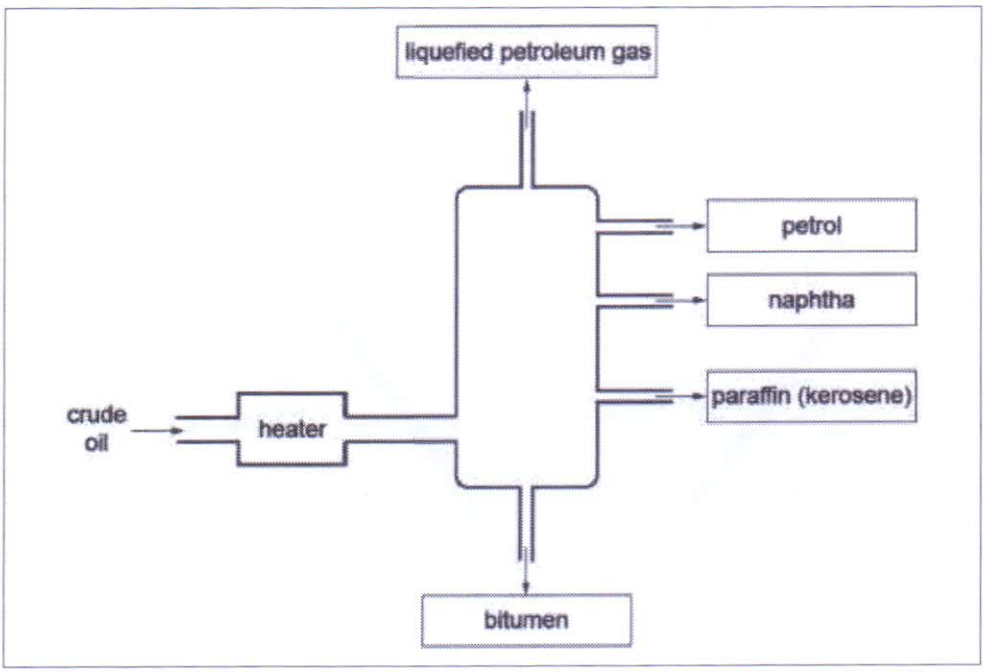
Section A

A 1. Petroleum is a mixture of hydrocarbons. In an oil refinery it is separated into fractions by fractional distillation. The diagram shows a fractionating column and some of the fractions obtained from Petroleum



(i) State **one** use for the naphtha fraction.

.....[1]

(ii) State **one** use for the bitumen fraction.

.....[1]

(iii) State **one** use for the petrol fraction.

.....[1]

(iv) State **one** use for the kerosene fraction.

.....[1]

(v) State **one** use for the petroleum gas fraction.

.....[1]

[Total: 05]

A 2. River water contains many substances including minerals, dissolved oxygen, organic material, nitrates and phosphates.

(a) (i) Describe a chemical test to show the presence of the nitrate ion. [2]

.....

.....

.....

(ii)Describe a chemical test to show the presence of the Iron (III) ion (Fe^{3+}). [2]

.....

.....

.....

(iii)Find the mass of one mole of Iron (III) nitrate Fe $(NO_3)_3$.

.....

.....

..... [2]

(b) Potassium sulphate can be prepared by the reaction between dilute sulphuric acid and potassium carbonate.

$$H_2SO_4 + K_2CO_3 \rightarrow K_2SO_4 + CO_2 + H_2O$$

Calculate the mass of potassium sulphate that can be prepared from 3.45 g of potassium carbonate

.....

.....

.....

