



THE KENYA NATIONAL EXAMINATIONS COUNCIL
Kenya Certificate of Secondary Education



Paper 1

233/1

CHEMISTRY (Theory)

Serial No.
11387992

Nov. 2023 - 2 hours

Name: Index Number:

Candidate's signature: Date:

Instructions to candidates

- (a) Write your name and index number in the spaces provided above.
- (b) Sign and write the date of examination in the spaces provided above.
- (c) Answer all the questions in the spaces provided in the question paper.
- (d) **Non-programmable** silent electronic calculators and KNEC mathematical tables may be used.
- (e) All working must be clearly shown where necessary.
- (f) **This paper consists of 16 printed pages.**
- (g) **Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.**
- (h) **Candidates should answer the questions in English.**



For Examiner's Use Only

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

17	18	19	20	21	22	23	24	25	26	27	Grand Total



KCSE 2023



Turn over



1 The atomic numbers of nitrogen and fluorine are 7 and 9 respectively.

(a) Draw electron dot (•) and cross (x) diagrams to illustrate bonding in the molecules of: (1 mark)

(i) nitrogen;

(ii) fluorine. (1 mark)



(b) With reference to the diagrams in (a), state why fluorine is more reactive than nitrogen. (1 mark)

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2 Classification of types of salts includes normal and acid salts.

(a) Give the name of another type of salt. (1 mark)

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(b) (i) Describe how an acid salt can be prepared using 0.1 M sulphuric(VI) acid and 0.1 M sodium hydroxide. (1 mark)

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(ii) Write an equation for the reaction in b(i). (1 mark)

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3 Complete Table 1 by writing the formulae of all the products formed when the metal nitrates are heated strongly. (3 marks)

Table 1

Nitrate	Formulae of products
Potassium nitrate	
Lead(II) nitrate	
Silver nitrate	

4 Zinc metal is extracted from zinc blende ore through the following processes; concentration, roasting and reduction.



(a) Explain how the ore is concentrated. (2 marks)

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(b) Write an equation for the reaction that takes place when the ore is roasted. (1 mark)

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5 Figure 1 shows how the solubility of oxygen varies with changes in temperature.

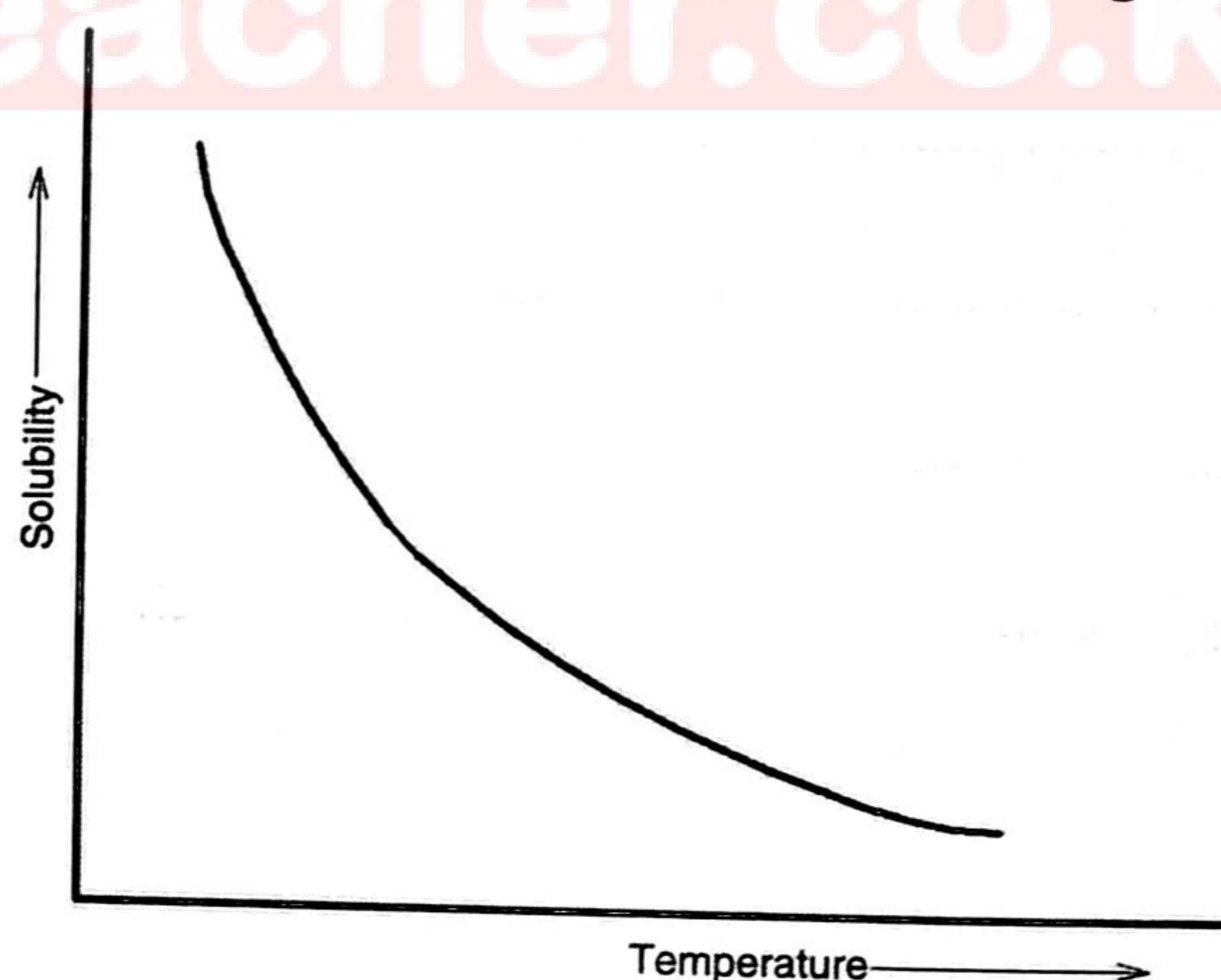


Figure 1

(a) Explain using kinetic theory why the solubility varies as shown. (2 marks)

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- (b) With reference to Figure 1, explain the pollution effect that may be caused by a large increase in the temperature of sea water. (1 mark)

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- 6 A flow diagram for production of sulphuric(IV) acid is shown in Figure 2.

