii) Draw the full structural formula of the fifth member of the alkyne homologous series.

[1]

(b) The chemical reactivity of alkynes is similar to alkenes.

(i) When propyne reacts with chlorine gas, the reaction is similar to reaction with aqueous bromine, a mixture of organic compounds are formed. One compound is able to decolourise aqueous bromine while the other does not.
Draw two possible full structural formulae of these organic compounds.

[2]

(ii) X is an isomer of pent-1-yne that can form a polymer. Part of this polymer structure is shown in Fig. 11.1.

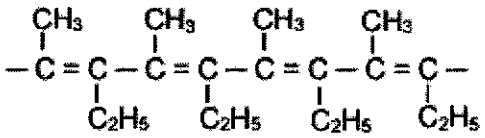


Fig. 11.1

State the type of polymerisation that X can undergo and draw the full structural formula of this isomer.

.....[2]

(iii) One of the organic compounds formed in **(b)(i)** continues to react with chlorine gas and formed a mixture of organic molecules when exposed to ultra-violet light. Draw the full structural formulae of a product formed. Name the product you have drawn.

name of organic compound: .....[2]

[Total: 10]

B12 **(a)** Fig. 12.1 shows various reactions involving organic compounds, with ethene as the starting material.

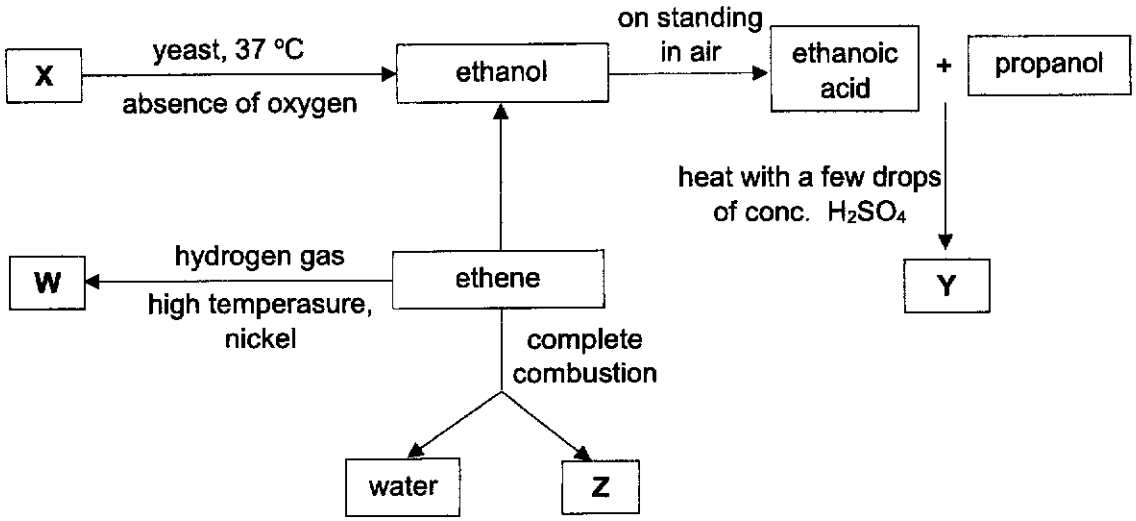


Fig. 12.1

Identify **W**, **X**, **Y** and **Z**.

W ..... **X** .....

Y ..... **Z** ..... [4]

(b) Fumaric acid is a white crystalline chemical compound which can be extracted from plants. When solid fumaric acid is dissolved in water, a colourless solution is formed. Fig. 12.2 shows the structural formula of fumaric acid.

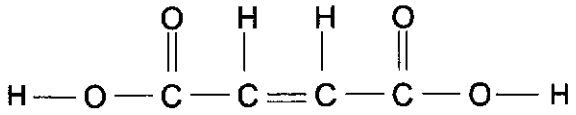


Fig. 12.2

(i) Describe what you would observe when aqueous fumaric acid is added to bromine solution and draw the **full structural formula** of the product formed.

.....

.....[2]

(ii) Fumaric acid can undergo condensation polymerisation with ethane-1,2-diol to form polymer **M**. Fig. 12.3 shows the structural formula of ethane-1,2-diol.

