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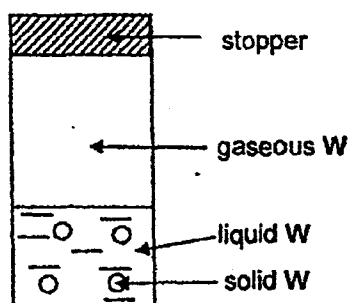


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- 1 A new substance was discovered and a series of experiments were conducted on it. Which observation suggests that the substance cannot be an element?
- A It dissolved in water to form a colourless solution.
 B It had a fixed melting point.
 C Electrolysis of the molten substance formed two products.
 D When heated in air, it could form two oxides.
- 2 The gas jar contains compound W which is present in the solid, liquid and gaseous states.



Which one of the following statements is correct?

- A Gaseous W molecules move at fixed position.
 B Energy is released when W changes from gas to liquid.
 C A gaseous W molecule has a lower mass than liquid W molecule.
 D Energy is released when W changes from solid to liquid.
- 3 You are given a mixture of methylbenzene and dilute aqueous solution of copper(II) sulfate. Methylbenzene boils at 111°C and is insoluble in water. To obtain samples of methylbenzene and copper(II) sulfate crystals, which two methods would you employ?

	Method 1	Method 2
A	using of a separating funnel	evaporation
B	fractional distillation	crystallization
C	simple distillation	evaporation
D	using of a separating funnel	crystallization

- 4 In paper chromatography, which of the following is true of the substances in the mixture?
- A They have the same R_f value.
 B They are soluble in the solvent used.
 C They are coloured.
 D They are placed such that the spot is just below the liquid.

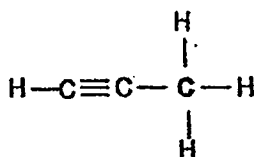
- 5 Deuterium is an isotope of hydrogen and has the symbol D. Which formula is incorrect for a deuterium compound?

A ZnOD
 B $\text{CD}_3\text{CO}_2\text{D}$
 C $\text{C}_2\text{D}_4\text{Br}_2$
 D D_2O_2

- 6 Which one of the following ions has the most shells that contain electrons?

A Be^{2+}
 B S^{2-}
 C O^{2-}
 D Mg^{2+}

- 7 An organic molecule has the structural formula:



What is the total number of shared pairs of electrons?

A 12
 B 10
 C 8
 D 6

- 8 The table gives information about three solid substances, L, M and N.

Test on substances	Results		
	L	M	N
Electrical conductivity	Non-conductor in both solid and liquid state	Good conductor in both solid and liquid states	Non-conductor in solid state but good conductor in liquid state
Hit with a hammer	No change	Flattened	Shattered

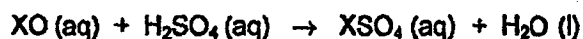
What could these three substances be?

	L	M	N
A	bromine	zinc	calcium oxide
B	silicon dioxide	sodium	copper(II) sulfate
C	iodine	copper	methane
D	sodium	sulfur	sodium chloride

9 Which statement explains why aluminium oxide has a high melting point?

- A There is a strong force of attraction between the ions and the delocalized electrons.
- B The structure of aluminium oxide is similar to that of silicon(IV) oxide.
- C Aluminium atoms and oxygen atoms are joined together by very strong triple covalent bonds.
- D There is a very strong force of attraction between the aluminium ions and the oxide ions.

10 The equation shows the reaction between oxide of the metallic element X and dilute sulfuric acid.



Which particles are responsible for the electrical conductivity in X, XO and XSO₄?

	X	XO	XSO ₄
A	cations	electrons	electrons
B	cations and anions	anions	cations
C	electrons	electrons	cations and anions
D	electrons	cations and anions	cations and anions

11 In moving across Period 3 from Group I to Group VII, the elements

- 1 have oxides whose characteristics change from acidic to basic.
- 2 have mass numbers differing by one unit.
- 3 show a gradual transition in properties from metallic to non-metallic properties.

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

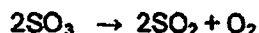
12 Phosphorus and nitrogen are both in Group V of the Periodic Table. Which ions would be produced when phosphine, PH₃, dissolves in water?

- A PH₄⁺, OH⁻
- B PH₃⁺, OH⁻
- C PH₄⁺, H⁺
- D PH₃⁺, H⁺

- 13 Element Y forms the compound Na_2YO_4 . Which property of the compound shows that element Y is a transition element?

A Aqueous Na_2YO_4 gives a precipitate with aqueous lead(II) nitrate.
B Aqueous Na_2YO_4 can be produced by reacting an oxide of Y with aqueous sodium hydroxide.
C Acidified aqueous Na_2YO_4 oxidises aqueous iron(II) sulfate.
D Aqueous Na_2YO_4 has a yellow colour.

- 14 Sulfur trioxide decomposes according to the following equation:



What is the total volume of gas produced from the decomposition of 100 cm^3 of sulfur trioxide (all volumes of gases being measured at r.t.p.)?

A 200 cm^3
B 100 cm^3
C 150 cm^3
D 50 cm^3

- 15 The active component of tobacco, nicotine, found in cigarette smoking is thought to increase the chances of a person developing lung cancer. The relative molecular mass of nicotine is 162 and quantitative elemental analysis gave the following percentages by mass:

Carbon	74.0%
Hydrogen	8.7%
Nitrogen	17.3%

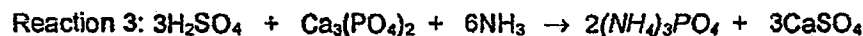
Which of the following is the correct molecular formula for nicotine?

A $\text{C}_{10}\text{H}_{14}\text{N}_2$
B $\text{C}_{10}\text{H}_{16}\text{N}_2$
C $\text{C}_5\text{H}_7\text{N}$
D $\text{C}_9\text{H}_{10}\text{N}_2$

- 16 Which of the following has the same number of atoms as 6 dm^3 of chlorine gas at room temperature and pressure?

A 0.125 g of hydrogen
B 8.5 g of ammonia
C 20 g of argon
D 24 g of magnesium

- 17 The overall equations to manufacture three fertilizers (ammonium sulfate, calcium hydrogen phosphate and ammonium phosphate) are shown below.



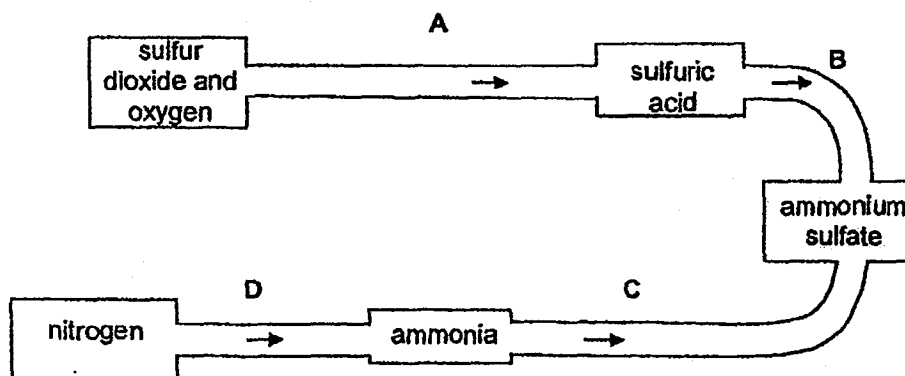
The relative molecular mass, M_r , of sulfuric acid and of each fertilizer is shown in the table.

Name of Compounds	H_2SO_4	$(\text{NH}_4)_2\text{SO}_4$	$\text{Ca}(\text{H}_2\text{PO}_4)_2$	$(\text{NH}_4)_3\text{PO}_4$
M_r	98	132	234	149

In each reaction, 98 tonnes of sulfuric acid was used. Which reactions gave the greatest and least mass of fertilizer?

	Greatest Mass	Least Mass
A	2	1
B	1	3
C	2	3
D	3	1

- 18 The diagram shows some of the stages in the manufacture of an important fertiliser, ammonium sulfate.



From which of the connecting pipes, A – D, would a major leak produce the greatest increase in the pH of rainwater?

- 19 The table below gives information about three indicators.

Indicator	Colour at pH 1	pH at which colour changes	Colour at pH 12
thymol blue	red	3	yellow
congo red	blue	5	red
phenolphthalein	colourless	10	red

Which colours would be obtained when each indicator was added separately to pure water?

	Thymol Blue	Congo Red	Phenolphthalein
A	blue	colourless	red
B	yellow	red	colourless
C	yellow	blue	colourless
D	red	blue	red

- 20 Which of the following elements form oxides whose aqueous solutions have a pH greater than 7?

- 1 Copper
- 2 Iron
- 3 Zinc
- 4 Calcium

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

- 21 In the reaction



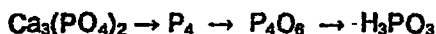
Which of the following are true?

- 1 Hydrogen sulfide is reduced to hydrochloric acid.
 - 2 Iron(III) ions gain electrons.
 - 3 The colour of the solution changes from yellow brown to a pale green.
 - 4 Oxidation state of sulfur decreases.
- A 1, 2 and 3 only
 - B 2 and 4 only
 - C 2 and 3 only
 - D 3 and 4 only

22 Which of the following is an example of a redox reaction?

- A $\text{ZnCl}_2 + 2\text{NaOH} \rightarrow \text{Zn(OH)}_2 + 2\text{NaCl}$
 B $\text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3$
 C $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$
 D $\text{Na}_2\text{CO}_3 + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{H}_2\text{O} + \text{CO}_2$

23 The following sequence shows the steps in the conversion of calcium phosphate, $\text{Ca}_3(\text{PO}_4)_2$, to phosphorous acid, H_3PO_3

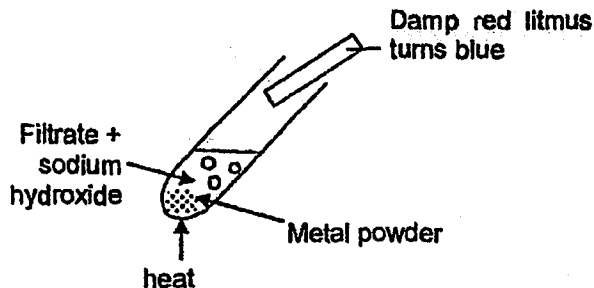


The oxidation numbers of phosphorous in this sequence are respectively

- A +5, 0, +3, +3
 B +5, 0, +5, +5
 C +1, +4, +3, +1
 D +2, +4, +4, +1

24 A crime suspect was thought to have been in a field on which a farmer had recently sprayed some fertiliser consisting of a potassium salt.

The forensic scientist obtained the mud from the suspect's shoe and dissolved it in water. The mixture was filtered and the filtrate was heated with aqueous sodium hydroxide and a metal in powdered form. The result of the reaction is shown in diagram below.



What is the fertiliser?

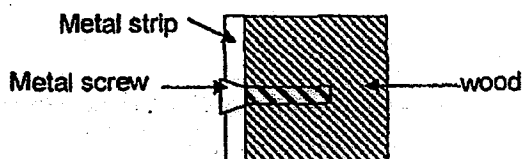
- A KCl
 B KNO_3
 C K_2HPO_4
 D K_2SO_4

- 25 The following observations were made when nickel and iron were put separately into salt solutions of three metals P, Q and R.

Metals	Salt solution of P	Salt solution of Q	Salt solution of R
Nickel, Ni	Yes, displaced	Not displaced	Not displaced
Iron, Fe	Yes, displaced	Yes, displaced	Not displaced

What is the correct order in decreasing reactivity of the five metals?

