CHEMISTRY

MSCE Questions & Model Answers

Ambitious Student Series

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Section A

Question Papers

ALDEHYDE QUESTION PAPER

An aldehyde is any organic molecule that has a -COH group

1a. State the difference between "accuracy" and "precision" (2marks).

1b. Figure 1 is a diagram of a container with molecular modls in various positions. The models are supposed to be at the centre of the container.

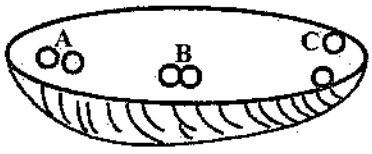


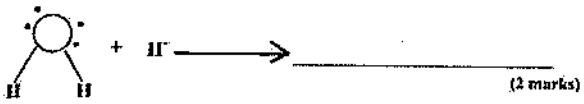
Figure 1

Using letters **A, B** and **C**, identify the molecular models that have: **(i)** good precision but poor accuracy (1mark) **(ii)** both poor precision and accuracy (1mark) **(iii)** both good precision and accuracy (1mark).

1c. In an experiment, 136g of gaseous ammonia (NH_3) and water (H_2O). **(i)** Write a balance equation for the reaction (3marsk). **(ii)** How much nitric acid (HNO_3) could be produced from this reaction? (RAM: N = 14; H = 1, O = 16) (3marks).

2a. Work out the number of nitrogen atoms in 8 molecules of urea $CO(NH_2)_7$ (2marks).

2b. Complete the equation and label the dative bond (2marks)



2c. Explain each of the following statements: **(i)** Ionic compounds are soluble in water (3marks) **(ii)** Graphite conducts electricity (3marks).

2d. Explain how a polar bond is formed (4marks)

3a. Give any one use of electronic configuration (1mark).

3b. **(i)** Why is nitrogen gas inert at room temperature? (2marks) **(ii)** Explain any one way in which inertness of nitrogen is important.

3c. The table below shows electronic configuration and relative abundance of isotopes of an element.

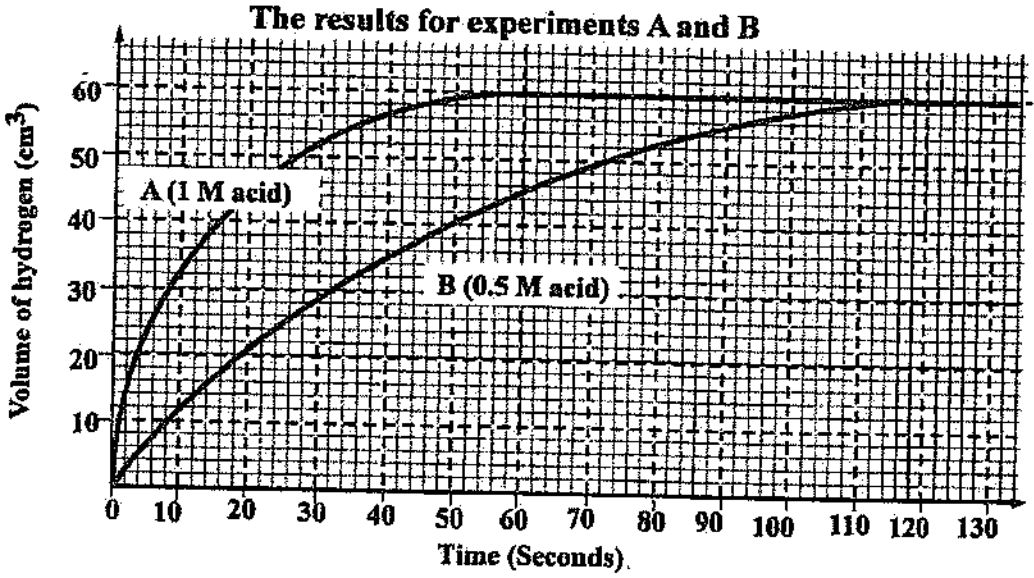
Isotope	Electron Configuration	Relative Abundance
X – 28	2 – 8 – 4	8/10
X – 29	2 – 8 – 4	1/10
X – 30	2 – 8 – 4	1/10

(i) To which group of the periodic table does element X belong? (1mark) **(ii)** Element X reacts with element Y whose valency is 2. Write the chemical formula of the product (2marks)

4a. A hydrocarbon contains 85.7% carbon and 14.3% hydrogen by mass. Write the molecular formula of the hydrocarbon if its relative formula mass is 56. (RAM: C = 12, H = 1) (7marks).

4b. Why is burning of plastic not recommended as a method of disposal? (2marks)

5. Figure 2 is a diagram showing results of experiments **A** and **B** on one of the factors effecting rate of reaction.



Adapted from complete chemistry by Rose pp 122

5a. State the factor affecting the rate of reaction which was being investigated (1mark)

5b. Which reaction is faster than the other? (1mark)

5c. Give a reason for the answer in 5b (1mark)

6. Aluminium reacts with chloride gas according to the following equation:

$$2Al_{(s)} + 3Cl_{3(g)} \rightarrow 2AlCl_{3(s)}$$

6a. Write oxidation and reduction half reactions (4marks)

6b
Calculate the volume of 8MKNO_3 stock solution to be diluted to 40ml so that the final concentration is 0.2M (3marks)

7. Figure 3 shows different structures of an organic compound.

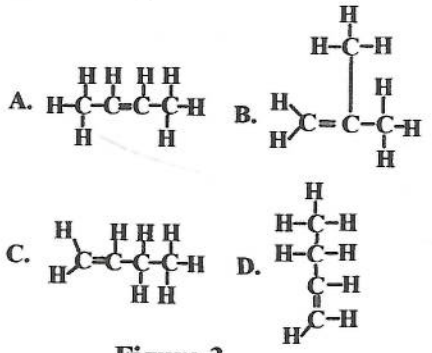


Figure 3

7a. Identify conformers (1mark)

7c. Give a reason for the answer in **7b.** (2marks)

8a. Ethene (C_2H4) and water (H_2O) react to form ethanol (C_2H_5OH) according to the following chemicalequation.

$$C_2H_4 + H_2O \xleftrightarrow{H_2SO_4} C_2H_5OH$$

(i) Name the type of reaction in the equation (1mark)

(ii) Give the function of H_2SO_4 in the reaction (1mark).

8b (i) Complete the following equation

$$C_2H_5OH \xrightarrow{Cr_2O^{-2}_7}$$

(ii) What is the function of $Cr_2O_7^{2-}$ in the reaction? (1mark) (iii) Name the products in the equation (2marks)

9a. Why is argon gas obtained before oxygen gas during separation of air into component gases?

9b. Describe how carbon dioxide is removed from air (2marks).

10a. Mention any one type of wastes based on degradability (1mark)

10b. Explain how burning of the fuel causes global warming (2marks)

11a. Why is the boiling point of hexanoic acid higher than that of hexanol? (3marks)

11b. With the aid of chemical equations, explain how ozone layer is depleted (7marks)

12. Describe the process of soap making (10marks)

13. With the aid of a well labelled diagram, describe how copper can be refined using electrolysis. In your description, include half equations at the cathode and anode (10marks).

BOND ENERGY QUESTION PAPER

***Bond energy** is the amount of energy required to break one mole of chemical bonds.*

Figure 1 is a diagram showing the set up of an experiment to investigate the relationship between temperature and volume of gas.

1a. What happens to the drop of concentrated sulphuric acid when water in the beaker is heated? (1mark)

1b. Give a reason for the answer in 1a (2marks)

1c. Why is the glass capillary tube open? (1mark)

1d. What is the value of the gas pressure in the tube? (1mark)

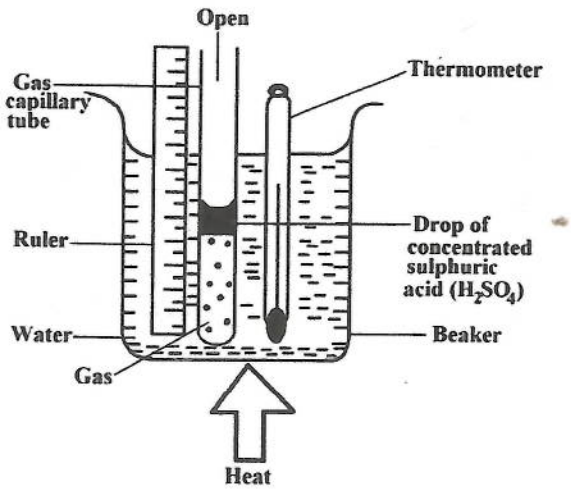


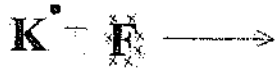
Figure 1

2a. State any two physical properties of halogens (2marks)

2b. Explain why bromine (Br_2) has a higher boiling point than chlorine (Cl_2) (3marks).

2c. Write a balanced chemical equation to show the reaction between sodium (Na) and water (H_2O) (3marks)

2d. Complete the following equation to show the bonding between potassium (K) and fluorine (F) (3marks)



2e. Explain why ionic compounds conduct electricity in molten state and not when in solid state (2marks)

3a. Define "Standard Solution" (1mark)

3b. State two ways of expressing the concentration of solution (2marks)

3c
Calculate the molarity of sodium chloride (NaCl) solution made by dissolving 11.7g of NaCl in water and making up the volume to $4dm^3$. (RAM: Na = 23, Cl = 35.5).

3d. Zinc (Zn^0) reacts with copper ions (Cu^{2+}) according to the following equation:

$$Zn^0(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu^0(s)$$

(i) Which element is oxidized? (1mark)

(ii) Give a reason for the answer in **3d(i)** (1mark).

(iii) What does "s" and "aq" mean in the equation? (2marks).

(iv) Write two half equations for the reaction between zinc and copper ions (4marks).

4c.
(i) Define "half - life" of a radioisotope (1mark)

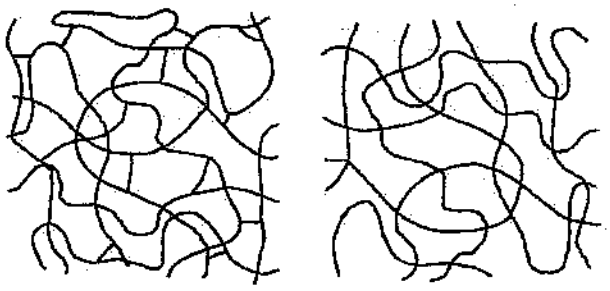
(ii) What is the difference between "natural" and "induced" radioactivity? (2marks).

4d.
(i) Explain why gamma rays are not deflected in an electric field (3marks).

(ii) Explain why gamma rays are used in sterilization of food (2marks).

(iii) Give any two safety measures that could be followed when handling radioactive sources at school (2marks).

5a. Figure 2 is a diagram showing the arrangement of polymer chains after heating plastics **K** and **L**.



K **L**

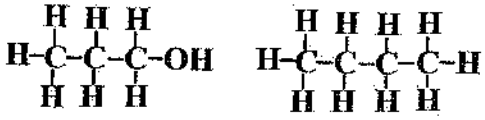
Figure 2

(i) Identify the type of plastics **K** and **L** (2marks)

(ii) State any two properties of plastics with polymer chains represented by **L** (2marks).

(iii) Explain why structure **K** does not easily melt when heated (3marks).

5b. Figure 3 is a diagram showing structures of organic compounds **X** and **Y**.



X Y

Figure 3

(i) To which families of organic compounds do X and Y belong? (2marks)

(ii) Write down the structure of an Isomer of compound **Y** (2marks).

(iii) Describe a test that could be done to distinguish compound **X** from **Y** (6marks).

Interesting Science facts

OFFICE BUILDINGS ARE EVER-SO-SLIGHTLY TALLER AT NIGHT: *After all the employees go home, tall office buildings get just a little taller. A 1300-foot-tall skyscraper shrinks about 1.5 millimeters under the weight of 50,000 occupants (assuming they weigh about the human average)*

Who is Who in the History of Chemistry

AMEDEO AVOGADRO

In full Lorenzo Romano Amedeo Carlo Avogadro, conte di Quaregna e Cerreto.
Born August 9, 1776, Turin, in the Kingdom of Sardinia and Piedmont in Italy
Died July 9, 1856, Turin

As a chemist and a mathematical physicist, he was something of a pioneer. Avogadro's great discovery is what has come to be known as Avogadro's Law, which states that, under the same temperature and pressure conditions, the same volumes of different gases will have the same number of molecules. Why did this matter? Because it ultimately helped to distinguish between the molecule and the atom, which he rather called the 'elementary molecule'.

COVALENT BOND QUESTION PAPER

A covalent bond is a chemical bond formed when two atoms share two electrons

1a. State any three characteristics of radioactive substances (3marks)

1b. Explain how beta particle is released from an unstable nucleus (4marks)

1c. A sample of chlorine gas contains two isotopes $^{35}_{17}Cl$ and $^{37}_{17}Cl$. Calculate the relative atomic mass of the chlorine if 75% of the isotope are of $^{35}_{17}Cl$ and 25% of the isotope are of $^{37}_{17}Cl$ (3marks).

2a. State any two conditions that are necessary for rusting to take place (2marks)

2b. Figure 1 is a diagram showing the process of electroplating a carbon rod.

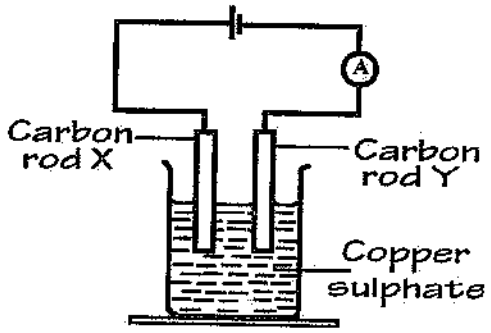


Figure 1

(i) Which carbon rod will be electroplated? (1mark) **(ii)** Give any two observations that will be made in the experiment after some time (2marks). **(iii)** Write don a half equation for the reaction at the carbon rod **Y** (2marks).

2c. Calculate the molecular formula of a compound if its empirical formula is CH_2O and has a molar mass of 180g. (RAM: C = 12, H = 1, O = 16).

2d. What is a strong acid? (1mark)

2e. Ethanoic acid (CH_3COOH) reacts with water (H_2O) according to the following chemical equation:

$$CH_3COOH(l) + H_2O(l) \leftrightarrow CH_3COO^-(aq) + H_3O^+(aq)$$

(i) Identify the two conjugate acid-base pairs (2marks).

4a. State any three sources of sulphur (3marks)

4b. Table 1 shows the arrangement of some elements in the periodic Table.

Table 1

H							He
Li	Be	B	C	N	O	F	Ne
Na	Mg	Al	Si	P	S	Cl	Ar
K	Ca					Br	Kr

(i) To which period does Li belong? (1mark) **(ii)** Write the electronic configuration for **P** (1mark) **(iii)** Explain the rend in reactivity when moving up the group of **Br, Cl** and **F** (4marks) **(iv)** Draw an electron dot and cross diagram to show bonding in a carbon dioxide molecule (4marks).

7b. Figure 5 is a diagram showing how ethanol and ethanoic acid is produced.

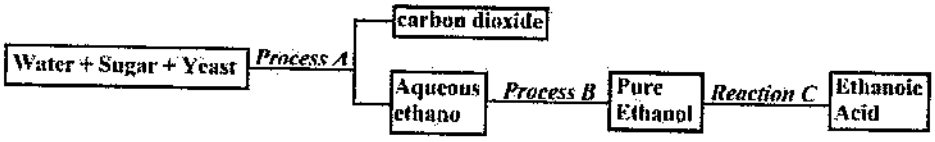


Figure 5

(i) Name process A and B (2marks) **(ii)** What is the role of the yeast? (1mark)

7c. Given below are general formulae of some homologous series represented by the letters **M, N, O** and **P.**

M C_nH_{2n}
N C_nH_{2n-2}
O $C_nH_{2n+1}OH$
P $C_nH_{2n-1}COOH$

(i) Name the homologous series represented by the letters **M**, and **P** (2marks).
(ii) Which general formulae represents hydrocarbons? (2marks)

7d. Draw any three isomers of butanol (C_4H_9OH) (3marks)

7e. Explain why pentanol ($C_5H_{11}OH$) has a higher melting point than ethanol (C_2H_5OH) (3marks).

DELOCALIZATION QUESTION PAPER

***Delocalization** is when electrons become free to move all over a molecule*

2a. (i) What is "hydrocarbon"? (1mark) **(ii)** Write down the general formula for alkanols (1mark).

2b. The molecular formulas of organic compounds **R, S** and **T** are C_2H_5OH, C_6H_{12} and CH_3COOH respectively. **(i)** Draw the structure of compound **T** (1mark). **(ii)** classify the compounds as soluble or insoluble in water (3marks). **(iii)** Which of the compounds would undergo addition reaction with chlorine gas? (1mark). **(iv)** Give a reason for the answer in **2b (iii)** (2marks). **(v)** Write down a balanced equation for the reaction between **R** and **T** (3marks).

2c. Mention the two main types of polymerization (2marks)

2d. Draw three isomers of butane (C_4H_8) using carbon chains only (3marks).

3a. Write the formulas for the three isotopes of hydrogen (H) (3marks). **3b. Figure 2** is a graph of activity against time for the decay of a radioactive substance.

