- END TERM ~~EXAMS~~ I EXAMS.
- CHEMISTRY PAPER 2.
- TIME 2hours.
- Form 4.

(08)

(1) Bellow is a table of oxides of period 3 elements. Use it to answer the questions that follow.

Element	Na	Mg	Al	Si	P	S	Cl.
Oxides	Na_2O Na_2O_2	MgO	Al_2O_3	SiO_2	P_2O_3 P_2O_5	SO_2 SO_3	Cl_2O_7
Nature of oxides	I	II	III	IV	V	VI	VII

(a) Compare the electrical conductivity of oxides of sodium to those of phosphorus. 2marks.

- oxides of sodium are good conductors in aqueous solution and molten form due to the presence of mobile ions.
- oxides of phosphorus are non conductors in all states since they lack mobile ions.

(b) Which oxides would react with dilute sulphuric acid explain. (2marks)

- oxides of sodium, magnesium and aluminium. These are basic oxides.

(c) Write down balanced equation to show how one of the oxides would react with both 2M hydrochloric acid and 2M sodium hydroxide solution. (2marks)

$$Al_2O_{3(s)} + 6HCl_{(aq)} \longrightarrow 2AlCl_{3(aq)} + 3H_2O_{(l)}.$$

$$Al_2O_{3(s)} + 2NaOH_{(aq)} \longrightarrow 2Na(Al(OH)_4)_{(aq)} + 3H_2O_{(l)}.$$

(d) (i) What structure would be formed by the oxides of silicon? Explain your answer. (2marks.)

Giant atomic or Giant covalent structure, silicon and oxygen have small differences in electron affinity.

- continous covalent bonds exists in the structure of the oxides to create stable compounds.

(ii) Compare the melting points of SO_2 and that of MgO. (2 marks)

(02)

Answer (ii) The melting point of SO_2 is lower than that of MgO. MgO has a giant ionic structure while SO_2 has a simple molecular structure. 2marks.

- ~~The melting point of SO_2 is lower than that of MgO.~~

(e) Describe how you would prepare a dry sample of lead (II) nitrate from the following reagents: lead (II) oxide and dilute nitric (V) acid. (3marks)

- Add dilute nitric (V) acid to lead (II) oxide and stir until all the oxide has dissolved.
- Filter the mixture to obtain a clear nitrate.
- Evaporate the filtrate until crystals begin to appear on a string rod
- allow to cool for crystals to form.
- Drain off the excess filtrate and dry in the sun.

f) Alum used in treating water is both advantageous and disadvantageous. Explain. (2marks)

- Alum causes acidity therefore disadvantageous
- Alum coagulates dissolved or suspended particles therefore purifier.

g) When a blue litmus paper is dipped in a solution of aluminium chloride it turns red. Explain. (1mark)

- Aluminium chloride hydrolyses in solution producing hydronium ions which turn blue litmus paper red.

(2) The set up bellow was used to prepare hydrogen chloride gas and salt T. (1½ marks)

(a) Identify the following
(i) Liquid M. – Concentrated Sulphuric (VI) acid
(ii) Gas V. – Hydrogen
(iii) Salt T. – Aluminium (III) chloride.

(b) Write down balanced chemical equations for reactions that occur at (2 marks)
(i) Flask I
$NaCl_{(s)} + H_2SO_{4(l)} \longrightarrow NaHSO_{4(aq)} + HCl_{(aq)}$
(ii) Combustion tube.
$2Al_{(s)} + 6HCl_{(g)} \longrightarrow 2AlCl_{3(s)} + 3H_{2(g)}$.

(c) Name the process that formed salt T as shown in the diagram (½ marks)
Sublimation

(d) Sulphuric (VI) acid is used as a drying agent in this experiment. Explain why calcium oxide is unsuitable for the same purpose in this reaction (1 marks)
It reacts with hydrogen chloride gas to form a salt.

(e) The water in the beaker was found to have a pH of 2.0 at the end of the experiment. Explain (1 mark)
– excess HCl dissolved in the water to form hydrochloric acid.