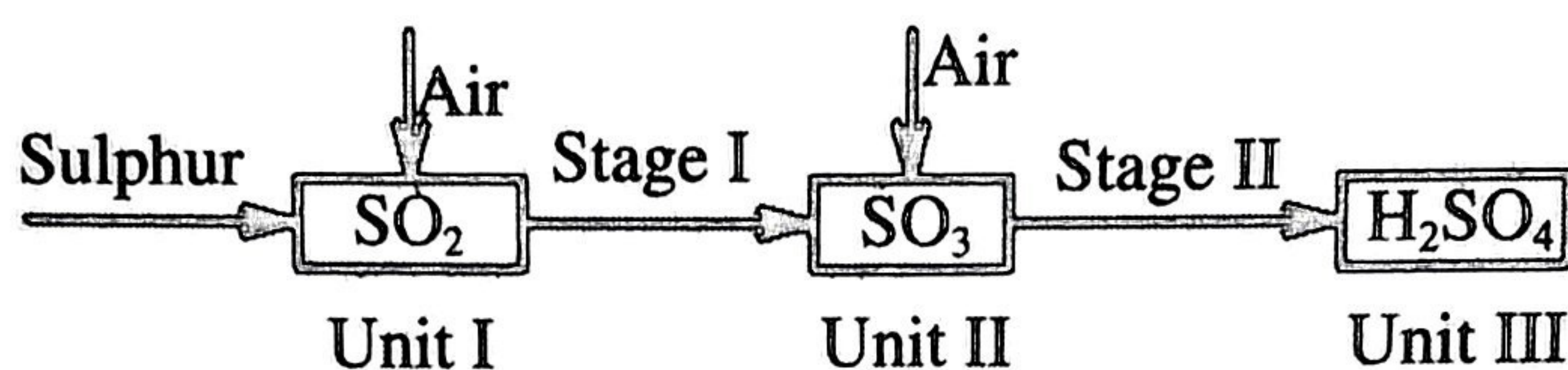


Figure 2

- (a) State the optimum conditions necessary for carrying out the reaction in unit II. (1 mark)

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- (b) Stage II takes place in two steps. Describe the steps. (2 marks)

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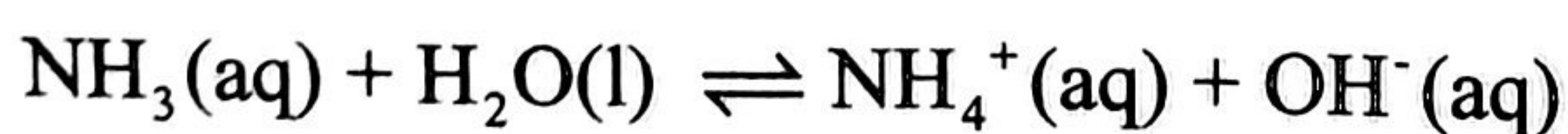
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- 7 The following equilibrium exists in aqueous ammonia:



- (a) With reference to this equilibrium, explain why ammonia is a weak base. (1 mark)

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(b) When aqueous ammonia is added drop-wise to aqueous copper(II) sulphate, a blue precipitate is formed. The blue precipitate redissolves giving a deep blue solution. Write the formula of the substance responsible for the:

(i) blue precipitate;

(1 mark)

.....

.....

(ii) deep blue colour.

(1 mark)

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8 The molecular formula of two straight chain hydrocarbons is C_4H_6 .

(a) Give the general formula of the homologous series to which the hydrocarbons belong.

(1 mark)

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(b) Draw the structures of the two compounds and give their names.

(2 marks)

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9 Water hardness may be temporary or permanent.

(a) Write the formula of an ion that causes temporary hardness.

(1 mark)

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(b) Temporary hardness can be removed by boiling. Give **one** disadvantage of using this method in industries.

(1 mark)

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- (c) State one method that can be used to remove permanent hardness. (1 mark)

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- 10 (a) Figure 3 shows an energy level diagram for the formation of hydrogen fluoride. (1 mark)