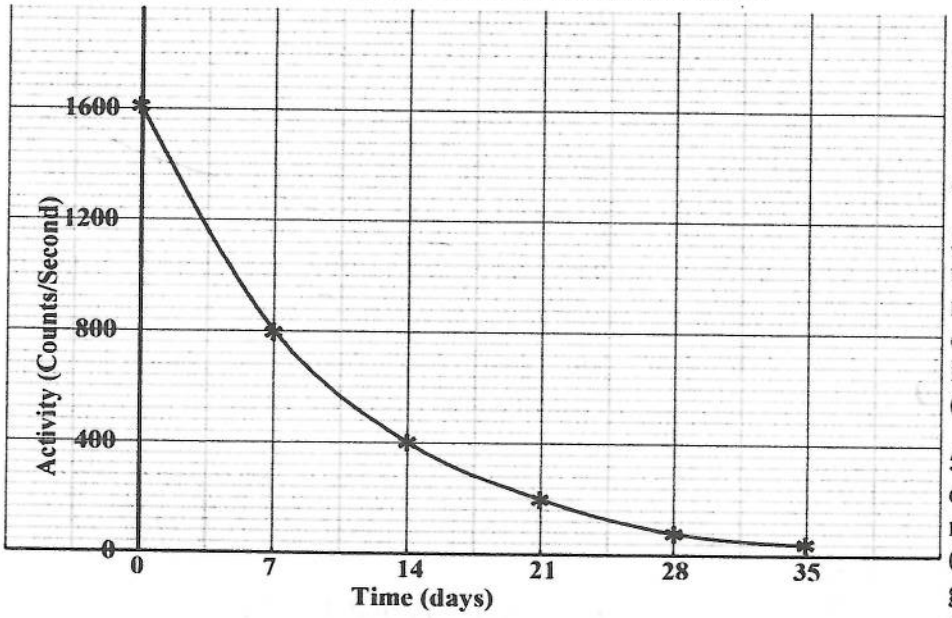


Figure 2

(i) What is the half – life of the substance? (1mark) **(ii)** How much was the loss in activity after 21 days? (2marks)

3c. Calculate the time taken for the mass of a radioactive substance to decrease from 800g to 50g if its half – life is 6 hours (4marks).

5a. (i) State any two conditions necessary for rusting to take place (2marks) **(ii)** How does galvanizing prevent iron sheets from rusting? (2marks).

5b Table 1 shows results of an experiment on displacement reactions involving copper (Cu), magnesium (Mg), zinc (Zn) and their aqueous solutions.

Reaction	Observations
$Cu(s) + MgSO_4(aq)$	No reaction
$Mg(s) + CuSO_4(aq)$	Fast Reaction
$Zn(s) + CuSO_4(aq)$	Slow Reaction
$Mg(s) + ZnCl_2(aq)$	Moderate reaction
$Zn(s) + MgSO_4(aq)$	No reaction

(i) Write a balanced chemical equation for the reaction between magnesium (Mg) and copper sulphate ($CuSO_4$) solution (2marks).

(ii) Arrange the metals in order of increased reactivity (3marks).

5c. Figure 4 is an energy level diagram for the dissolving of sodium hydroxide (NaOH) in water.

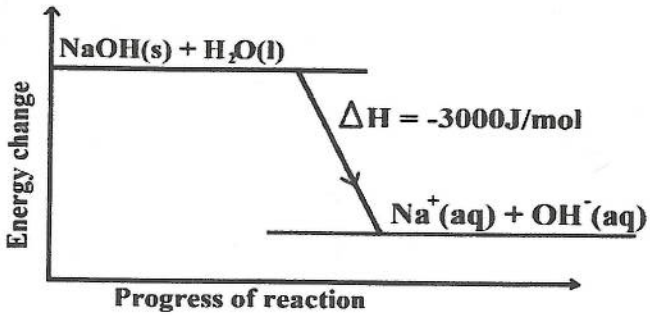


Figure 4

(i) What type of change is shown by the energy level diagram? (1mark) **(ii)** Give a reason for the answer in **5c(i)** (2marks).

5d. Calculate the amount of water that must be added to $5cm^3$ of 2M hydrochloric acid to dilute it to 0.1M (3marks)

7a. State any three physical properties of alkali metal (3marks).

7b. Figure 6 is a graph of atomic radius across the periods against atomic number for some elements in the periodic table.

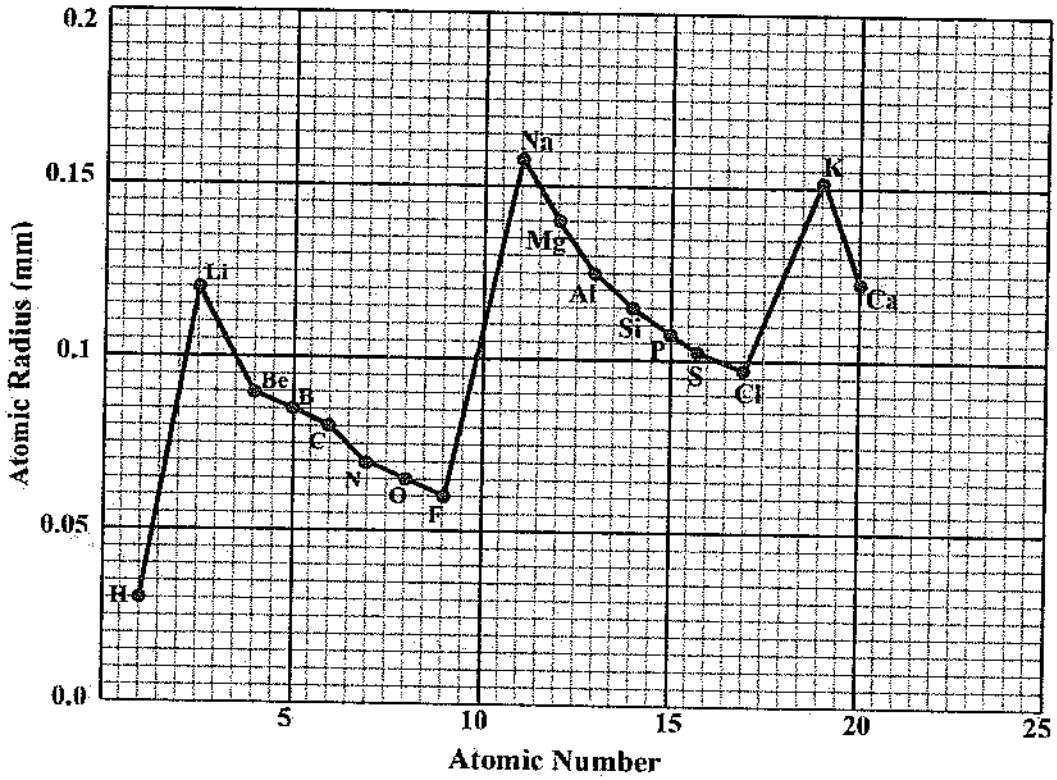


Figure 6

(i) Which group 2 element has the atomic radius? (1mark)

(ii) Explain the trend in atomic radii across a period (3marks).

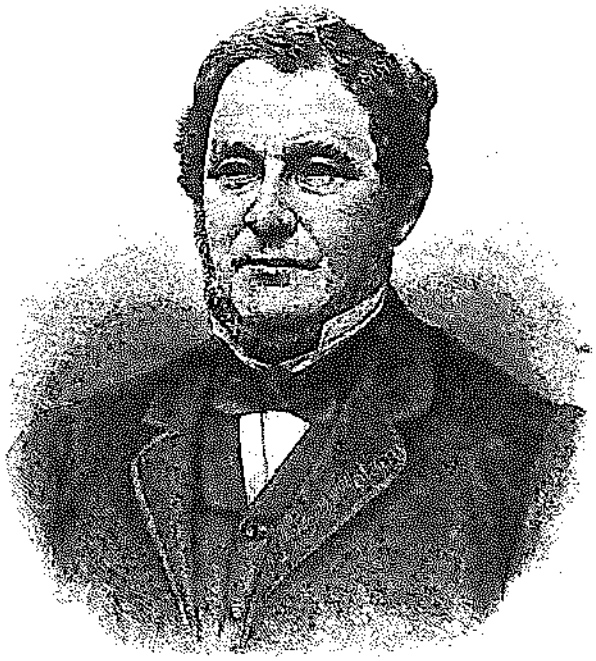
(iii) Why is there a sudden increase in atomic radius from Cl to K? (2marks) (iv) Draw electron dot and cross diagrams for the reaction between Lithium (Li) and Chlorine (Cl) to form Lithium Chloride (LiCl) (4marks).

Who is Who in the History of Chemistry

ROBERT BUNSEN

In full Robert Wilhelm Bunsen,
Born March 30, 1811, Göttingen, Westphalia Germany
Died August 16, 1899, Heidelberg

A German chemist who, with Gustav Kirchhoff, about 1859 observed that each element emits a light of characteristic wavelength. Such studies opened the field of spectrum analysis, which became of great importance in the study of the Sun and stars and also led Bunsen almost immediately to his discovery of two alkali-group metals, cesium and rubidium. He discovered the antidote to arsenic poisoning; invented the zinc-carbon battery and flash photography. He also discovered how geysers operate. Interesting fact: Robert Bunsen was interested in burning things, and particularly concerned with the different colours (emission spectra) that different elements produced when they are heated. That's why he produced his famous burner so that these colours weren't ruined by the colour of the flame itself!



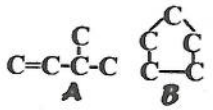
ENANTIOMERS QUESTION PAPER

Enantiomers are molecules that are non superimposable mirror images of each other

3a(i) name the products formed during the fermentation of sugar by yeast (2marks).
3a(ii) Describe how fermentation of sugar by yeast occurs; (2marks).

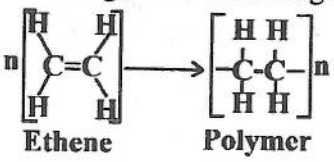
3b. Explain why thermosetting plastics do not melt when heated; (3marks).

3c. The following are isomers of organic compounds **A** and **B**.



(i) Name the isomers **A** and **B**; (2marks).
(ii) To which homologous series do the isomers belong? (2marks).

3d. Polymerisation of ethane takes place according to the following equation:



(i) Name the polymer (1mark). **(ii)** Give any two advantages of the polymer (2marks). **(iii)** Explain how the polymer takes place; (3marks).

5a. Give two ways of determining the strength of an acid; (2marks).

5b. State any two ways of expressing the concentration of a solution (2marks)

5c. In a titration, $25cm^3$ of hydrochloric acid (HCl) of an unknown concentration was titrated against $20cm^3$ of 2M sodium hydroxide (2M NaOH) to which phenolphthalein was added. **(i)** Name the standard solution in the titration (1mark). **(ii)** Give a reason for the answer in **5c(i)**; (1mark).

5d. (i) Which metal is used to galvanize iron? (1mark). **(ii)** Explain how a scratched galvanized iron is protected from rusting (3marks).

6a. Figure 3 is an electron dot and cross diagram of ammonia.

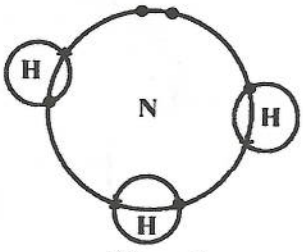


Figure 3

(i) Name the type of bonding that holds the atoms together (1mark). **(ii)** Give a reason for the answer in **6a(i)**. **(iii)** Write the chemical formula for ammonia (1mark).

6b. (i) Mention any three properties of metals (3marks). **(ii)** Explain how metallic bonding occurs (3marks).

6c.
(i) Mention any two properties of beta particles (2marks).

(ii) State any two safety precautions when handling radioactive substances (2marks).

(iii) Explain how radioactivity could be induced (3marks).

6d. Figure 4 is a diagram showing the effect of magnetic field on nuclear radiation.

Identify the type of radiation **P**, **Q** and **R** (3marks).

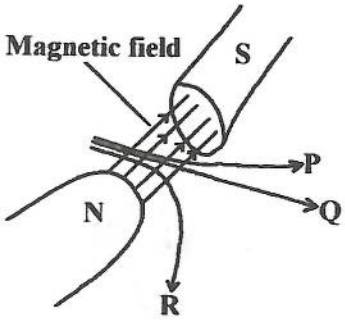


Figure 4

8a. Figure 5 is a diagram showing the reaction between magnesium (Mg) and silver chloride solution (AgCl).

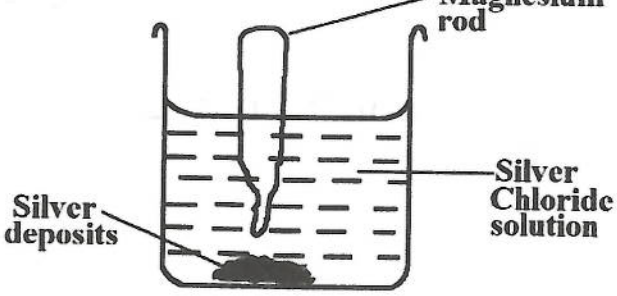


Figure 5

(i) Explain the reaction in **Figure 5**; (4marks).

(ii) Write a chemical equation for the reaction (3marks)

8b. In terms of electrical conductivity, explain the difference between "polar" and "non-polar" covalent molecules (4marks).

FAMILY QUESTION PAPER

A family is a group of elements sharing similar properties

2a. State the three sub-atomic particles of an atom (3marks).

2b. An atom with a mass number of 23 has 13 neautrons. Work out the electron configuration for the atom; (3marks).

2c. Table 1 shows the electrical conductivity of solds **A, B C, D** and E when dissolved in water.

Table 1

Compound	Conductivity
A	Does not conduct
B	Conducts
C	Does not conduct
D	Conducts
E	Does not conduct

(i) Classify the compounds as ionic and molecular (5marks). **(ii)** Give a reason for the answers in **2c(i)**; (2marks).

3a. Define "mole" (1mark)

3b. Magnesium (Mg) react with oxygen (O_2) according to the following equation:

$$Mg_{(s)} + O_{2(g)} \rightarrow MgO_{(s)}$$

(i) What does "s" stand for in the equation? (1mark).

(ii) Balance the equation (2marks). **(iii)** If 120g of magnesium reacts completely in excess oxygen, how many moles of oxygen are used? (RAM: Mg = 24, O = 16); (4marks).

3c. Sodium chloride (NaCl) dissociates in water as follows:

$$NaCl_{(s)} + H_2O_{(l)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)} : \Delta H = +4kJmol^{-1}$$

(i) Name the type of reaction basing on enthalpy change; (1mark).

(ii) Draw an energy level diagram for the process (3marks).

3d.
(i) What is a "weak acid"? (1mark).
(ii) State any one way of determining the strength of an acid (1mark).

(iii) The conjugate acid – base pair for the reaction between water molecules are H_2O/ H_3O^+ and H_2O/OH. Write an equation for the reaction (3marks)

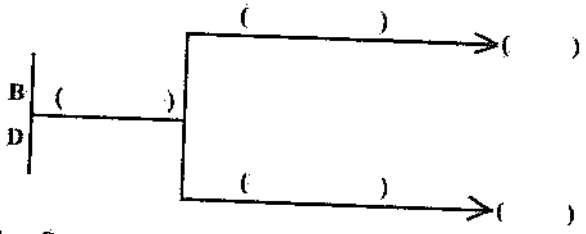
5a. What are "hydrocarbons"? (1mark)

5b. Figure 3 shows formulae of some organic compounds **A, B C** and **D**.

C_3H_7OH	C_5H_{10}	C_2H_5COOH	C_5H_{20}
A	B	C	D

Figure 3

(i) Which compounds are hydrocarbons? (1mark). **(ii)** Name compound **A** (1mark). **(iii)** Draw molecular structure of compound **C**; (2marks). **(iv)** Complete the flow diagram for differentiating compounds **B** and **D** by filling the missing information in the brackets (5marks).



5c. State any three properties of synthetic polymers; (3marks).

5d. Draw the structure of the two isomers of butane (C_4H_{10}); (2marks).

7a. The equation below shows nuclear decay of carbon $\left({}^{14}_{6}C\right)$ and cobalt $\left({}^{60}_{27}C\right)$.

(1) ${}^{14}_{6}C \rightarrow$ _____ $+ {}^{14}_{7}N$

(2) ${}^{60}_{27}Co \rightarrow {}^{60}_{27}Co +$ _____

(i) Complete the equations; (2marks).

(ii) Which equation represents gamma emission? (1mark).

(iii) Why has ${}^{60}_{27}Co$ not changed its atomic mass and atomic number in the daughter nuclide? (2marks).

7b. State any three properties of beta particle (3marks).

7c. What do **A** and **Z** stand for in the following nuclear notation? ${}^{A}_{Z}X$ (2marks).

7d. The half life sodium – 24 is 15 hours. If the initial count rate is 240 counts/second, calculate the count rate after 30 hours (2marks).

Who is Who in the History of Chemistry?

MARIE CURIE

Née Maria Salomea Skłodowska,
Born November 7, 1867, Warsaw, Congress Kingdom of Poland, Russian Empire
Died July 4, 1934, near Sallanches, France

A Polish-born French physicist, famous for her work on radioactivity and twice a winner of the Nobel Prize. With Henri Becquerel and her husband, Pierre Curie, she was awarded the 1903 Nobel Prize for Physics. She was the sole winner of the 1911 Nobel Prize for Chemistry. She was the first woman to win a Nobel Prize, and she is the only woman to win the award in two different fields. Discovered the chemical elements radium and polonium; carried out the first research into the treatment of tumors with radiation.

KELVIN QUESTION PAPER

Kelvin is a unit of temperature

2a. Mention any one difference between "polar" and "non polar" molecules; (2marks).

2b. Table 1 shows atomic numbers, melting points and boiling points of group 7 elements.

Table 1

Element	Atomic Number	Melting Point (^oC)	Boiling Point (^oC)
Fluorine	9	-220	-188
Chlorine	17	-101	-34
Bromine	35	-7	59
Iodine	53	114	184

(i) Which elements are gases at room temperature (2marks). **(ii)** Draw the atomic structure of chlorine (Cl); (3marks). (iii) Why does iodine have a higher melting point than fluorine; (3marks). **(iv)** Calculate the number of neutrons in an iodine atom it its atomic mass is 127; (3marks).

