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233/1

CHEMISTRY PAPER 1 (THEORY)

THEORY

TERM 2

2 HOURS

FORM 4

Kenya Certificate of Secondary Education (K.C.S.E)

MARKING SCHEME

1. An atom of element A has mass number 23 and 12 neutrons.

   (a) Write the electron arrangements of the atom   (1 mark)

   2.8.1

   (b) State the period and group to which element A belongs

   Group (I)   (½ mark)

   Period 3   (½ mark)

   (c) State whether the element is a metal or a non-metal.   (1 mark)

   Metal

2. (a) What is an indicator?   (1 mark)

   A substance that shows different colours in acids and bases

   (b) Name the indicator which can be used to determine the pH value of lemon juice. Give a reason for your answer.   (2 marks)

   Universal indicator; ✓1 it indicates the strength of acidic or basic solutions✓1

3. At 20^OC, NO_2 and N_2O_4 gases exist in equilibrium as shown in the equation below

   $2\ NO_{2(g)}$ ⇌ $N_2O_{4(g)};$ $\triangle H$ = -ve

   Brown   pale yellow
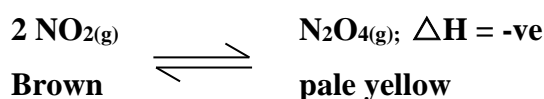
   State and explain the observation that would be made when;

   (a) A syringe containing the mixture at 20^OC is immersed in ice-cold water. (1 ½ marks)

   Pale yellow intensifies. ✓½ Forward reaction is exothermic; ✓½ lowering temperature shifts the equilibrium to the right hence more N_2O_4 is formed✓½
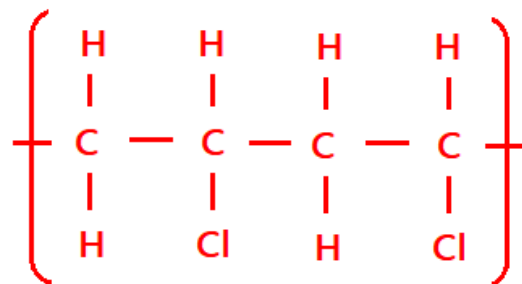
   (b) Lowering temperature shifts the equilibrium to the right. The volume of the gaseous mixture in a syringe is reduced.   (1 ½ marks)

   Pale yellow intensified ✓½ reducing the volume of syringe increases the pressure ✓½ favouring the forward reaction ✓½

4. A monomer has the following structure

$$
\begin{array}{ccc}
\text{H} & & \text{H} \\
| & & | \\
\text{C} & = & \text{C} \\
| & & | \\
\text{H} & & \text{Cl}
\end{array}
$$
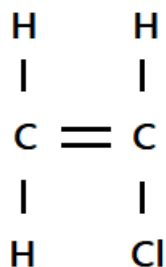
(a) Draw the structure of its polymer that contains two monomers.　　(1 mark)

$$
\left[
\begin{array}{cccc}
\text{H} & \text{H} & \text{H} & \text{H} \\
| & | & | & | \\
\text{C} - & \text{C} - & \text{C} - & \text{C} \\
| & | & | & | \\
\text{H} & \text{Cl} & \text{H} & \text{Cl}
\end{array}
\right]
$$

(b) A sample of the polymer formed from the monomer has a molecular mass of 4500. Determine the number of monomers that formed the polymer (C= 12; H= 1; Cl=35.5).

(2 marks)

RFM of the monomer = (12 x 2) + (1 x 3) + 35.5 = 62.5 ✓1

No of monomers = $\dfrac{4500}{62.5}$ = 72 ✓1

5. (a) Name the gaseous pollutant produced during Contact Process　　(1 mark)
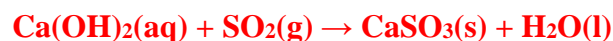
Sulphur (IV) oxide 　　　　　　　**(Reject SO₂)**

(b) Describe how scrubbing of the gas named in (a) above is done to reduce pollution.