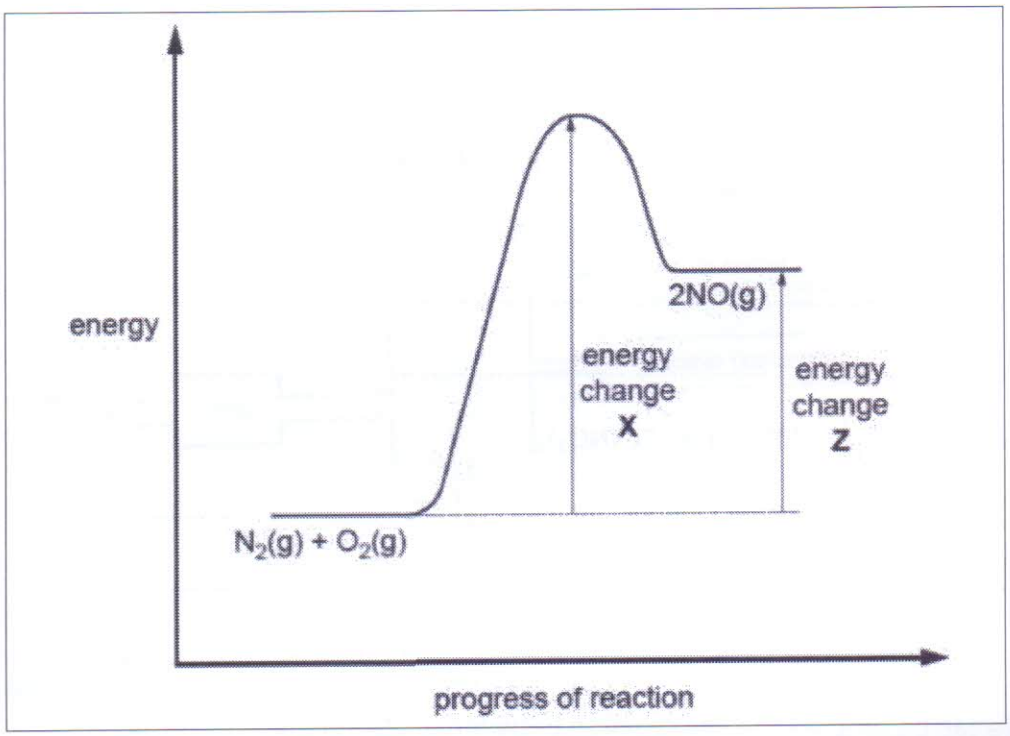
..... [3]

[Total: 09]

A 3. Oxides of nitrogen are atmospheric pollutants. Nitrogen monoxide, NO, is formed in an internal combustion engine when nitrogen and oxygen react together.

$$N_2(g) + O_2(g) \text{=====} \rightarrow 2NO(g)$$

The diagram shows the energy profile for this reaction.



(a) Identify the energy changes **X** and **Z**. [2]

.....

(b) The reaction between nitrogen and oxygen is endothermic.

(i) Explain how you can tell from the diagram that the reaction is endothermic. [1]

.....

(ii) Explain, using ideas about bond breaking and bond making, why the overall reaction is endothermic.

.....

.....

..... [2]

(c) The exhaust system of a motor car is fitted with a catalytic converter. When nitrogen monoxide passes through the converter it reacts with carbon monoxide.

$$2NO(g) + 2CO(g) \longrightarrow N_2(g) + 2CO_2(g)$$

The catalyst increases the rate of this reaction.

(i) Explain how the catalyst in the converter increases the rate of this reaction. [1]

.....

.....

(ii) During the course of a journey 2.4 dm^3 of nitrogen monoxide was produced by the engine. Calculate the volume of nitrogen gas produced if all the nitrogen monoxide reacted in the converter. [2]

.....

.....

.....

.....

[Total: 08]

A 4. Iron(II) sulphate, $FeSO_4$, is easily oxidised to iron(III) sulphate.

(a) Calculate the percentage by mass of iron in iron(II) sulphate.

..... % [2]

(b) A sample of iron(II) sulphate is dissolved in water. Describe a test to show the presence of sulphate ions in this solution.

reagents .....

observation ..... [2]

(c) In the presence of aqueous hydrogen ions and dissolved oxygen, aqueous iron(II) ions are oxidised to form iron(III) ions and water.

Find the number of moles in 32g of Iron II chloride $FeCl_2$

.....

.....

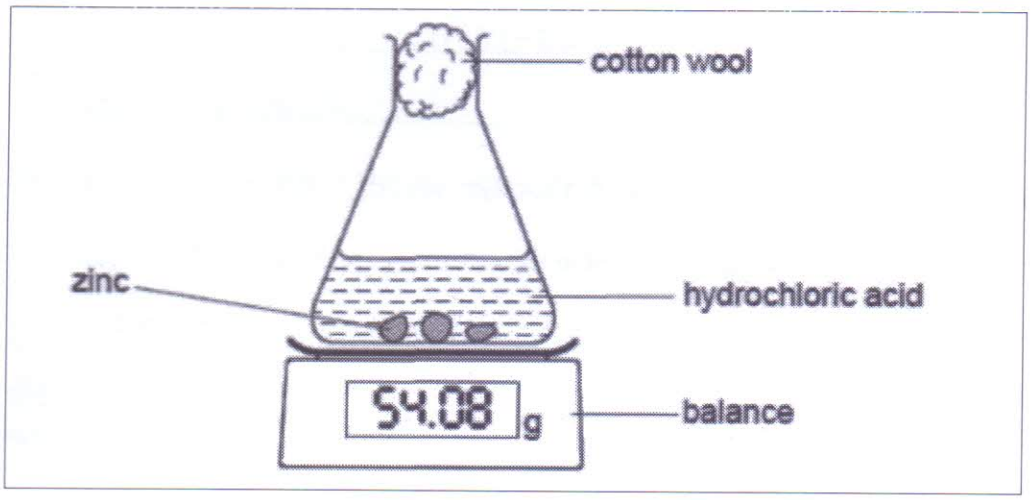
.....