3a. What is an "empirical formula"? (1mark).

3b. Calculate the empirical formula of copper oxide (CuO) with chemical composition of 32g of copper and 8g of oxygen. (RAM: O = 16, Cu = 64); (6marks).

3c. Figure 1 is a diagram showing the set up of an experiment on titration.

(i) What is the function of phenolphthalein indicator in the experiment? (1mark).

(ii) Name the standard solution in the experiment (1mark). **(iii)** Give a reason for the answer in 3c (ii); (1mark).

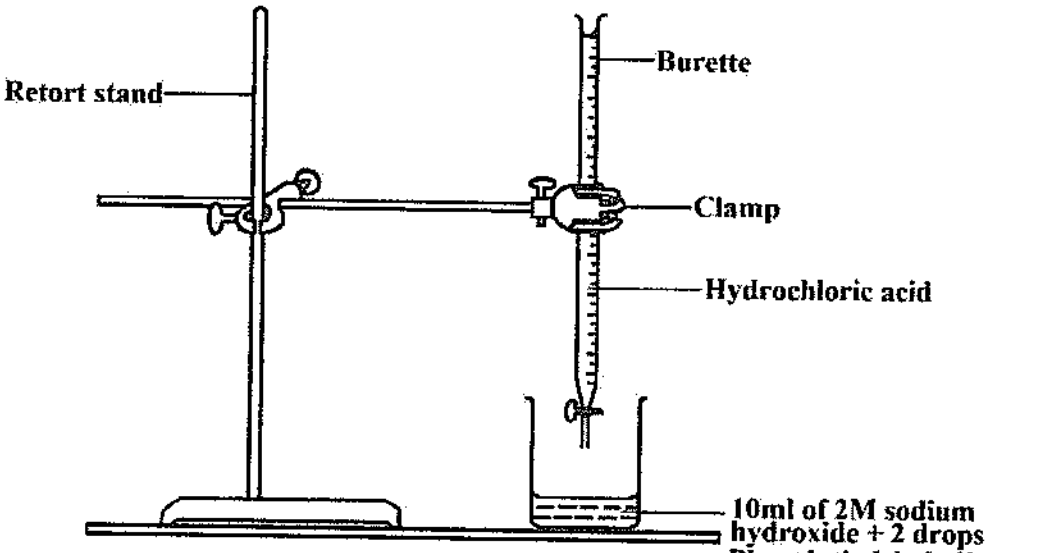


Figure 1

3d. State any two ways of expressing the concentration of a solution (2marks).

3e. (i) State any two ways of preventing rusting (2marks). **(ii)** Explain how rusting occurs (3marks).

5a. Figure 3 is showing structures of some organic compounds **W, X, Y** and **Z.**

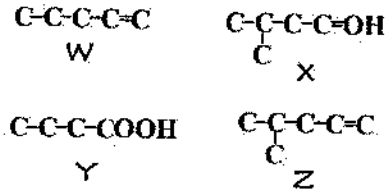


Figure 3

(i) To which homologous series do compounds **X** and **Z** belong? (2marks). **(ii)** Mention any three chemical properties of compound **X**; (3marks). **(iii)** Write the general formula for compound Y; (1mark). **(iv)** Name two products that are formed when compounds **X** and **Y** react; (2marks). **(v)** Which compounds belong to the same homologous series? (2marks). **(vi)** Give reason for the answer in **5a(v)**; (1mark).

5b. Figure 4 is a diagram showing structures of plastics **A** and **B.**

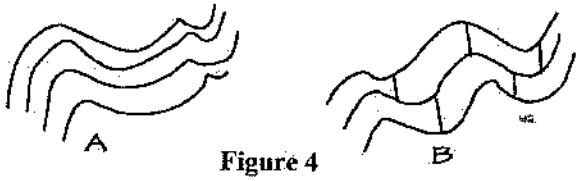


Figure 4

(i) Which structure represents thermosetting plastics? (1mark). **(ii)** Give a reason for the answer in **5b(i)**; (2marks).

5c. Explain how ethanol (C_2H_5OH) could be distinguished from hexane (C_6H_{14}); (3marks).

7a. State any two safety measures when handling radioactive substances at a school; (2marks).

7b. Mention two particles that are formed when a neutron disintegrates; (2marks).

7c. Explain how gamma emission occurs; (3marks).

7d. A radioactive substance with an activity of 30 counts/second is disintegrating. Calculate the number of disintegrated atoms after 10 minutes; (3marks).

LATTICE ENERGY QUESTION PAPER

***Lattice energy** is the amount of energy released when one mole of a crystal forms from its gaseous ions*

3. The following are general formulae of organic compounds **A** and **B**: **A.** $C_nH_{2n+1}COOH$; **B.** $C_nH_{2n+1}OH$.

3a. To which family does compound **B** belong? (1mark).

3b. Mention any three properties of compound **A**; (3marks).

3c. State three uses of compound **B**; (3marks).

3d. Mention the products formed when compounds **A** and **B** react; (2marks).

3e. Work out the molecular formula of compound **A** if n is 5; (3marks).

3f. Describe how compound **A** could be distinguished from compound **B**; (5marks).

5a. Define "electroplating" (2marks).

5b. Iron (Fe) displaces copper (Cu) from copper sulphate solution ($CuSO_4$).
(i) Write down a balanced chemical equation for the reaction; (3marks).
(ii) What is the reducing agent in the reaction? (1mark).

(iii) Give a reason for the answer in **5b(ii)**; (1mark).

5c. What is the difference between "oxidation" and "reduction"? (2marks).

5d.
(i) Define "concentration" of a solution; (1mark).

(ii) The volume of sodium hydroxide solution (NaOH) of concentration 20g/l is increased from $60cm^3$ to $600cm^3$ by adding distilled water. Calculate the concentration of the new solution in g/l; (3marks).

5e. Figure 3 is an energy level diagram for the reaction between magnesium (Mg) and Oxygen gas (O_2).

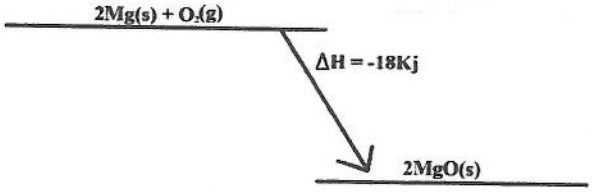


Figure 3

(i) Is the reaction exothermic or endothermic? (1mark). **(ii)** Give a reason for the answer in **5e(i)**; (2marks). **(iii)** State the meaning of the arrow in the diagram (1mark).

6a. The Table below shows electron configuration of elements **R, S, T U** and **V.**

Element	Electron Configuration
R	2,7
S	2,8,6
T	2,8,2
U	2,4
V	2

(i) Which elements in the table belong to period 2 of the periodic table (2marks).
(ii) Give a reason for the answer in **6a(i)**; (1mark).

(iii) Give a pair of elements that would form an ionic compound when they react; (2marks).
(iv) Draw an electron dot diagram for the compound formed when S combines with **U**; (3marks).

6b. State any three physical properties of halogens; (3marks).

6c. Explain what happens if chloride is mixed with potassium bromide solution; (2marks).

6d. (i) Name two types of radioactivity (2marks). **(ii)** Define "half life" of a radioactive element; (1mark). (iii) Mention any three properties of an alpha particle; (3marks).

MOLAR VOLUME QUESTION PAPER

3a. (i) Define "molar volume" of a gas; (2marks). **(ii)** Calculate the number of moles of sulphur dioxide occupying $120dm^3$ at room temperature and pressure. (molar volume at room temperature and pressure is $24dm^3$); (3marks).

3b. (i) Define an "acid" according to lowry/Bronsted theory; (1mark). **(ii)** Describe how a hydronium ion (H_3O^+) is formed; (2marks).

3c. Explain why bond breaking is endothermic while bond making is exothermic; (4marks).

3d. (i) Mention any two ways of preventing corrosion in metals; (2marks). **(ii)** Calculate the oxidation number of nitrogen (N) in a nitrate ion (NO_3) given that the oxidation number of oxygen (O) is –2; (3marks).

4a. (i) State three ways in which atoms attain stability; (3marks). (ii) Explain how ionic bonding accurs; (3marks).

4b. Table 1 shows atomic numbers and boiling points of some elements represented by letters **D, Q, T, X** and **Z**.

Table 1

Element	Atomic Number	Boiling Point (°C)
D	3	1342
Q	13	2467
T	16	445
X	18	-186
Z	19	760

(i) Identify any two letters that represent elements which belong to period in the periodic table; (2marks). **(ii)** Which element is in gaseous state at room temperature (25°C)? (1mark). **(iii)** What type of bonding would exist when element **Q** reacts with element **T**? (1mark). **(iv)** Write down the chemical equation for the reaction that would occur between **D** and **T**; (3marks).

5a. (i) Give any two properties of polymers; (2marks). **(ii)** Explain how "condensation polymerization" occurs; (2marks).

5b. Mention any two properties of alkanols; (2marks).

5c. Ethanol (CH_3CH_2OH) changes to ethanoic acid (CH_3COOH) in the presence of atmospheric oxygen (O_2). **(i)** What is the function of atmospheric oxygen in the reaction? **(ii)** Write a balanced chemical equation for the reaction; (3marks).

5d. Figure 3 shows structures of some organic compounds **P, Q, R** and **S**.

(i) Name the organic compounds labelled **P** and **Q**; (2marks). **(ii)** Identify the structure which is in an isomer of compound **Q**; (1mark). **(iii)** Give a reason for the answer in **5d(i)**; (1mark). **(iv)** Explain how compound P could be distinguished from compound R using bromine solution; (3marks).

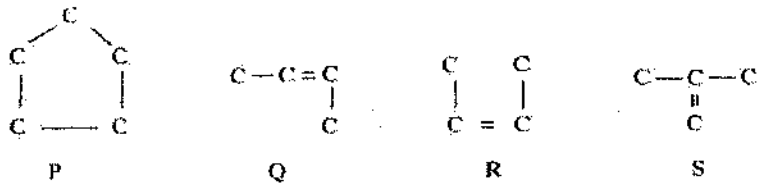


Figure 3

7d. (i) Define "nuclear fission" (1mark). **(ii)** Write down two symbols representing isotopes of hydrogen; (2marks).

7e. Explain why two symbols representing isotope is not suitable for detecting beta radiation; (2marks).

7f. Thorium $\left({}^{232}_{90}Th\right)$ decays by alpha emission to radium $\left({}^{228}_{88}Ra\right)$. **(i)** What do the number 228 and 88 represent in ${}^{228}_{88}Ra$? (2marks). **(ii)** Write the nuclear equation for the decay of thorium $\left({}^{232}_{90}Th\right)$; (3marks).

Who is Who in the History of Chemistry ?

JOHN DALTON

Born September 5 or 6, 1766, Eaglesfield, Cumberland, England
Died July 27, 1844, Manchester.

An English meteorologist and chemist, a pioneer in the development of modern atomic theory. Dalton's Atomic Theory is the basis of chemistry; discovered Gay-Lussac's Law relating gases' temperature, volume, and pressure; discovered the law of partial gas pressures. Remembered for proposing his atomic theory, literally the basis of chemistry today. This theory suggested that every substance is made of atoms and that the atoms of each element are identical. Dalton's atomic theory also held that chemical compounds are the combination of atoms of different elements and that, in chemical reactions, these atoms are rearranged and combined. In his laboratory experiments, he also studied, and ultimately formulated a theory of, atomic weight. From this notion, we reached our realization of the different molecular structure of different substances.

NODE QUESTION PAPER

A node is a location in an orbital with no probability of containing an electron

1c.
(i) State any three properties of metals (3marks).

(ii) Explain why potassium is more reactive than sodium (2marks).

1d. Figure 1 is a diagram of atomic nuclei of elements **R** and **Q**.

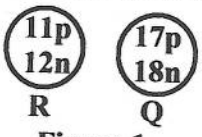


Figure 1

(i) Write down the electronic configurations of elements **R** and **Q**; (2marks).

(ii) To which period and group of the periodic table does element R belong? (2marks).

(iii) Draw a dot and cross diagram of the compound that would be produced when R reacts with Q; (4marks).

1e. Explain why helium, which has 2 valence electrons, is taken as a group 8 element; (2marks).

1f. State any two uses of sulphates (2marks).

2a. State any two advantages of electroplating a metal; (2marks).

2f. Figure 2 is a diagram showing the set of an experiment to investigate conditions for rusting in iron.

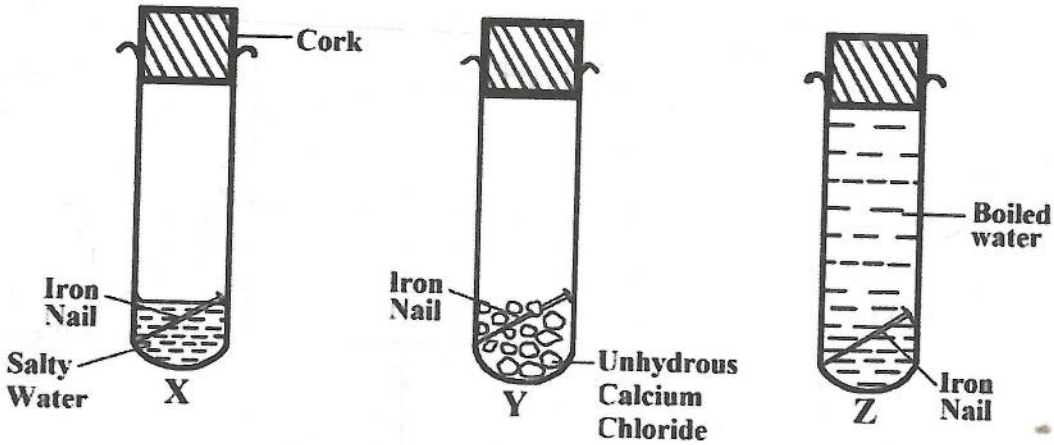


Figure 2

(i) Why was water unhydrous calcium chloride used in tube **Y**? (1mark).

(ii) Why was water in tube **Z** boiled? (1mark).

(iii) State any two conditions necessary for rusting of iron; (2marks).

4a.
(i) What are "Polymers"? (1mark).

2b. Below is part of a displacement series of metals.

Calcium(Ca)
Magnesium(Mg)
Zinc (Zn)
Iron (Fe)
Copper (Cu)

↑ Increasing Reactivity

(i) Which metal would displace all other metals from their solution? (1mark).

(ii) Give a reason for the answer in **2b(i)**; (1mark).

(iii) What would happen if a piece of magnesium metal was placed in copper sulphate solution? (2marks).

2c. Water reacts with the carbonate ion according to the following chemical equation:

$$H_2O_{(l)} + CO^{2-}_{3(aq)} \rightleftharpoons OH^-_{(aq)} + HCO^-_{3(aq)}$$

Give one conjugate acid-base pair in the reaction (2marks).

2d. Define "oxidation" in term of oxygen content in a substance (1mark)

2e. The chemical equation below shows displacement reaction between zinc (Zn) and lead nitrate ($Pb(NO_3)_2$).

$$Zn + Pb(NO_3)_2 \rightarrow Zn(NO_3)_2 + Pb$$

Name the reducing and oxidising agent in the reaction (2marks).

(ii) Mention any two uses of polythene; (2marks).

(iii) Give any three properties of plastics; (3marks).

4b
(i) Give three properties of carboxylic acids; (3marks).

(ii) Mention any two natural sources of carboxylic acids; (2marks).

4c
(i) Define "Isomers" (2marks).

(ii) Draw structural formulae for the four isomers of butanol (C_4H_9OH); (4marks).

(iii) Write down the condensed formula of pentane; (2marks).

4d. Ethanol (C_2H_5OH) reacts with ethanoic acid (CH_3COOH) according to the following chemical equation.

$$CH_3COOH + C_2H_5OH \underset{H_2SO_4}{\overset{\text{Concentrated}}{\rightleftharpoons}} ____ + H_2O$$

(i) Complete the equation (1mark).

(ii) Name the process in which ethanol reacts with ethanoic acid; (1mark).

5a.
(i) Name two particles found in the nucleus of an atom; (2marks).

(ii) State two characteristics of a radioactive substance; (2marks).
(iii) State any two uses of nuclear radiation; (2marks).

5b. Table 1 shows the activity of radioactive element with time.

Activity (Disintegrations per second)	40	30	20	10
Time (days)	0	4	8	16

(i) Plot a graph of activity against time.
(ii) Use the graph to find the time taken for the activity to drop from 30 to 15 disintegrations per second; (2marks).

5c. Name the particles emitted when radium $\left({}^{226}_{88}Ra\right)$ decays to radon $\left({}^{222}_{86}Rn\right)$ (2marks).

8c. Explain why propanoic acid (C_2H_5COOH) conducts electricity when dissolved in water while propanol (C_3H_7OH) does not; (2marks).

