

ACK DIOCESE MOCK 2024

CHEMISTRY – PAPER TWO (233/2)

FORM FOUR (4)

Time - 2 Hours

Name Admission Number

Candidate's Signature Class

TIME 2h

INSTRUCTIONS TO CANDIDATES:

- Answer **all** the questions in the spaces provided.
- Write your **Name** and **Index Number** in the spaces provided above.
- Mathematical tables and electronic calculators may be used for calculations.
- All working **must** be clearly shown where necessary

For Examiner's Use only.

QUESTION	MAXIMUM SCORE	CANDIDATE'S SCORE
1	12	
2	11	
3	13	
4	12	
5	11	
6	09	
7	12	
Total score	80	

This paper consists of 14 printed pages. Candidates should check the questions to ascertain that all the pages are printed as indicated and no questions are missing.

1. (a) Study the information given below and answer the questions that follow.

Element	Atomic radius (nm)	Ionic radius (nm)	Formula of oxide	Melting point of oxide ($^{\circ}\text{C}$)	Electrical conductivity of oxide in solid or molten state
A	0.064	0.136	OA_2	-224	Does not conduct
B	0.117	0.040	BO_2	1710	Does not conduct
C	0.125	0.054	C_2O_3	2045	Conducts in molten state
D	0.110	0.212	D_2O_5	563	Does not conduct
E	0.157	0.095	E_2O	1193	Conducts in molten state

(i) Select two elements, whose oxides have giant ionic structure (2 marks)

C and E

(ii) Which element is likely to be silicon? Give a reason. (2 marks)

B - Giant atomic structure hence high melting point

(iii) Explain why the melting point of the oxide of A is lower than that of the oxide of C

A is a non metal and forms an oxide with simple molecular structure while the oxide of C has a giant ionic structure. (2 marks)

(iv) State the nature of the solution formed when oxide of D, D_2O_5 dissolves in water.

Acidic solution (1 mark)

(b) Study the information in the table below and answer the questions that follow (The letters do not represent the actual symbols of the elements)

Element	Electronic configuration	Electron affinity(kJ/mol)
F	2.7	-322
G	2.8.7	-349
H	2.8.18.7	-325

(i) What chemical family do the elements F, G and H belong?

(1 mark)

Halogen +

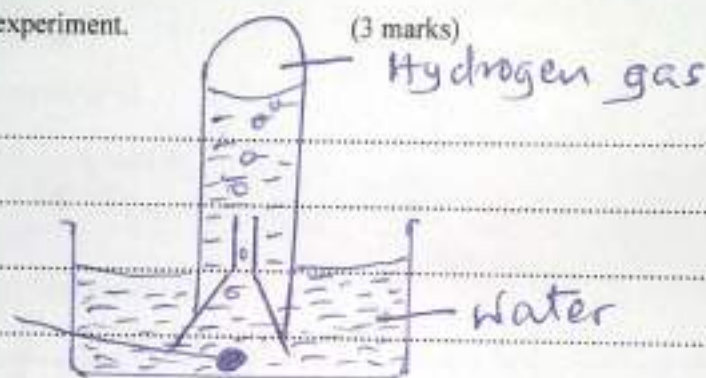
(ii) What is meant by the term electron affinity?

(1 mark)

Refers to the energy released when an atom gains an electron(s)

(c) When a piece of calcium is placed in cold water, it sinks to the bottom and a colorless gas that extinguishes a burning splint with a pop sound is produced. Use a simple diagram to illustrate how this gas can be collected during this experiment.

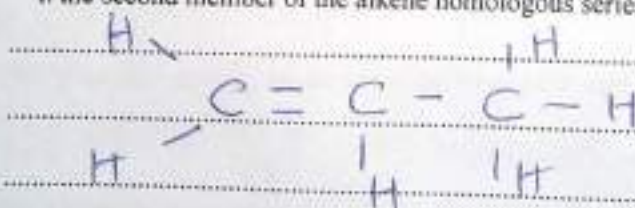
(3 marks)



2.(a) Draw and name the structures of;

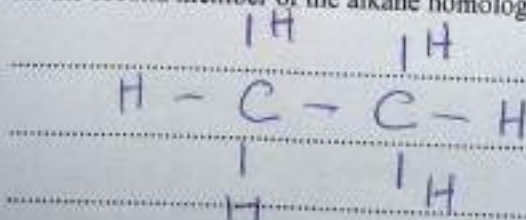
i. the second member of the alkene homologous series