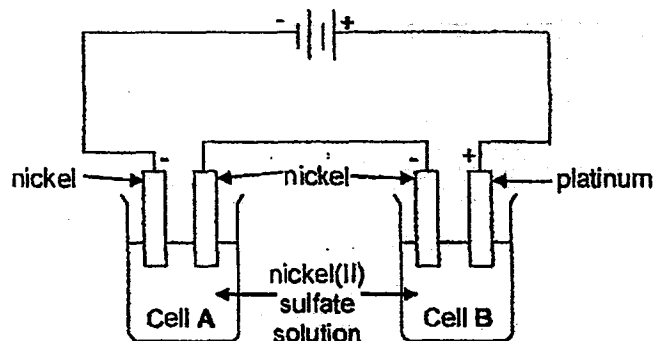
- A R, Q, Fe, Ni, P
 B R, Fe, Q, Ni, P
 C R, Fe, Ni, Q, P
 D P, Ni, Fe, Q, R
- 26 Metal strips are secured on the outside of the wooden box by means of screws. After a few weeks of being exposed to the wind and rain, the screws are heavily corroded but the metal strips are not.



Which of the following statements best explains the observation?

- A The metal screw loses electrons less readily than the metal strip.
 B The metal screw stops oxygen in the air from getting to the metal strip.
 C The metal strip has a protective oxide layer but not the metal screw.
 D The metal screw is a pure metal and the metal strip is an alloy.
- 27 A metal W is placed between calcium and aluminium in the reactivity series. Which method can be used to extract W?
- A Reduction of the oxide of W using aluminium
 B Reduction of the oxide of W using carbon.
 C Electrolysis of an aqueous solution of a chloride of W.
 D Electrolysis of a molten compound of W.

- 28 Two electrolytic cells, A and B, were set up as shown below. The electrolyte in both cells is green nickel(II) sulfate solution of the same concentration. Cell A has two nickel electrodes, while Cell B has a nickel cathode and a platinum anode.

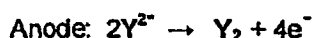


A steady current was passed through both cells for some time, and the results were summarised in the table below.

Cell	Cathode	Anode
A	3.0 g of nickel is deposited	Nickel dissolves
B	Nickel is deposited	Oxygen evolved

Which statement about the reactions is true?

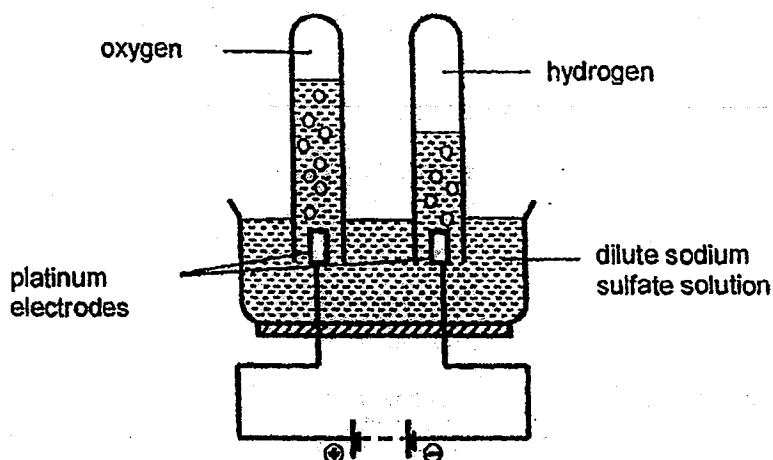
- 1 The platinum anode in Cell B decreases in mass by 3.0 g.
 - 2 The green colour of the nickel(II) sulfate solution in Cell B fades slowly and eventually disappears.
 - 3 The nickel anode in Cell A gains mass by 3.0 g.
 - 4 The intensity of the green colour of the nickel(II) sulfate solution in Cell A remains the same.
- A 1 and 3 only
 B 2 and 4 only
 C 1 and 2 only
 D 1, 2 and 4 only
- 29 Element X is extracted by electrolysis of a molten compound of elements X and Y. The electrode reactions are as follows:



Which of the following could be the compound?

- A Magnesium sulfate
 B Potassium oxide
 C Sodium chloride
 D Aluminium chloride

- 30 The diagram represents an experiment in which electric current is passed through dilute sodium sulfate solution.

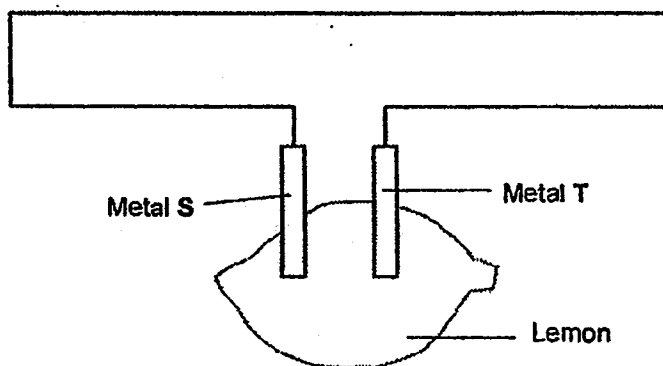


Which of the following correctly explains the result of the experiment.

- 1 Oxygen is formed due to the discharge of sulfate ions.
- 2 The ratio of hydrogen to oxygen atoms in a water molecule is 2:1.
- 3 Hydroxide ion is discharge in preference to sulfate ion.
- 4 Sodium is discharged in preference to hydrogen.

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

- 31 In the set-up shown below, metal S is more reactive than metal T.



Which one of the following statements concerning this set-up is correct?

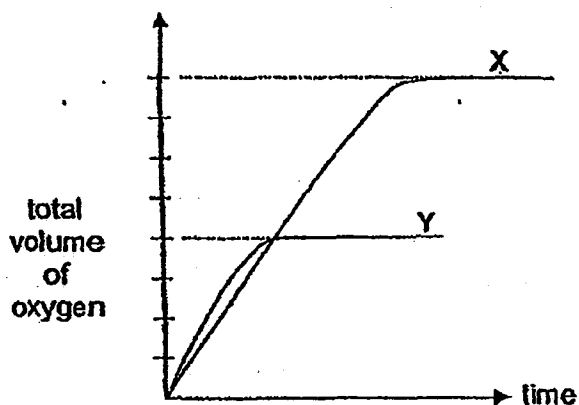
- A Electrons flow from metal T to metal S in the external circuit.
 B Oxygen will be liberated at metal T.
 C Oxidation occurs at Metal S.
 D Electrical energy is changed into chemical energy

- 32 When excess calcium carbonate reacts with dilute hydrochloric acid, the reaction slows down and finally stops.

Which statement best explains why this happens?

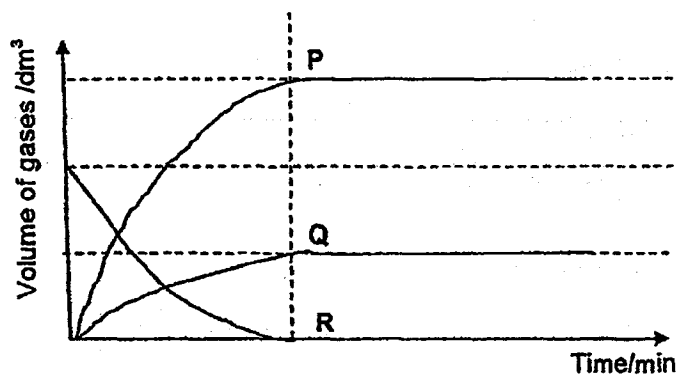
- A The calcium carbonate is completely used up.
- B The calcium carbonate is covered by bubbles of carbon dioxide.
- C An insoluble layer of calcium chloride is formed.
- D The hydrochloric acid is completely used up.

- 33 Graphs X and Y shown below represent the results of two experiments demonstrating the catalytic decomposition of hydrogen peroxide. Assuming that all other conditions are kept constant, which one of the following is a correct explanation of the results?



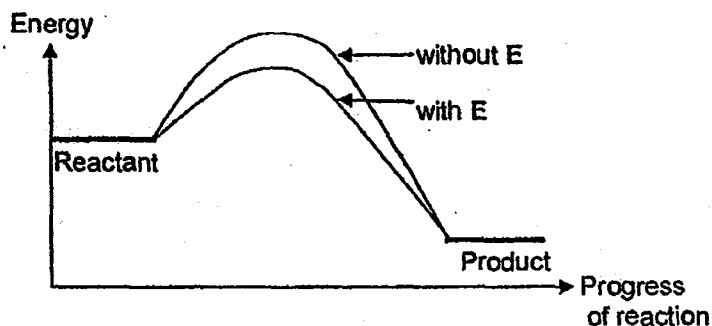
	Experiment X	Experiment Y
A	20 cm ³ of 1.0 mol/dm ³ hydrogen peroxide was used.	10 cm ³ of 2.0 mol/dm ³ hydrogen peroxide was used.
B	20 cm ³ of 1.0 mol/dm ³ hydrogen peroxide was used.	5 cm ³ of 2.0 mol/dm ³ hydrogen peroxide was used.
C	1.0 g of manganese(IV) oxide was used.	0.5 g of manganese(IV) oxide was used.
D	The reaction was carried out at 60°C.	The reaction was carried out at 30°C.

- 34 The following graph shows the changes in the volume of three gases P, Q and R with time during a chemical reaction. The volumes are all measured at the same temperature and pressure.



Which equation represents the reaction?

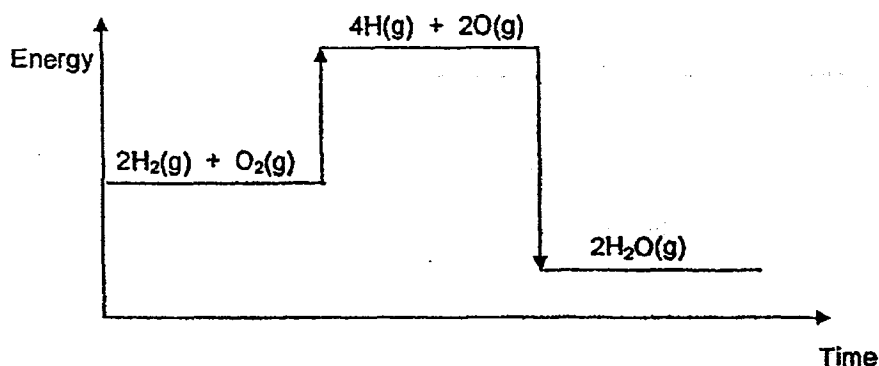
- A $R \rightarrow 2P + Q$
 - B $2P \rightarrow Q + R$
 - C $2R \rightarrow 3P + Q$
 - D $3P + Q \rightarrow 2R$
- 35 The energy profile diagram shows how adding a substance E to a reaction mixture changes the reaction pathway.



Which change is likely to be observed when E is added to the reaction mixture?

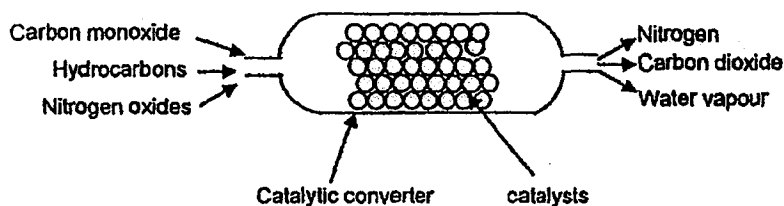
- A The speed of the reaction increases.
- B The speed of the reaction decreases.
- C The reaction becomes less exothermic.
- D The reaction becomes more exothermic.

- 36 The energy level diagram for burning hydrogen gas in oxygen to form steam is shown in the diagram.



Which of these statements about the reaction is correct?

- A The volume of the reactants is equal to the volume of the products.
 - B The reaction is endothermic as heat energy is taken in.
 - C Less energy is given out during the making of the O-H bond than is absorbed during the breaking of H-H and O=O bonds.
 - D The enthalpy change of the reaction (ΔH) has a negative value.
- 37 The diagram below shows a section of a catalytic converter in the exhaust system of a car.