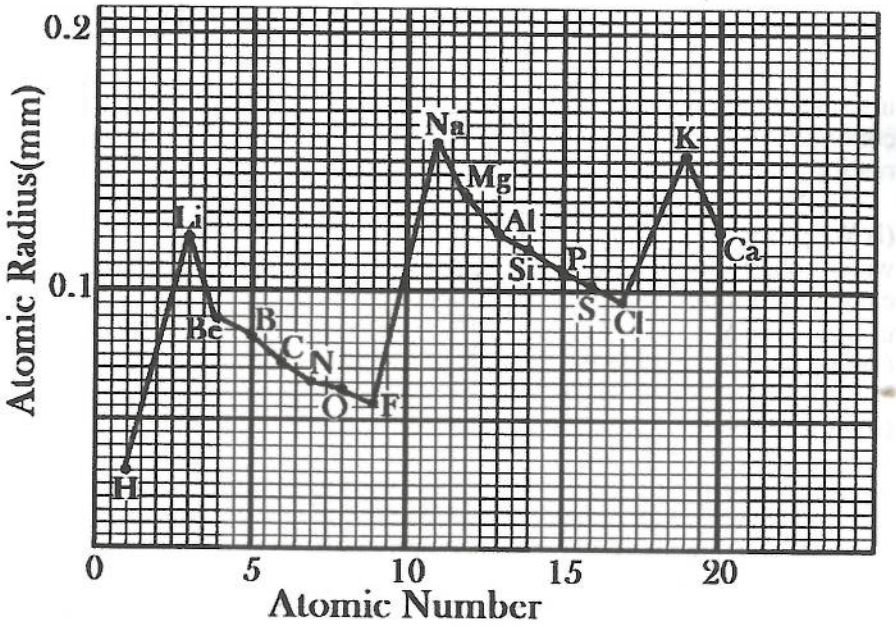
8d. Explain how polythene is formed; (3marks).

OXIDATION NUMBER QUESTION PAPER

*The **oxidation number** is the apparent charge on an atom*

1a. Define "electron configuration" (1mark).

1b. Figure 1 is a graph of atomic radius across the periods against atomic number for some elements in the periodic table.



(i) To which group of the periodic table does element O belong? (1mark).

(ii) Give a reason for the answer to **1b(i)**; (1mark).

(iii) Why is there a sudden increase in atomic radius from F to Na? (2marks).

(iv) In terms of atomic radius, Explain the difference in reactivity between F and Cl; (4marks).

(v) Give two difference between the type of bonding in Lithium metal (Li) and chlorine gas (Cl_2); (2marks).

1c

(i) Mention any two uses of sulphur; (2marks).

(ii) Give any two physical properties of sulphur; (2marks).

1d. Table 1 shows the number of valence electrons and valencies of some elements.

Element	Number of valence electrons	Valency
Li	1	1
Be	2	2
N	5	3
O	6	2

(i) How can element N attain a stable configuration? (1mark).

(ii) Give a reason for the answer to **1d(i);** (1mark).

(iii) What is the formula of a compound that is formed between Li and O? (2marks).

(iv) Give the charge on a Be ion; (1mark).

3a. Define "radioactivity" (2marks).

3b. Name three types of radiation (3marks)

3c. Mention any two instruments that are used to detect radiation (2marks)

3d. (i) How do chemical properties of the isotopes of uranium $^{238}_{92}U$ and $^{234}_{92}U$ compare? (1mark).

(ii) Give a reason for the answer to **3d(i);** (2marks).

3e. Mention any one natural source of radiation; (1mark).

3f. A radioactive source has a half-life of 30minutes. Calculate the fraction left after 2 hours; (4marks).

5a. State any three uses of ethanoic acid (3marks).

5b. Why is ethanoic acid regarded as a weak electrolyte? (1mark).

5c. Write down the ionisation equation of ethanoic acid (CH_3COOH) in water (H_2O); (4marks).

5d. Why does sodium metal react with ethanol in the same way as it does with water? (1mark).

5e. Silver ions $(Ag^+{}_{(aq)})$ react with iron (Fe) according to the following equation:

$$2Ag^+{}_{(aq)} + Fe^0{}_{(s)} \rightarrow Fe^{2+}{}_{(aq)} + 2Ag^0{}_{(s)}$$

(i) What is the meaning of (2+) on $Fe^{2+}{}_{(aq)}$? (1mark).

(ii) What is the oxidation number of silver before reaction? (1mark).

(iii) Which substance has been reduced? (1mark). **(iv)** Give a reason for the answer in **5e (iii);** (1mark).

5f (i) Write down the general formula for carboxylic acids; (1mark).

(ii) What is the formula and name of the smallest carboxylic acid? (2marks).

(iii) How would the boiling point of butane compare with that of a carboxylic acid of similar size? (1mark).

(iv) Explain your answer to **5f(iii);** (2marks).

5g. State any three ways of managing plastic wastes; (3marks).

7a. Explain any three characteristics of thermoplastics; (6marks).

7b. Explain any two advantages of recycling organic compounds; (4marks).

7c. Explain why thermosetting plastics can be heated and moulded only once; (5marks).

8a. What is an "electrolyte"? (2marks).

8b. With the aid of a well labelled diagram, describe an experiment that can be carried out to compare the electrical conductivity of potassium nitrite solution and potassium chloride solution; (13marks).

THE DIRECTOR
TARGET PVT SEC SCHOOL
20 SEP 2023

Who is Who in the History of Chemistry?

ANTOINE LAVOISIER

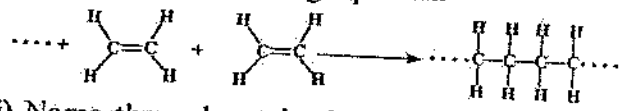
In full Antoine-Laurent Lavoisier
Born August 26, 1743, Paris, France
Died May 8, 1794, Paris

A prominent French chemist and leading figure in the 18th-century chemical revolution who developed an experimentally based theory of the chemical reactivity of oxygen and coauthored the modern system for naming chemical substances. Discovered oxygen's role in combustion and respiration; discovered that water is a compound of hydrogen and oxygen; proved that diamond and charcoal are different forms of the same element, which he named carbon. One of his most famous discovery was the law of conservation of mass, which states that whilst substances may change their state or form, they retain the same mass. This was important because it allowed other scientists to think about the differences between substances in terms other than differences in qualitative properties. Having also served as a leading financier and public administrator before the French Revolution, he was executed with other financiers during the revolutionary terror

PRECISION QUESTION PAPER

Precision is how repeatable a measurement is

1a. Polymerisation of ethane can be presented by the following equation:



(i) Name the polymerisation represented by the equation (1mark).

(ii) Describe how the polymer is formed from ethane molecules; (3marks).

(iii) Give two examples of artificial polymers; (2marks).

1b. The following are formulae of some organic compounds:

A. $CH_3CH_2CH_2CH_2OH$
B. $CH_3CH_2CH_3$
C. $CH_3CH_2CH_2COOH$
D. $CH_3CH_2CH{=}CH_2$
E. $CH_3CH_2CH_2CH_3$

(i) Identify one compound which is in alkanol (1mark).

(ii) Which compounds belong to the same homologous series? (1mark).

(iii) Explain why a solution of compound **C** conducts electricity; (2marks).

(iv) Draw a full structure of compound **D**; (1mark).

(v) Name compound **D** (1mark).

1c

(i) Give three differences between thermosetting and thermoplastic polymers; (3marks).

(ii) State two ways of disposing off plastic waste to avoid pollution; (2marks).

(iii) Give three advantages of plastic materials over metallic materials; (3marks).

3a. Ammonia is an example of strong base.

(i) What is a "strong base"? (1mark).

(ii) Write a chemical equation to show the ionisation of ammonia in water; (3marks).

(iii) Identify one conjugate acid-base pair from the equation in 3a(ii); (1mark).

3b. (i) Draw an energy level diagram for the following chemical reaction:

$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)\ \Delta H = -57kj/mol$

(3marks).

(ii) Is the reaction in **3b(i)** endothermic or exothermic? (1mark).

(iii) Give a reason for the answer to **3b(ii)**; (2marks).

(iv) What is the meaning of (aq) and (l) in the equation? (2marks).

3c. A 300mg tablet of drug was a completely dissolved in 10ml of water. The molecular formula of the drug is $C_9H_8O_4$.

(i) Calculate the number of moles in the tablet. (RAM: C=12, H=1 and O = 16); (4marks).

(ii) Calculate the concentration of the solution in moles per litre; (3marks).

5a. Table 1 shows atomic numbers and electron configurations of some elements.

Table 1

Element	Atomic number	Electron configuration
A	18	2,8,8
B	10	2,8
C	20	2,8,8,2
D	12	2,8,2
E	2	2
F	9	2,7

(i) Identify an element that comes first in period 2; (1mark).

(ii) Which two elements can form positive ions? (2marks).

(iii) Give a reason for the answer to 5a(ii); (2marks). **(iv)** Give any three properties of element A; (3marks).

6e. The following is part of reactivity series.

Magnesium (Mg)
Aluminium (Al)
Zinc (Zn)
Iron (Fe)
Copper (Cu)

↑ Increase reactivity

(i) Which two elements will displace Zinc (Zn) from its oxide? (2marks)

(ii) Give a reason for the answer to 6e(i); (1mark).

6f. The following are half equations for the reaction between magnesium (Mg) and silver nitrate ($AgNO_3$):

$$2Ag^{+}(aq) + 2e \rightarrow 2Ag^{o}(s)$$

$$Mg^{o}(s) - 2e \rightarrow Mg^{2+}(aq)$$

(i) Write a full chemical equation for the reaction; (2marks)

(ii) Name the reducing and oxidising agents in **6fi**); (2marks).

7a. Draw full structures of ethanol (C_2H_5OH) and water (H_2O); (2marks).

7b. Explain the difference in boiling points between ethanol and water; (5marks).

7c. With the help of a labelled diagram, describe an experiment that can be done to separate a mixture of ethanol and water; (8marks).

8. Describe the following radioactive process: Alpha decay (5marks), beta decay (6marks) and gamma emission (4marks). In the description include atomic numbers, penetrating power, ionising ability and behaviour in magnetic and electric fields.

QUANTUM THEORY QUESTION PAPER

***Quantum theory** is the description of energy levels and the predictions about the behavior of atoms at specific energy levels*

1a. Given below are general formula of some homologous series represented by letters P, Q, R and S.
P: C_nH_{2n}
Q: C_nH_{2n+2}
R: $C_nH_{2n+1}OH$
S: $C_nH_{2n+1}COOH$

(i) Name the homologous series represented by letters **Q** and **S** (2marks).

(ii) Which general formulae represent hydrocarbons? (2marks).

(iii) Draw the structure of a compound with three carbon atoms in homologous series **P** (2marks).

(iv) Name the compound drawn in **1a(iii)**, (1mark).

(v) Explain how a compound of homologous series **Q** could be distinguished from a compound of homologous series **R**; (3marks).

1b
(i) Write down all structural isomers of pentane; (3marks).

(ii) Name the isomers in **1b(i)**; (3marks).

1c. Ethene (C_2H_4) reacts with bromine (Br_2) in an addition reaction

(i) Draw the structure of the product formed; (1mark).

(ii) Name the product formed in **1c(i)**; (1mark).

(iii) Why are addition reaction important in industries? Give two reasons (2marks).

2a. Halogens such as bromine (Br_2), chlorine (Cl_2) and Iodine (I_2) can be prepared by reacting an alkaline metal salt with concentrated sulphuric acid in the presence of catalyst. Name any salt from which each of the following can be prepared.
(i) Br_2; (1mark).

(ii) Cl_2; (1mark).

(iii) I_2; (1mark).

2b. State any two properties of halogens; (2marks).

2c. Draw an electron shell diagram for a fluorine atom $\left({}^{19}_{9}F\right)$; (2marks).

2d. Arrange the elements $^{127}_{53}I$, $^{35.5}_{17}Cl$ and $^{80}_{35}Br$ in order of increasing reactivity; (3marks).

2e. Explain the difference in reactivity of the elements in 2d; (5marks).

2f. State any chemical property of sulphur; (1mark).

2g. Explain, with the aid of a diagrams, why rhombic sulphur is more stable than monoclinic sulphur; (4marks).

3a. Define "nuclear fission" (2marks).

3b. Name two particles found in the nucleus of an atom; (2marks).

3c. Two radioactive samples showed the following characteristics.

Sample	Effect on gold leaf	Effect of card board on sample
A	No effect	Sample passes through
B	Discharge	Sample blocked

(i) Identify particles emitted by samples **A** and **B**; (2marks).

(ii) Why does the particle emitted by sample **B** get blocked by card board? (2marks).

3d. Figure 1 is a diagram showing radiation passing through an electric field.

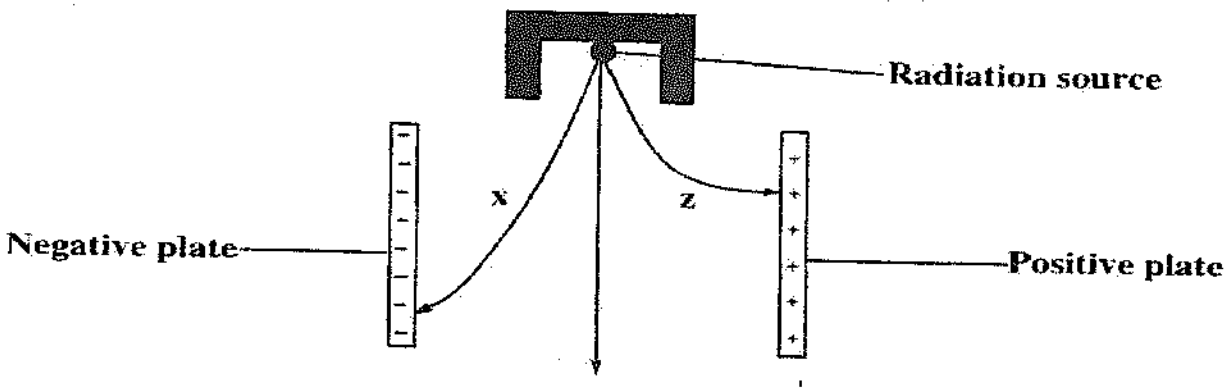


Figure 1

(i) Name the particles taking path **X, Y** and **Z**; (3marks). **(ii)** Explain why particles **Z** will deflect towards the positive plate; (3marks).

5a.

(i) Name the ion responsible for the acidic properties of a substance, (1mark).

(ii) Why is carbonic acid a weak acid while hydrochloric acid a strong acid? (2marks).

5b. Calculate the volume of 0.1M sodium hydrochloric that is needed to neutralize $20cm^3$ of 0.1M hydrochloric acid; (3marks).

5c. (i) What does the symbol $\rightleftharpoons$ means in a chemical equation? (1mark).

(ii) Complete the following chemical equations:

(1) $HSO_4^-{}_{(aq)}$ + _____ $\rightleftharpoons$ $H_3O^+{}_{(aq)}$ + _____$_{(aq)}$ (2marks).

(2) $H_3PO_{4(aq)} + NH_{3(l)} \rightleftharpoons$ _____ + $H_2PO_4^-{}_{(aq)}$ (1mark).

5d. The following is part of an activity series

Lithium (Li)
Sodium (Na)
Magnesium(Mg)
Lead (Pb)
Hydrogen (H)
Copper (Cu)
Silver (Ag)

↑ Increasing reactivity

(i) State whether copper (Cu) will react with a solution of magnesium sulphate ($MgSO_4$); (1mark). **(ii)** Explain the answer to **5d(i)**; (2marks). **(iii)** Which element is the most electropositive in the activity series? (1mark). (iv) Give a reason for the answer to **5d(iii)**; (2marks).

5e. (i) Write half equations for the reaction between silver nitrate ($AgNO_3$) and Sodium (Na); (2marks).

(ii) Name the reducing and oxidising agents in **5e(i)**; (2marks).

Who is Who in the History of Chemistry

JÖNS JACOB BERZELIUS

Born Aug. 20, 1779, near Linköping, Swed.
Died Aug. 7, 1848, Stockholm

One of the founders of modern chemistry. He is especially noted for his determination of atomic weights, the development of modern chemical symbols, his electrochemical theory, the discovery and isolation of several elements, the development of classical analytical techniques, and his investigation of isomerism and catalysis, phenomena that owe their names to him. He was a strict empiricist and insisted that any new theory be consistent with the sum of chemical knowledge. Primarily, Berzelius is known for formalising the language of chemistry. He invented the system of notation by which we refer to different elements, and he came up with fundamental terms in physical chemistry such catalysis, polymer, and what we now call ionic bonding. Not only this, but he also discovered a number of elements himself: cerium, thorium, and selenium. However, perhaps most importantly, Berzelius is credited with being the first person to measure accurately the weight of atoms. Drawing on Dalton's prior work, Berzelius experimental success in this field paved the way for everyone who came after.

RADIOACTIVITY QUESTION PAPER

Radioactivity occurs when the atomic nucleus is unstable and breaks apart, releasing energy or radiation

1a

(i) Draw a labelled diagram of the set up of an apparatus that could be used to separate a mixture of water and ethanol (5marks).

(ii) Explain why the distillate is not pure (2marks).

1b.

(i) Define "Molarity" (1mark)

(ii) Calculate the molarity of a solution prepared by dissolving 5g of sodium chloride (NaCl) in water to make one litre of solution. (RFM for NaCl is 58.5).

(iii) If $10cm^3$ of the solution in 1b(ii) was vaporized, how much NaCl would be left on the evaporating basin? (2mrks).

1c

(i) In which of the following substances are atoms covalent bonded? CH_3OH, $CuCl_2$, SO_2 and BeF_2 (2marks).

(ii) Draw an electron dot and cross diagram of CH_3OH (2marks).

1d

(i) Balance the following chemical equation:

$CH_4 + O_2 \rightarrow CO_2 + H_2O$ (2marks).

(ii) What type of reaction is represented by the equation in **1d(i)**? (1mark).

3a. Define the following: **(i)** atomic number (1mark)

(ii) electron configuration (1mark).

3b. Figure 3 is a graph of density against atomic number for the first 20 elements of the periodic table.