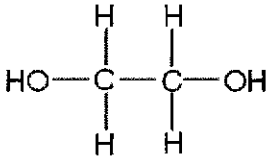


Fig. 12.3

Name the linkage present in **M**.

.....[1]

(c) Fumaric acid can also undergo addition polymerisation to form polymer **N**. Polymer **N** is non-biodegradable and can possibly pose problem to our environment during disposal.

(i) Draw the structure of polymer **N**, showing two repeating units.

[1]

(ii) Define *non-biodegradable.*

.....

.....[1]

(iii) Suggest a possible problem that polymer **N** can pose to our environment during disposal.

.....

.....[1]

[Total: 10]

The Periodic Table of Elements

Group 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
							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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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.).
The Avogadro constant, $L = 6.02 \times 10^{23}\ mol^{-1}$.

Swiss Cottage Secondary School
Preliminary Examination 2024
Secondary Four (O Level)
Chemistry 6092 (Mark Scheme) – Paper 1 & 2

Paper 1 (40 marks, [1] per qn)

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

Paper 2 Section A: 70 marks

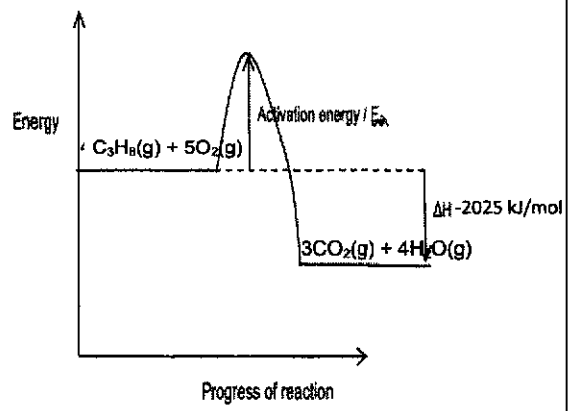
Qn No.		Answer	marks	markers' comment
A1	(a)	zinc	[1]	
	(b)	copper / hydrogen	[1]	
	(c)	hydrogen / carbon	[1]	
	(d)	argon	[1]	
	(e)	fluorine	[1]	
	(f)	silicon	[1]	
		Total	**[6]**	
A2	(ai)	The **atomic radii increase** down the group due to the **increase in the number of electron shells** [1] to hold the electrons, thus resulting in a bigger atom.	[1]	
	(aii)	The **atomic radii increase** while **electronegativity decreases** as it is **harder for the nucleus to attract electrons to itself.** [1]	[1]	
	(aiii)	2.25 (accept value between 2.0 to 2.3). It has a **larger atomic radii** compared to the elements above it in the group . Since the **nucleus is further away from the valence shell**, it is harder for the nucleus to attract electrons. [1]	[1]	
	(bi)	Melting point and boiling point decreases down the group	[1]	
	(bii)	As the atomic radii increases down the group, the negatively-charged valence electrons are further away from the positively-charged nucleus. The electrostatic forces of attraction between valence electrons and the nucleus becomes weaker. [1] Less energy is required to overcome the metallic bonding/forces of attraction [1] between the valence electrons and the nucleus.	[2]	
		Total	**[6]**	
A3	(a)	It is because the acid **contains oxygen** and can **dissociate/ionise** in **aqueous solution to form H^+ ions.**	[1]	
	(b)	name of acid / oxidation state of chlorine: hypochlorous acid: +1 chlorous acid: +3 chloric acid: +5 perchloric acid: +7 **Every 2 correct answer [1m]**	[2]	