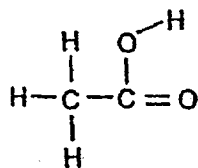


Carbon monoxide, hydrocarbons and nitrogen oxides in the exhaust gases are converted to nitrogen, carbon dioxide and water vapour in the catalytic converter through a number of processes.

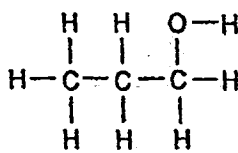
Which processes take place at the converter?

- 1 Carbon monoxide reacts with hydrocarbons.
 - 2 Redox reactions occur.
 - 3 Carbon monoxide reacts with nitrogen oxides.
 - 4 Hydrocarbons react with nitrogen oxides.
- A 1 and 2 only
 - B 2 and 3 only
 - C 3 and 4 only
 - D 2, 3 and 4 only

- 38 The structural formulae of compounds (i) and (ii) are shown below :



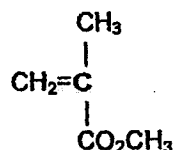
(i)



(ii)

What is the best method to distinguish between (i) and (ii)?

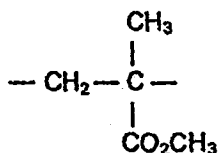
- A Using potassium hydroxide
 B Using bromine water
 C Using dilute sulfuric acid
 D Using sodium carbonate
- 39 In an artificial hip joint, bone cement is used to attach the poly(ethene) cup for the joint to the pelvic girdle. Bone cement is formed by the polymerisation of methyl 2-methylpropenoate and the process is highly exothermic.



methyl 2-methylpropenoate

Which of the following are correct statements about this polymerisation?

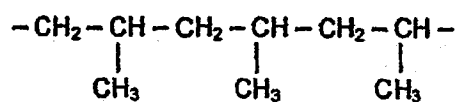
- 1 The repeat unit of the polymer is



- 2 Less energy is released in making the C – C bonds than absorbed in breaking a C = C bond.
 3 The formation of the cement occurs by addition polymerisation.

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

- 40 The structure of the polymer is shown below.



Which is the molecular formula of the monomer?

- A C_4H_8
- B C_3H_6
- C C_5H_{10}
- D C_2H_4

END OF PAPER

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
1 H Hydrogen																	

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

2014 MGS Chemistry (5073) Prelim P1 answer key

1	C		21	C	
2	B		22	C	
3	D		23	A	
4	B		24	B	
5	A		25	B	
6	B		26	C	
7	C		27	D	
8	B		28	B	
9	D		29	B	
10	D		30	B	

11	A		31	C	
12	A		32	D	
13	D		33	B	
14	C		34	C	
15	C		35	A	
16	C		36	D	
17	B		37	B	
18	C		38	D	
19	B		39	C	
20	A		40	B	

Section A (50 marks)

Answer all the questions from this section in the spaces provided.

- 1 Choose from the following elements to answer the questions below.

Aluminium, Argon, Iron, Nickel, Nitrogen, Phosphorus, Sodium

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

Name the element that

- (a) is used as a catalyst in the hydrogenation of alkenes,

[1]

- (b) is manufactured by electrolysis,

[1]

- (c) reacts with oxygen to give an acidic oxide,

[1]

- (d) reacts with chlorine to form a solid that dissolves in water to give a coloured solution.

[1]

- 2 Chlorine exists as a gas at room temperature and pressure. A sample of chlorine gas was bubbled into a beaker of aqueous potassium iodide.

- (a) Describe the arrangement and movement of the chlorine molecules.

[2]

- (b) Describe and explain what you see when the chlorine was bubbled into the beaker of aqueous potassium iodide.

[2]

- (c) This reaction is an exothermic reaction. Explain in terms of bond making and bond breaking why this is so.

[2]

- 3 (a) Zinc sulfide is a commonly-found compound which is insoluble in water. State and explain the difference in electrical conductivity between zinc sulfide and sulfur dioxide in terms of bonding and structure.

[3]

- (b) Zinc sulfide is roasted in oxygen and the products are zinc oxide and sulfur dioxide. Describe how you would test for sulfur dioxide.

[2]

- (c) Another purpose of zinc oxide is to remove sulfur dioxide from waste gases in factories before they are released into the environment. Only one product is formed.

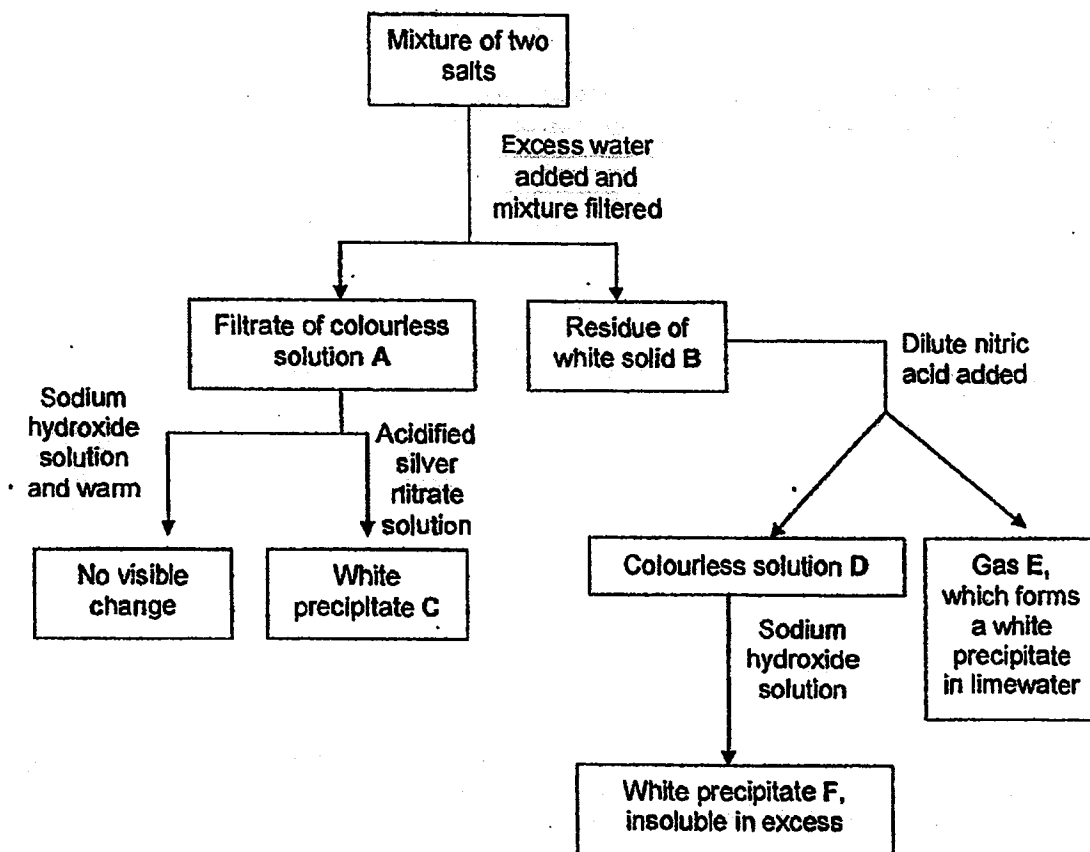
- (i) Suggest why sulfur dioxide is a pollutant.

[1]

- (ii) Write the balanced chemical equation, including state symbols, for the reaction to remove sulfur dioxide and name the product.

[3]

- 4 Two white salts, one soluble and another insoluble in water, were mixed and a series of tests were carried out according to the reaction scheme given.



- (a) Identify substances A, B, D and F.

A:

B:

D:

F:

[4]

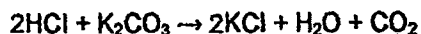
- (b) Write the ionic equation for the formation of precipitate C.

[1]

- (c) Gas E can react with sodium hydroxide solution to produce a salt and water. Write the balanced chemical equation for this reaction.

[1]

- 5 25 cm³ of 1.5 mol/dm³ of dilute hydrochloric acid was reacted with 20 cm³ of 2.0 mol/dm³ of aqueous potassium carbonate at room temperature and pressure to obtain potassium chloride.



- (a) Discuss the suitability of reacting potassium with dilute hydrochloric acid to obtain potassium chloride. State the expected observation.

[2]

- (b) Draw a 'dot and cross' diagram of the electronic structure of potassium chloride. Show only the valence shells.

[2]

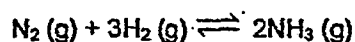
- (c) Suggest and explain how the speed of reaction and volume of carbon dioxide would be affected should the hydrochloric acid be replaced with 25.0 cm³ of 1.5 mol/dm³ ethanoic acid.

[2]

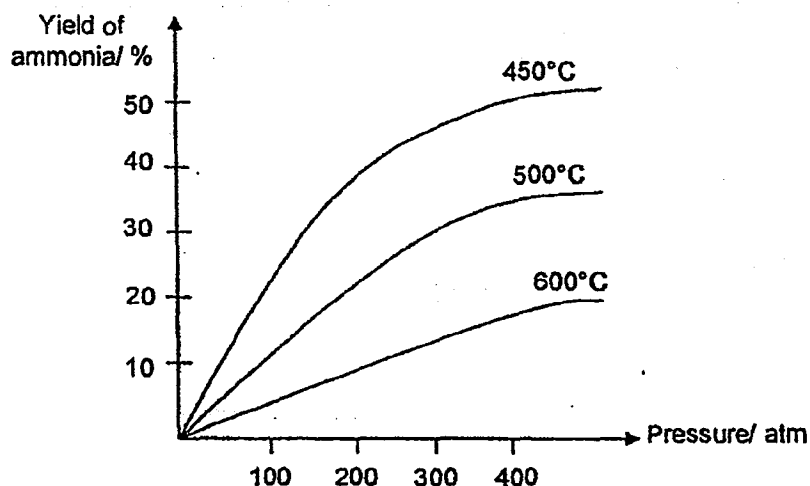
- (d) Write the chemical equation for another suitable method of obtaining potassium chloride salt besides the reaction shown above.

[1]

- 6 Ammonia is formed during the Haber process by reacting hydrogen with nitrogen.



The graph below shows the percentage yield of ammonia formed under different conditions of temperature and pressure.



- (a) Use the graph to deduce the effect of increasing temperature and pressure on the yield of ammonia.

[2]

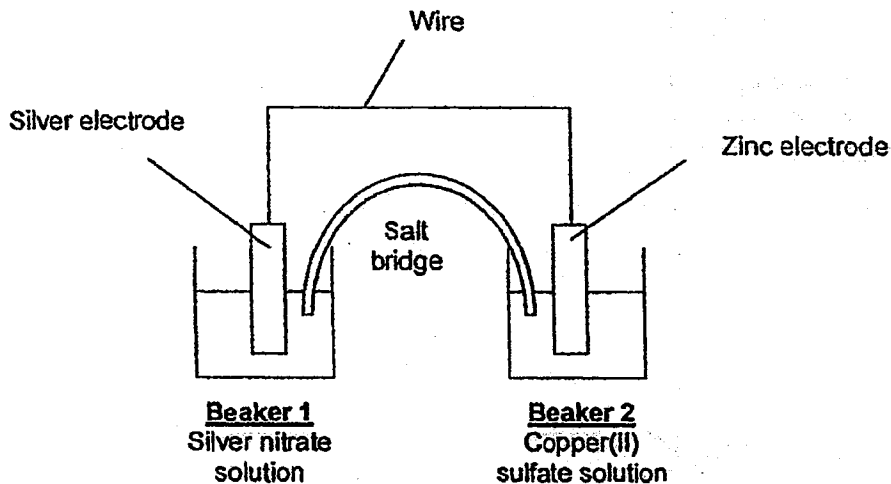
- (b) Calculate the volume of ammonia produced from 350 dm³ of hydrogen if the percentage yield of ammonia is 10 %.