(1 mark)

Passing the exhaust gases through chimneys lined with calcium hydroxide ✓1

OR

$Ca(OH)_2(aq) + SO_2(g) \rightarrow CaSO_3(s) + H_2O(l)$

6. Use the table below to answer the questions that follow. (The letters are not the actual symbols of the elements)

| Element	Atomic number	Boiling point (°C)
A	19	774

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B	11	890
C	17	-35
D	13	2470
E	14	2360

(a) Identify an element that exists as a gas at room temperature. Explain.   (2 marks)

C;✓1 its boiling point is lower than room temperature ✓1

(b) Using dots (●) and crosses(x) draw the bonding formed when element **A** and **C** react to form a compound.   (1 mark)
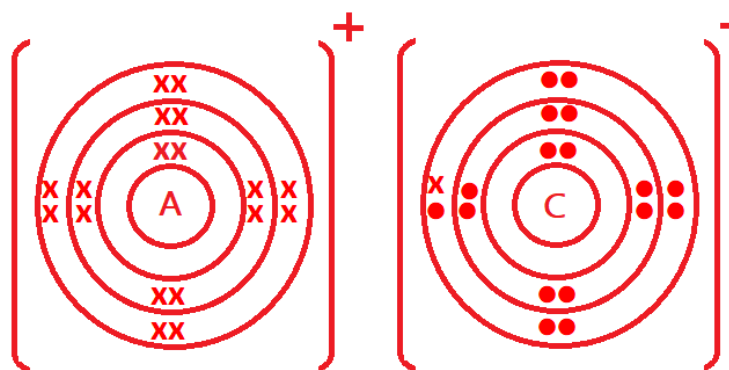
7. Lead (II) chloride can be prepared from lead (II) carbonate using the following procedure:

Step 1: Add excess lead (II)carbonate to dilute nitric (v) acid.
Step 2: Filter to obtain lead (II)nitrate solution as filtrate.
Step 3: Add sodium chloride solution to the filtrate.
Step 4: Filter off to obtain lead (II)chloride as residue.
Step 5: Wash the lead (II)chloride residue with distilled water dry between filter papers.

Why are the following steps necessary?
(a) Using **excess** lead (II)carbonate used in step 1   (1 mark)

   To ensure all the acid has reacted

(b) Using dilute nitric(V) acid instead of sulphuric (VI) or hydrochloric acid in step 1

(1 mark)

   Reacting lead (II)carbonate with H_2SO_4 or HCl would lead to formation of an insoluble salt ✓½ that would prevent further reaction ✓½

(c) Washing the lead (II)chloride residue with distilled water in step 5   (1 mark)

   To remove traces of sodium chloride

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8. Phosphorus is in group (V) of the periodic table. Explain the following observations.
   (a) Phosphorus exhibits two melting points. (1 mark)

   Phosphorous has two allotropes

   (b) The chloride of phosphorus forms musty fumes in damp air. (2 marks)

   Chlorides of phosphorous hydrolyse ✓1 in moisture to form $HCl_{(g)}$ ✓1

9. The apparatus below was used to separate a mixture of **water** and **kerosene**.
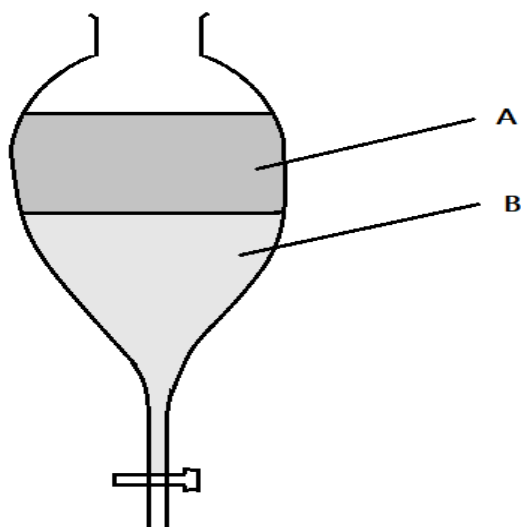
   (a) State **two** properties of the liquids that make it possible to separate them using such apparatus. (1 mark)
   Density   ✓½
   Immiscibility   ✓½
   (b) Name the liquids **A** and **B.** (1 mark)
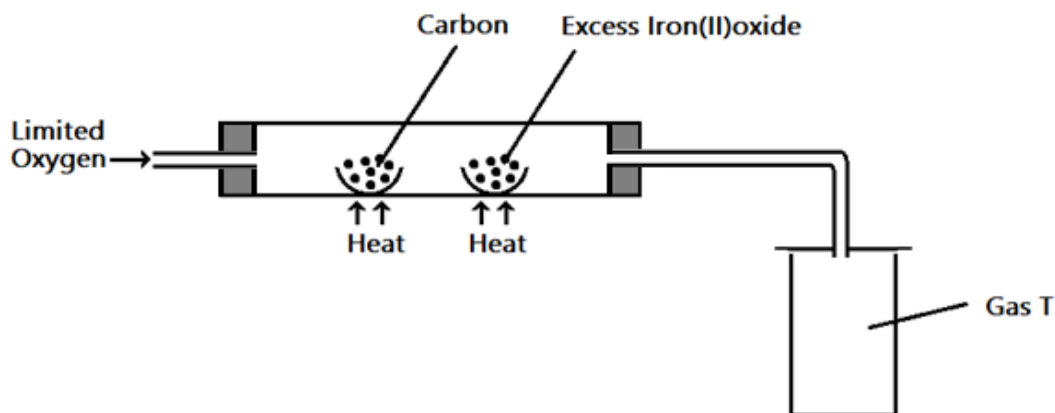   **A- water   ✓½   (Reject H_2O)**
   B- kerosene   ✓½
   (c) Give the name of the above method of separation. (1 mark)
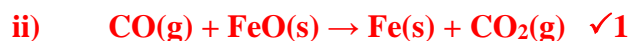   **Use of a separating funnel / funnel separation**