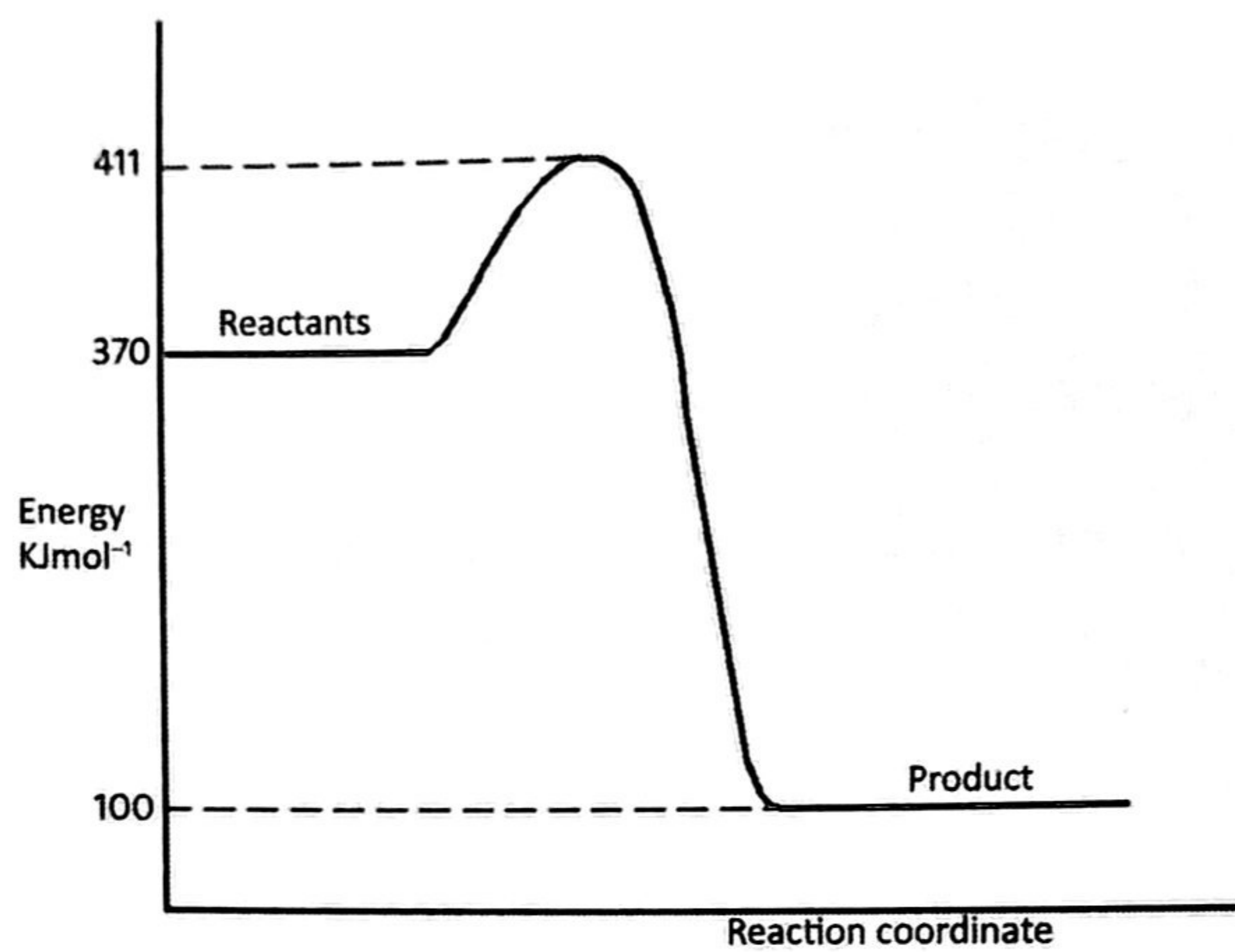


Figure 3

Calculate the:

- (i) enthalpy change for the formation of hydrogen fluoride; (1 mark)

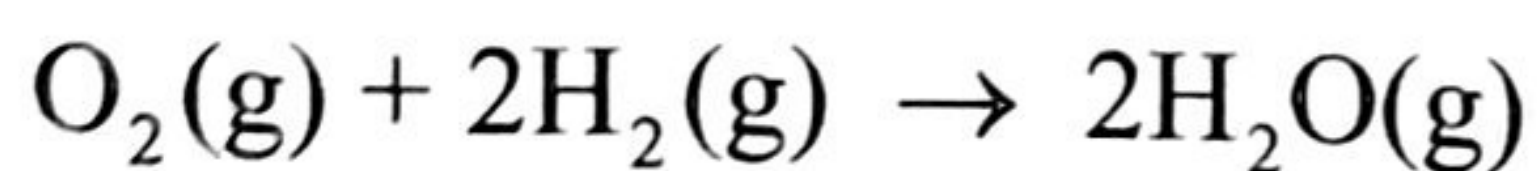
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- (ii) activation energy of the reaction. (1 mark)

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- 11 At high temperature, hydrogen and oxygen react as shown in the following equation:



In an experiment, a mixture containing 200 cm³ oxygen and 300 cm³ hydrogen was heated to form water.

- (a) Determine which gas was in excess and by how much. (1 mark)

.....

- (b) Calculate the volume of water that was formed. (1 mark)

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- (c) Explain how one could confirm that the product was pure water. (1 mark)

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12 Silk and rubber are examples of natural polymers.

- (a) Give the name of another natural polymer. (1 mark)

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(b) State the sources of:

- (i) silk; (1 mark)



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- (ii) natural rubber. (1 mark)

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- 13 (a) Give the formula of the compound referred to as rust. (1 mark)

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- (b) Four test tubes were setup to investigate rusting of iron as shown in Figure 4. The setup was allowed to stand for one week.