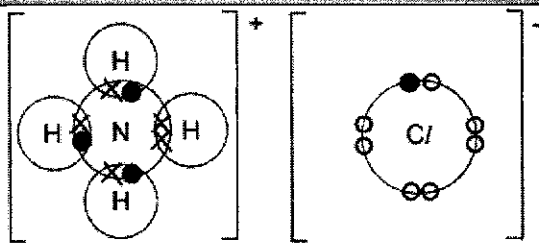
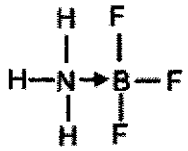
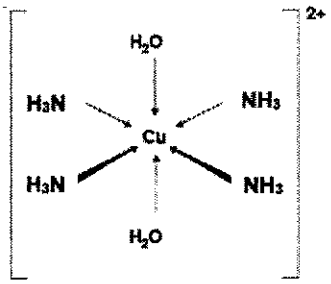
	(c)	As the oxidation state of chlorine increases, the strength of acid increases. [1] When oxidation state of chlorine increases **from +1 to +7**, the **reaction** between the acid and Mg **become more vigorous**. [1]	[2]	
	(d)	Hypochlorous acid / HC*l*O has the lowest electrical conductivity. It has the least vigorous reaction with magnesium and is therefore the weakest acid. This means that it must have the **lowest concentration of mobile ions** [1] to act as charge carriers.	[1]	
		Total	**[6]**	
A4	**(ai)**	Air is made up of a mixture of many gases, like oxygen and nitrogen. Hence • oxygen can react with hydrogen to form water if air is used during Haber process. • nitrogen reacts with oxygen to form oxides of nitrogen • air contains oxygen which oxidises iron catalyst to iron(II) oxide/iron(III) oxide • iron react with oxygen and water and rusting occurs. [choose any one point]	[1]	
	(aii)	No. of mole of H_2SO_4 $= \frac{10.5}{1000} \times 0.150$ = 0.001575 mol $\frac{No.of\ mole\ of\ NH_3}{No.of\ mole\ of\ H_2SO_4} = \frac{2}{1}$ No. of mole of $NH_3 = \frac{2}{1} \times 0.001575$ = 0.00315 mol Concentration of $NH_3 = \frac{0.00315}{0.002}$ = 0.1575 = 0.158 mol/dm^3 (to 3.s.f) [1]	[2] [1]	

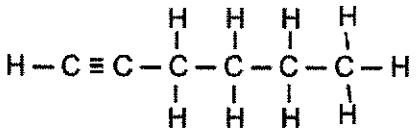
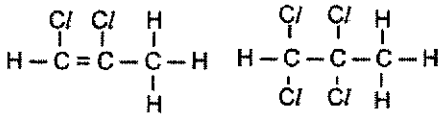
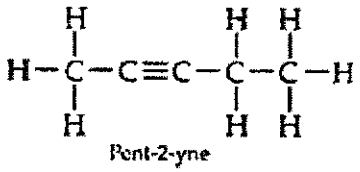
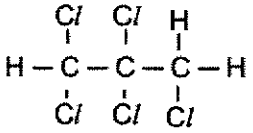
	(b)	Mr of NH_4NO_3 = 80 % N in NH_4NO_3 = 2(14) / 80 x 100% = 35.0% (to 3 s.f) Mr of $CO(NH_2)_2$ = 60 %N in $CO(NH_2)_2$ = 2(14) / 60 = 46.667 = 46.7% (3 s f) **[1] for both correct %N** Hence, urea would give more nitrogen per kg. [1]	[2]	
	(c)	1. Add excess calcium carbonate to nitric acid and stir. Filter the mixture to obtain a solution of calcium nitrate as the filtrate. 2. Add the calcium nitrate solution to aqueous sodium sulfate/ sulfuric acid/ any solution with sulfates. 3. Filter the mixture to obtain calcium sulfate as the residue. Wash the residue with distilled water and leave the residue to dry on filter paper. [1]: steps 1-2 [1]: step 3	[2]	
		Total	**[7]**	
A5	**(a)**	**A:** Iron / Fe [1] **B:** Iron(III) oxide / Fe_2O_3 [1] **C:** Iron(III) sulfate / $Fe_2(SO_4)_3$ [1] **D:** Ammonia / NH_3 [1]	[4]	
	(b)	Zn^{2+} and NH_4^+	[1]	
	(c)	$Zn^{2+} + 2OH^- \rightarrow Zn(OH)_2$ *{Note: Please follow instructions! State symbols are not required. Please do not include. If correct state symbols are given, no extra credit will be given. However, for incomplete or wrong state symbols, marks will be deducted.}*	[1]	
	(d)	Cl^- / chloride and I^- / iodide are not present in the filtrate.	[1]	
		Total	**[7]**	