(1 mark)

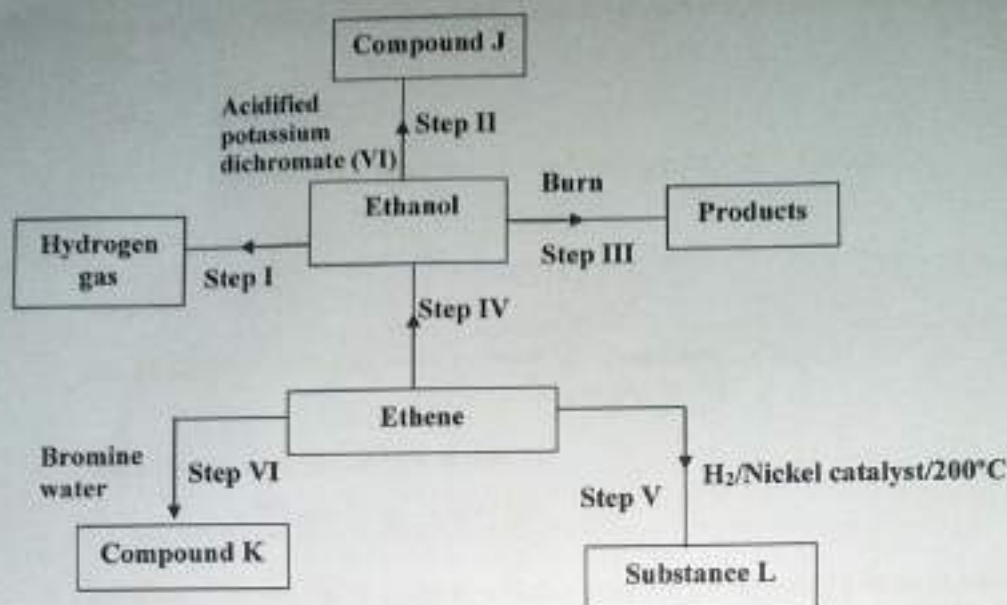


..ii the second member of the alkane homologous series

(1 mark)



(c) Use the information in the scheme below to answer the questions that follow.



(i) give the name of ;

(I) compound J

(1 mark)

Ethanoic acid

(II) compound K

(1 mark)

2-Bromoethanol

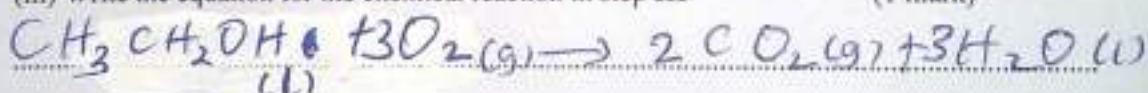
(ii) Give the name of the reaction which occurs in step V

(1 mark)

Addition reaction / Hydrogenation

(iii) Write the equation for the chemical reaction in step III

(1 mark)



(iv) Name the reagent(s) and conditions necessary for the reaction step IV

Reagent(s)

(1 mark)

Sulphuric (VI) acid / Steam

Condition (s)

(1 mark)

300°C / pressure 65at

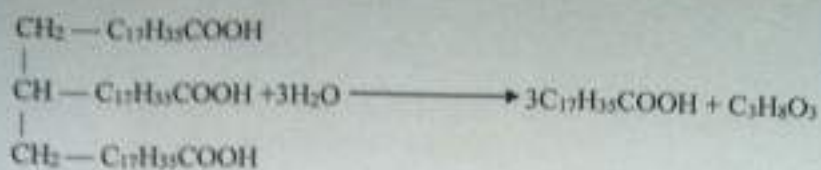
(v) State the observations made in step II

(1 mark)

Acidified $\text{K}_2\text{Cr}_2\text{O}_7$ changes from orange to green

(d) The two reactions below show how a long chained alkanoic acid can be converted into detergent M.