.....

..... [2]

[Total: 06]

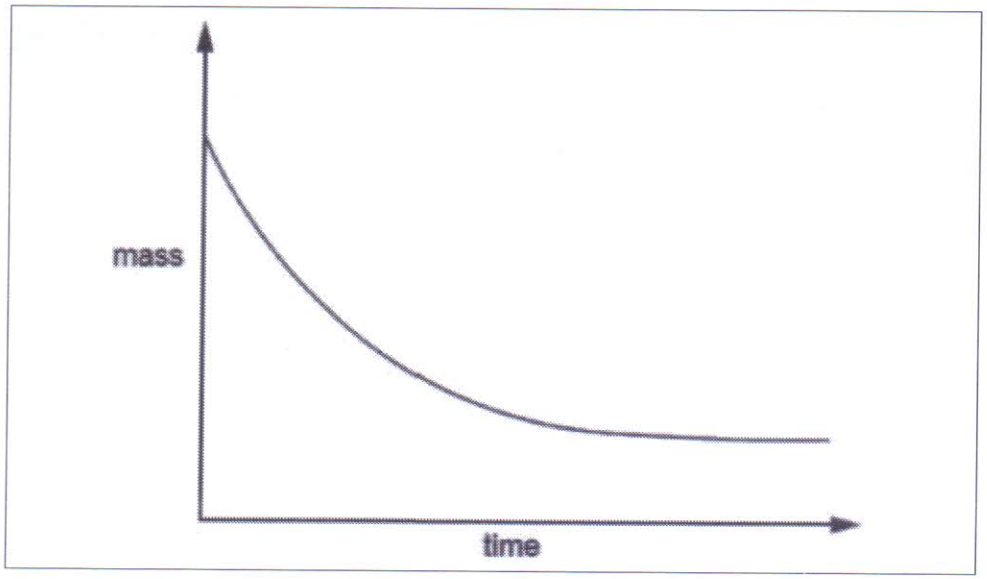
A 5. The diagram below shows apparatus that can be used to investigate the rate of reaction between zinc and hydrochloric acid.



(a) Write the equation, including state symbols, for the reaction between zinc and hydrochloric acid.

.....[2]

(b) The graph shows the change in mass that occurs during the reaction between zinc and hydrochloric acid.



(i) Explain why the mass decreases during the course of the reaction.

.....

.....

.....[2]

(ii) Exactly the same experiment was repeated but with a catalyst added.

Sketch on the graph the results that would be obtained in the presence of the catalyst. [2]

(c) Explain why zinc reacts more slowly with dilute hydrochloric acid than with concentrated hydrochloric acid.

.....

.....

.....[2]

(d) Explain why hydrochloric acid reacts much faster with zinc powder than with lumps of zinc.

.....

.....

.....[2]

[Total: 10]

A 6. Hydrogen-oxygen fuel cells are used to generate electricity.

The overall reaction in a hydrogen-oxygen fuel cell is shown below.

$$2H_2(g) + O_2(g) \text{ =====} \rightarrow 2H_2O(g)$$

This reaction is exothermic.

(a) Explain the meaning of the term *exothermic*.

.....

.....[2]

(b) Explain, in terms of the energy changes associated with bond breaking and bond forming, why the reaction is exothermic.

.....

.....

.....

.....[2]

(c) A hydrogen-oxygen fuel cell uses 2000 dm^3 of hydrogen measured at room temperature and pressure.

Calculate the volume of oxygen, measured at room temperature and pressure, used by the fuel cell.

[One mole of any gas at room temperature and pressure occupies a volume of 24 dm^3.]

.....

.....

.....

volume of oxygen = ... dm^3 [3]

[Total: 07]

Section B

B 1. Methanol, CH_3OH, is manufactured from carbon dioxide and hydrogen.

$$CO_2(g) + 3H_2(g) \rightleftharpoons CH_3OH(g) + H_2O(g) \quad \Delta H = -49 \text{ kJ / mol}$$

The reaction is carried out in the presence of a catalyst containing copper. The conditions used are 70 atmospheres pressure and a temperature of 250 °C.

(a) If the temperature of the reaction mixture is **increased** to 400 °C, explain, in which Direction the equilibrium will shift.