[2]

- (c) Identify the reducing agent. Explain your answer in terms of oxidation state.

[2]

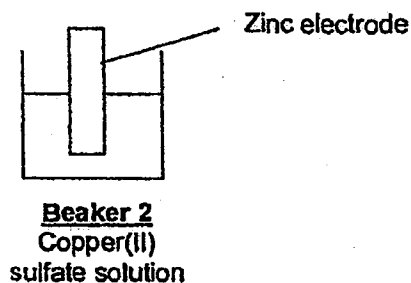
- 7 A simple cell was set up as shown below. The salt bridge allows for the flow of ions so as to maintain electrical conduction.



- (a) Write the half-equations for the reactions that take place at both electrodes.

[2]

- (b) State and explain one similarity and one difference in the observations made of the reactions in Beaker 2 before and after the wires and salt bridge are removed.



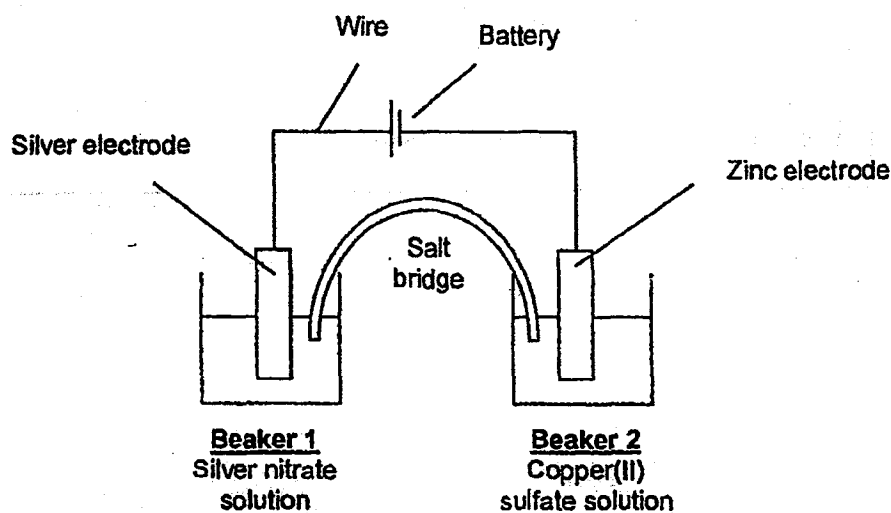
- (i) Similarity

[1]

- (ii) Difference

[2]

- (c) A battery was added to the setup as shown in the diagram below.



Write the half-equations that occur in this setup.

Silver electrode:

Zinc electrode:

[2]

- 8 Underground iron pipelines are used in transporting substances such as natural gas from place to place. When underground, these iron pipes will rust relatively rapidly.

- (a) State the essential conditions needed for the rusting of iron.

[1]

- (b) Pieces of magnesium are often attached to underground iron pipes. Explain how this helps prevent iron from rusting.

[2]

- (c) A sample of a compound of iron is analysed. The sample contains 0.547 g of potassium, 0.195 g of iron, 0.252 g of carbon and 0.294 g of nitrogen. Determine the empirical formula of this compound.

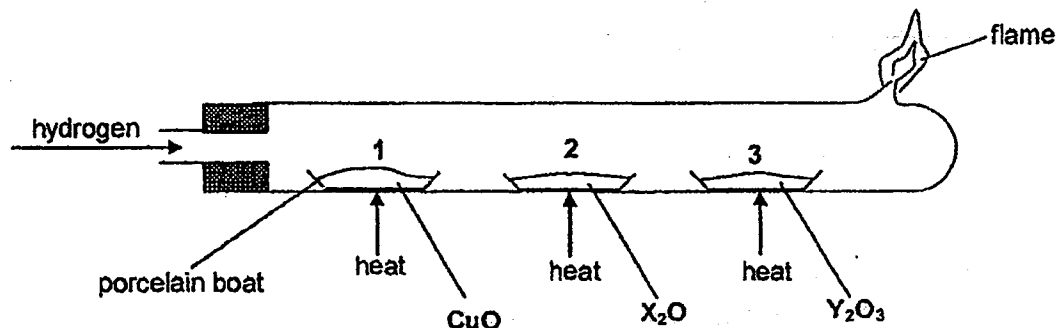
[2]

Section B (30 marks)

Answer all three questions from this section on the writing papers provided.

The last question is in the form of EITHER/OR and only one alternative should be attempted.

- 9 In an experiment, hydrogen gas was passed over equal masses of three heated metal oxides in identical porcelain boats as shown in the diagram.



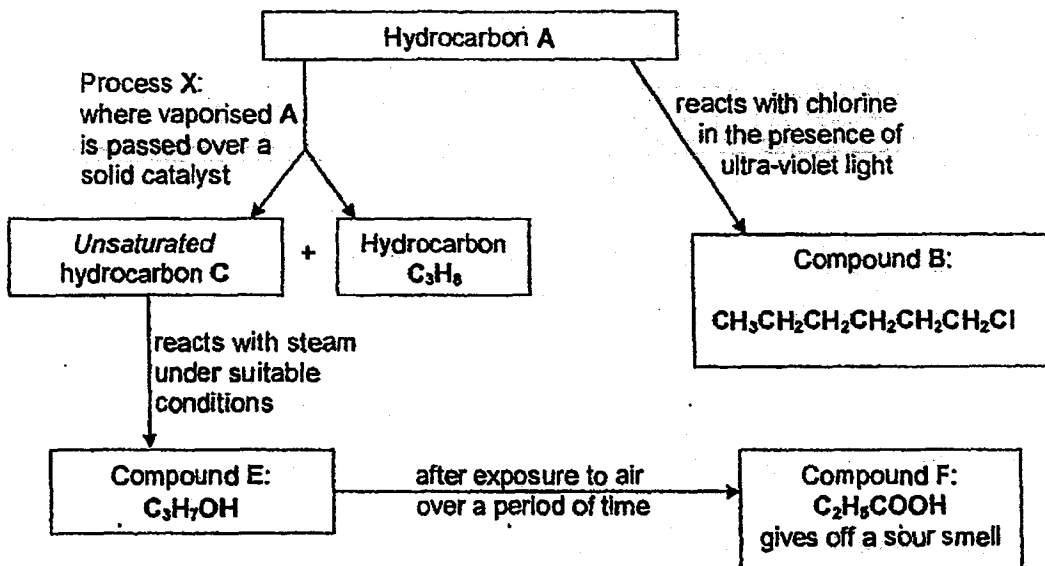
The porcelain boats were weighed 5 minutes into the experiment. After weighing, the experiment was allowed to continue for another 20 minutes where no further changes were observed. At the end of the experiment, the heat source was turned off. However, the hydrogen is kept flowing until the tube is cold.

The table shows some data from this experiment.

	at the start of experiment	5 minutes into the experiment	at the end of experiment
mass of empty porcelain boat / g	16.35	-	16.35
mass of porcelain boat 1 and its contents / g	22.35	21.15	21.15
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mass of porcelain boat 3 and its contents / g	22.35	21.20	20.55

- (a) Explain why a flame is necessary at the end of the glass tube. [1]
- (b) Describe the observation seen in porcelain boat 1.
Write a chemical equation for the reaction that had occurred. [2]
- (c) Arrange the three metals, Cu, X and Y, in the order of their reactivity from the most reactive metal to the least reactive metal. With reference to the data given, explain how you reach this conclusion. [3]
- (d) Suggest a possible metal for X. [1]
- (e) (i) Use the data given to calculate the mass of O in Y_2O_3 in boat 3. [1]
(ii) Hence, or otherwise, calculate the relative atomic mass of Y.
From your result, identify Y. [2]

10 The reaction scheme below involves several organic substances.



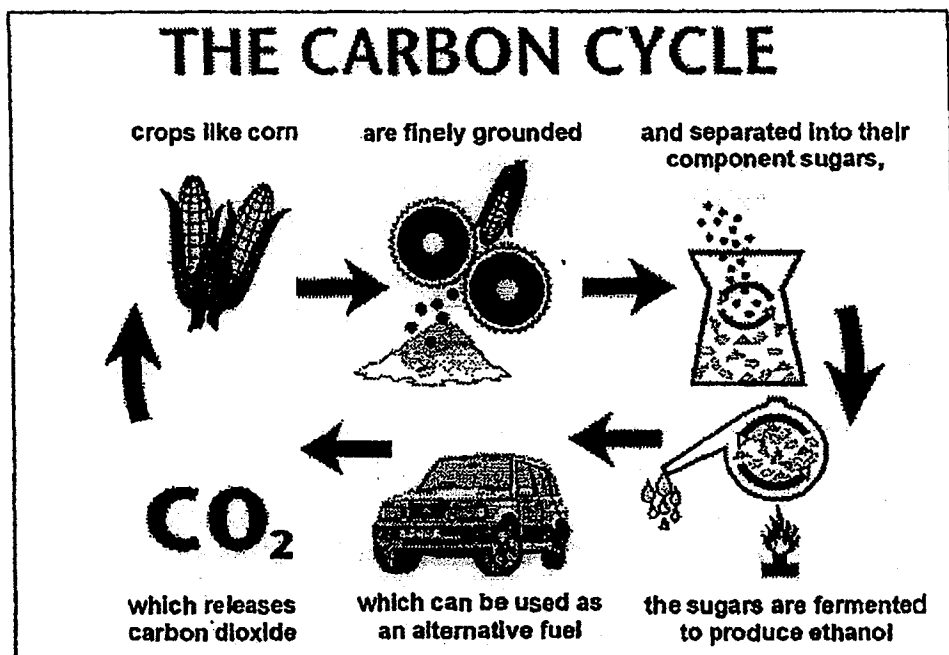
Answer the following based on the reaction scheme.

- (a) Explain what is meant by "unsaturated" hydrocarbon. [1]
- (b) Draw the structural formula of hydrocarbon C. [1]
- (c)
 - (i) Name process X and give a substance that can be used as the solid catalyst. [2]
 - (ii) Write a balanced chemical equation for process X to show how unsaturated hydrocarbon C can be formed from hydrocarbon A. [1]
- (d) Compound E can also be converted quickly into compound F in the chemistry laboratory.
 - (i) Describe how this can be done and state any observation from the reaction. [2]
 - (ii) Describe a test to show that compound E has indeed been turned into compound F. [2]
- (e) Compound E has two isomers with molecular formula C_3H_7OH . Draw the structural formulae of both isomers. [1]

Either

- 11 To rely less heavily on crude oil for fuels, scientists have been exploring different types of alternative fuels. One of such alternative fuels is bioethanol. A number of countries, including the United States and Brazil, have been producing ethanol from plants, such as corn or sugar cane, to be used as an alternative to petrol. Scientists claim that it is more environmentally friendly to use bioethanol than petrol because bioethanol is 'Carbon Neutral'. Furthermore, ethanol *burns cleanly* with a non-luminous flame.

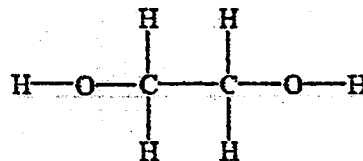
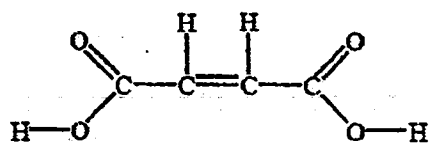
The diagram below, extracted from a poster, shows the carbon cycle for bioethanol.