Step I



Step II



(i) Name the type of reaction in step II

(1 mark)

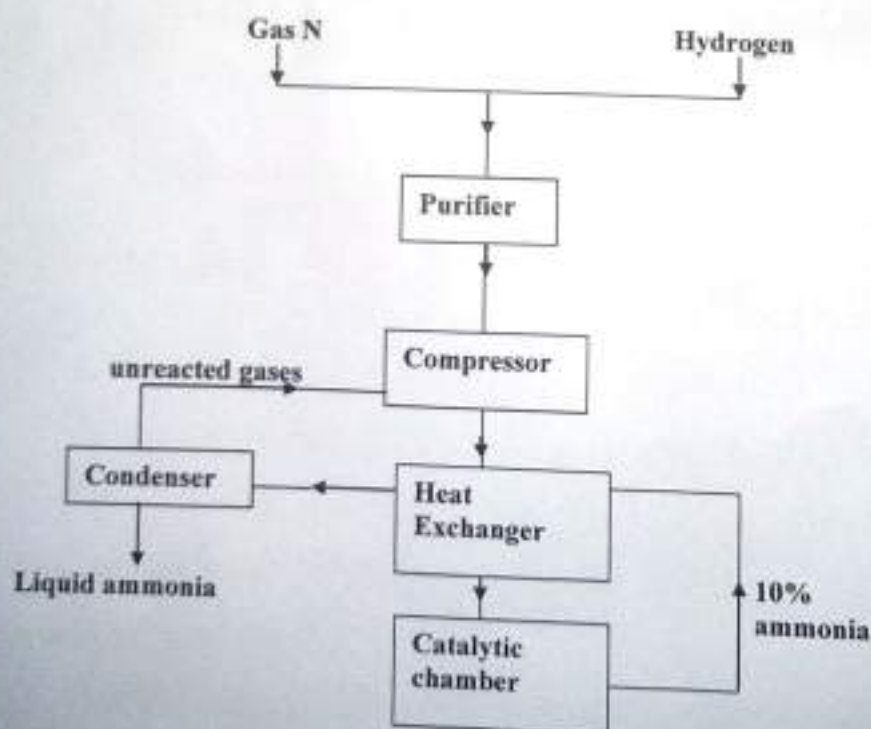
Neutralisation

(ii) When detergent M is added to a beaker containing hard water a scum is formed. Write the formula of the scum.

(1 mark)

$(\text{C}_{17}\text{H}_{35}\text{COO})_2\text{Mg}$

3. (a) The diagram below represents an industrial process for the manufacture of ammonia. Study it and answer the questions that follow.



(i) Give the name of;

(I) the process above

(1 mark)

Harber process

(II) Gas N

(1 mark)

Nitrogen

(ii) Carbon (IV) oxide, sulphur (VI) oxide and dust are the impurities in this process. Give a reason why these impurities are removed.

(1 mark)

They damage the catalyst / Reduce the efficiency of the catalyst

(iii) Other than iron catalyst, state two optimum conditions for this process (2 marks)

Pressure - 200 atm

Temperature - 500°C

(iv) Give two uses of ammonia

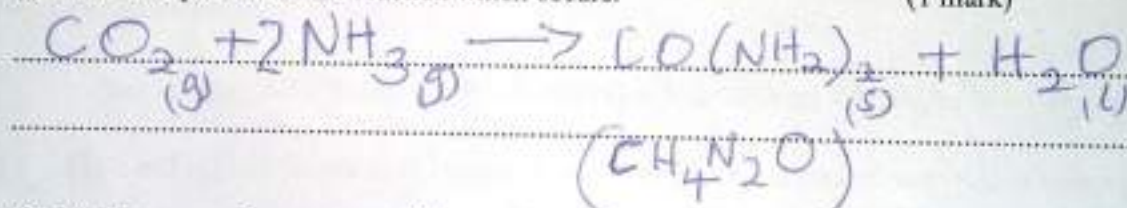
(2 marks)

Large scale Manufacture of HNO_3
Manufacture of ^{ammonium} fertilizers

(b) Urea, $\text{CO}(\text{NH}_2)_2$ is prepared by reacting carbon (IV) oxide and ammonia.

(i) Write an equation for the reaction which occurs.

(1 mark)



(ii) 20 kilograms of urea was applied to a farm and 25 kilograms of ammonium nitrate applied to another farm. Determine the farm enriched with nitrogen. (C=12, N=14, O=16, H=1)

(3 marks)

$$\text{MM urea} = 60$$

$$\% \text{ N} = \frac{28}{60} \times 100$$

$$= 46.67\%$$

$$\text{MM NH}_4\text{NO}_3 = 80$$

$$\% \text{ N} = \frac{28}{80} \times 100$$

$$= 35\%$$

The farm with urea
it has a higher % of nitrogen.