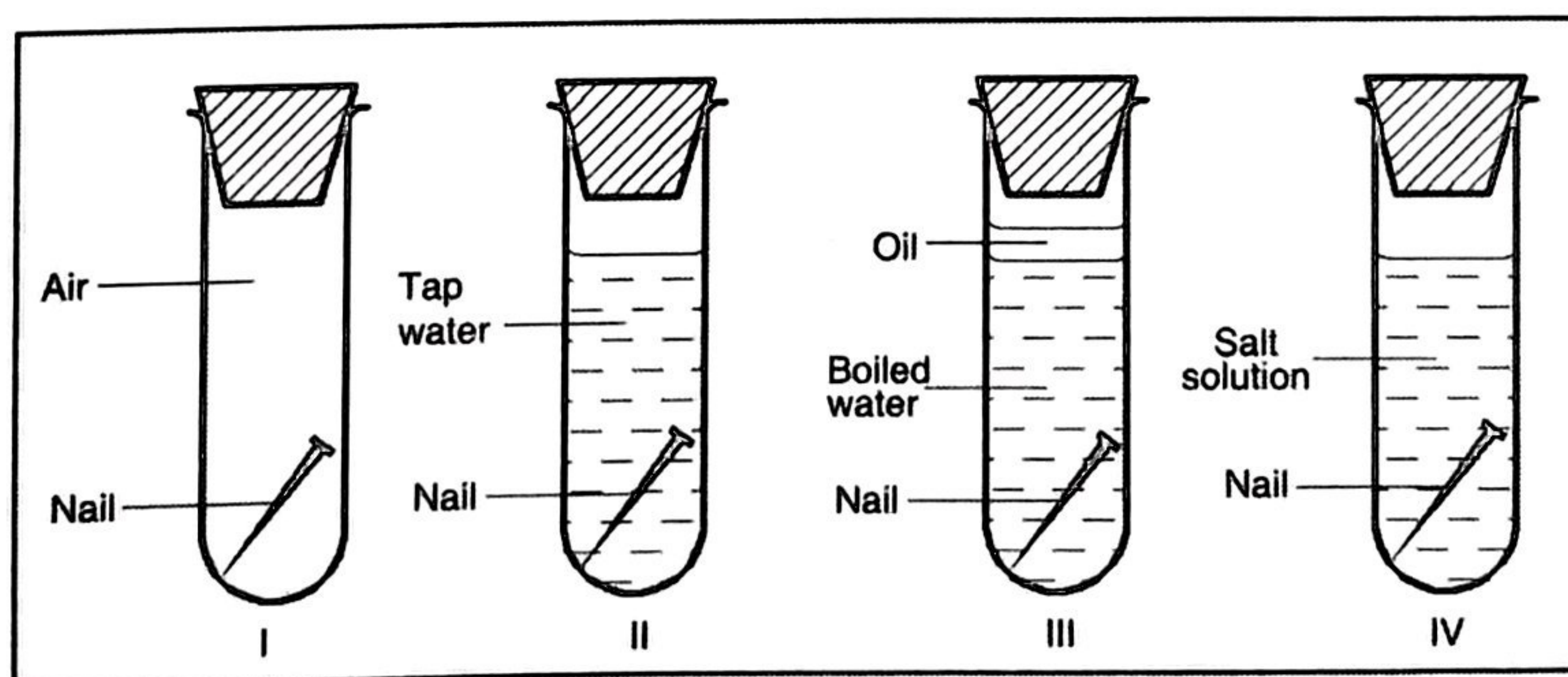


Figure 4

Explain why:

- (i) no rusting took place in test tube III. (1 mark)

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(ii) select the test tube in which there was highest amount of rust. Give a reason. (1 mark)

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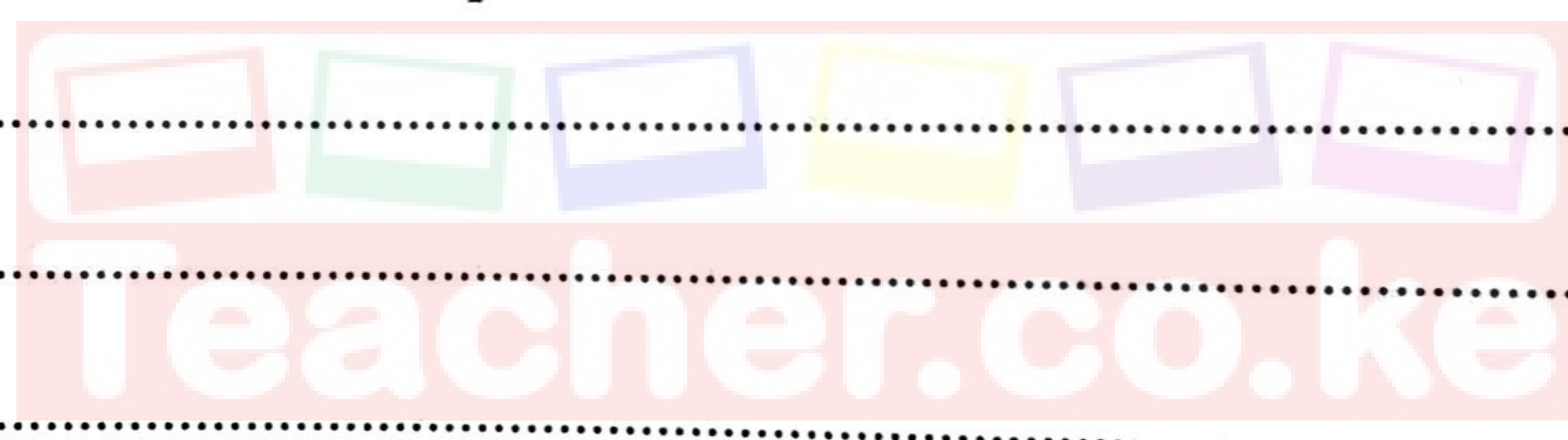
14 (a) Avogadro's constant is $6.02 \times 10^{23} \text{ mol}^{-1}$. Determine the total number of ions that are present in 500 cm^3 of 2.0 M calcium nitrate. (2 marks)

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(b) The electrical conductivity of 2.0 M calcium nitrate is higher than that of 2.0 M potassium nitrate. Explain. (1 mark)

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15 Carbon(IV) oxide and methane are gases found in the atmosphere.

(a) State **one** disadvantage of carbon(IV) oxide in the atmosphere. (1 mark)

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(b) Name **one** source of emissions of methane into the atmosphere. (1 mark)

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(c) State how emissions of carbon(IV) oxide into the atmosphere can be reduced. (1 mark)

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16 5.70g of a chloride of element D was found to contain 4.55g of chlorine.

(a) Determine the empirical formula of the chloride (D = 27.0; Cl = 35.5). (2 marks)

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(b) Given that the relative formula mass of the chloride is 267, determine its molecular formula. (1 mark)

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17 Table 2 shows the boiling points of ethane, butane and ethanol.
(H = 1.0; C = 12.0; O = 16.0)

Table 2

Compound	CH_3CH_3	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$	$\text{CH}_3\text{CH}_2\text{OH}$
Relative molecular mass	30	58	46
Boiling point, °C	- 88.6	- 0.5	78.5

Give reasons for the following:

(a) boiling point of butane is higher than that of ethane; (1½ marks)

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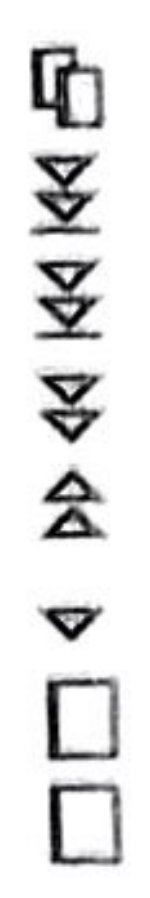
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(b) boiling point of ethanol is higher than that of butane. (1½ marks)

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18 Small pieces of beryllium, magnesium and calcium metals were placed in test tubes containing cold distilled water mixed with phenolphthalein indicator as shown in Figure 5.