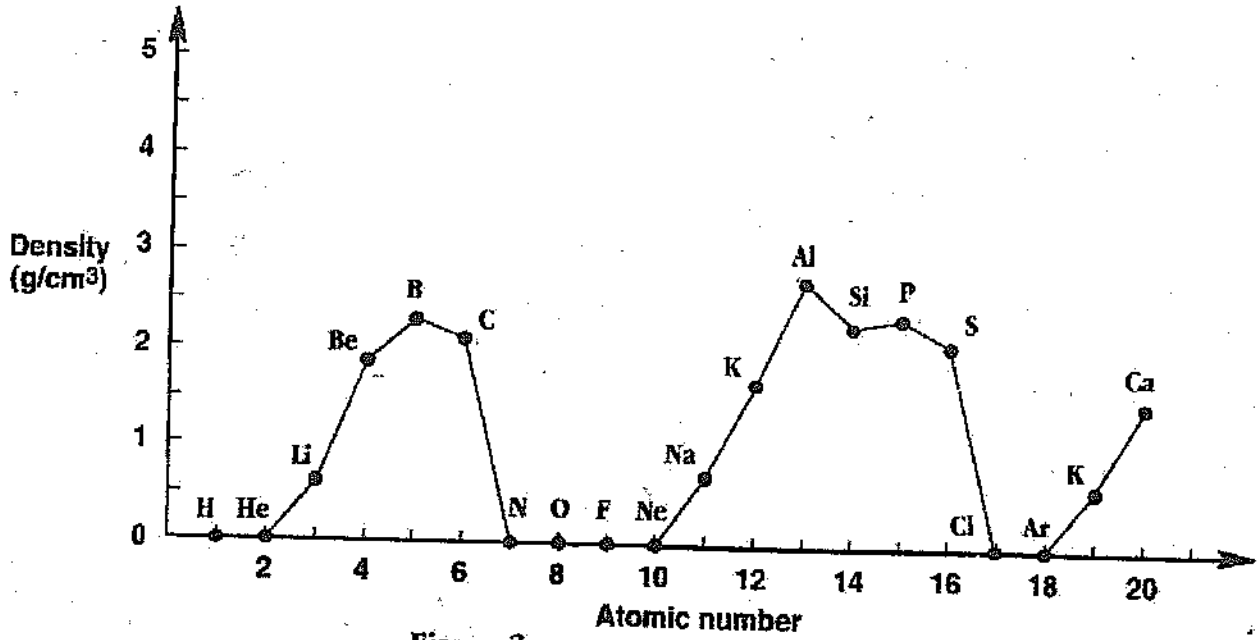


Figure 3

(i) What is the density of Be? (1mark). **(ii)** How does the graph show that density is a periodic property of the elements? (1mark). **(iii)** Which element has the greatest density? (1mark). **(iv)** How many complete periods are represented by the graph? (1mark).

3c.

(i) Define "reduction" (1mark).

(ii) A pupil carried out a series of experiments to find out positions of metals in a displacement series.

The following results were obtained after dipping metals in **Column X** into solutions containing ions in **Column Z**.

X	Z	
METAL	IONS	RESULTS
Fe	Pb^{2+}	Lead (Pb) deposited
Pb	Cu^{2+}	Copper (Cu) deposited
Na	Mg^{2+}	Magnesium (Mg) deposited
Mg	Na^{+}	No change

(1) Name the type of reaction that took place during deposition of the metals (1mark)

(2) List down the metals in order of decreasing reactivity. (3marks)

3d. Figure 4 is a diagram of Daniel cell being used to light a bulb.

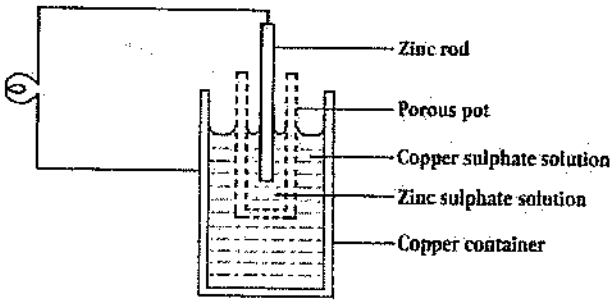


Figure 4

(i) State two functions of the porous pot (2marks).

(ii) Write down a half equation for the reaction at the zinc electrode (2marks).

5a.
(i) What is the difference between strong and weak acids? (2marks).

(ii) Give an example of:

(1) strong acid (1mark).

(2) Weak acid; (1mark).

5b.
(i) State the products formed when acids react with metals (2marks).

(ii) Write a chemical equation to represent the reaction between hydrochloric acid (HCl) and zinc metal (Zn); (2marks).

5c. Figure 5 is a diagram of the apparatus used in the purification of copper metal where one electrode is pure copper and the other impure copper.

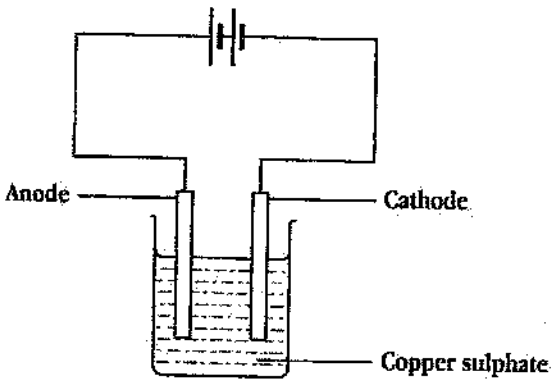


Figure 5

(i) Which of the electrodes is impure copper? (1mark). **(ii)** Give a reason for your answer to **5c(i)** (2marks). **(iii)** What happens to the electrodes if the experiment is left for a few hours? (2marks). **(iv)** What evidence will be there to show that the purification process was taking place? (1mark).

(v) Why does the colour of copper sulphate solution remain the same as the purification process takes place? (1mark).

5d. Figure 6 is a graph of the reaction between dilute hydrochloric acid (HCl) and calcium carbonate ($CaCO_3$).

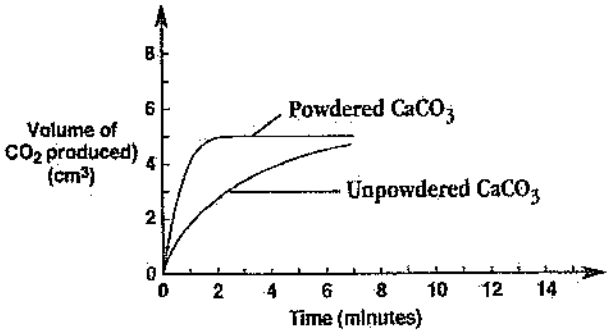


Figure 6

(i) What factor affecting the rate of reaction was being investigated? (1mark). **(ii)** State any two factors that should be kept constant when investigating the factor, you have mentioned in **5d(i)** (2marks). **(iii)** Calculate the rate of reaction for powdered $CaCO_3$ in the first minute of the reaction (3marks).

7a. A certain hydrocarbon has a carbon to hydrogen ratio of 4:9 and a relative molecular mass of 114. (RAM: carbon = 12, hydrogen = 1). Work out the molecular formula of the compound (4marks).

7b. A student was given a sample of C_5H_{12}, C_9H_{20}, C_5H_9COOH and CH_3COH in unlabelled bottles. Using a flow diagram, describe an investigation he would carry out in order to identify the samples (11marks).

SUBLIMATION QUESTION PAPER

Sublimation is when a solid changes directly into a gas

1. Figure 1 is a diagram of a longitudinal section of a cell.

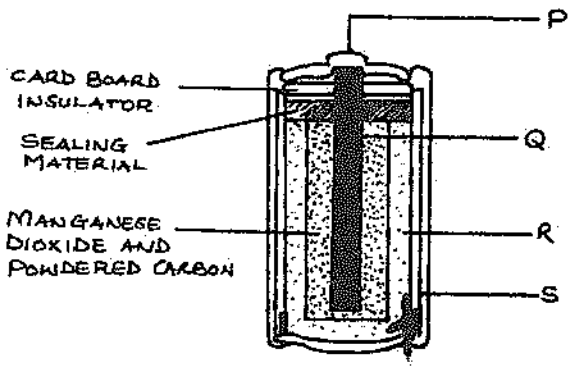


Figure 1

1(a) Name the parts labelled **P, Q, R, S**; (4marks).

1(b). State the function of the parts **P, Q, R** and **S** (4marks).

1(c). There are different sizes of dry cells which can be bought from most shops but all are marked 1.5v.

(i) Why is the voltage of each cell 1.5v regardless of the size of the dry cell? (2marks).

(ii) Give two advantages of using a large cell; (2marks).

1(d) Rust is an example of corrosion.

(i) State the conditions that are favourable for rusting (3marks).

(ii) One way of preventing rusting is galvanising. What is involved in the galvanizing process? (2marks).

(e) In a punctured tin can, iron (Fe) and tin (Sn) react according to the following half equations:

$$Fe(s) - 2e^- \rightarrow Fe^{2+}(aq)$$

$$Sn^{2+}(aq) + 2e^- \rightarrow Sn(s)$$

Write a balanced overall equation for the reaction. (3marks).

3a. The relationship between organic compounds, compounds that dissolve in water, and hydrocarbons can be represented by a venn diagram. Using the letter A to represent organic compounds, B to represent that of dissolved in water and C to represent Hydrocarbons:

(i) Draw a venn diagram to show the relationship of the compounds; (3marks).

(ii) Write the following in the appropriate areas of the venn diagram: $CH_3CH_2CO_2H$, ethane and sodium hydroxide; (3marks).

3(b) The reaction between ethanoic acid and potassium hydroxide can be represented by the equation below:

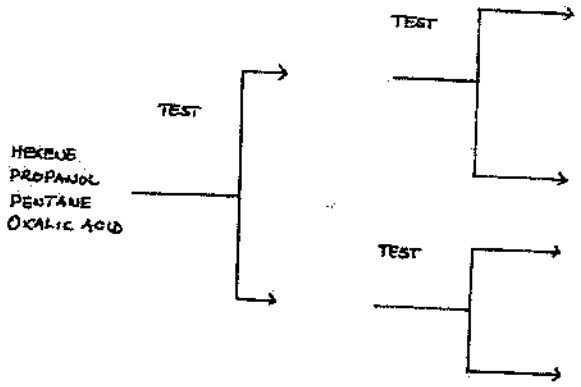
$$CH_3CO_2H(aq) + KOH(aq) \rightarrow H_2O(l) + CH_3CO_2K(aq)$$

(i) Write the full ionic equation for the reaction; (4marks).

(ii) What are spectator ions? (1mark).

(iii) Write the spectator ions in the ionic equation in **3b(i)**; (2marks).

(c) The flow diagram below could help in identifying the four chemical substances given. Compete the diagram by describing the necessary tests you would use as well as results expected in order to identify the four substances; (7marks).



5a. Figure 5 shows nuclear charges of some atoms **D, E, F** and **G**.

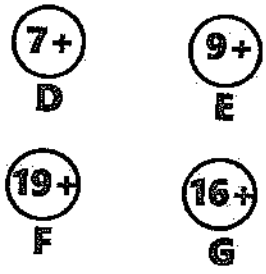


Figure 5

(i) Complete the diagrams by drawing the energy levels and indicating the number of electrons in each energy level; (4marks).

(ii) What are the valences of **E** and **F**? (2marks).

(iii) What type of bonding takes place when elements **E** and **F** combine? (1mark).

(iv) To which group of the periodic table does element **G** belong? (1mark).

(v) From the electron configurations how can you tell the period to which the elements belong? (1mark).

(vi) Which of the two elements **E** and **G** is more reactive? (1mark).

(viii) Give a reason for your answer to 5a(vi); (3marks).

7a. What are Van der Waals Force? (1mark).

7(b) Explain giving examples, how the strength of van der waals forces depend on molecular size and the kind of atoms in the molecule; (10marks).

7(c) Explain why sodium chloride (NaCl) has a much higher melting point than $C_{70}H_{142}$; (4marks).

Who is Who in the History of Chemistry

ROSALIND FRANKLIN

In full Rosalind Elsie Franklin,
Born July 25, 1920, London, England
Died April 16, 1958, London.

A British scientist best known for her contributions to the discovery of the molecular structure of deoxyribonucleic acid (DNA), a constituent of chromosomes that serves to encode genetic information. Discovered that DNA can exist in two forms; established that coal acts as a molecular sieve. Franklin also contributed new insight on the structure of viruses, helping to lay the foundation for the field of structural virology.

Section B

Answers to Question Papers

ALDEHYDE QUESTION PAPER ANSWERS

1a
Accuracy is the degree of closeness of a measurement to the actual volume while precision is the degree to which repeated measurements undergo changed condition and show the same results.

1b(i)
good precision but poor accuracy: It is **A**

1b(ii)
both poor precision and accuracy: It is **C**

1b(iii)
both good precision and accuracy: It is **B**

1c(i)
It is

$NH_3 + 2O_2 \rightarrow HNO_3 + H_2O$

1c(ii)
RFM

$HNO_3 \rightarrow (1\times1)+(1\times14)+(3\times16) = 63g$

RFM

$NH_3 \rightarrow 14+(3\times1) = 17g$

∴ If 63g is produced from 17g of ammonia;
Then

$\frac{17g}{136g} \times 63g = 7.875g$

2a
1 molecule of urea contains 7 Nitrogen Atoms

∴ 8 molecule = (8/1)X7 = 56 Nitrogen Atoms

2c(i)
Ionic compounds are soluble in water: This is because graphite has three covalent bonds formed between carbon atoms within the layers, an unbonded electron is present on each carbon atom. These are delocalised electrons from electron between the layers.

2c(ii)
Graphite conducts electricity: This is because water molecules are able to bond with the positive and negative ions which break up lattice and keeps ions apart.

2d
It is formed when a pair of electrons unequally shared as one atom spends more time with the electrons than other atom. This means that one atom has a stronger pull than the other atoms and attracts electrons.

3a
It helps to determine the group of an element

3b(i)
This is because Nitrogen exits as diatomic at a room temperature

3b(ii)
It dilutes the oxygen in air and weaken its power. As well as the beans, peas have bacteria in their roots which converts nitrogen in the air into compounds and make them richer in nitrogen.

3c(i)
X belongs to Group 4

3c(ii)
X^4 and Y^2

$X^4Y^2 = X_2Y_4$

4a
85.7% carbon
85.7g carbon

Number of moles

$= \frac{85.7g}{12g} \times 1mole$

$= 7.14$

$= \frac{7.14}{7.14}$

$= 1$

14.3% Hydrogen
14.3g Hydrogen
Number of moles

$= \frac{14.3g}{1g} \times 1mole$

$= 14.3g$

$= \frac{14.3}{7.14} mole$

$= 2moles$

$4(CH_2) = 14EF$

$\therefore \frac{56}{14}$

$\Rightarrow C_4H_8$ Butene

4b
It is because it causes air pollution

5a
Solubility of the concentrated solution

5b
Reaction A

5c
Because an acid with a high concentration of 1M is dissolved in shorter period of time.

6a
Oxidation:

$Al_{(s)} \rightarrow 2Al^{2+} + 2l^-$

Reduction:

$Cl_{2(g)} + 2e^{-2} \rightarrow 2Cl_3^-$

6b
$M_1 = 8M$
$V_1 = 40ml = 0.04l$
$M_2 = 0.2M$

$\therefore V_2 = \frac{M_1V_1}{M_2}$

$= \frac{8\times0.04}{0.2}$

$= 16l$
$= 1600ml$

7a
Conformers of butane

7c
Because it has more less like a straight chain

8a(i)
It is Hydration

8a(ii)
Acts as a catalyst

8b(i)
$C_2H_5OH \xrightarrow{Cu,\Delta} C_2H_4 + H_2O$

8b(ii)
It is acting as a catalyst

8b(iii)
Ethene and water

9a
Because it has a low boiling point of -186°C than oxygen.

9b
Carbon dioxide is derived from the air through the process of fractional distillation. The first air is liquefied and the dust is removed. Then at – 79°C, carbon dioxide freezes and then removed.

10a
It is Biodegradable wastes

10b
When we are burning the fuels, they produce a lot of or large quantities of carbon dioxide. Carbon emission trap heat in the atmosphere which lead to climate change.

11a
The Boiling point of hexanoic acid is higher because of the presence of dimers in it which increases the Van der Waals dispersion forces while in hexanol there is less dimers.

11b
Ozone layer is depleted from the Chlorofluorocarbons (CFCs). These CFCs are like aerosols, coolant and foams. When the CFCs get to the atmosphere, the chlorine atom (CI) is released from the CFCs molecule. Then the Chlorine atom split the Ozone to Oxygen atoms and Oxygen molecules. The free oxygen atoms then combine with ozone molecules to form another oxygen molecule.

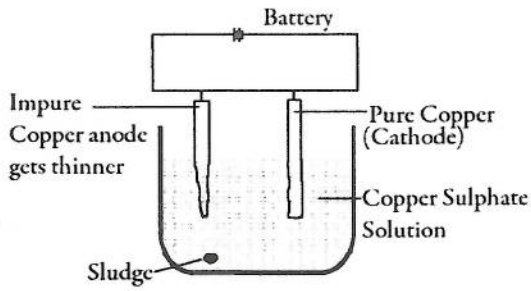
$O_{3(g)} \longrightarrow O_{2(g)} + [O]$
$O_{3(g)} \longrightarrow [O] \rightarrow 2O_{2(g)}$

This results in depletion of ozone layer.

12
Soap is made through the process of saponification. This is the process in which esters are hydrolysed using an alkaline. In this process, the alkali is a reactant not a catalyst. When a fat is boiled with strong alkaline solution like concentrated sodium hydroxide solution, it is hydrolysed to give glycerol and soap (sodium octadecanoate). This process can be summarised by the following equation.