(c) State and explain what would be observed when aqueous ammonia is added dropwise until in excess to a solution of copper (II) chloride.

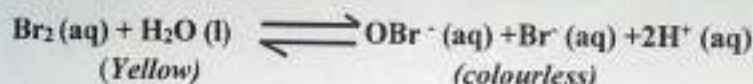
(2 marks)

blue precipitate is formed which dissolves to form a deep blue solution. The blue precipitate dissolves to form a complex.

4. (a) (i) State Le Chatelier's principle.

in condition
states that when a change is applied to a system at equilibrium, the system moves so as to oppose the change.

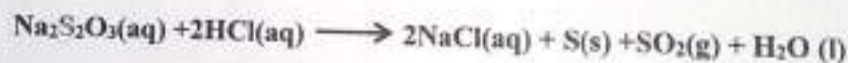
(ii) Bromine water can be prepared by dissolving 1 cm^3 of liquid bromine in 100 cm^3 of water. After shaking, the equilibrium below is established.



State and explain the effect of adding sodium hydroxide to the above equilibrium

(2 marks)
Solution changes from yellow to colourless.
NaOH introduces OH^- which removes H^+ hence need for more to be formed. OH^- introduced reduces the concentration of H^+ hence need for more to be formed.

(b) Colloidal sulphur may be formed by reacting sodium thiosulphate and dilute hydrochloric acid shown in the equation below.



(i) State and explain the effect of increase in temperature on the rate of the reaction above.

(2 marks)

Rate of reaction increases. Increase in temperature increases the motion of the particles, thus effective collisions increases increasing reaction rate.

(ii) Other than temperature name one factor that can alter the rate of the reaction in b (i)

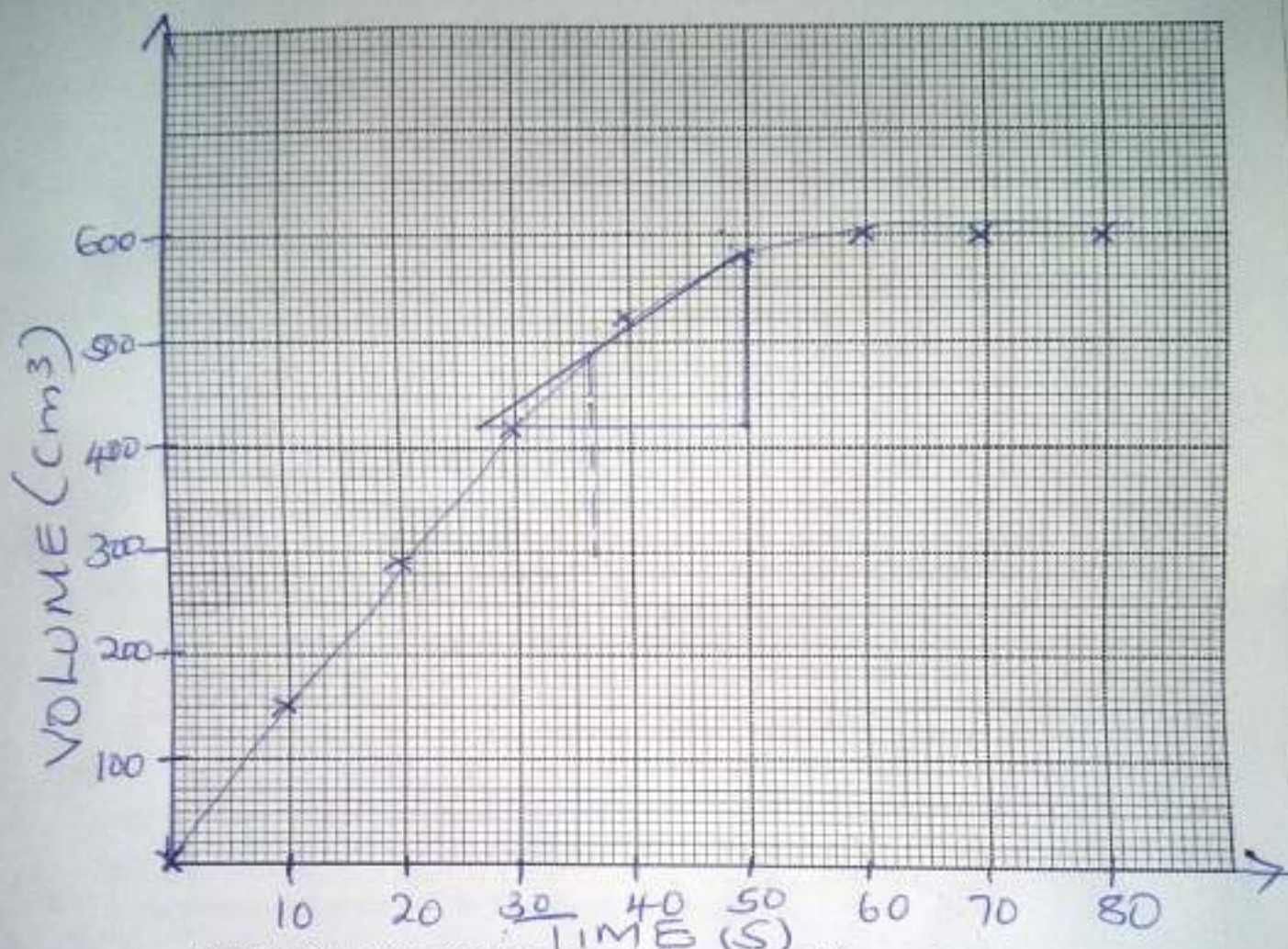
(1 mark)