10. The set up below was used to obtain a sample of iron.

(a) Write **two** equations for the reactions which occur in the combustion tube.

(2 marks)

i) $2C(s) + O_2(g) \rightarrow 2CO(g)$ ✓1

ii) $CO(g) + FeO(s) \rightarrow Fe(s) + CO_2(g)$ ✓1

(Award ½ mark for a balanced equation with wrong states; zero mark for unbalanced equation)

(b) Identify Gas **T**   (1 mark)

Carbon (IV)oxide / CO_2   **(Reject Co_2)**

11. Chlorine gas was bubbled through potassium iodide solution.

a) State the observation that would be made.   (1 mark)

The solution turns from colourless to brown

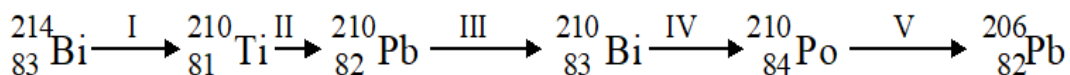b) Write the ionic equation for the reaction that took place in (a) above.   (1 mark)

$Cl_2(g) + 2I^-(aq) \rightarrow 2Cl^-(aq) + I_2(s)$

c) Identify the oxidizing agent in the ionic equation (b) above.   (1 mark)

Cl_2 / Chlorine   **(Reject Cl^-)**
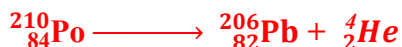
12. Consider the reaction chain below.

$$^{214}_{83}Bi \xrightarrow{\text{I}} ^{210}_{81}Ti \xrightarrow{\text{II}} ^{210}_{82}Pb \xrightarrow{\text{III}} ^{210}_{83}Bi \xrightarrow{\text{IV}} ^{210}_{84}Po \xrightarrow{\text{V}} ^{206}_{82}Pb$$

(a) Identify the particles emitted in

(i) I ^4_2He / alpha particle   (½ mark)

(ii) II $^0_{-1}e$ / beta particle   (½ mark)

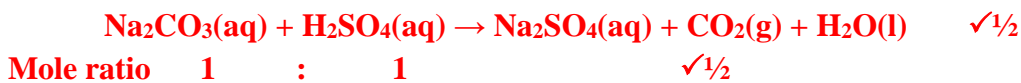(b) Write the nuclear equation for the reaction that takes place in V.   (1 mark)

$$^{210}_{84}Po \longrightarrow {}^{206}_{82}Pb + {}^4_2He$$

(c) State one environmental effect of radioisotopes.   (1 mark)

     - **Genetic mutation in living tissues causing cancers**   ✓1

     - **Mass destruction of property & lives when used be used as weapons**

13. $25cm^3$ of 0.1M sulphuric (VI) acid required $20cm^3$ of sodium carbonate solution for complete neutralization. Calculate the concentration of sodium carbonate in moles per litre.   (3 marks)

     Moles of H_2SO_4 = $\underline{0.1 \times 25}$ = 0.0025 moles   ✓½
                     1000

     $Na_2CO_3(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + CO_2(g) + H_2O(l)$ ✓½
   Mole ratio   1   :   1   ✓½