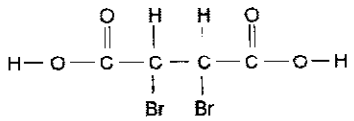
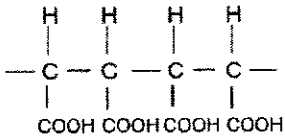
A6	**(a)**	$ZnCO_3 \rightarrow ZnO + CO_2$ No. of mole of zinc carbonate $= \frac{2.00}{125}$ = 0.016 mol $\frac{No.of\ mole\ of\ CO_2}{No.of\ mole\ of\ ZnCO_3} = \frac{1}{1}$ No. of mole of $CO_2 = \frac{1}{1}$ X 0.016 = 0.016 mol Mass of CO_2 = 0.016 x 44 = 0.704g (to s.f.) Actual mass of CO_2 produced = 2.00 – 1.35 = 0.65g % yield of CO_2 $= \frac{0.65g}{0.704g}$ X 100% = 92.330 = 92.3 % (3 s.f) [1]	[3] [1] [1]	
	(b)	It is because • different carbonates have different Mr values, hence the number of moles of carbonate present in the fixed mass of carbonate is also different. **OR** • different metals in the various carbonates have different Ar values, hence the number of moles of carbonate present in the fixed mass of carbonate is also different. **OR** • % of carbon in each compound is different, hence the number of moles of carbonate present in the fixed mass of carbonate is also different.	[1]	
	(c)	Observations: **No visible change** occurs when hydrogen was passed over heated aluminium oxide. **Black solid** turned **pink / red-brown** when hydrogen was passed over heated copper(II) oxide. [1] *{Note: water droplets/ colourless liquid is not acceptable in this case. See remarks on the right.}*	[2]	

		Explanations (method 1- displacement) Hydrogen is less reactive than aluminium, so hydrogen is not able to displace aluminium from aluminium oxide. Hydrogen is more reactive than copper, so hydrogen is able to displace copper from copper(II) oxide. [1] *{"to displace copper from copper(II) oxide" here means "to form the copper metal from copper(II) oxide"}* Explanations (method 2- reduction) Hydrogen is less reactive than aluminium, so hydrogen is not able to reduce aluminium oxide to aluminium. Hydrogen is more reactive than copper, so hydrogen is able to reduce copper(II) oxide to copper [1] *{"to reduce copper(II) oxide to copper" means "to convert copper(II) oxide [before] to copper [after]"}*		
		Total	**[6]**	
A7	**(a)**	Experiment 1: A1 Experiment 2: B1	[1]	
	(b)	Copper(II) ions (Cu^{2+}) gain electrons more readily than hydrogen ions (H^+), hence copper(II) ions are reduced to form copper solid. **OR** Copper(II) ions (Cu^{2+}) are preferentially discharged over hydrogen ions to form copper solid [1] $Cu^{2+} + 2e^- \rightarrow Cu$ [1]	[2]	
	(c)	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$ *{Note: Please follow instructions! State symbols are not required. Please do not include. If correct state symbols are given, no extra credit will be given. However, for incomplete or wrong state symbols, marks will be deducted.}*	[1]	
	(d)	Colour of Universal Indicator in expt 1: red [1] pH of electrolyte in expt 1: pH 1 **OR** 2 [1] OH^- ions and Cu^{2+} ions are selectively discharged (while H^+ and SO_4^{2-} are not). This results in a higher concentration of H^+ ions than OH^- ions thus resulting in an acidic solution [1]	[3]	
		Total	**[7]**	