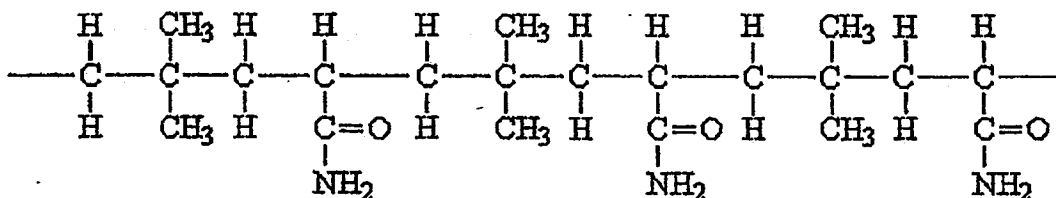
- (a) Other than environmental concerns, suggest two reasons why crude oil should not be used as fuels. [2]
- (b) With the help of an equation, describe how ethanol is produced from sugar solution by fermentation. [2]
- (c) Based on the carbon cycle, explain why bioethanol is 'Carbon Neutral' and therefore more environmentally friendly. [2]
- (d) Suggest what is meant by 'burns cleanly' as given in the passage above. [1]
- (e) Biodiesel is another alternative fuel for motorcars that is similar to bioethanol. It is produced from used vegetable oil that can be collected from the food industries. The used vegetable oil is treated and undergo a chemical process which turns it into biodiesel.
 - (i) Refer to the diagram above and draw a similar carbon cycle for biodiesel. [2]
 - (ii) Biodiesel is also carbon neutral. Suggest another advantage of using biodiesel. [1]

Or

- 11 (a) The structural formulae of butanedioic acid and ethane-1,2-diol are shown below.



- (i) State the observations when aqueous bromine is added to butanedioic acid and ethane-1,2-diol. Draw the structural formula of the product(s) formed. [3]
- (ii) Butanedioic acid and ethane-1,2-diol can polymerize under suitable conditions to form a polymer. Draw the polymer showing 2 repeat units. [2]
- (iii) Is the polymer formed by butanedioic acid and ethane-1,2-diol an *addition* polymer or a *condensation* polymer? Explain. [1]
- (b) Another polymer P has the following structure:



- (i) Derive the structural formula of the two monomers that are used to form polymer P. [2]
- (ii) Explain why polymer P is a solid at room temperature while its monomers are liquids. [2]

--- End of Paper ---

DATA SHEET

The Periodic Table of the Elements

Group

I	II	III	IV	V	VI	VII	0										
1 H Hydrogen																	
2 He Helium																	
3 Li Lithium	4 Be Beryllium	5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon	11 Na Sodium	12 Mg Magnesium	13 Al Aluminum	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon	19 K Potassium	20 Ca Calcium
21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton	37 Rb Rubidium	38 Sr Strontium
39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon	55 Ba Barium	56 La Lanthanum
57 Ce Cerium	58 Pr Praseodymium	59 Nd Neodymium	60 Pm Promethium	61 Sm Samarium	62 Eu Europium	63 Gd Gadolinium	64 Tb Terbium	65 Dy Dysprosium	66 Ho Holmium	67 Er Erbium	68 Tm Thulium	69 Yb Ytterbium	70 Lu Lutetium	71 Hf Hafnium	72 Ta Tantalum	73 W Tungsten	74 Re Rhenium
75 Os Osmium	76 Ir Iridium	77 Pt Platinum	78 Au Gold	79 Hg Mercury	80 Tl Thallium	81 Pb Lead	82 Bi Bismuth	83 Po Polonium	84 At Astatine	85 Rn Radon	86 Fr Francium	87 Ra Radium	88 Ac Actinium	89 Th Thorium	90 Pa Protactinium	91 U Uranium	92 Np Neptunium
93 Pu Plutonium	94 Am Americium	95 Cm Curium	96 Bk Berkelium	97 Cf Californium	98 Es Einsteinium	99 Fm Fermium	100 Md Mendelevium	101 No Nobelium	102 Lr Lawrencium	103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118	119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500						

58-71 Lanthanoid series
90-103 Actinoid series

a = relative atomic mass
X = atomic symbol
b = proton (atomic)

Key
a
X
b

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

Section A (50 marks)

Answer all the questions from this section in the spaces provided.

- 1** Choose from the following elements to answer the questions below.

Aluminium, Argon, Iron, Nickel, Nitrogen, Phosphorus, Sodium

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

Name the element that

- (a) is used as a catalyst in the hydrogenation of alkenes,

[1]

- (b) is manufactured by electrolysis,

[1]

- (c) reacts with oxygen to give an acidic oxide,

[1]

- (d) reacts with chlorine to form a solid that dissolves in water to give a coloured solution.

[1]

- 2** Chlorine exists as a gas at room temperature and pressure. A sample of chlorine gas was bubbled into a beaker of aqueous potassium iodide.

- (a) Describe the arrangement and movement of the chlorine molecules.

[2]

- (b) Describe and explain what you see when the chlorine was bubbled into the beaker of aqueous potassium iodide.

[2]

- (c) This reaction is an exothermic reaction. Explain in terms of bond making and bond breaking why this is so.

[2]

- 3 (a) Zinc sulfide is a commonly-found compound which is insoluble in water. State and explain the difference in electrical conductivity between zinc sulfide and sulfur dioxide in terms of bonding and structure.

[3]

- (b) Zinc sulfide is roasted in oxygen and the products are zinc oxide and sulfur dioxide. Describe how you would test for sulfur dioxide.

[2]

- (c) Another purpose of zinc oxide is to remove sulfur dioxide from waste gases in factories before they are released into the environment. Only one product is formed.

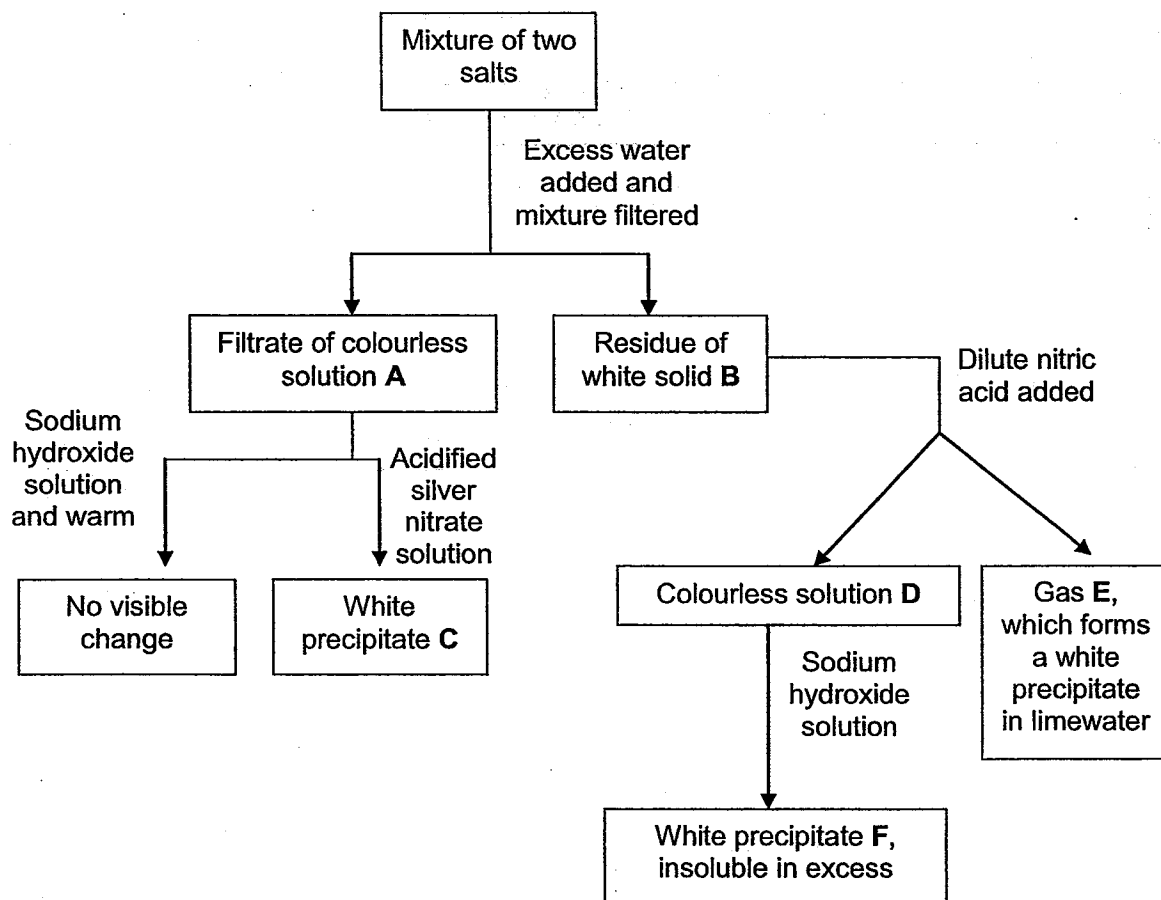
- (i) Suggest why sulfur dioxide is a pollutant.

[1]

- (ii) Write the balanced chemical equation, including state symbols, for the reaction to remove sulfur dioxide and name the product.

[3]

- 4 Two white salts, one soluble and another insoluble in water, were mixed and a series of tests were carried out according to the reaction scheme given.



- (a) Identify substances A, B, D and F.

A:

B:

D:

F:

[4]

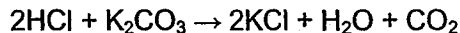
- (b) Write the ionic equation for the formation of precipitate C.

[1]

- (c) Gas E can react with sodium hydroxide solution to produce a salt and water. Write the balanced chemical equation for this reaction.

[1]

- 5 25 cm³ of 1.5 mol/dm³ of dilute hydrochloric acid was reacted with 20 cm³ of 2.0 mol/dm³ of aqueous potassium carbonate at room temperature and pressure to obtain potassium chloride.



- (a) Discuss the suitability of reacting potassium with dilute hydrochloric acid to obtain potassium chloride. State the expected observation.

[2]

- (b) Draw a 'dot and cross' diagram of the electronic structure of potassium chloride. Show only the valence shells.

[2]

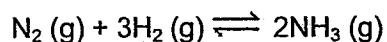
- (c) Suggest and explain how the speed of reaction and volume of carbon dioxide would be affected should the hydrochloric acid be replaced with 25.0 cm³ of 1.5 mol/dm³ ethanoic acid.

[2]

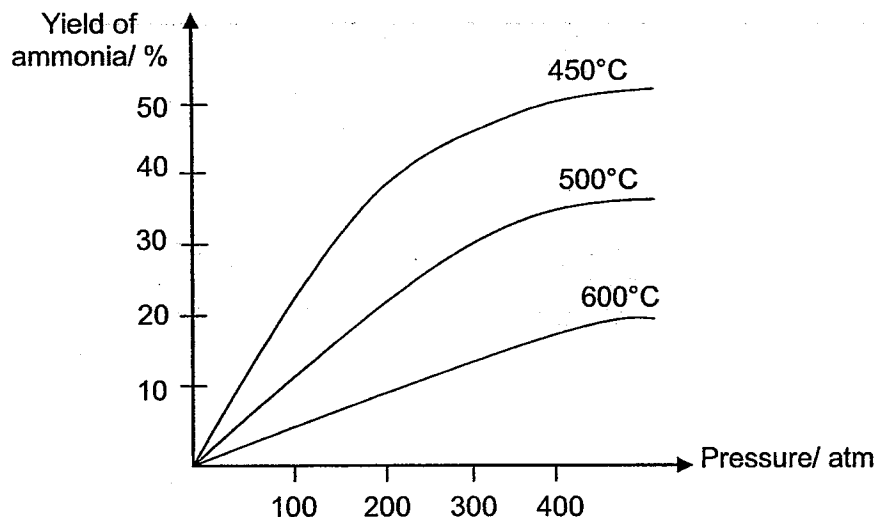
- (d) Write the chemical equation for another suitable method of obtaining potassium chloride salt besides the reaction shown above.

[1]

- 6 Ammonia is formed during the Haber process by reacting hydrogen with nitrogen.



The graph below shows the percentage yield of ammonia formed under different conditions of temperature and pressure.