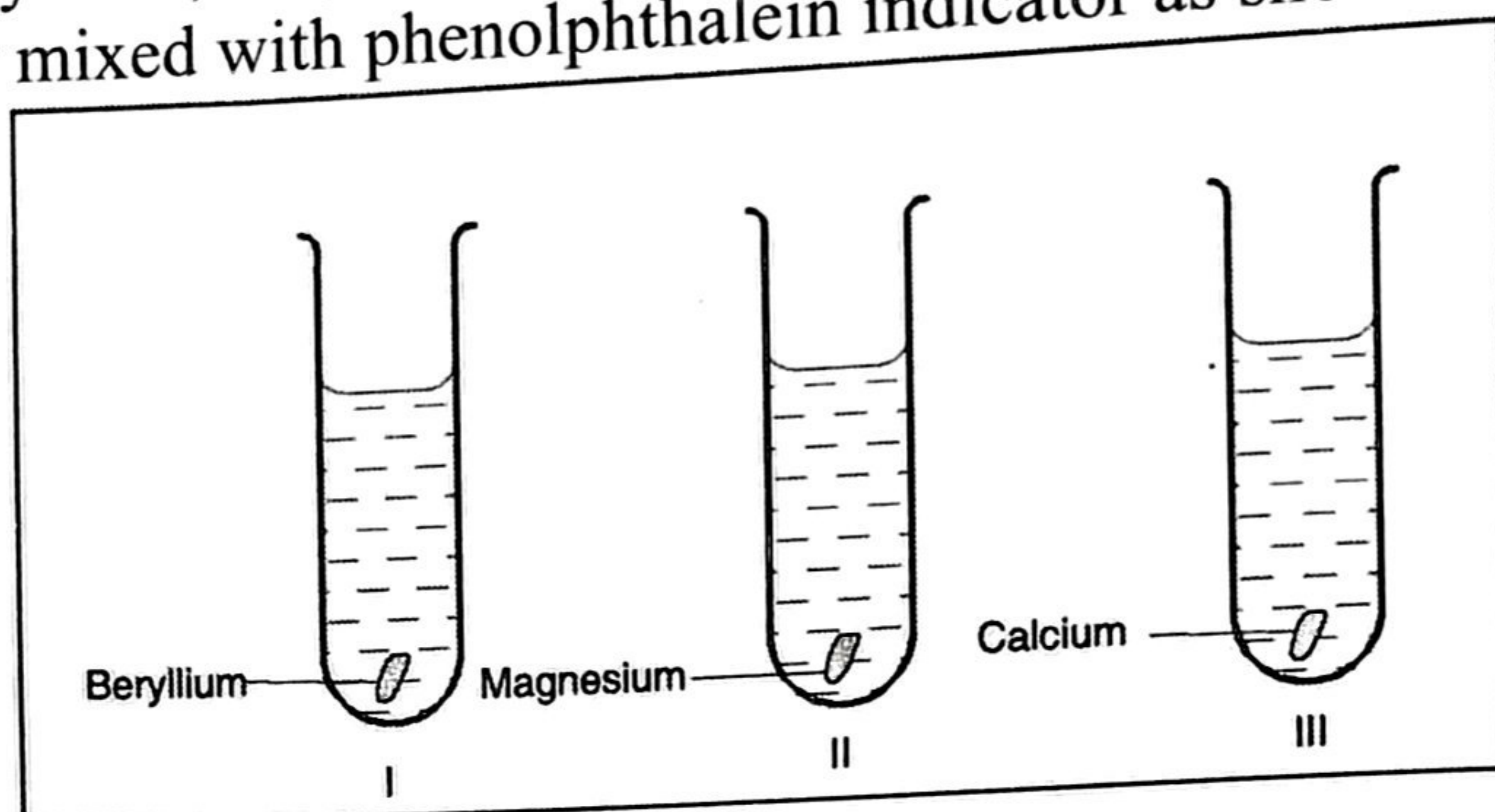


Figure 5

State and explain the observations that were made in each of the following test tubes:

Test tube I;

(1 mark)

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Test tube II;

(1 mark)

.....

Test tube III.

(1 mark)

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19 A laboratory assistant wanted to investigate the effect of an electric current on substances. Figure 6 shows arrangement of the apparatus used.