     Moles of Na_2CO_3 = 0.0025 x 1 = 0.0025 moles   ✓½

     Molarity = $\underline{0.0025 \times 1000}$ ✓½
                20

        = 0.125 M   ✓½

14. Study the flow chart **below**.
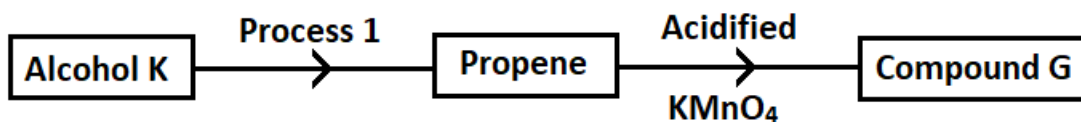
(a)   Write the molecular formula of alcohol **K**.   (1 mark)

     C_3H_7OH

(b)   Name

(i)   Compound **G**   **Propan -1, 2 - diol**   (1 mark)

(ii)   Process **1**   **Dehydration**   (1 mark)

15. (a) Define the term oxidation state.   (1 mark)

Apparent charge that an element has in a compound or the charge on an ion

(b) Calculate the oxidation states of chromium and manganese in the following ions.

(i) Chromium in $Cr_2O_7^{2-}$ (1 mark)

2Cr + 7(-2) = -2   ✓½

2Cr = +12

Cr = +6   ✓½

(ii) Manganese in MnO_4^- (1 mark)

Mn + 4(-2) =-1   ✓½

Mn + -8-8 =-1+8

Mn = +7   ✓½

16. (a) What is a flame?   (1 mark)

Mass of burning gases

(b) Which type of flame is produced when the air hole of a Bunsen burner is closed?   (1 mark)

Luminous flame

(c) State one observable differences between the two types of flame.   (1 mark)

| **Non-luminous**		**Luminous**	
(i)	**Has three zones.**	**(i)**	**Has four zones**
(ii)	**Is short and steady**	**(ii)**	**Large and wavy.**
(iii)	**Does not give out much light**	**(iii)**	**It gives out much light**
(iv)	**Burns with a roaring sound**	**(iv)**	**Burns silently**
(v)	**Does not produce soot.**	**(v)**	**Produces soot**
(vi)	**Blue**	**(vi)**	**Yellow**

17. In an experiment to electroplate a copper spoon with silver, a current of 0.5A was passed for 18 minutes. Calculate the amount of silver deposited on the spoon (1 Faraday = 96500 coulombs, Ag =108)   (3 marks)

$$Ag^+_{(aq)} \rightarrow Ag(s) + e^-$$
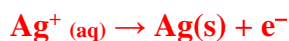
$$\frac{0.5A \times 18 \times 60 \times 108}{1 \times 96500} = 0.6044g \qquad \checkmark \text{3 marks}$$

(Alternatively)

$$Ag^+_{(aq)} \rightarrow Ag(s) + e^-$$
1 Ag mole = 1 Faraday $\qquad \checkmark\frac{1}{2}$
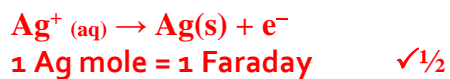
Time = 18 × 60 = 1080 sec $\quad \checkmark\frac{1}{2}$