- (a) Use the graph to deduce the effect of increasing temperature and pressure on the yield of ammonia.

[2]

- (b) Calculate the volume of ammonia produced from 350 dm³ of hydrogen if the percentage yield of ammonia is 10 %.

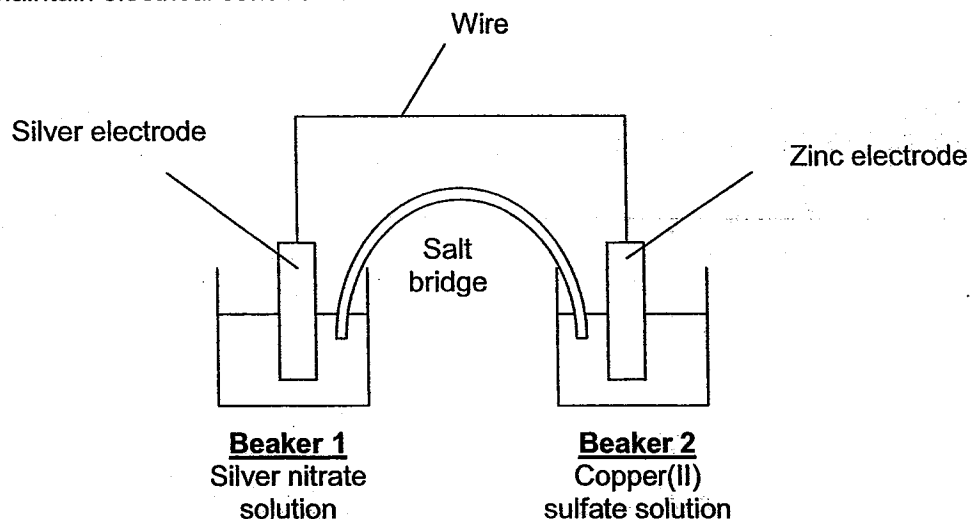
[2]

[2]

- (c) Identify the reducing agent. Explain your answer in terms of oxidation state.

[2]

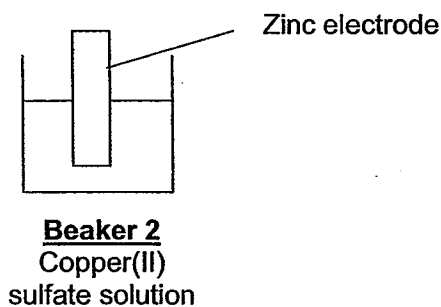
- 7 A simple cell was set up as shown below. The salt bridge allows for the flow of ions so as to maintain electrical conduction.



- (a) Write the half-equations for the reactions that take place at both electrodes.

[2]

- (b) State and explain one similarity and one difference in the observations made of the reactions in **Beaker 2** before and after the wires and salt bridge are removed.



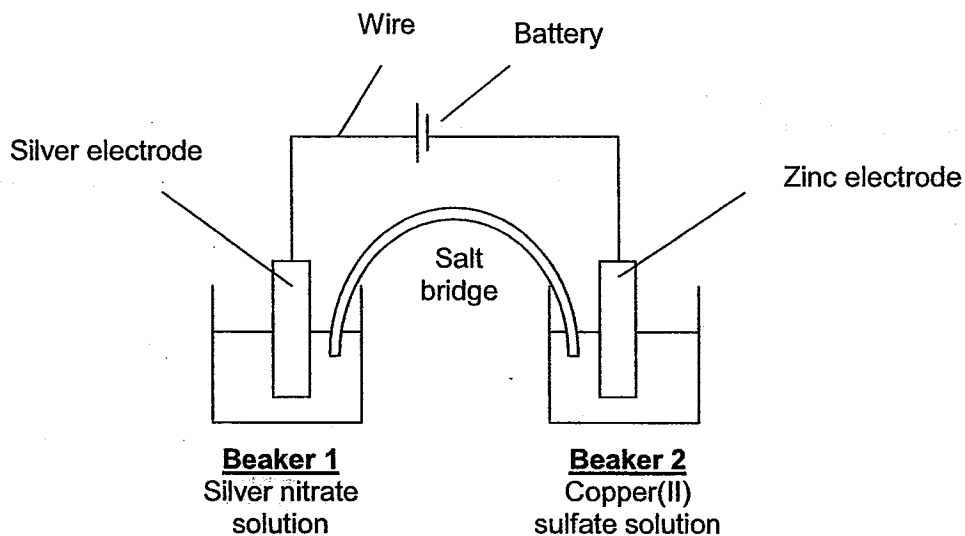
- (i) Similarity

[1]

- (ii) Difference

[2]

- (c) A battery was added to the setup as shown in the diagram below.



Write the half-equations that occur in this setup.

Silver electrode:

Zinc electrode:

[2]

- 8 Underground iron pipelines are used in transporting substances such as natural gas from place to place. When underground, these iron pipes will rust relatively rapidly.

- (a) State the essential conditions needed for the rusting of iron.

[1]

- (b) Pieces of magnesium are often attached to underground iron pipes. Explain how this helps prevent iron from rusting.

[2]

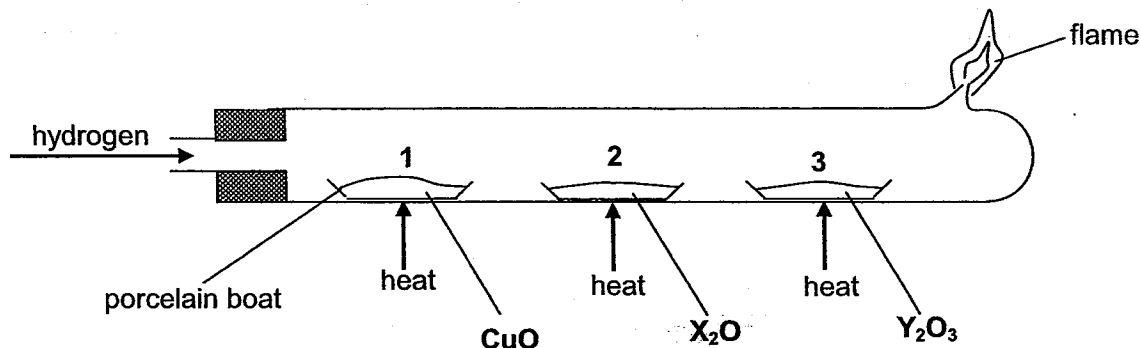
- (c) A sample of a compound of iron is analysed. The sample contains 0.547 g of potassium, 0.195 g of iron, 0.252 g of carbon and 0.294 g of nitrogen. Determine the empirical formula of this compound.

[2]

Section B (30 marks)

Answer all three questions from this section on the writing papers provided.
The last question is in the form of EITHER/OR and only one alternative should be attempted.

- 9 In an experiment, hydrogen gas was passed over equal masses of three heated metal oxides in identical porcelain boats as shown in the diagram.



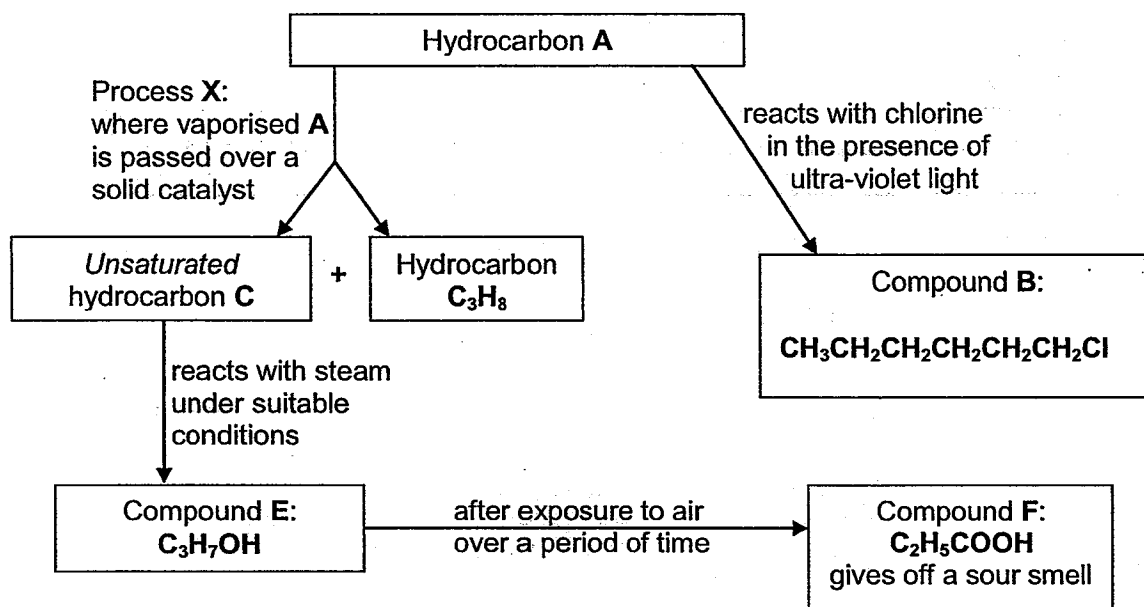
The porcelain boats were weighed 5 minutes into the experiment. After weighing, the experiment was allowed to continue for another 20 minutes where no further changes were observed. At the end of the experiment, the heat source was turned off. However, the hydrogen is kept flowing until the tube is cold.

The table shows some data from this experiment.

	at the start of experiment	5 minutes into the experiment	at the end of experiment
mass of empty porcelain boat / g	16.35	-	16.35
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mass of porcelain boat 2 and its contents / g	22.35	22.35	22.35
mass of porcelain boat 3 and its contents / g	22.35	21.20	20.55

- (a) Explain why a flame is necessary at the end of the glass tube. [1]
- (b) Describe the observation seen in porcelain boat 1.
Write a chemical equation for the reaction that had occurred. [2]
- (c) Arrange the three metals, Cu, X and Y, in the order of their reactivity from the most reactive metal to the least reactive metal. With reference to the data given, explain how you reach this conclusion. [3]
- (d) Suggest a possible metal for X. [1]
- (e) (i) Use the data given to calculate the mass of O in Y_2O_3 in boat 3. [1]
(ii) Hence, or otherwise, calculate the relative atomic mass of Y.
From your result, identify Y. [2]

10 The reaction scheme below involves several organic substances.



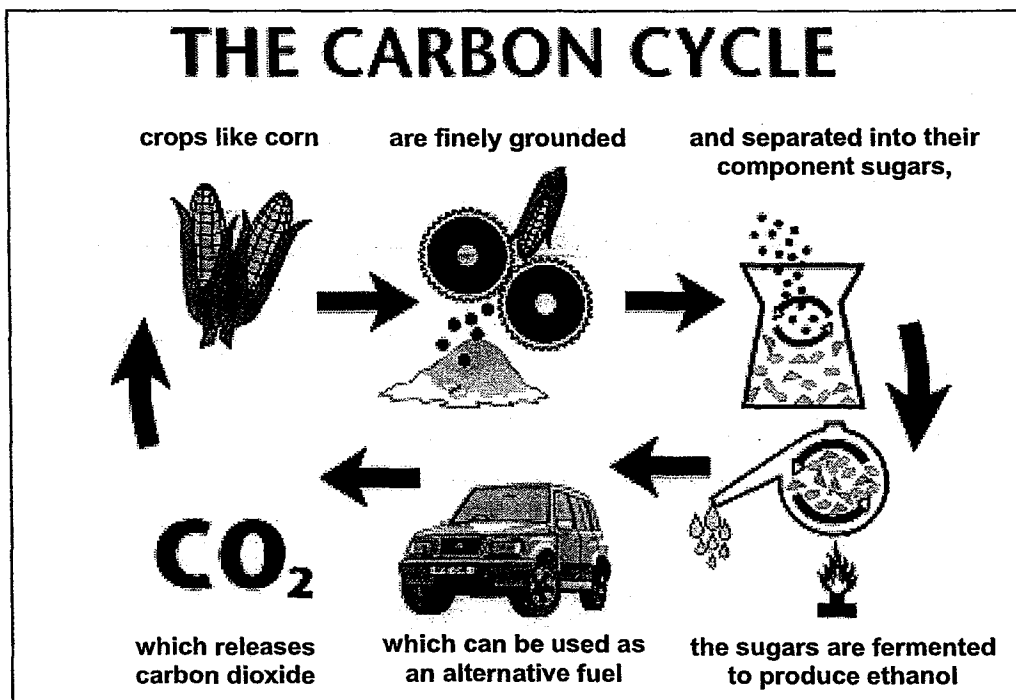
Answer the following based on the reaction scheme.