Fat or Oil + Sodium Hydroxide Soap + Glycerol

13



During the refining of copper, the following must be followed whereby cathode must be made of thin sheet of pure copper, and the anode must be made of impure copper and the electrolyte must contain copper ions. For example, copper sulphate solution. At cathode, the positively charged (CU^{2+}) ions are attracted to the cathode and get discharged by accepting two electrons. They can get deposited on the cathode as pure copper solid. While at anode, the copper atoms lose electrons and enter into a solution as ions.

Equation at Anode
$Cu_{(s)} \rightarrow Cu^{2+}_{(aq)} + 2e^-$
Equation at the anode
$Cu^{2+}_{(aq)} + 2e \longrightarrow Cu_{(s)}$

When the impure block at the cathode dissolves and the pure copper is deposited at the cathode. The impurities form a sludge at the bottom of the container.

Interesting Science facts

BABIES' BODIES CONTAIN MORE WATER THAN ADULTS: *Adults are around 60 percent water. By contrast, newborn babies are about 80 percent water. But that percentage quickly drops: A year after birth, kids' water content is down to around 65 percent.*

Who is Who in the History of Chemistry?

THE DIRECTOR
TARGET INT SEC SCHOOL
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P.O.BOX 20664, MZUZU 2

ROBERT BOYLE

Born January 25, 1627, Lismore Castle, County Waterford, Ireland
Died December 31, 1691, London, England

An Anglo-Irish natural philosopher and theological writer, a preeminent figure of 17th-century intellectual culture. He was best known as a natural philosopher, particularly in the field of chemistry, but his scientific work covered many areas including hydrostatics, physics, medicine, earth sciences, natural history, and alchemy. He transformed chemistry from a field bogged down in alchemy and mysticism into one based on measurement. He defined elements, compounds, and mixtures; and he discovered the first gas law – Boyle's Law.

BOND ENERGY QUESTION PAPER ANSWERS

1a
The height of sulphuric acid increases

1b
This because length of a capillary tube is directly proportional to the volume of the air trapped inside.

1c
To trap in some air

1d
The value is very high since the gas molecules will be moving at a fast rate to the heating.

2a
The atomic radii increase down the group and The atomic sizes increases down the group.

2b
IMF of halogens increases down the group, so Bromine has more IMF due to increase of nuclear charge as the number of electrons increases than Chlorine.

2c
$2Na + 2H_2O \longrightarrow 2NaOH + H$

2d

2e
In molten state, ions are free to move while in a solid state ions are held strongly together.

3a
It is a solution whose concentration is known.

3b
Through Grams per volume and Through Moles per volume

3c
Molar Mass of NaCl
= 23+35.5
= 58.5g/mol

$$Mass\ of\ NaCl = 11.7g$$

$$\therefore No\ of\ mol = \frac{11.7g}{58.5g/mol}$$

$$= 0.2mol$$

3d(i)
Zinc has been oxidized

3d(ii)
Because its oxidation number has been increased from 0 to 2

3d(iii)
"s" means solid while "aq" means aqueous solution

3d(iv)
$Zn \longrightarrow Zn^{2+}_{(aq)} + 2e$

$Cu^{2+}_{(aq)} + 2e \longrightarrow Cu^{0}_{(s)}$

4c(i)
This is time taken for an activity to decrease to half-life of the initial value.

4c(ii)
Natural radioactivity is the type of radioactivity by which atoms disintegrate on their form in order to be stable, while artificial is the type of radioactivity which happens due to the bombarding of a neutron to an Isotope.

4d(i)
It is because gamma rays have a highest penetrating power. when it has been irradiate to the food, all the bacteria can be killed in no time.

4d(ii)
This is because gamma rays travel in a straight line but have no well-defined path. It also has very strong photon energy.

4d(iii)
Handling them with tongs
People should sit behind a shielding wall made of concrete and lead

5a(i)
K is Thermosoftening plastic
L is Thermosetting plastic

5a(ii)
They cannot be remoulded
They do not soften when heated

5a(iii)
They have no cross linked chains but they are held together by Van Der Waals forces of attraction. So the heat is needed to break those forces first for them to start melting.

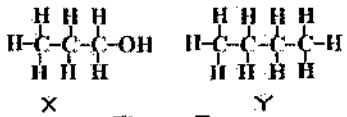
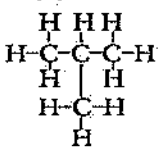
5b


Figure 3

5b(i)
X belongs to Alkanals
Y belongs to Alkenes

5b(ii)


5b(iii)
X and Y can be distinguished using solubility test. Water will be filled in the test tubes having the same volume. Then the solution containing the solution of X and Y will be added to the test tubes. The test which contains will be colourless will be X as an alkanal while for Y, it will have two layers.
The solution which turned will be an alkanal (X) because alkanals are soluble in water while the alkanes (Y) are insoluble in water.

COVALENT BOND QUESTION PAPER ANSWERS

1a

- The substance must be unstable
- Substance should have power of emitting
- The substance should be active

1b

Beta particle is when fast moving electron is emitted. A neutron inside the nucleus becomes a proton. The neutron number decreases by 1 whereas the proton number. The atomic number increases by 1 whereas the mass number remains the same.

1c.

To calculate the atomic mass of chlorine gas

$$\frac{75}{100} of \left[{}^{35}_{17}Cl\right]$$

$$= \frac{75}{100} \times \frac{35}{1}$$

$$= 26.25$$

$$\frac{25}{100} of \left[{}^{37}_{17}Cl\right]$$

$$= \frac{25}{100} \times \frac{37}{1}$$

$$= 9.25$$

Total atomic mass = 26.25+9.25 = 35.50

2a

Moisture
Oxygen

2b(i)

Carbon Rod Y

2b(ii)

Colour of copper sulphate solution will change
Carbon Rod Y will be coated with brown substance

2b(iii)

$$Cu^{2+}_{(aq)} + 2e \rightarrow Cu_{(s)}$$

2c

Ratios
C:H:O = 1:2:1
Mass Ratio = 12:2:16
Total = 30

$$C = \frac{180}{30} \times 1 = 6$$

$$H = \frac{180}{30} \times 2 = 12$$

$$O = \frac{180}{30} \times 1 = 6$$

Molecular formula = $C_6H_{12}O_6$

2d

A strong acid is an acid that easily dissociate, and donate more protons.

2e

$$CH_3COOH(l) + H_2O(l) \leftrightarrow CH_3COO^-(aq) + H_3O^+(aq)$$

2e(i)

CH_3COOH and CH_3COO^-
H_3O^+ and H_2O

4a.

Metal ores
Natural gas in the form of (H_2S)
Crude oil

4b(i)

It belongs to period 2

4b(ii)

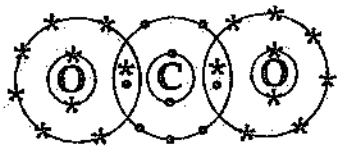
It is 2.8.5

4b(iii)

The reactivity increases as you go up from Br to F. This is because attraction force between nucleus and outer electrons decreases as you move from Br to F.

4b(iv)

The electron Dot and Cross Diagram will be as below:



7a(i)

These are: H_2O and CO_2

7a(ii)

These are alkanols and alkanoic acid

7b(i)

A is fermentation
B is distillation

7b(ii)

The role of yeast is to convert sugars into alcohol. The yeast release ethanol as a waste product during fermentation.

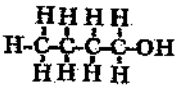
7c(i)

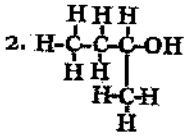
M is alkene
P is alkanoic Acid

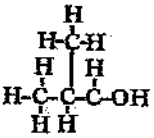
7c(ii)

It is N

7d.

1. 

2. 

3. 

7e.

Pentanol has higher boiling point than ethanol. This is because boiling point of alcohol increases with increase in molecular mass and mass of molecules increases with increase in number of carbons.

Who is Who in the History of Chemistry?

ALFRED NOBEL
In full Alfred Bernhard Nobel,
Born October 21, 1833, Stockholm, Sweden
Died December 10, 1896, San Remo, Italy

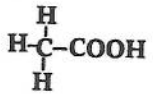
A Swedish chemist, engineer, and industrialist who invented dynamite, the blasting cap, gelignite, and ballistite; grew enormously wealthy manufacturing explosives; used his wealth to bequeath annual prizes in science, literature, and peace. In his later years, as the story goes, he felt a little guilty about producing one of the most destructive chemical substances ever devised.

DELOCALIZATION QUESTION PAPER ANSWERS

2a(i)
These are substances that contain2 carbons and Hydrogen atoms only in their structure.

2a(ii)
$C_nH_{2n}OH$

2b.



2b(ii)
Soluble: C_2H_5OH and CH_3COOH
Insoluble: C_6H_{12}

2b(iii)
C_6H_{12}

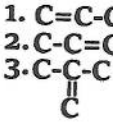
2b(iv)
This is because C_6H_{12} has a double bond in its structure

2b(v)

$$C_2H_5OH_{(aq)} + HCO_2H_{(aq)} \rightarrow HCO_2C_2H_{5(aq)} + H_2O_{(l)}$$

2c
Natural polymerisation
Synthetic polymerization

2d.



3a.

H_1^1, H_1^2, H_1^3

3b(i)
The half-life is 7 days.

3b(ii)
$N_0 = 1600$
$N_{21} = 200$

Loss = $N_0 - N_{12}$
= 1600 – 200
= 1400 counts

3c
To calculate time taken
800 x 400 x 200 x 100 x 50

Time for half-life is 6 hours
Therefore, x = 6hrs
4x = 4x6hrs
= 24hrs

5a(i)
Moisture
Oxygen

5a(ii)
The coat prevents direct contact between iron and oxygen. The coat reacts with oxygen.

5b(i)

$$Mg_{(s)} + CuSO_{4(aq)} \rightarrow MgSO_{4(aq)} + Cu_{(s)}$$

5b(ii)
Cu<Zn<Mg (Cu, Zn, Mg)

5c(i)
It is an exothermic change

5c(ii)
Because ΔH is negative. The reaction releases energy.

5d

$$\frac{C_1 \times V_1}{C_2} = \frac{C_2 \times V_2}{C_2}$$

$$V_2 = \frac{C_1 \times V_1}{C_2}$$

$$= \frac{2 \times 5}{0.1}$$

$$= \frac{10}{0.1}$$

$$= 100cm^3$$

7a
- Good conductors of heat
- Shiny surface when fleshly cut
- Low melting point
- Very soft and can be cut with an ordinary knife

7b(i)
It is Ca

7b(ii)
Atomic radii decrease across a period because atomic number increases which increases the size of the nucleus.

7b(iii)
Due to an increase in number of shells from 3 of Cl to 4 of K

7b(iv)
Cross and dot diagram

ENANTIOMERS QUESTION PAPER ANSWERS

3a(i)
Ethanol and carbon dioxide

3a(ii)
yeast cells produce enzymes that catalyze sugar

3b
Because they have cross links which are permanent chemical bond which need high temperature to break

3c(i)
A: 3-methylbut-1-ene
B: cyclopentane

3c(ii)
A: Alkene
B: Alkane

3d(i)
Polythene/polyethene

3d(ii)
It is durable.
It is tough

3d(iii)
Occurs by addition polymerization when the double bond dissociates and breaks producing two new free bond allowing other monomers to be added.

5a
-Using pH scale
- using universal indicator

5b
-grams per cubic decimetre (g/dm^3)
-number of moles dissolved in cubic (md/dm^3)

5c(i)
Sodium **hydroxide**

5c(ii)
Because its concentration is known

5d(i)
Zinc

5d(ii)
Metal zinc used is more reactive than iron, hence zinc around the scratched area will react with air and form oxides faster thereby protecting iron.

6a(i)
Covalent bonding

6a(ii)
It involves of bonding of non -metals

6a(iii)
NH_3

6b(i)
-metals are malleable
-metals are sonorous
-metals are ductile

6b(ii)
When atoms of metals are closely packed, each metal atom loses its innermost electrons to form a sea of free moving electrons resulting in positive ions being. Embedded in the sea of electrons causing an attraction between ions and electrons.

6c(i)
- have a negative charge
- ionize less than alpha particles but more than gamma particles

6c(ii)
- wear protective clothing
- hold radioactive substances using forceps

6c(iii)
Striking a stable nucleus with a neutron which penetrates into the nucleus where it disturbs the delicate balance of neutrons

6d
P: Alpha radiation
Q: Gamma radiation
R: Beta radiation

8a(i)
Magnesium rod dissolves and ionizes such that its lost electrons are immediately handed to the silver ions making the silver ions change to silver atom

8a(ii)
$Mg_{(s)} + AgCl_{(aq)}^{+2} \rightarrow Mg_{(aq)}^{+2} + Aq_{(s)}$

8b
Polar covalent molecules like HCL conduct electricity while non-polar covalent molecules do not. This is because in polar, electrons in the boundary are not equally shared hence there are free electrons that can conduct electricity.

FAMILY QUESTION PAPER ANSWERS

2a
Protons, neutrons and electrons

2b
Mass#
= #of protons+#of neutrons
23 = #of protons+13
∴ #of protons = 23-13
#of protons =10

2c(i)
Ionic: B and D
Molecular: A, C and E

2c(ii)
Because ionic compounds conduct electricity in molten form

3a
Is the amount which contains units of that substance as there are in 12g of carbon-12 isotope.

3b(i)
Solid

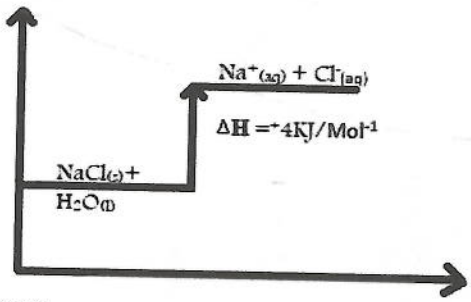
3b(ii)
$2Mg_{(s)} + O_{2(g)} \rightarrow 2MgO_{(s)}$

3b(iii)
1 mole of Mg = 24
Therefore;
120g Mg = (1molex120g)/24g
= 5moles

1 mole of oxygen = 16g
Therefore;
1 mole Mg react with 1 mole oxygen
5 mole Mg will react with:
(1molex5mole)/1mole = 5 moles of oxygen

3c(i)
Endothermic

3c(ii)



3d(i)
Is one which dissociates partially in aqueous solution

3d(ii)
Electricity conductivity

3d(iii)

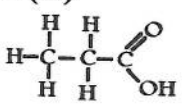
$H_2O_{(l)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + OH^-_{(aq)}$

5a
Are compounds that have oxygen and carbon only in their formula

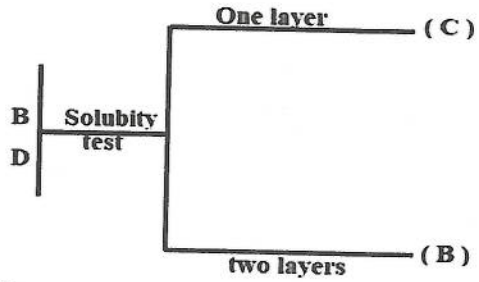
5b(i)
B and D

5b(ii)
Propanol

5b(iii)

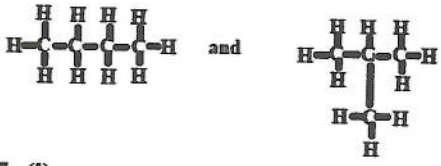


5b(iv)



5c
- they do not corrode in air or water
- they do not decompose easily
- they are cheap

5d



7a(i)
(1)
$^{14}_{6}C \rightarrow ^{0}_{-1}B + ^{14}_{7}N$
(2)
$^{60}_{27}Co \rightarrow ^{60}_{27}Co + ^{0}_{0}Y$

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7a (ii)
Equation 2

7a(iii)
Because it releases only heat energy which has no mass and no charger.

7b
has a negative charge
moderate raising power
has medium penetrating power

7c
A: Mass number
Z: Atomic number

7d
N= No(1/2)(T/t)
N=240 x(1/2)(30/15)
N= 240x(1/2)(2)
=240x(1/4)
=60
the count rate after 30 hours is 60

Interesting Science facts

DENSITY EXPLAINS WHY COLD WATER FEELS COLDER THAN AIR AT THE SAME TEMPERATURE: *Because water is denser than air, your body loses heat 25 times more quickly while in water than it would in air at the same temperature. Water's density gives it a high specific heat capacity, meaning it takes a lot of heat to raise its temperature even a little, and it's very good at retaining heat or cold (the reason why hot soup stays hot for a long time, and why the ocean is much cooler than land). Water is a great conductor, so it's very effective at transferring that heat or cold to your body*

Who is Who in the History of Chemistry

DMITRI MENDELEEV

In full Dmitry Ivanovich Mendeleyev
Born January 27 (February 8, New Style), 1834, Tobolsk, Siberia, Russian Empire
Died January 20 (February 2), 1907, St. Petersburg, Russia

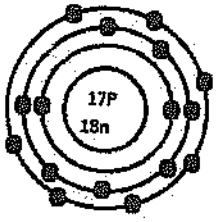
A Russian chemist who developed the periodic classification of the elements. He came up with the periodic table of the elements apparently in a dream, in which he saw patterns between different chemicals that could allow them to be arranged in a certain order. Mendeleev found that, when all the known chemical elements were arranged in order of increasing atomic weight, the resulting table displayed a recurring pattern, or periodicity, of properties within groups of elements. In his version of the periodic table of 1871, he left gaps in places where he believed unknown elements would find their place. He even predicted the likely properties of three of the potential elements. The subsequent proof of many of his predictions within his lifetime brought fame to Mendeleev as the founder of the periodic law. He was also interested in geology, meteorology and other disciplines; he's probably had the most significant impact on what we understand to be chemistry.