A8	**(a)**	B **most reactive** C D copper A **least reactive** [1]: first 2 [1]: next 3	[2]	
	(b)	Observation 1: Colour of solution will change from blue to colourless./fades to light blue [1] Observation 2: Red-brown solid/pink solid will be deposited. [1]	[2]	
	(c)	Voltage reading = 0.00 V / 0 V Ethanol exists as molecules and <u>does not have any mobile ions and mobile electrons</u> to act as charged carriers hence it cannot conduct electricity. [1]	[1]	
A9	**(a)**	$2H_2 + O_2 \rightarrow 2H_2O$ $\Delta H = -495$ kJ/ mol or $H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ $\Delta H = -247.5$ kJ/ mol **correction equation [1] and ΔH [1]** **ecf is given to** ΔH based on the number of moles of hydrogen stated in the equation.	[2]	
	(bi)	**More energy is given off/released** in **bond forming** of **3 mol of CO_2 and 4 mol of H_2O** [1] than **energy is taken in/absorbed** to **break the bonds** in **1 mol of C_3H_8 and 5 mol of O_2.** [1]	[2]	
	(bii)		[2]	
		correct labels of reactants and products [1] correct exothermic graph, activation(upward arrow label) and energy change (downward arrow) labelled [1]		

	(c)	Piped gas: cleaner fuel as it only produces water as the only product / more convenient as the gas is on demand and you don't need to buy canisters / won't need to worry about the gas supply running out / takes up less space as don't have to install a bulky canister beneath the stove [1] Liquified petrol gas: generates more energy per mole of fuel as compared to piped gas/ more energy efficient [1]	[2]	
		Total	[8]	
A10	**(ai)**	 1m for each ions for each ion the number of valance shell must be completely filled.	[2]	
	(aii)	 Accept if brackets given with no charge.	[1]	
	(bi)	Light blue / blue precipitate formed. [1] Light blue precipitate dissolves in excess to form a dark blue solution. [1] Reject: Light blue/blue solution	[2]	
	(bii)	$[Cu(H_2O)_2(NH_3)_4]^{2+}$	[1]	
	(biii)	 **1m correct ligands with correct direction of arrows, 1m correct charge**	[2]	
	(ci)	$Fe(H_2O)_4(OH)_2$	[1]	
	(cii)	$Cu(H_2O)_4(OH)_2$ forms $[Cu(H_2O)_2(NH_3)_4]^{2+}$ which is soluble in excess aqueous ammonia while $Fe(H_2O)_4(OH)_2$ is insoluble.	[1]	

	(ciii)	When exposed to air/oxygen[1], green iron(II) hydroxide oxidises to form iron(III) hydroxide which is the red-brown precipitate. [1] Accept: iron(II) ions/iron/green precipitate oxidised	[2]	
		Total	**[12]**	
Section B				
B11	**(ai)**	Ethyne and propyne contain **only hydrogen and carbon atoms** [1] with **carbon-carbon triple bonds.** [1]	[2]	
	(aii)	C_nH_{2n-2} , where n = number of carbon atoms	[1]	
	(aiii)		[1]	
	(bi)	 [1] for each correct structure	[2]	
	(bii)	 Pent-2-yne correct structure, bonding between C – C and C – H must be accurate [1] addition Polymerisation [1]	[2]	
	(biii)	 correct structure [1] pentachloropropane [1]	[2]	
		Total	**[10]**	
B12	**(a)**	W: ethane / C_2H_6 [1] X: glucose / $C_6H_{12}O_6$ [1] Y: propyl ethanoate / $CH_3COOC_3H_7$ [1] Z: carbon dioxide / CO_2 [1]	[4]	

	(bi)	 The bromine solution will turn from **reddish-brown to colourless.** correct observation [1] and structural formula [1]	[2]	
	(bii)	Ester linkage	[1]	
	(ci)	 **reject if bonds are not correctly drawn**	[1]	
	(cii)	Substances that **cannot be decomposed** or **broken down by bacteria** or **natural biological processes** into **simpler substances**.	[1]	
	(ciii)	It will cause land pollution as plastic do not decompose hence burying plastic waste in land fills leads to an increase amount of built-up waste, or Water pollution, plastic thrown into the sea endanger marine animals. or Air pollution, plastics are mostly flammable, when plastics are incinerated, the produces air pollutants. Incineration of polymer produces carbon dioxide which is green house gases leads to global warming. Reject if students just state land pollution/water pollution/air pollution. (any one)	[1]	
		Total	**[10]**	