Q = 0.5A × 1080 = 540C $\quad \checkmark\frac{1}{2}$

$$108g \rightarrow 96500C$$
$$g? \leftarrow 540C \qquad \checkmark\frac{1}{2}$$

$$\frac{540C \times 108}{1 \times 96500C} \qquad \checkmark\frac{1}{2}$$

0.6044g $\qquad \checkmark\frac{1}{2}$

18. A measuring cylinder containing moist iron filings was inverted in a trough of distilled water as shown in the diagram below.
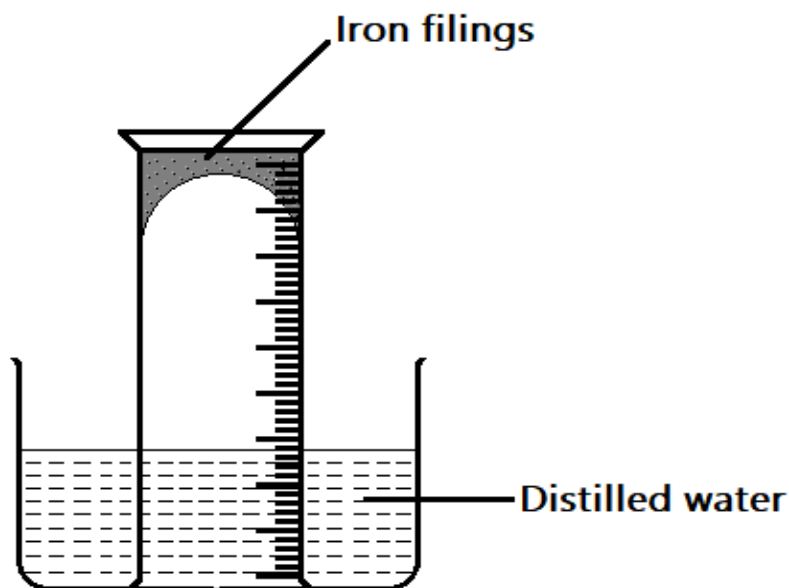
(a) State and explain the observations made on the:

   (i)   Moist iron filings after four days;   (1 mark)

Iron filings changed from grey to brown. Iron reacted with moisture and oxygen to form rust

    (ii)   Water level in the measuring cylinder after four days.   (1 mark)

Water level rise in the measuring cylinder to occupy the space left by oxygen during rusting.

(b) What would be the effect of using iron filings moistened with tap water?

    (1 mark)

The iron filings would rust faster, salts contained in tap water accelerate rusting

19. Below are properties of some elements in period 3 of the periodic table

| Element	Na	Mg	Al
Atomic radius (nm)	0.152	0.136	0.125
Melting points (^{O}C)	97.8	650	660

(a) Explain the trend in the melting points   (2 marks)

Melting points increase from Na to Al; ✓1 due to decrease in atomic radius (accept increase in the number of delocalised electrons) ✓½ which increases the strength of the metallic bonds ✓½

(b) Why is there a decrease in size of the atoms from Na to Al?   (1 mark)

Increase in nuclear charge (or number of protons) ✓½ across the period which pulls electrons closer to the nucleus. ✓½

20. The flow chart below shows steps used in the extraction of zinc from one of its ores.
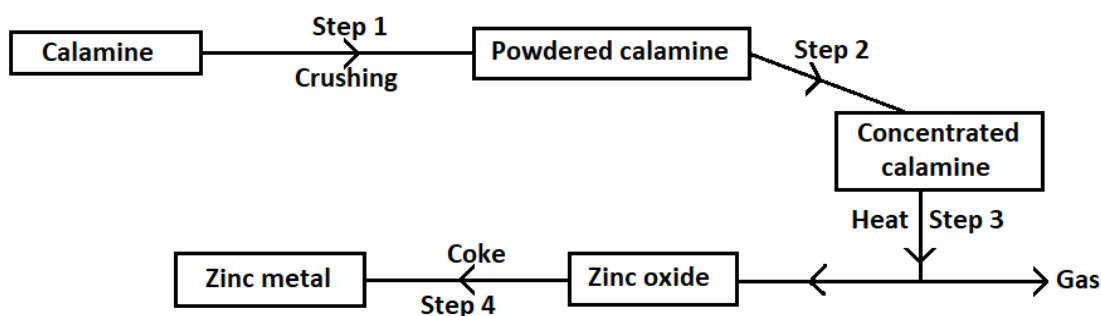
(a) Name the process that is used in **step 2** to concentrate the ore.   (1 mark)

Froth floatation

(b) Write an equation for the reaction which takes place in **step 3**. (1 mark)

$ZnCO_3(s) \rightarrow ZnO(s) + CO_2(g)$

(c) State one use of zinc other than galvanizing. (1 mark)

- **Making of outer casing in dry cells.**

- **To make brass, an alloy of copper and zinc which is used in to manufacture locks, hinges, gears, bearings, ammunition casings, zippers, plumbing, hose couplings, valves and electrical plugs and sockets**

21. (a) What is the type of the heat change that occurs when one mole of a substance burns completely in oxygen? (1 mark)

Molar heat of combustion

(b) Methane reacts with oxygen according to the equation given below.

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$ $\Delta H = 890$ kJ mol^{-1}
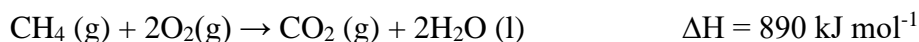
Calculate the volume of methane which would produce 111.25 kJ when completely burnt.