- (a) Explain what is meant by “unsaturated” hydrocarbon. [1]
- (b) Draw the structural formula of hydrocarbon C. [1]
- (c)
 - (i) Name process X and give a substance that can be used as the solid catalyst. [2]
 - (ii) Write a balanced chemical equation for process X to show how unsaturated hydrocarbon C can be formed from hydrocarbon A. [1]
- (d) Compound E can also be converted quickly into compound F in the chemistry laboratory.
 - (i) Describe how this can be done and state any observation from the reaction. [2]
 - (ii) Describe a test to show that compound E has indeed been turned into compound F. [2]
- (e) Compound E has two isomers with molecular formula C₃H₇OH. Draw the structural formulae of both isomers. [1]

Either

- 11 To rely less heavily on crude oil for fuels, scientists have been exploring different types of alternative fuels. One of such alternative fuels is **bioethanol**. A number of countries, including the United States and Brazil, have been producing ethanol from plants, such as corn or sugar cane, to be used as an alternative to petrol. Scientists claim that it is more environmentally friendly to use bioethanol than petrol because bioethanol is '*Carbon Neutral*'. Furthermore, ethanol *burns cleanly* with a non-luminous flame.

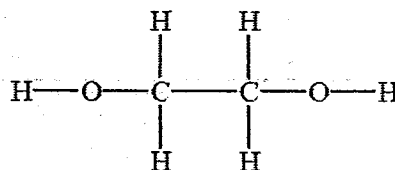
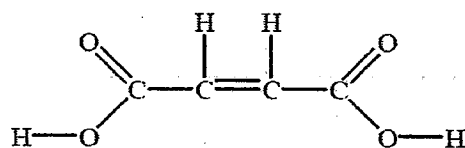
The diagram below, extracted from a poster, shows the carbon cycle for bioethanol.



- (a) Other than environmental concerns, suggest two reasons why crude oil should not be used as fuels. [2]
- (b) With the help of an equation, describe how ethanol is produced from sugar solution by fermentation. [2]
- (c) Based on the carbon cycle, explain why bioethanol is '*Carbon Neutral*' and therefore more environmentally friendly. [2]
- (d) Suggest what is meant by '*burns cleanly*' as given in the passage above. [1]
- (e) Biodiesel is another alternative fuel for motorcars that is similar to bioethanol. It is produced from used vegetable oil that can be collected from the food industries. The used vegetable oil is treated and undergo a chemical process which turns it into biodiesel.
 - (i) Refer to the diagram above and draw a similar carbon cycle for biodiesel. [2]
 - (ii) Biodiesel is also carbon neutral. Suggest another advantage of using biodiesel. [1]

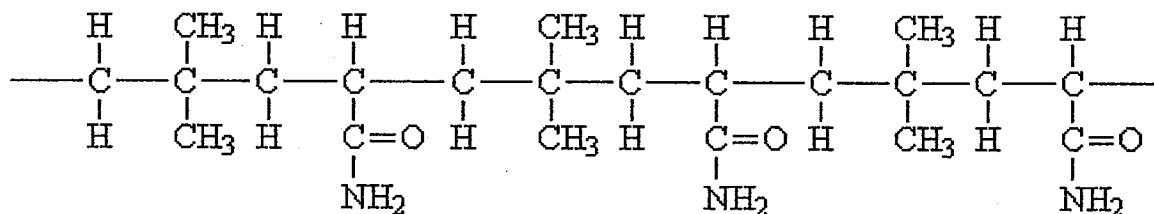
Or

- 11 (a) The structural formulae of butanedioic acid and ethane-1,2-diol are shown below.



- (i) State the observations when aqueous bromine is added to butanedioic acid and ethane-1,2-diol. Draw the structural formula of the product(s) formed. [3]
- (ii) Butanedioic acid and ethane-1,2-diol can polymerize under suitable conditions to form a polymer. Draw the polymer showing 2 repeat units. [2]
- (iii) Is the polymer formed by butanedioic acid and ethane-1,2-diol an *addition* polymer or a *condensation* polymer? Explain. [1]

(b) Another polymer **P** has the following structure:



- (i) Derive the structural formula of the two monomers that are used to form polymer **P**. [2]
- (ii) Explain why polymer **P** is a solid at room temperature while its monomers are liquids. [2]

--- End of Paper ---

Periodic Table

DATA SHEET
The Periodic Table of the Elements

Group																		
I	II											III	IV	V	VI	VII	0	
1 H Hydrogen																		
3 Li Lithium	4 Be Beryllium											5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon	2 4 He Helium
11 Na Sodium	12 Mg Magnesium											13 Al Aluminium	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon	
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton	
37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon	
55 Cs Cesium	56 Ba Barium	57 La Lanthanum	58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium	86 Rn Radon	
87 Fr Francium	88 Ra Radium	89 Ac Actinium	90 Th Thorium	91 Pa Protactinium	92 U Uranium	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		

a

X

b

Key

a = relative atomic mass

X = atomic symbol

b = proton (atomic)

*58-71 Lanthanoid series

*90-103 Actinoid series

*58-71 Lanthanoid series
*90-103 Actinoid series

Key: $\begin{matrix} a & X & b \\ a = \text{relative atomic mass} \\ X = \text{atomic symbol} \\ b = \text{proton (atomic)} \end{matrix}$

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

5073 Chemistry Prelim Exam 2014 Paper 2 Section A Answers

- 1 Choose from the following elements to answer the questions below.

Aluminium, Argon, Iron, Nickel, Nitrogen, Phosphorus, Sodium

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

Name the element that

(a) is used as a catalyst in the hydrogenation of alkenes,
nickel [1]

(b) is manufactured by electrolysis,
Aluminium/ sodium [1]

(c) reacts with oxygen to give an acidic oxide,
Phosphorus/ nitrogen [1]

(d) reacts with chlorine to form a solid that dissolves in water to give a coloured solution.
Iron/ nickel [1]

- 2 Chlorine exists as a gas at room temperature and pressure. A sample of chlorine gas was bubbled into a beaker of aqueous potassium iodide.

(a) Describe the arrangement and movement of the chlorine molecules.
Arrangement is disorderly and far apart. [1]

moving randomly at high speeds in all directions. [1]

(b) Describe and explain what you see when the chlorine was bubbled into the beaker of aqueous potassium iodide.
Colourless potassium iodide solution turned reddish-brown. [1]

Chlorine is more reactive than iodine and displaces the iodide ions from the potassium iodide solution. [1]

(c) This reaction is an exothermic reaction. Explain in terms of bond making and bond breaking why this is so.

The amount of energy taken in to break the bonds in chlorine and potassium iodide is less than the amount of energy given out to form the bonds in potassium chloride and iodine.

(minus 1m if specific reactants and products aren't stated)

No marks if student writes 'more than' rather than 'less than')

[1] State specific reactants and products
[1]

- 3 (a) Zinc is commonly found in the form of zinc sulfide, a solid which is insoluble in water. Zinc sulfide is roasted in oxygen and the products are zinc oxide and sulfur dioxide. State and explain the difference in electrical conductivity between zinc sulfide and sulfur dioxide in terms of bonding and structure.

Zinc sulfide has a giant ionic lattice structure and sulfur dioxide has a simple molecular structure. [1]

Zinc sulfide conducts electricity when molten due to the mobile ions/ions no longer held in fixed positions. [1]

Sulfur dioxide does not conduct electricity in any physical state due to the absence of mobile charged particles. [1]

- (b) Describe how you would test for sulfur dioxide.

Place a piece of filter paper soaked with acidified potassium dichromate (VI)/ manganate(VII) solution at the mouth of the test tube. [1]

If the orange acidified potassium dichromate (VI) solution turns green, the gas is sulfur dioxide./ If the purple acidified potassium manganate (VII) solution turns colourless, the gas is sulfur dioxide. [1]

- (c) Another purpose of zinc oxide is to remove sulfur dioxide from waste gases in factories before they are released into the environment. Only one product is formed.

- (i) Suggest why sulfur dioxide is a pollutant.

(Any of the following reasons) [1]

- Irritates the eyes and lungs and causes breathing difficulties.
- Reacts with water in the atmosphere to form acid rain which corrodes building and harms aquatic life and plants.

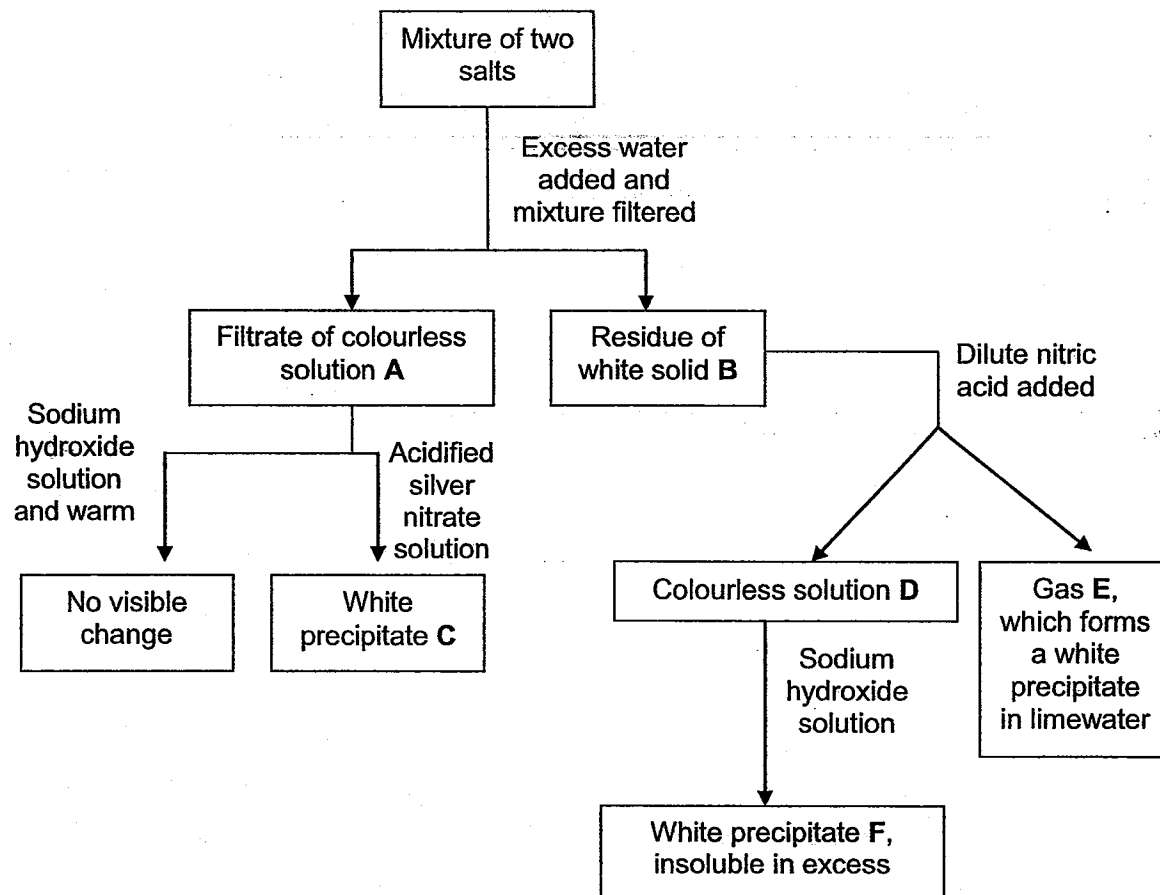
- (ii) Write the balanced chemical equation, including state symbols, for the reaction to remove sulfur dioxide and name the product.