.....

.....

.....

..... [3]

(b) If the pressure of the reaction mixture is **decreased** to 50 atmospheres, explain what happens to the position of equilibrium.

.....

.....

.....

..... [3]

(c) In the reaction when 3.0 moles of hydrogen react, 49 kJ of heat energy is released. Calculate how much heat energy is released when 500 kg of hydrogen react.

heat energy = ... kJ [4]

B 2. Analysis of compound **X** shows it has the following composition.

element	percentage by mass
hydrogen	3.40
nitrogen	12.0
oxygen	41.0
vanadium	43.6

(a) Show that **X** has the empirical formula H_4NO_3V.

[2]

(b) Aqueous sodium hydroxide is added to solid **X** and the mixture is warmed.

A colorless gas that turns moist red litmus blue is evolved.

Deduce the formula and name of the ion present in **X**.

.....

.....[2]

(c) Find the number of moles in 16g of each of the following substances. [6]

(i)NaOH

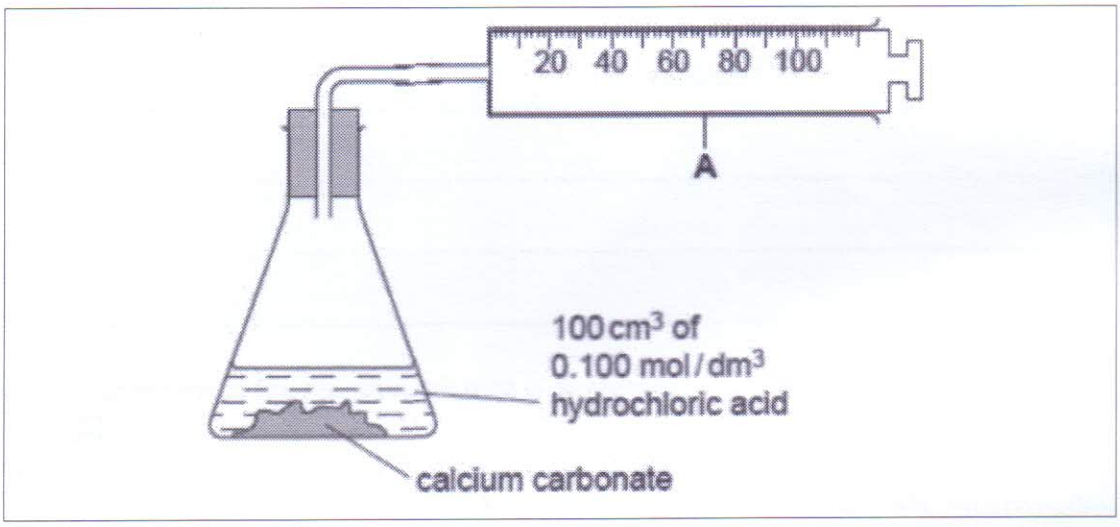
(ii)$CaCO_3$

(iii)H_2SO_4

B 3. A student added 100 cm^3 of 0.100 mol/dm^3 hydrochloric acid (an excess) to a known mass of calcium carbonate contained in a conical flask. The reaction produced carbon dioxide according to the following equation.

$$CaCO_3 + 2HCl \text{ =====} \rightarrow CaCl_2 + H_2O + CO_2$$

The apparatus is shown below.



(a) Name the apparatus labeled **A**.

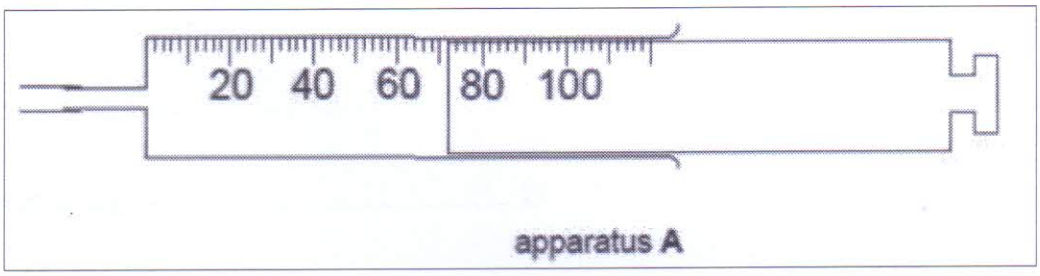
.....[1]

(b) Give a test to confirm the presence of carbon dioxide.

test .....

observation .....[2]

(c) The diagram below shows apparatus **A** at the completion of the reaction.



What volume of carbon dioxide in cm^3 was collected?