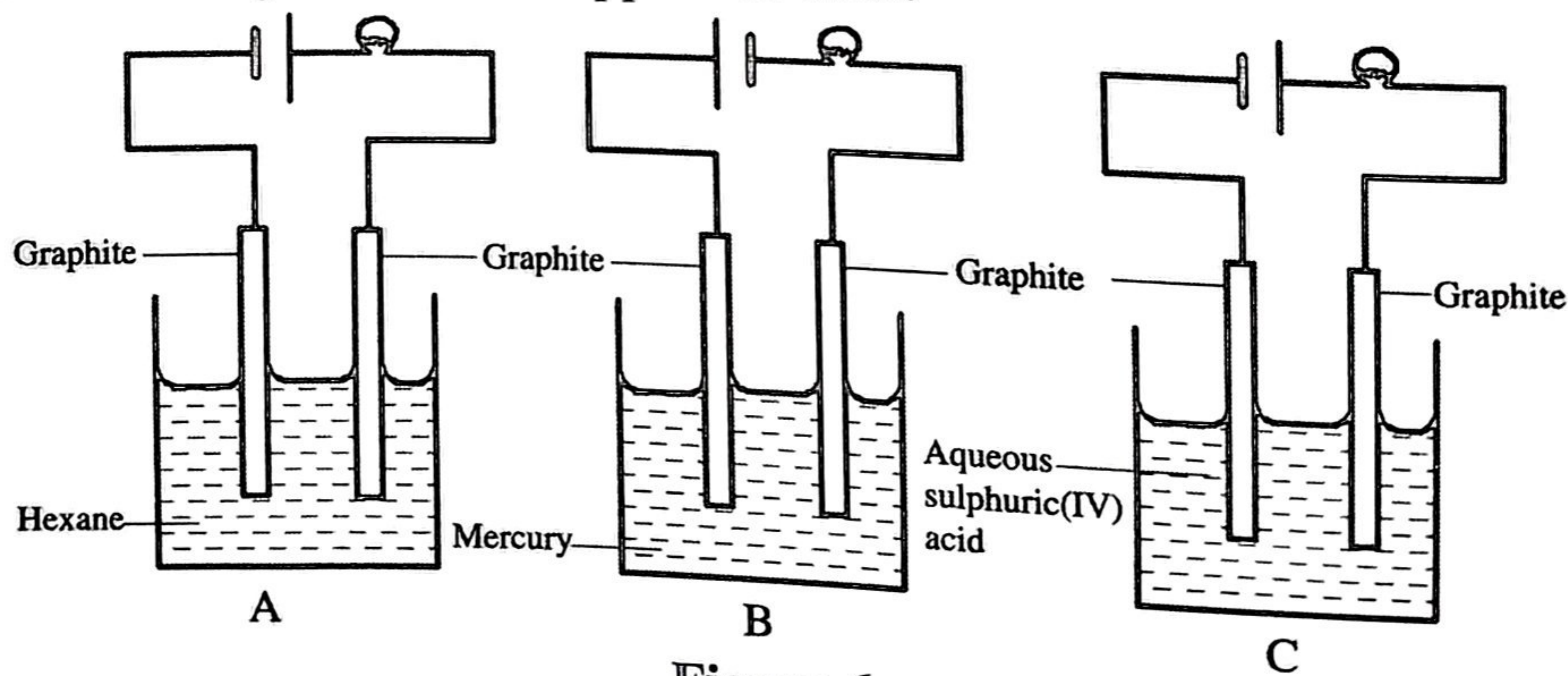


Figure 6

Explain why:

(a) in A, the bulb did not light up and no electrolysis took place;

(1 mark)

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(b) in B, the bulb lit but no electrolysis took place; (1 mark)

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(c) in C, the bulb lit and electrolysis took place. (1 mark)

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20 Carbon - 14 , ¹⁴C, is a radioactive isotope of carbon. It decays to form an isotope of nitrogen (Atomic numbers of : N = 7; C = 6).

(a) Write a nuclear equation for the decay process. (1 mark)

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(b) Archeologists calculate the age of organic matter using the proportion of carbon - 14 present and the half-life of carbon -14.

(i) State what is meant by the term half-life of carbon - 14. (1 mark)

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(ii) Given that the half-life of carbon -14 is 5570 years, calculate the age of a piece of bone found to contain $\frac{1}{16}$ as much carbon -14 as living matter. (1 mark)

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21

A student used the following procedure when standardising sodium hydroxide. The student placed 25.00 cm³ of the hydroxide in a conical flask and titrated it with 0.1 M hydrochloric acid using phenolphthalein indicator. The average titre was 21.50 cm³ of the acid. State and explain how each of the following steps in the procedure may have affected the titre value:

(a) the student rinsed the conical flask with the sodium hydroxide before using it; (1 mark)

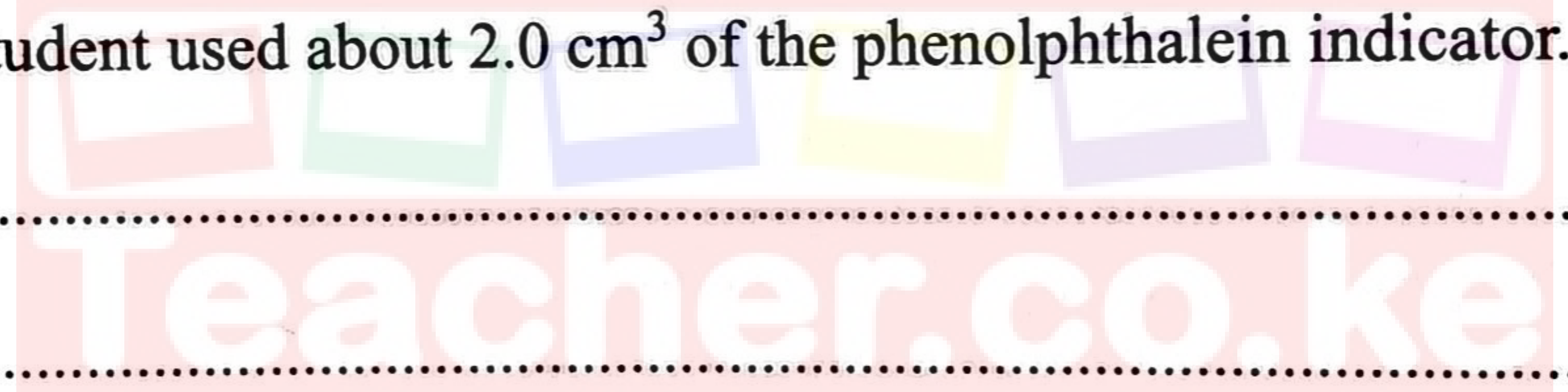
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(b) the student did not rinse the freshly cleaned burette with the hydrochloric acid before filling it; (1 mark)

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(c) the student used about 2.0 cm³ of the phenolphthalein indicator. (1 mark)

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22 The setup shown in Figure 7 (a) was used to determine the approximate percentages of the major components of air.