Concentration

(c) 2.50 grams of a calcium carbonate was reacted with excess 1.8 M hydrochloric acid. The volume of carbon (IV) oxide evolved measured and recorded at 10 second intervals. The results were recorded as shown in the table below.

Time (seconds)	0	10	20	30	40	50	60	70	80
volume of gas (cm ³)	0	150	295	420	525	580	600	600	600

- (i) (I) On the grid provided, plot a graph of volume (vertical axis) against time. (3 marks)



- (II) From your graph, determine the rate of reaction at 37th second.

$$\frac{580 - 420}{50 - 27} = 6.9565 \text{ cm}^3/\text{s} \quad (3 \text{ marks})$$

5. (a) The table below shows the standard reduction potentials for four half cells. Study it and answer the questions that follow.

Number	Half-reaction	E ⁰ volts
I	$\text{Ag}^+_{(\text{aq})} + 2\text{e}^- \rightleftharpoons \text{Ag}_{(\text{s})}$	+ 0.80
II	$\text{Cu}^{2+}_{(\text{aq})} + 2\text{e}^- \rightleftharpoons \text{Cu}_{(\text{s})}$	+ 0.34

III	$\text{Pb}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Pb}(\text{s})$	-0.13
IV	$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Fe}(\text{s})$	-0.44

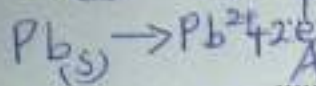
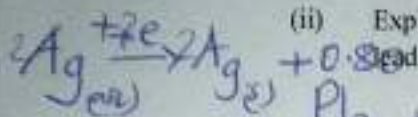
(i) Identify the strongest oxidizing agent

(1 mark)

Ag

(ii) Explain why it's not advisable to store a solution of silver nitrate in a container made of

(2 marks)

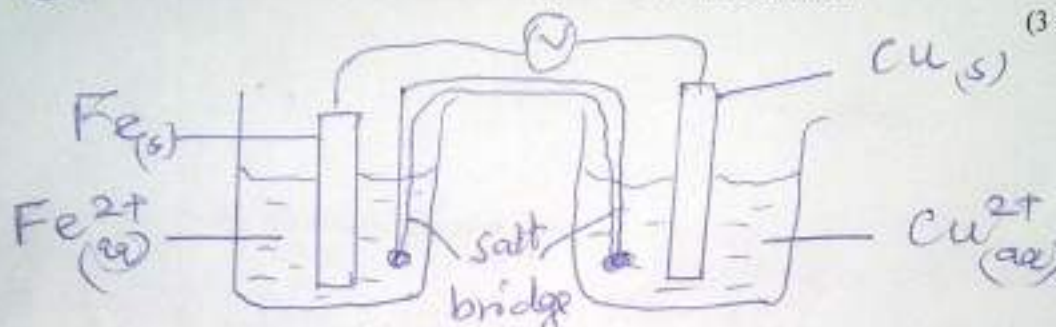


Pb will reduce the silver ions to Ag (ref calculated E value).