KELVIN QUESTION PAPER ANSWERS

2a
In polar molecules, electrons are not equally shared while in non-polar, electrons are shared equally

2b(i)
Fluorine and chlorine

2b(ii)



2b(iii)
Iodine is below fluorine in group 7 hence fluorine molecule is larger as such stronger intermolecular forces which needs higher temperature to be broken.

2b(iv)
Mass = number of neutrons + number of protons
127= number of protons + 53
127 –53 = number of protons
Number of protons =74

3a
It is the simplest ratio of a formula

3b

Element	Cu	O
composi-tion by mass	32	8
get reach-ing moles by diving by R.A.M	32/64 = 0.5	8/16 = 0.5
Divide by the smallest value	0.5/0.5 = 1	0.5/0.5 = 1
Mole ratio	1	1

∴the empirical formula for copper oxide is **CuO**

3c(i)
To show the point at which the reaction is complete (to show the point whereby an acid is completely neutralized by a base).

3c(ii)
Sodium hydroxide

3c(iii)
Its concentration is known

3d
Mole per cubic decimeter (mole per litre)
grams per litre (grams per cubic decimeter)

3e(i)
Electroplating
galvanizing the metal

3e(ii)
When iron metal dissolve in water, and its electrons are used up by water and air to form hydroxyl ions which react with iron ions and more water and air to give rusting

5a(i)
X: Alkanols
Z: Alkenes

5a(ii)
Dissolve in water
they react with alkanoic acid to form esters
the poor conductors of electricity

5a(iii)
Cn H_{2n+1} COOH

5a(iv)
Esters and water

5a(v)
W and Z

5a(vi)
They both have a single double bond which is functional group of alkene

5b(i)
It Is B

5b(ii)
Because of presence of gross-links which are held together by permanent chemical bonds.

5c
By performing water solubility test in which $2cm^3$ of ethanol and hexane are put in separate test tubes to which 10 drops of distilled water are added and shake well. If its ethanol only one layer is formed and two layers if its hexane.

7a
- handle radioactive substance with forceps
- avoid holding them pointed towards a person

7b
Protons and electrons

7c
During alpha or beta emission, protons and neutrons are left in an excited arrangement. As they are rearranging, they emit only heat energy within mass and charge.

7d
If 1 second = 30 counts
Therefore, 10 minutes will take more counts

But 1min = 60 seconds
∴10minutes
= (10min×60s)/1m
= 600sec

∴after 10 minutes, disintegrated atoms will be (600s×30conts)/1s which is equal to 18, 000conts

LATTICE ENERGY QUESTION PAPER ANSWERS

3a
Alkanols

3b
- It is soluble in water
- turn blue litmus paper red
- they react with based to form salt and water in neutralization process

3c
As fuel for cars
used to speed up digestion
used as medicine

3d
esters
water

3e
$C_nH_{2n+1}COOH$
$C_5H_{2(5)+1}COOH$
$C_5H_{10+1}COOH$
$C_5H_{11}COOH$

3f
By performing acid test. To separate test tubes, add 10 drops of sodium hydroxide, 2 drops of phenolphthalein and $2cm^2$ of A in one test tube and B in another test tube. If is observed that A remains colorless hence carboxylic acid while B turns pink hence alkanol

5a
Is the coating of a metal with another metal by means of electrolysis?

5b(i)
$Fe^{\circ}_{(s)} + CuSO_{4(aq)} \longrightarrow FeSO_{4(aq)} + Cu^{\circ}_{(s)}$
$Fe^{\circ}_{(s)} + Cu^{+2}_{(aq)} \longrightarrow Fe^{+2}_{(aq)} + Cu^{\circ}_{(s)}$

5b(ii)
Fe (iron)

5b(iii)
Has resulted into the reduction of Cu by becoming oxidized itself

5c
Oxidation is the losing of an electron while reduction is the gaining of an electron

5d(i)
Is the amount of solute in a specific volume of solvent?

5d(ii)

$$M_1V_1 = M_2V_2$$
$$20g/l \times \frac{60cm^3 \times 1l}{1000cm^3}$$
$$= M_2 \times \frac{600cm^3 \times 1l}{1000cm^3}$$
$$\frac{1200g/l}{1000cm^3} = \frac{600l \times M_2}{1000cm^3}$$
$$\frac{12g/l}{10cm^3} = \frac{3l \times M_2}{5cm^3}$$
$$M_2 = \frac{12g/l \times 5cm^3}{3l \times 10cm^3}$$
$$M_2 = 2g/l$$

5e(i)
Exothermic

5e(ii)
Because negative in enthalpy change which shows heat loss

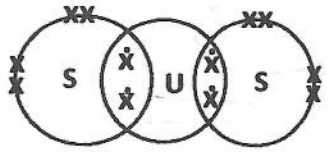
5e(iii)
Direction of reaction

6a(i)
R and U

6a(ii)
Because they have two shells

6a(iii)
S and T

6a(iv)



6b
They have pungent smell
Are slightly soluble in water
They have varying color

6c
Forms a white water soluble salt called sodium chloride

6d(i)
Natural radioactivity and artificial radioactivity

6d(ii)
Time taken for radioactive sample to fall to half into original amount

6d(iii)
Have a positive
have highest ionizing power
have least penetrating power

MOLAR VOLUME QUESTION PAPER ANSWERS

3a(i)
It is the volume occupied by 1mole of a gas which is $22.4dm^3$ at STP and $24dm^3$ at RT.

3b(i)
Acid is a proton donor

3a(ii)

$$Volume\ of\ SO_2 = 120dm^3$$
$$Molar\ volume\ of\ SO_2\ at\ RT = 24dm^3/mol$$
$$\therefore No\ of\ mol = \frac{120dm^3}{24dm^3/mol}$$
$$= 5mol$$

3b(ii)
It is formed when water (H_2O) behaves as a base (accepts a proton) in acid-base reactions/equations

3c
This is because for a bond to be broken, heat energy is absorbed while during a bond making, heat energy is lost during a reaction.

3d(i)
Painting
Electroplating
Greasing/oiling

3d(ii)
N+ 3(O) = -1
N+ 3(-3) = -1
N – 6 = -1
∴N = +6-1
= +5

4a(i)
- By losing electrons in the last shell
- By gaining electrons in the last shell
- By sharing electrons in the last shell

4a(ii)
By transferring electrons in the last shell that is losing and gaining

4b(i)
Q, T and X

4b(ii)
It is element X

4b(iii)
It is Ionic bonding

4b(iv)
First we write the electron configurations
D: 2:1
Q: 2:8:3
T: 2:8:6
X: 2:8:8
Z: 2:8:8:1

Equation: $2D + T \rightarrow D_2T$

5a(i)
They are light (portable)
They are durable (long lasting)

5a(ii)
It happens when different types of monomers are joined together to form a long chain molecule and a small molecule is eliminated eg water.

5b
They are soluble in water
They burn in air

5c (i)
It is a catalyst

5c(ii)
$CH_3CH_2OH + (O) \rightarrow CH_3COOH$

5d(i)
P – Cytopentane
Q – But–2–ene

5d(ii)
It is S

5d(iii)
They have the same molecular formula but structures are different

5d(iv)
P – will give the brown colour of bromine
R – will remove the brown colour of bromine (will become colourless)

7d(i)
It is the process of splitting of a nucleus of an atom to two nuclei

7d(ii)
$^{3}_{1}H(Tritium)$ and $^{2}_{1}H(Deuterium)$

7e
This is because they have the same atomic number but different mass numbers, so in beta decay, the atomic number changes and are different

7f(i)
228 – Mass Number
88 – Atomic Number

7f(ii)
$^{232}_{90}Th \rightarrow ^{228}_{88}Ra + ^{4}_{2}\alpha$

NODE QUESTION PAPER ANSWERS

1c(i)
They conduct electrons (electricity)
They are durable (longer lasting)
They are malleable (can be changed to different shapes)

1c(ii)
Potassium has a larger atomic radius therefore lose its last shell electron easily than sodium.

1d(i)
R is 2:8:1
Q is 2:8:7

1d(ii)
Period: 3
Group: 1

OXIDATION NUMBER QUESTION PAPER ANSWERS

1a
It is the distribution of electrons in shells of an atom according to the required number of electrons for a shell.

1b(i) Group Six

1b(ii)
It has an atomic number 8, therefore has 8 electrons in the last shell.

1b(iii)
Because there is high increase in atomic number from 9 to 11

1b(iv)
F has a small radius therefore has a higher force of attraction to gain electrons than Cl with larger radius therefore less force of attraction.

1b(v)
- In Lithium electrons are delocalised while in Chlorine electrons are shared.
- In Lithium the bonds can conduct electricity while in Chlorine they can not.

1c(i)
- For making gun powder and matches
- For making sulphuric acid
- For photographic development

1c(ii)
It is yellow in colour
It is solid at room temperature
It is insoluble in water

1d(i)
By gaining 3 electrons

1d(ii)
It is a non metal

1d(iii)
Li_2O

1d(iv)
+2

3a
Radioactivity is the sudden disintegration of the heavy nuclei of atoms to emit particles and electromagnetic radiation.

3b(i)
Alpha particles

3b(ii)
Beta particles

3b(iii)
Gamma particles

3c
1. Guiger Muller Counter
2. Cloud Chamber
3. Spark counter
4. The leaf electroscope

3d(i)

$$^{238}_{92}U \longrightarrow (92P, 146N)$$

$$^{234}_{92}U \longrightarrow (92P, 142N)$$

The two can be split into two roughly equal parts by the action of neutrons.

3d(ii)
Because neutrons having no charge are able to penetrate deep into the positively charged nucleus of U – 235

3e
Radium – 226
Carbon – 14
Uranium – 238

3f
After 30min = (1)(1/2)
= 1/2 left
After 60min = (1/2)(1/2)
= 1/4 left
After 90min = (1/4)(1/2)
= 1/8left
After 120min = (1/8)(1/2)
= 1/16left

5a
As a beverage
As a solvent
To manufacture esters

5b
It ionises partially when dissolved in water to produce flow H^+ ions for conductivity.

5c

$$CH_3COOH + H_2O \rightleftharpoons H_3O + CH_3COO^-$$

5d
Ethanol is like water because they both have an OH^- group.

5e(i)
Iron has lost two electrons to have the small charge of +2.

5e(ii)
It is +1

5e(iii)
Silver (Ag)

5e(iv)
Its charge has been reduced from +1 to 0.

5f(i)
It is $C_nH_{2n+1}COOH$

5f(ii)
HCOOH – Methanoic Acid

5f(iii)
It is lower

5f(iv)
Because butane has no functional group as it is the case in carboxylic acids.

5g
- Burning
- Burying
- Recycling them economically

7a
They are electrical insulators in that they do not conduct electricity and heat.

They do not decompose easily meaning that they do not decompose with the action of bacteria.

Some are soft and malleable in that one can easily mould them into different shapes.

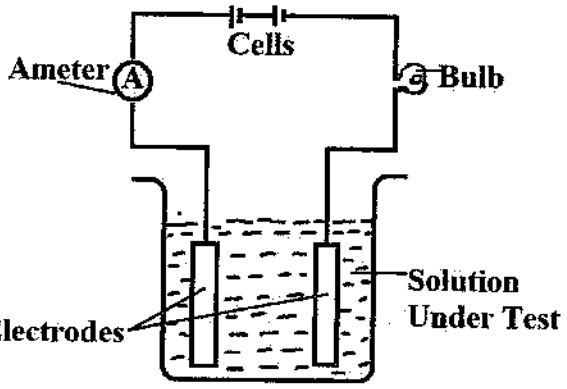
7b
Control pollution because most of them are dispensed properly ready for reuse thereby making the environment clean.

Economic gains as people will collect them and sell to industries for recycling to get money.

7c
Because they have cross-linked such that they can be not be re-melted once they have been formed. The cross-links provide the permanent bonds which are rigid when moulded and no softening takes place on heating, they just char.

8a
A solution which can conduct electricity by the use of its ions.

8b
An experiment will be set up as below:



Dip the electrodes into the solutions of potassium nitrate and potassium chloride in turns.
Record the ammeter reading
Observe the brightness of the bulb
Comparing the one with higher ammeter reading of high brightness conducts electricity better than the other.

PRECISION QUESTION PAPER ANSWERS

1a(i)
Addition Polymerisation

1a(ii)
Many ethene monomers are joined together to form a long chain molecule.

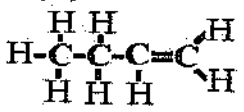
1a(iii)
Polythene
Polyester
Nylon

1b(i)
It is A

1b(ii)
They are B and E

1b(iii)
Because C ionises in water to produce H^+ ions which conduct electricity.

1b(iv)



1b(v)
Butene or But-1-ene

1c(i)

Differences	
Thermosoftening Plastics	Thermosetting Plastic
Softens when heated	Do not soften when heated
Can be re moulded after being heated	Cannot be remoulded after being heated
They have no cross -links chains	They have cross-links chains

1c(ii)
Burning
Burying

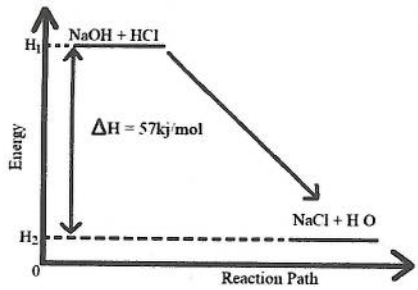
1c(iii)
Are not corroded
Are light
They are poor conductors of heat

3a(i)
It is the one which completely dissociate to yield many hydroxide ions dissolved in water.

3a(ii)
$NH_3 + H_2O \rightleftharpoons NH_4 + OH^-$

3a(iii)
NH_4 /NH_3 or H_2O/OH^-

3b(i)



$NaOH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

$\Delta H = -57kj/mol$

3b(ii)
Exothermic

3b(iii)
ΔH is negative showing that heat energy was released.

3b(iv)
(*aq*) means aqueous solution
(*l*) means liquid

3c(i)
mass = 0.3g (300/1000)
Molar Mass
= (9x12)+(8x1)+(4x16)
= 108+8+64
= 180g/mol

No of mol
= 0.3/180
= 1/600mol
= 0.002mol

3c(ii)
No of mol = 0.002
Vol = 10ml
= 10/1001
= 0.001

Con = 0.002/0.001
= 2/1
= 2mol/l

5a(i)
It is F

5a(ii)
They are C and D

5a(iii)
They are metals and react by losing electrons in the outer most shell.

5a(iv)
- It has the outer-most shell filled
- It is unreactive
- It is a noble gas

6e(i)
They are Mg and Al

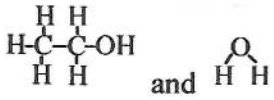
6e(ii)
They are above it on the series

6f(i)

$Mg^0_{(s)} + 2Ag^+_{(aq)} \rightarrow Mg^{2+}_{(aq)} + 2Ag^o$

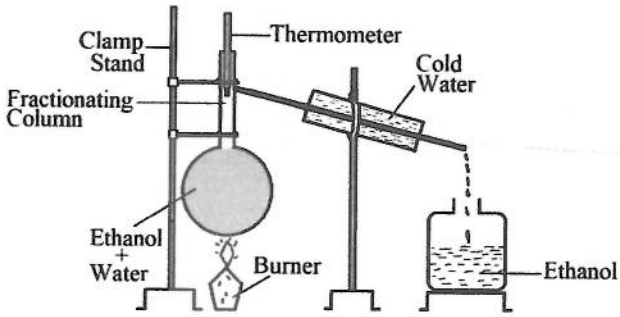
6f(ii)
Oxidation Agent: Ag^+ (silver)
Reducing Agent: Mg

7a



7b
Ethanol has one O-H bond while water has two O-H bonds which contribute to difference in boiling points.

7c



The two can be separated by fractional distillation. The mixture is heated until the contents reach temperatures when the two can be boiled and start separating. Ethanol with lower temperature will boil first and water will remain in the container.

8

Alpha Decay
During alpha decay the radioactive substance release the helium with atomic number of 2 and mass number of 4 which decreases the mass number by 4 and atomic number by 2. The alpha particle: is deflected in both magnetic and electric fields ionise the gas through which they travel
have less penetrating power
travel in a straight line in free space.

Beta Decay
During Beta decay the radioactive substance releases a neutron which is slightly heavier than a proton emits an electron and becomes a proton. The mass number remains the same but the atomic number increases by 1

The Beta particle:
is deflected in both magnetic and electric fields
ionises the gas through which they travel have penetrating power more than that of alpha particles are emitted with different energies

Gamma Emission
During Gamma emission the radioactive substance releases radiation of pure electromagnetic radiations. The mass number and the atomic number of the substance do not change. The Gamma is a charge less and massless particle. It ionises the gas through which it travels. It has the highest penetrating power in both magnetic and electric fields. It possesses energy called photon energy (E = hv).

Who is Who in the History of Chemistry?

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LINUS PAULING

In full Linus Carl Pauling
Born February 28, 1901, Portland, Oregon, U.S.
Died August 19, 1994, Big Sur, California

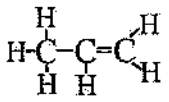
An American theoretical physical chemist who became the only person to have won two unshared Nobel Prizes. His first prize (1954) was awarded for research into the nature of the chemical bond and its use in elucidating molecular structure; the second (1962) recognized his efforts to ban the testing of nuclear weapons. Has often been hailed as one of the most important scientists ever to have lived. Pauling essentially invented, single-handedly, what we now know as molecular biology – the study of things like proteins and acids in the body – and quantum chemistry, or the study of the relationships between the smallest things in the atom and covalent or ionic bonds. Finally, his research into proteins also inspired the work of Francis Crick and James Watson, who, without Pauling, would never have discovered the structure of DNA

QUANTUM THEORY QUESTION PAPER ANSWERS

1a(i)
Q are Alkanes
S are Alkanoic Acids

1a(ii)
P: C_nH_{2n} and Q: C_nH_{2n+2}

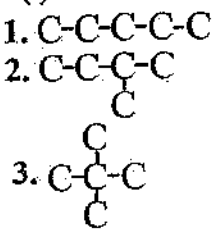
1a(iii)



1a(iv)
It is Propene

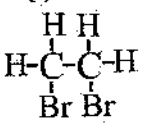
1a(v)
By using solubility Test where the two are mixed with water. The results are that Q will form two layers and R forms one layer.