(Molar volume of a gas = 24 litres.) (2 marks)

From the equation:
1 mole of methane produces 890kJ ✓½

Hence 890 kJ = 24 litres ✓½

111.25 kJ = $\underline{111.25 \times 24 \text{ litres}}$ ✓½
                        890

= 3 litres ✓½

22. (a) State the Graham's law diffusion. (1 mark)

At constant temperature and pressure, the rate of diffusion of a gas is inversely proportional to the square root of its density.

(b) The molar masses of gases W and X are 16.0 and 44.0 respectively. If the rate of diffusion of W through a porous material is 12cm^{3}s^{-1} calculate the rate of diffusion of X through the same material. (2 marks)

$\underline{\textbf{12}}$ = $\underline{\sqrt{\textbf{44}}}$ ✓½

$$R_X \qquad \sqrt{16}$$

$$R_X \quad = \quad \frac{12 \times \sqrt{16}}{\sqrt{44}} \quad \checkmark\tfrac{1}{2}$$

$$= \quad \frac{48}{6.63} \quad \checkmark\tfrac{1}{2}$$

$$= \quad 7.24 \ cm^3 s^{-1} \quad \checkmark\tfrac{1}{2}$$

23. Coal, oil and natural gas are major sources of energy. They are known as fossil. Hydrogen is also a source of energy.

(a) State and explain two reasons why hydrogen is a very attractive fuel compared to fossil fuels (2 marks)

- **Hydrogen burns to produce steam which is a non-pollutant/ does not cause pollution to the environment.**
- **Hydrogen has a high energy content hence very small amount produce a lot of heat energy.**
- **Hydrogen is renewable hence cannot be exhausted/ used completed.**

(b) State one disadvantage of using hydrogen fuel instead of fossil fuel. (1 mark)

- **A mixture of hydrogen and air is explosive when mixed ignited.**
- **It is expensive.**

24. (a) Other than salt, identify two substances that are formed when an acid reacts with a carbonate.

(1 mark)

- **Carbon (IV)oxide**
- **Water**

(b) When hydrogen chloride gas is dissolved in water, the solution formed turns blue litmus paper red but there is no effect on blue litmus paper, when the gas is dissolved in methylbenzene. (2 marks)

Hydrogen chloride dissociates/ionizes $\checkmark\tfrac{1}{2}$ in water because it is polar; producing hydrogen ions $\checkmark\tfrac{1}{2}$ while in methylbenzene it remains in molecular state$\checkmark\tfrac{1}{2}$ hence no hydrogen ions$\checkmark\tfrac{1}{2}$; methylbenzene is non-polar

25. When burning magnesium ribbon is introduced into a gas jar full of nitrogen, it continues to burn producing a greenish yellow powder.

(a) Write an equation for the reaction between nitrogen and magnesium. (1 mark)

$3Mg(s) + N_2(g) \rightarrow Mg_3N_2(s)$

(b) Explain why magnesium continues to bum in nitrogen but sulphur does not. (2 marks)

Burning magnesium produces a lot of heat✓½ that is enough to break N≡N triple bond ✓½ hence reacts with it while burning of sulphur produce little heat✓½ not enough to break N ≡N triple bond✓½.

(c) State one use of nitrogen. (1 mark)

- **In refrigeration e.g. storage of semen for artificial insemination**
- **Manufacture of ammonia; Haber process**
- **In light bulbs to prevent oxidation of the filament by creating inert environment**

26. Describe how the presence of calcium ions in a water sample can be tested in the laboratory. (3 marks)

- **Place 2 portions of the water sample in test tubes. ✓½**
- **To the first portion, add sodium hydroxide solution dropwise until excess. ✓½**
- **To the second portion, add ammonia solution dropwise until excess. ✓½**
- **A white ppt✓½ insoluble in excess✓½ sodium hydroxide and no white ppt✓½ with ammonia confirms the presence of calcium ions.**

27. (a) Name the particles that are responsible for electrical conductivity in:

    (i)   Solids (½ mark)

        Delocalised electrons

    (ii)   Both melts and aqueous solution (½ mark)

        Mobile ions

(b) Give two properties of graphite that make it suitable for use as an electrode. (2 marks)

- **Good conductor of electricity due to the presence of delocalised electrons**
- **Unreactive (relatively)**

(c) State one precaution that is necessary when carrying out electrolysis of molten lead (II) bromide (1 mark)

It must be carried out inside a fume chamber or in open air because the bromine vapour which is evolved is poisonous