(f) Calculate the mass of salt T formed if 430 cm^3 of hydrogen chloride gas measured at room temperature was reacted with aluminium powder. (Al = 27, Cl = 35.5)
(MGV = 24 dm^3). (2 marks)

Moles of HCl = $\frac{430}{24000}$
= 0.02 moles

Moles of $AlCl_3$ = $\frac{0.02 \times 1}{6}$ = 0.00667 moles

Mass = 0.00667 × 133.5
= 0.89 g

~~25~~ 17

(g) Draw a well labelled diagram showing how you would dissolve hydrogen chloride in water. (2 marks)

(h) Explain why hydrogen chloride gas dissolved in Methyl benzene does not react with calcium carbonate. (1 mark).

- HCl in methylbenzene exists as a molecule; no free ions.

(i) Using an equation, state the observation made when a gas jar containing hydrogen chloride gas is opened near an open bottle of liquid ammonia (1 mark)

$HCl_{(g)} + NH_{3(g)} \rightarrow NH_4Cl_{(s)}$

white fumes.

(3) Use the information bellow to answer the questions that follow.

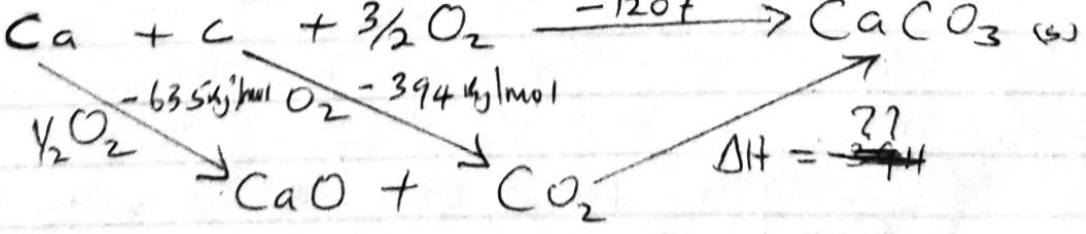
$Ca_{(s)} + \frac{1}{2}O_{2(g)} \rightarrow CaO_{(s)} \quad \Delta H = -635\ KJ/mole^{-1}$

$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} \quad \Delta H = -394\ KJ/mol.$

$Ca + C + \frac{3}{2}O_2 \rightarrow CaCO_{3(s)} \quad \Delta H = -1207\ KJ/mol.$

(a) Calculate the enthalpy change for the reaction. (3 marks)

$CaO_{(s)} + CO_{2(g)} \rightarrow CaCO_{3(s)}.$



$\Delta H = \Delta H_c Ca + \Delta H_c C = \Delta H_f CaCO_3$

$-635 + -394 = -1207$

$\Delta H = -1207 + 635 + 394.$

$= -178\ KJ\ mol^{-1}$

(b) State one factor that should be considered when choosing a fuel for cooking. (1mark)

- Heating value
- Availability
- Cost.
- Easy of storage
- Easy of combustion
- Effect of environment

(c) A student used the apparatus shown to calculate the energy released when ethanol burns.

The energy released by the burning ethanol raises the temperature of the water in the copper colorimeter. ~~Volume~~

Volume of water used = 500 cm^3

Initial temperature of water = 25 c^o.

Final temperature of water = 44.5 c^o.

Mass of ethanol + lamp before burning = 121.5g.

~~Calculate the~~ Mass of ethanol + lamp after burning = 120.0g.

Calculate the:

(i) Heat evolved during the experiment (density of water = 1g/cm^3, specific heat capacity of water = 4.2 $jg^{-1}K^{-1}$) (3marks)

Mass of water $500\,cm^3 \times 1\,g/cm^3 = 500g$

$\Delta T = 44.5 - 25.0 = 19.5\,c^o$

Heat evolved = $500g \times 4.2 j g^{-1}K^{-1} \times 19.5K$

= 409.50j

(ii) Molar heat of combustion of ethanol. (3marks)

(C=12, O=16, H=1)

Mass of ethanol used = 121.5 − 120.0 = 1.5g.

RMM of ethanol = ~~46~~ CH_3CH_2OH = 46.