1b(i)



1b(ii)
1. n – pentane
2. 2 – methyl butane
3. 2, 2 – dimethyl propane

1c(i)



1c(ii)
1,2 dibromoethane

1c(iii)
Important in the manufacture of margarine from oil fats
Production of fire extinguishers e.g CCl_4

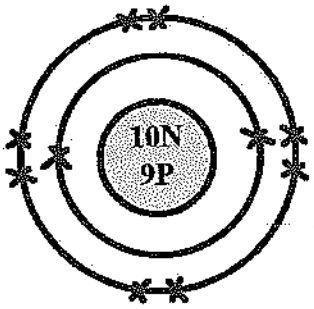
2a(i)
Potassium bromide

2a(ii)
Sodium chloride

2a(iii)
Potassium iodine

2b
They are diatomic
They react by gaining one electron in the last shell

2c



2d
$^{127}_{53}I$

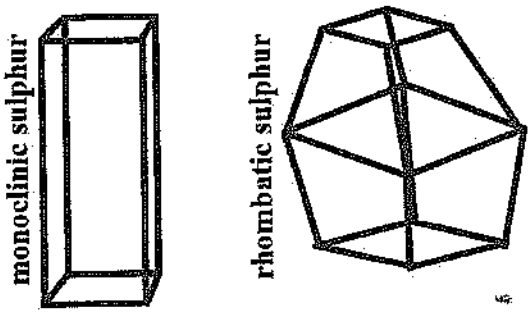
$^{80}_{36}B$

$^{35.5}_{17}Cl$

2e
The difference is due to the differences in their atomic radii where Cl has the smallest hence the most reactive followed by Br. Iodine has the largest radii hence the least reactive. Again this is because halogens react by gaining electrons.

2f
It is yellow in colour
It is insoluble in water

2g



Monoclinic sulphur, a Beta Sulphur (b) has a long prism shape as shown in the diagram, it is less stable than Rhombic sulphur, an alpha – sulphur (a) that has an octahedral shape as shown in the diagram which is more stable.

3a
It is the splitting of heavy nucleus into higher nucleus/nuclei with the release of energy.

3b
Protons and Neutrons

3c(i)
A: Beta particle (b)
B: Alpha (a)

3c(ii)
Because they have less penetrating power

3d(i)
X is Alpha
Y is Gamma
Z is Beta

3d(ii)
Because it is negatively charged hence attracted to the positive charges on the plate as unlike charges attract.

5a(i)
Hydrogen ion

5a(ii)
Carbonic acid has partial ionisation while hydrochloric acid has a complete ionisation when both are dissolved in water.

5b

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

$$\frac{MV}{N_1}(NaOH) = \frac{MV}{N}(HCl)$$

$$MV(NaOH) = MV(HCl) \quad (N = N = 1)$$

$$V = \frac{MV(HCl)}{M(NaOH)}$$

$$V = \frac{0.1 \times 20}{0.1}$$

$$V = \frac{1 \times 20}{1}$$

$$V = 20cm^3$$

5c(i)
The reaction can go to both directions (reversible)

5c(ii)

1. $HSO^-_{4(aq)} + H_2O \rightleftharpoons H_3O_{(aq)} + SO^{-2}_{4(aq)}$
2. $H_3PO_{4(aq)} + NH_{3(l)} \rightleftharpoons NH^+_4 + H_2PO^-_{4(aq)}$

5d(i)
No, it will not react

5d(ii)
Copper is below in the series therefore cannot displace magnesium ions in the solution.

5d(iii)
Lithium

5d(iv)
Because it is on the very top of the series

5e(i)
Dissolution:

$$Na - 1e^- \rightarrow Na^+$$

Precipitation:

$$Ag^+ + 1e^- \rightarrow Ag^o$$

5e(ii)
Oxidation Agent = Silver
Reducing Agent = Sodium

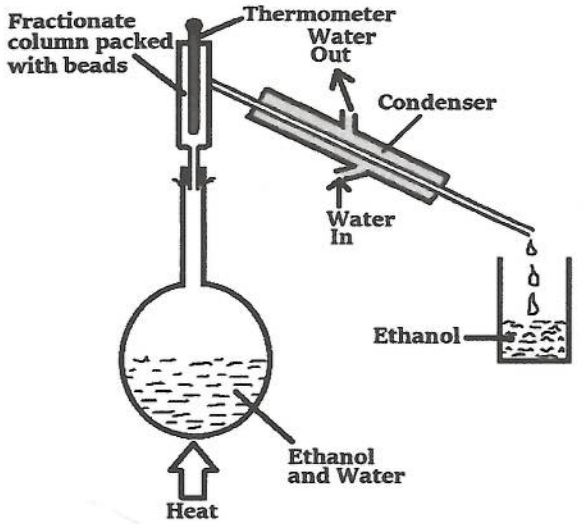
Interesting Science facts

POLISHING SHOES IS LIKE FILLING IN A ROAD'S POTHOLES

Regular leather appears dull to the eye because it's covered in teeny-tiny scrapes and scratches that scatter whatever light hits the material. When you polish a leather shoe, you coat it in a fine layer of wax, filling in those crevices much like a road crew smoothes out a street by filling in its potholes. Because the surface is more uniform, rays of light bounce back toward your eye more evenly, making it look shiny

RADIOACTIVITY QUESTION PAPER ANSWERS

1a (i)



1a(ii)
This is because some water evaporates together with ethanol vapour

1b.(i)
molarity is the number of moles per cubic decimetre

1b(ii)

$$Mol = \frac{5g}{58.5g}$$

$$Mol = 0.085$$

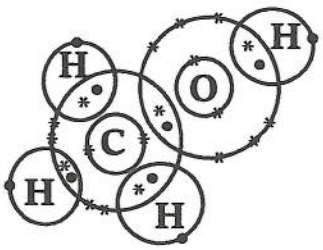
Molarity in 1000cm³

$$= \frac{1000cm^3}{0.085M}$$

1b(iii)
The NaCl remains the same 5g.

1c(i).
In SO_2 and in CH_3OH

1c(ii)



1d. (i)

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

1d(ii)
The equation is combustion

3a(i) Atomic number is the number of protons in an atom

3a(ii)
Electron configuration is the distribution of electrons of an atom in shells.

3b(i)
What is the density of Be? (1mark)
It is 2g/cm³

3b(ii)
Elements in the same period have the same density eg. N, O, F, Ne in period 2

3b(iii)
It is Al

3b(iv)
There are two periods

3c(i)
Reduction is the decrease in oxidation state

3c(ii)(1)
It is a displacement reaction

3c(ii)(2)
Na, Mg, Fe, Pb

3d(i)
1. Allowing ions to pass through
2. It keeps the two solutions from mixing

3d(ii)
It is

$$Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2e$$

5a(i)
Strong acid dissociates completely while weak acid dissociates partially.

5a(ii)
(1) strong acid: HCl
(2) Weak acid: Lemon Juice

5b(i)
They are salt and water

5b(ii)

$$Zn_{(s)} + 2HCl_{(aq)} \rightarrow ZnCl_{(aq)} + H_{2(g)}$$

5c(i)
It is an anode

5c(ii)
This is because at the anode the copper atoms lose electrons and enter into solution as ions.

5c(iii)
At the anode, the electrode dissolves and become thin. At the cathode pure copper is deposited and become fat.

5c(iv)
The impurities from the anode drop to the bottom of the cell

5c(v)
This is because the ions from the solution "Cu^{2+}" are replaced ions of copper from the anode.

5d(i)
It is the particle size of the substance

5d(ii)
These are:
Temperature
Amount of substance

5d(iii)
Rate

$$= \frac{CO_2\ Volume}{Total\ Time}$$

$$= \frac{5cm^3}{1\min}$$

$$= 5cm^3/\min$$

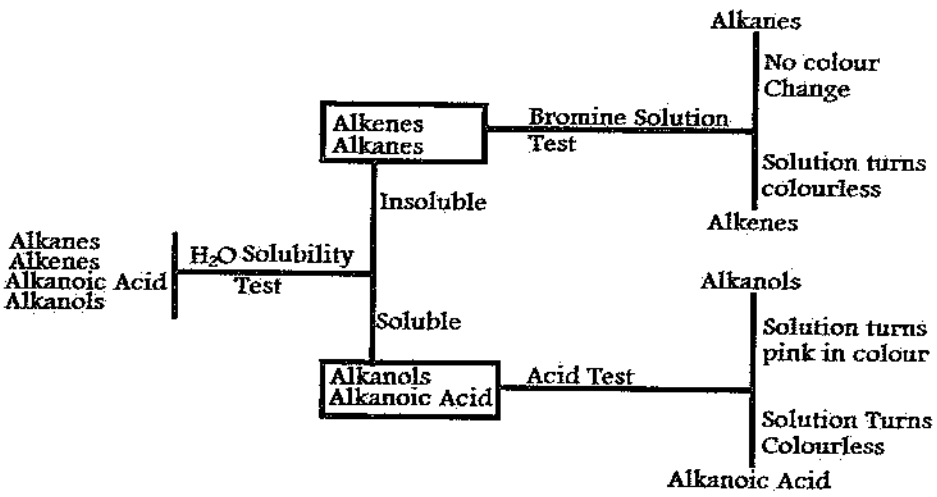
7a.
Total molecular mass = 114g
Total Ration mass
C = 12x4 = 48g
H = 1x9g = 9g

Therefore
Total = 48g+9g = 57g
Number of carbons
= (114g/57g)×4
= 8

Number of Hydrogens
= (114g/57g)×9
= 18

Molecular formula = C_8H_{18}

7b.



Water solubility test
Put 2cm^3 of substance in a test tube
Add 10 drops of distilled water and shake.

Acid Test
Add 2-3 drops of phenolphthalein in a test tube
Add 10 drops of NaOH solution
Put 2cm^3 of the substance
In alkanols, the solution turns pink in colour. In alkanoic acid the solution turns colourless

Bromine Solution Test
Put 2cm^3 of substance to be tested in a test tube.
Add 2 drops to bromine water.
No colour change of bromine in alkane and Bromine solution turns colourless in alkene.

SUBLIMATION QUESTION PAPER ANSWERS

1a
P. brass cap
Q. Carbon rod
R. Zinc can (container)
S. Ammonium chloride

1b
P. To provide contact between carbon rod outside positive terminal of battery
Q. acts a positive electrode
R. Acts as the negative electrode
S. acts as an electrolyte

1c(i)
Because voltage of electromotive force of a cell depends upon the nature of the chemicals used.

1c(ii)
- Provides a large space for electrochemical that store chemical energy
- increases the movement of ions which passes electric current

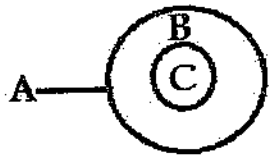
1d(i)
Presence of air (oxygen)
presence of water

1d(ii)
Involves dipping iron metal into molten zinc

1e

$$Fe_{(s)} + Sn^{+2}_{(aq)} \rightarrow Fe^{+2}_{(aq)} + Sn_{(s)}$$

3a(i)



Both B and C are organic compound hence contained in A but they respond differently to water hence in separate 'sets'.

3b(i)

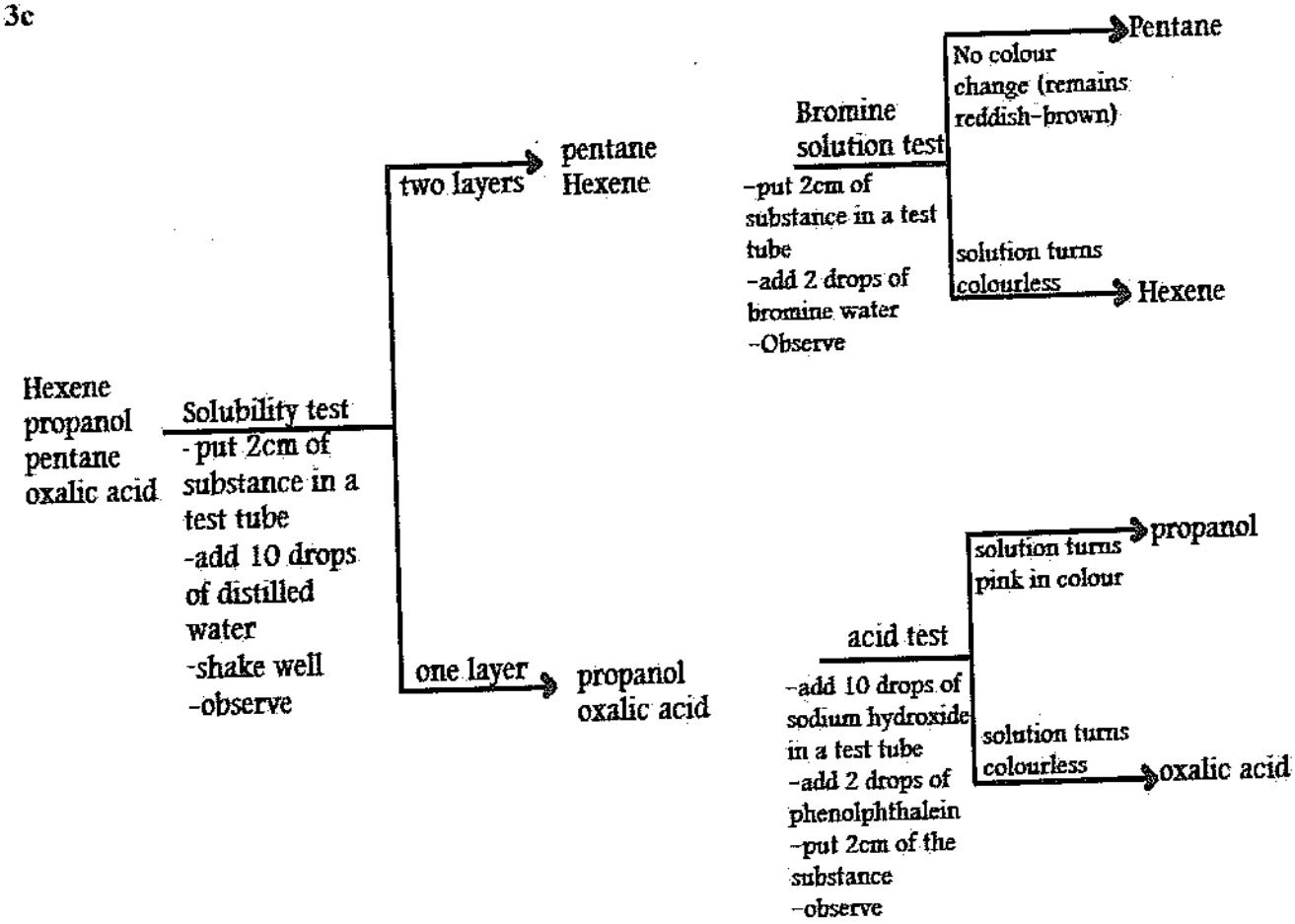
$$CH_3COOH_{(aq)} + KOH_{(aq)} \rightarrow H_2O + CH_3COOK_{(aq)}$$

$$CH_3COOH_{(aq)} + K^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O + CH_3COO^-_{(aq)} + K^+_{(aq)}$$

3b(ii)
Are ions that remain in solution

3b(iii)
$CH_3COOH_{(aq)}$ and $K^+_{(aq)}$

3c



5a(ii)
Valency for E: 1
Valency for F: 1

5a(iii)
Ionic bonding

5a(iv)
Group 6

5a(v)
Number of digits making up the electronic configuration is equal to period of an element.

5a(vi)
This is because element E has a smaller atomic number and less number of energy levels which reduces covalent radius hence being able to attract electrons more strongly than element G.

7a
Are relatively weak electric force that attract neutral molecules to one another

7b
When size of the molecule increases, for example from F_2 to Cl_2, the molecule has temporary dipole. As a result, the molecule ability to become polar and displace its electrons increases hence the molecule becomes of high melting and boiling point which signifies increase in forces of attraction known as van der Waals force.

Atoms in the molecule also affect strength of van der Waals force. For example, in molecule HCL, the molecule has a permanent dipole because of chlorine which has more electronegativity than hydrogen. As such, the permanent in built dipoles will cause the molecule to attract each other rather more, hence high Vander Waals force.

7c

Unlike $C_{70}H_{142}$ sodium chloride formed when sodium has lost one electron in its outermost shell to become Na^+ while chloride has gain lost electron from sodium to form Cl^-. These opposite charges attract forming a very strong bond which needs higher temperatures to separate them hence higher melting point, while $C_{70}H_{142}$ does not involve opposite charges to form a bond hence lens amount of heat can separate it.

Who is Who in the History of Chemistry ?

DOROTHY HODGKIN

In full Dorothy Crowfoot Hodgkin
Née Dorothy Mary Crowfoot,
Born May 12, 1910, Cairo, Egypt—died July 29, 1994,
Shipston-on-Stour, Warwickshire, England

English chemist whose determination of the structure of penicillin and vitamin B_{12} brought her the 1964 Nobel Prize for Chemistry. Her research had a massive impact on biochemistry and medicine. She and her team worked on the structure of penicillin, vitamin B12, and, importantly, insulin. Her career was notable for her advocating for the importance of knowledge of insulin, too – for its central role in diabetes.