$E = 0.8 + 0.13$
 $= 0.93 \text{V}$

(iii) In the space provided, draw a labeled diagram of the electrochemical cell that would be obtained when half-cell of copper and iron are combined.

(3 marks)



(iv) Calculate the E° of the electrochemical cell constructed in (iii) above.

(1 mark)

$$+0.44$$

$$+0.34$$

$$0.78 \text{V}$$

$$+0.34 - (-0.44)$$

$$= +0.78 \text{V}$$

(b) During the electrolysis of aqueous copper (II) sulphate using copper electrodes, a current of 0.75 A was passed through the cell for 3 hours and 45 minutes.

(i) Write a half-equation for the reaction that took place at the anode.

(1 mark)



(ii) Determine the change in mass of the anode which occurred as a result of the electrolysis process. (Cu = 63.5, 1 F = 96,500C)

(5 marks)

$Q = 1 \text{t}$
 $= 0.75 \times (3 \times 60 \times 60 + 45 \times 60)$
 $= 10125 \text{C}$
 $1 \text{m of e} = 96500 \text{C}$
 $2 \text{ mol of e} = 193000 \text{C}$
 $63.5 \rightarrow 193000 \text{e}$
 10125C

6. (a) (i) What is fractional crystallization

(1 mark)

$$\frac{63.5 \times 10125}{193000} = 3.3313 \text{g}$$

Decreased by 3.3313g

A process of separating crystals of a solid from a solution basing on their solubility in the same solvent.

- (ii) The table below shows the solubility of two salts A and B at various Temperatures

Salt	Solubility at various temperatures(°C)	
	50	20
A	86 g	31 g
B	18 g	8 g

A mixture of the salts contains 29.5 g of salt A and 16.25 g of salt B at 50 °C. The mixture is cooled to 20 °C. Determine the mass of the salt that crystallizes(2 marks)

$$16.25g - 8g = 8.25g$$

- (b) Explain how the use of ion exchange resin removes water hardness (2 marks)

Containing Ca^{2+} / Mg^{2+} are is through a column containing Na^+ where the ions are exchanged forming ppt which remain in the column as water containing Na^+ passes through the column

- (c) Name two disadvantages of hard water

(2 marks)

- Soap is wasted.

- Forms scales in boilers and electric kettles

- leaves spots on white linen during washing

- * (d) State the observations made when sodium hydroxide is added to a sample of water suspected to contain Magnesium ions (2 marks)

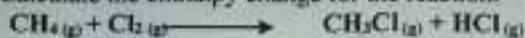
White precipitate insoluble in excess

7. Study the information given in the table below and answer the questions below the table:

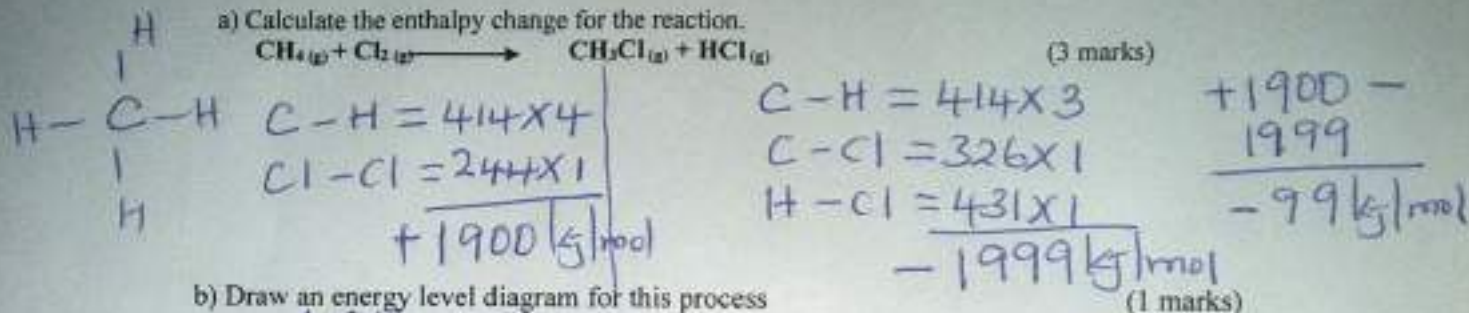
Bond	Bond energy (kJ mol^{-1})