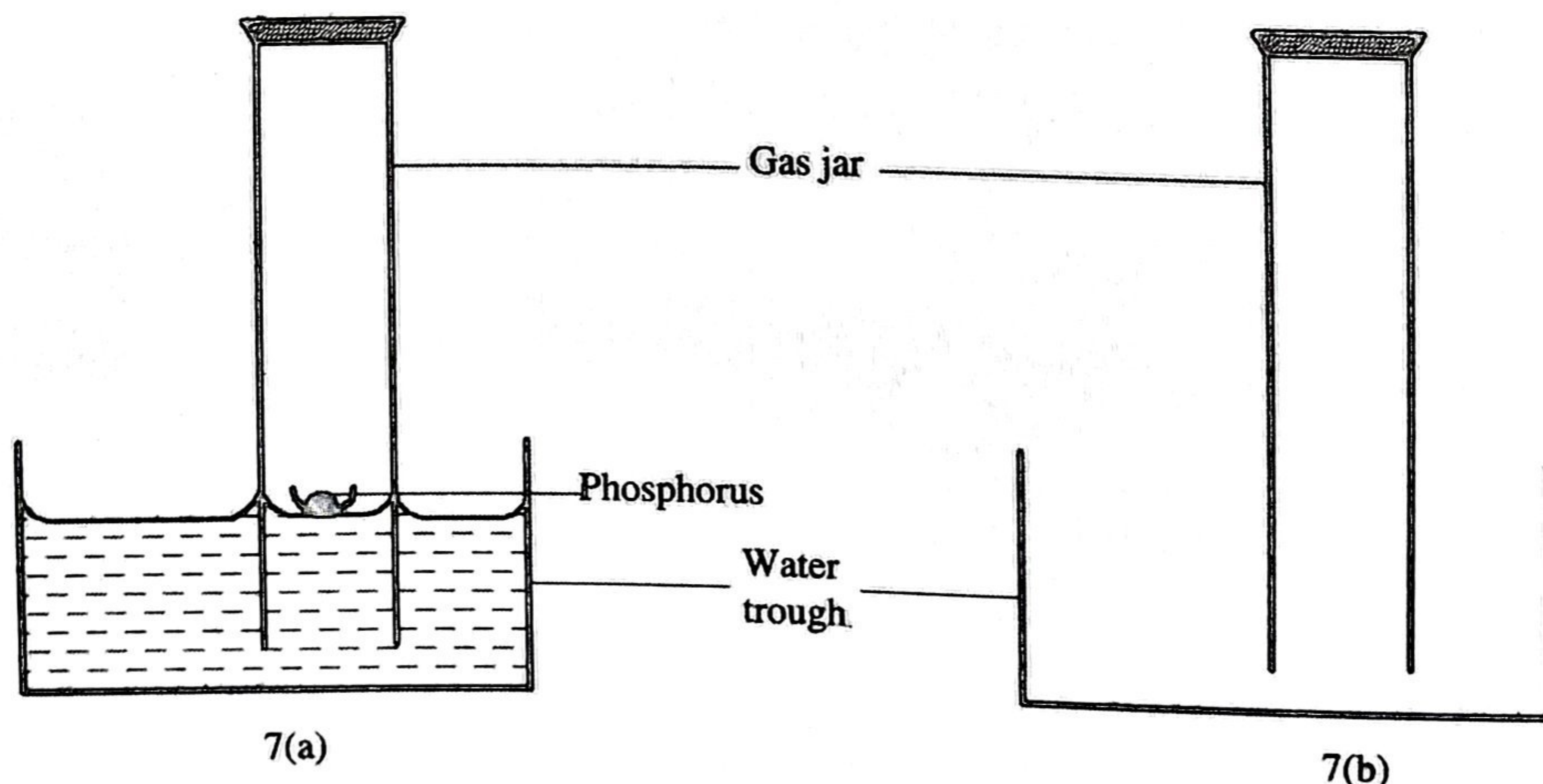


Figure 7

(a) Complete Figure 7 (b) to show the setup after it was left standing until no further changes were observed. (1 mark)

- (b) Explain how the percentages of the major components of air are calculated. (2 marks)

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23

The heat energy value of a fuel is defined as the amount of energy produced by 1.0 gram of the fuel. (C = 12.0; H = 1.0; O = 16.0)

- (a) Calculate the heat energy values of the fuels, hydrogen and ethanol and complete Table 3.

Table 3

Fuel	Enthalpy of Combustion (kJmol^{-1})	Heat energy value kJg^{-1}
H_2	286.0	
$\text{C}_2\text{H}_5\text{OH}$	1371.0	

(1 mark)

- (b) Other than its heat energy value, state one advantage of using hydrogen and ethanol as fuels: (1 mark)

(i) hydrogen;

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(1 mark)



(ii) ethanol.

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24 Study the structures of substances L and M shown in Figure 8 and complete Table 4 by giving the names that describe the type of structure and bonding in each substance.