(allow 1m for state symbols even if formula of zinc sulfite is incorrect)

The salt is zinc sulfite. [1]

- 4 Two white salts, one soluble and another insoluble in water, were mixed and a series of tests carried out on the mixture as shown below.



- (a) Identify substances A, B, D and F.

A – sodium chloride/ potassium chloride/ NaCl/ KCl	[1]
B – calcium carbonate/ CaCO_3	[1]
D – calcium nitrate/ $\text{Ca}(\text{NO}_3)_2$	[1]
F – calcium hydroxide/ $\text{Ca}(\text{OH})_2$	[1]

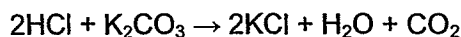
- (b) Write the ionic equation for the formation of precipitate C.

$\text{Ag}^+ (\text{aq}) + \text{Cl}^- (\text{aq}) \rightarrow \text{AgCl} (\text{s})$	[1]
No marks awarded if state symbols are not given.	

- (c) Gas E can react with sodium hydroxide solution to produce a salt and water. Write the balanced chemical equation for this reaction.

$2\text{NaOH} + \text{CO}_2 \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O}$	[1]
--	-----

- 5 25 cm³ of 1.5 mol/dm³ of dilute hydrochloric acid was reacted with 20 cm³ of 2.0 mol/dm³ of aqueous potassium carbonate at room temperature and pressure to obtain potassium chloride.



- (a) Discuss the suitability of reacting potassium with dilute hydrochloric acid to obtain potassium chloride. State the expected observation.

It is unsuitable as potassium is a very reactive metal and the reaction/ experiment is not safe [1].

The reaction will be explosive/ a lot of heat and light evolved. [1]

[2]

- (b) Draw a 'dot and cross' diagram of the electronic structure of potassium chloride. Show only the valence electrons.



OR

- (c) Suggest and explain how the speed of reaction and volume of carbon dioxide would be affected should the hydrochloric acid be replaced with 25 cm³ of 1.5 mol/dm³ ethanoic acid.

The speed of reaction will decrease and the volume of carbon dioxide will be the same. [1]

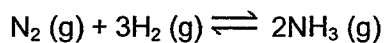
as ethanoic acid is a weak acid and has fewer hydrogen ions per unit volume at any one time. [1]

The volume of carbon dioxide will remain constant as the number of moles of hydrogen ions for both acids is the same/ both are monobasic. [1]

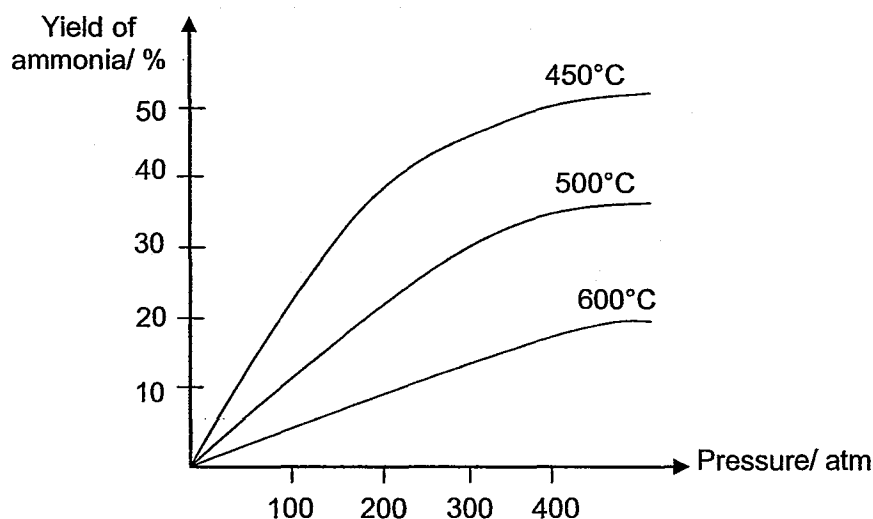
- (d) Write the chemical equation for another suitable method of obtaining potassium chloride salt besides the reaction shown above.



- 6 Ammonia is formed during the Haber process by reacting hydrogen with nitrogen.



The graph below shows the percentage yield of ammonia formed under different conditions of temperature and pressure.



- (a) Use the graph to deduce the effect of increasing temperature and pressure on the yield of ammonia.

Increasing the temperature will decrease the yield of ammonia and [1]
increasing the pressure will increase the yield of ammonia. [1]

- (b) Calculate the volume of ammonia produced from 350 dm³ of hydrogen if the percentage yield of ammonia is 10 %.

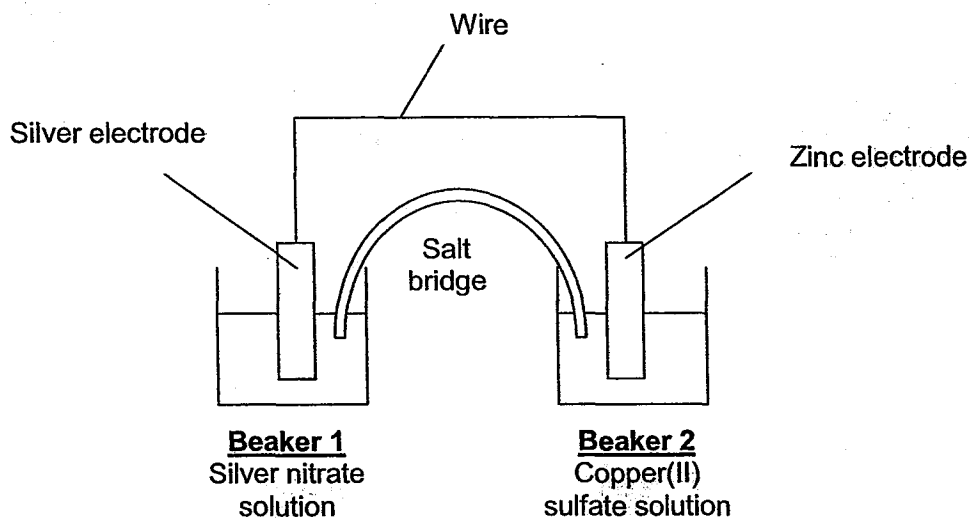
Volume of ammonia produced = $350/3 \times 2 \times 10\%$ [1]
= 23.3 dm³ [1]

- (c) Identify the reducing agent. Explain your answer in terms of oxidation state.

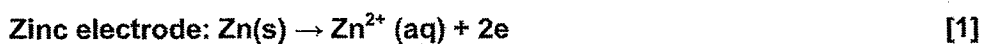
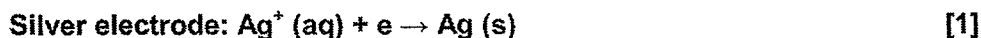
The reducing agent is hydrogen. [1]

It has caused the oxidation state of nitrogen to decrease from 0 in N₂ to -3 in NH₃. [1]

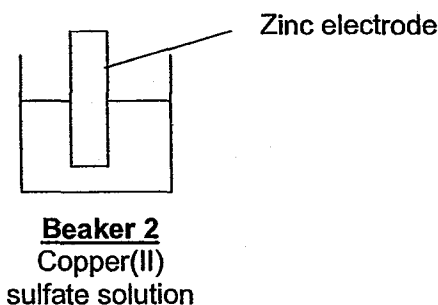
- 7 A simple cell was set up as shown below.



- (a) Write the half-equations for the reactions that take place at both electrodes.



- (b) State and explain one similarity and one difference that will be observed in **Beaker 2** when the wires and salt bridge are removed.



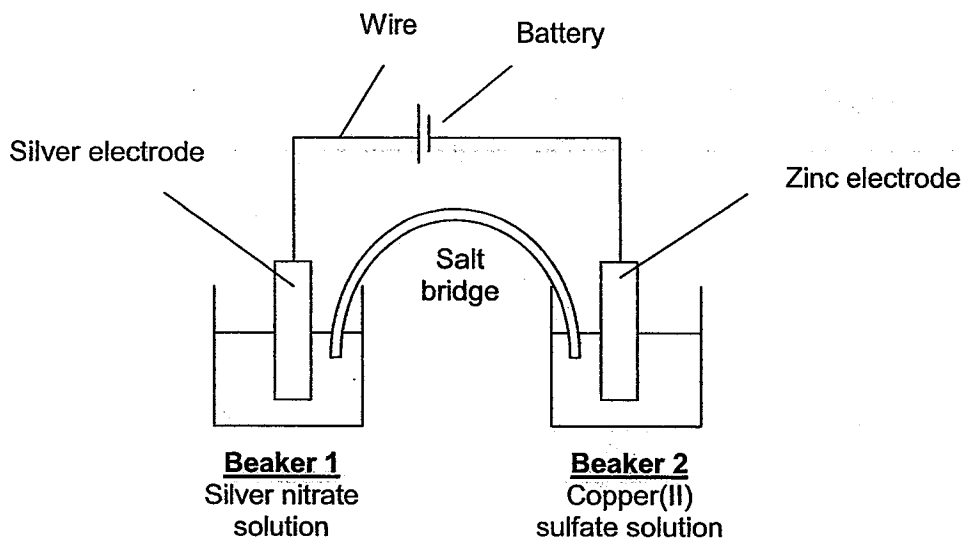
- (i) Similarity: Zinc electrode dissolves/ shrinks. [1]

- (ii) Differences (choose either one):

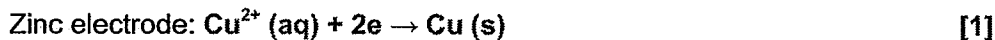
When wire was present, no change to blue colour of solution. [1]
 When wire was removed, blue colour of solution fades/ becomes lighter as copper(II) ions are being displaced from the solution by the more reactive zinc. [1] } Ans 1

Reddish-brown solid deposited when wires were removed, not seen when wires were there as copper(II) ions are being displaced from the solution by the more reactive zinc. [1]
 [1] } Ans 2

(c) A battery was added to the setup as shown in the diagram below.



Write the half-equations that occur in this setup.



Note: If state symbols are not written for all the half-equations, only penalise once throughout the paper.

- 8 Underground iron pipelines are used in transporting substances such as natural gas from place to place. When underground, these iron pipes will rust relatively rapidly.

(a) State the essential conditions needed for the rusting of iron.

Air/ oxygen and water [1]

(b) Pieces of magnesium are often attached to underground iron pipes. Explain how this helps prevent iron from rusting.

Magnesium is more reactive than iron. [1]

It will undergo sacrificial protection/ corrode in its place/ lose electrons to iron. [1]

- (c) A sample of a compound of iron is analysed. The sample contains 0.547 g of potassium, 0.195 g of iron, 0.252 g of carbon and 0.294 g of nitrogen. Determine the empirical formula of this compound.

Simplest mole ratio of Fe, K, C, N

$$\begin{aligned} &= \frac{0.195}{56} : \frac{0.547}{39} : \frac{0.252}{12} : \frac{0.294}{14} \\ &= 0.003482 : 0.01403 : 0.021 : 0.021 \\ &= \frac{0.003482}{0.003482} : \frac{0.01403}{0.003482} : \frac{0.021}{0.003482} : \frac{0.021}{0.003482} \\ &= 1 : 4 : 6 : 6 \end{aligned}$$

Empirical formula is $\text{FeK}_4\text{C}_6\text{N}_6$.

[1] for working, [1] for giving empirical formula.

[2]