C — H	414
Cl — Cl	244
C — Cl	326
H — Cl	431

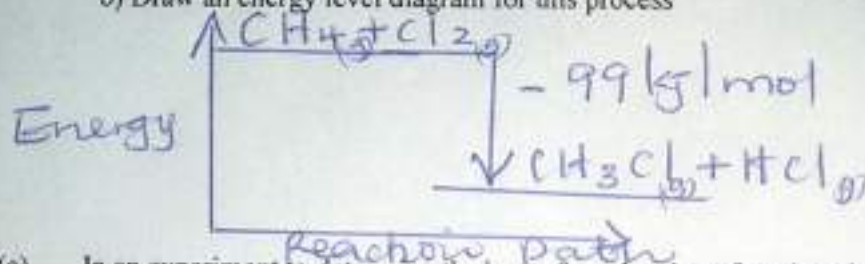
a) Calculate the enthalpy change for the reaction.



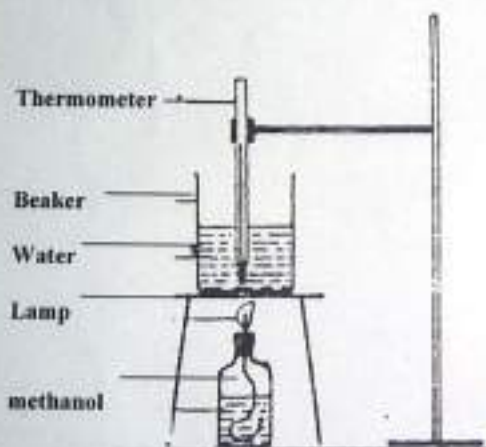
(3 marks)



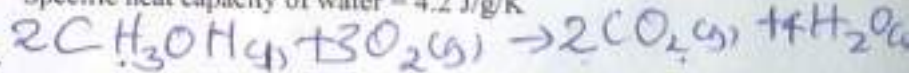
b) Draw an energy level diagram for this process



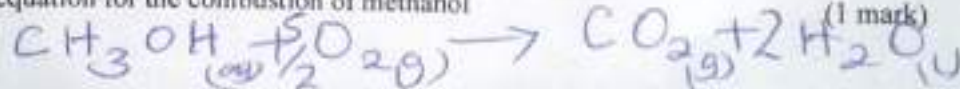
(c) In an experiment to determine the heat of combustion of methanol, CH_3OH a student used a set up like the one shown in the diagram below.



Volume of water = 500 cm^3
 Final temperature of water = 27.0°C
 Initial temperature of water = 20.0°C
 Final mass of lamp + methanol = 22.11 g
 Initial mass of lamp + methanol = 22.98 g
 Density of water = 1.0 g cm^{-3}
 Specific heat capacity of water = $4.2 \text{ J/g}^\circ\text{C}$



d) Write an equation for the combustion of methanol



e) Calculate:

(i) The number of moles of methanol used in this experiment ($\text{C} = 12$; $\text{O} = 16$; $\text{H} = 1$)

Mass of methanol burnt = $22.98 - 22.11$
 $= 0.87$ (2 marks)

$$\text{mol} = \frac{0.87}{32} = 0.02719 \text{ mol}$$

* (ii) The heat of combustion per mole of methanol.

$$4H = mC\Delta H$$

$$= 500 \times 4.2 \times (27 - 20) = 14700 \text{ J}$$

(iii) The heat of combustion per mole of methanol

$$0.02719 \rightarrow \frac{14700 \times 1}{0.02719}$$

$$= 540,639.94 \text{ J/mol} / 540.639 \text{ kJ/mol}$$

(f) Explain why the value of the molar heat of combustion for methanol obtained in this experiment is different from the theoretical value. (1 mark)

- Some heat is lost to the environment
- Heat absorbed by apparatus is not accounted for

(g) State two environmental effects of using methanol as a fuel (2 marks)

- Produces gaseous products which pollute the environment.
- It is flammable hence can result in fire outbreaks.