.....[1]

(d) Using your answer to **(c)**, calculate the number of moles of carbon dioxide produced in the reaction.

[One mole of a gas occupies $2dm^3$ at room temperature and pressure.]

.....

.....

.....

.....[2]

(e)Write down test for following gases

(i)Hydrogen

Test.....

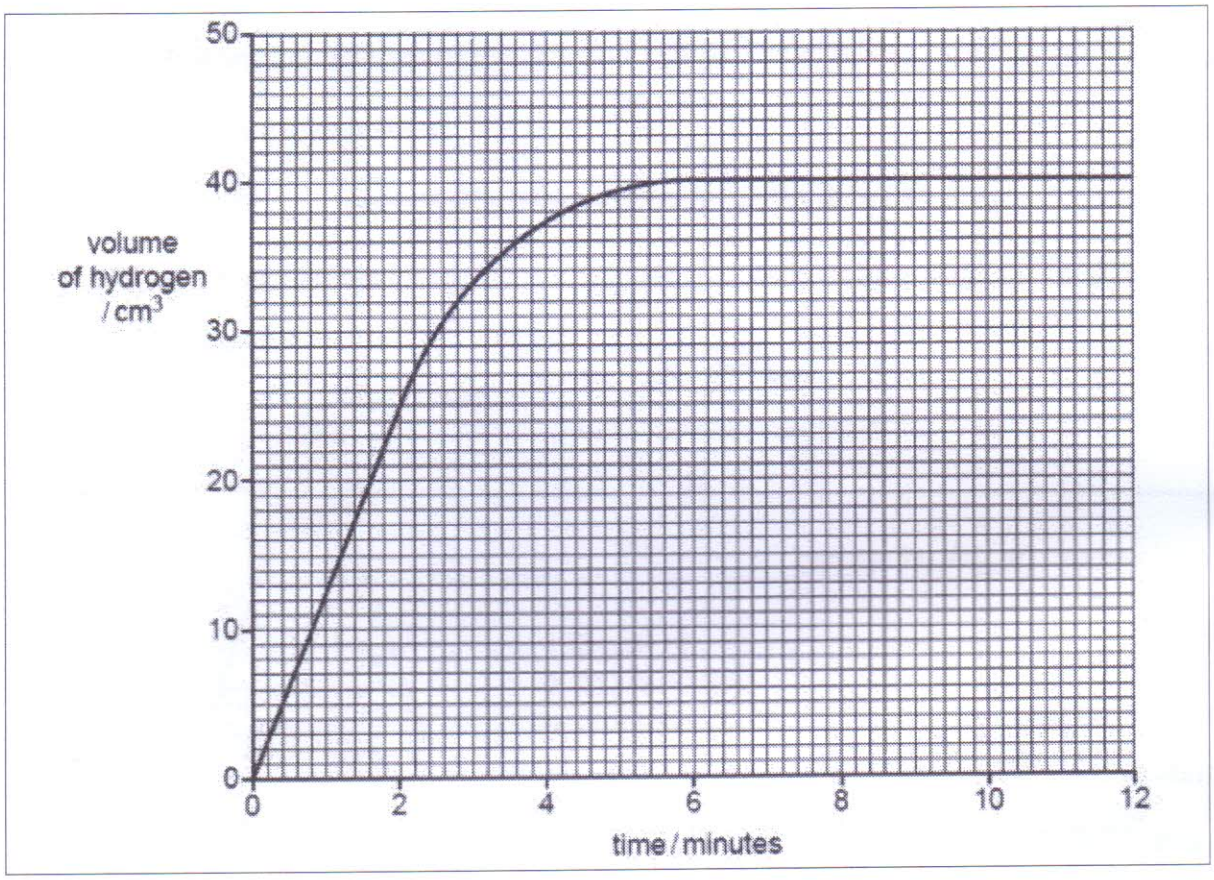
Observation.....[2]

(ii)Oxygen

Test.....

Observation.....[2]

B 4. A student measured the volume of hydrogen produced over time when small pieces of zinc reacted with excess sulfuric acid. The results are shown in the graph below.



(a) Use the information from the graph to calculate the average speed of reaction in the first two minutes. [2]

.....

.....

(b) Explain why the reaction stopped after 6 minutes.

.....[2]

(c) Copper catalyses this reaction.

(i) On the axes above, sketch a line to show the expected results for the catalyzed reaction. [1]

(ii) Explain how a catalyst changes the speed of reaction.

.....

..... [2]

(d) Using the ideas of particle collisions, explain what happens to the speed of this reaction when temperature is decreased.

.....

.....

.....

..... [3]