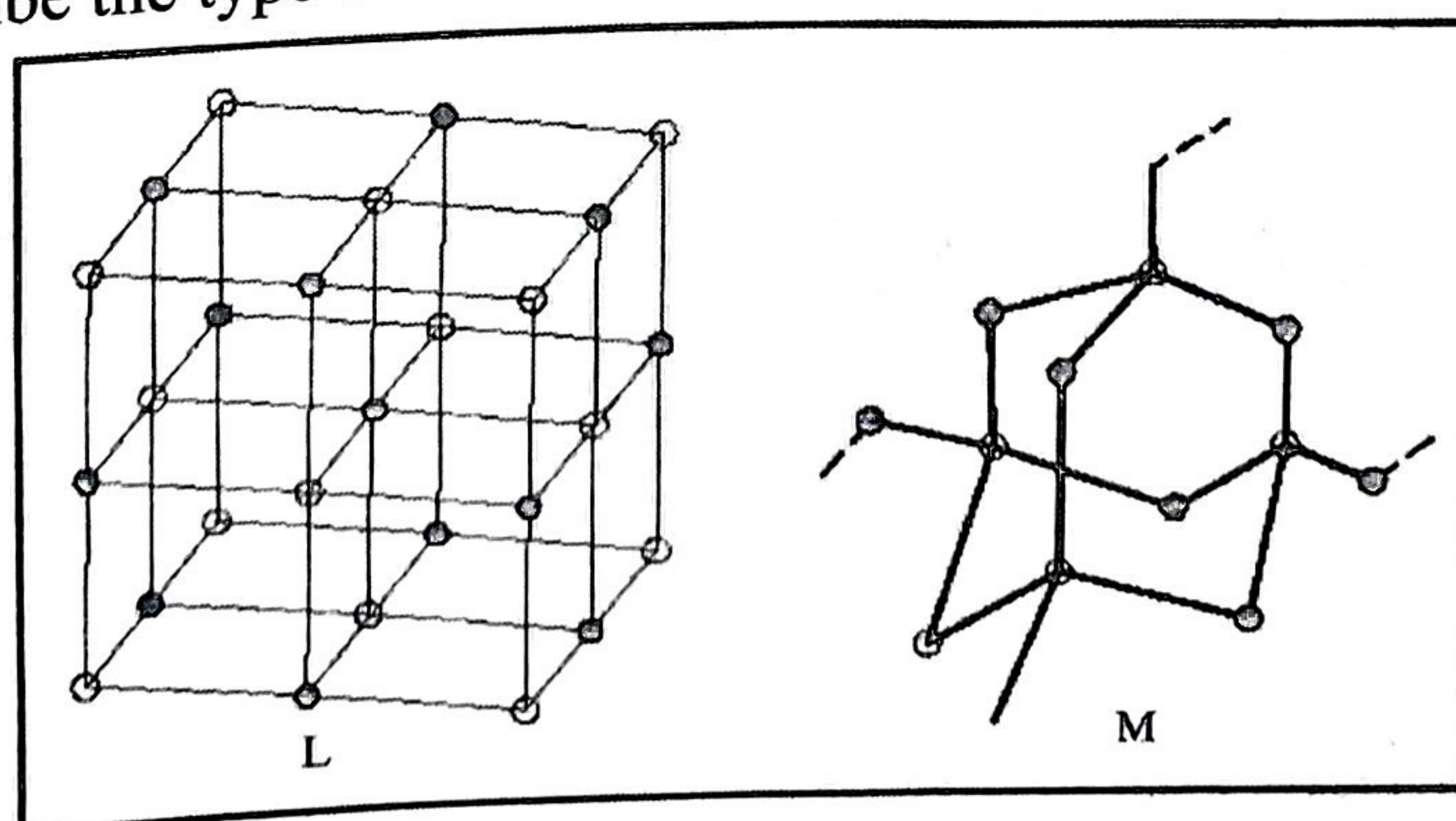


Figure 8

Table 4

	L	M
Substances		
Structure		
Bonding		

(2 marks)

25 State one physical property that would suggest the presence of each of the following gases from a leaking gas cylinder:



(a) H_2S

(1 mark)

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.....

(b) N_2O

(1 mark)

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(c) Cl_2

(1 mark)

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26 (a) Give the names of the type of compounds whose reaction is described as:

(i) esterification;

(1 mark)

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(ii) saponification.

(1 mark)

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(b) State the importance of vulcanisation.

(1 mark)

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Figure 9 shows a setup used to separate a mixture of two liquids, Q (boiling point 117°C) and R (boiling point 103°C).

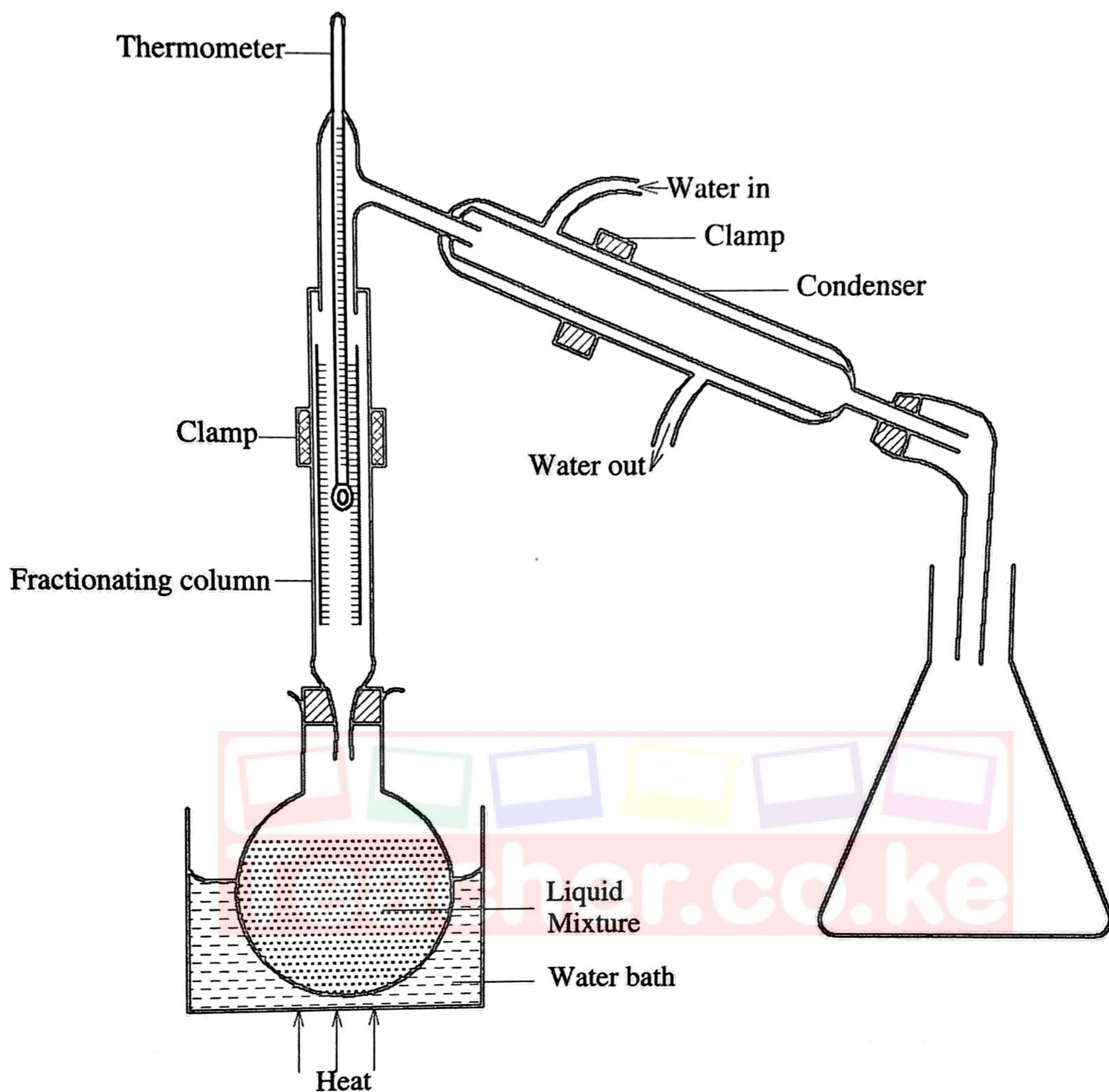


Figure 9

Identify **three** mistakes in this setup. Give a reason in each case.

Mistake 1

(1 mark)

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Mistake 2

(1 mark)

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Mistake 3

(1 mark)

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