1.5g of ethanol produced 409.50j

46 ⟶ x

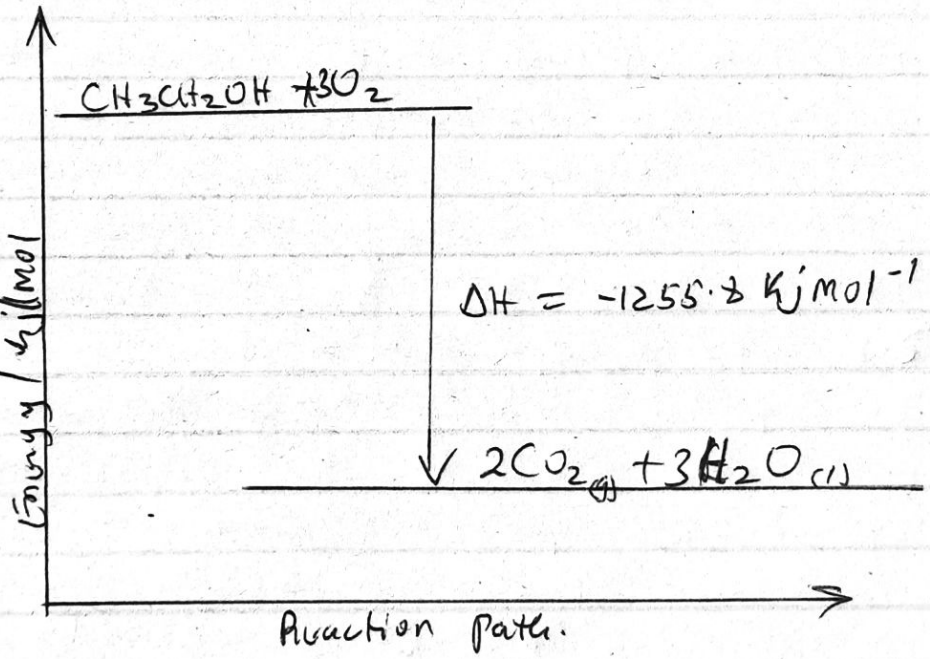
$(409.50 \times 46) = 1255800\,j/mol = \frac{1255800}{1000}$

(d) Write the thermal equation for the complete combustion of ethanol. (2marks)

~~Mass of ethanol~~

$CH_3CH_2OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O \quad \Delta H = -1255.8\ kJ/mol$

(e) Sketch a simple energy diagram for the reaction of ethanol in air. (3 marks)



(4) Name the following compounds using the IUPAC system

(a) (i) $CH_3CH_2COOCH_2CH_3$. (1mark)

Ethyl Propanoate

(ii) $CH_3CH_2\underset{Br}{\underset{|}{C}}H-\underset{CH_3}{\underset{|}{C}}=CH_2$ (1mark)

~~2-Bromo~~ 3-Bromo Hex-2-ene.

(b) Study the scheme bellow and answer the questions that follow.

(07)

(i) Identify the catalyst used in step I. (1mark)

Nickel / Palladium

(ii) Name the compounds A and B (1mark)

A - Ethane

B - Chloroethene

(iii) Give one disadvantage of Compound formed in step (II) (1mark)

Non-biodegradable

(iv) Name the reactions taking place at steps (2mark)

III Polymerisation

IV Substitution reaction.

(v) Under certain conditions, heptane can be converted to two products. The formula of one of the products is C_4H_{10}. Write down the structural formula of the other product. 2marks.

(c) A compound of carbon, hydrogen, and oxygen contains 71.12, by Mass of Oxygen, 2.2 hydrogen and the rest is Carbon. It has a relative Molecular Mass of 90.

(i) Calculate the empirical formula of the compound. (3 marks)

(c) Compound A and B have the same molecular formular $C_3H_6O_2$. Compound A liberates Carbon (IV) oxide on addition of aqueous Sodium Carbonate while Compound B does not. Compound B has a sweet smell. Draw the possible structures of:

(i) compound A (1mark)

CH_3CH_2COOH

(ii) Compound B. (1mark)

CH_3COOCH_3 or $HCOOCH_2CH_3$

(6½)

(d) A student mixed equal volumes of ethanol and butanoic acid. He added a few drops of concentrated sulphuric (vi) acid and warmed the mixture.

(i) Name and write the formula of the main products. (2marks)

- $CH_3CH_2CH_2COOCH_2CH_3$
- ethylbutanoate.

(ii) Which homologous series does the product named in (i) above belong? (1mark)

Esters or Alkylalkanoate.

(5) Using the standard electrode potentials given below to answer the questions that follow.

Element		Volts (V)
$Ag^+_{(aq)} + e^-$	$\longrightarrow Ag_{(s)}$	+0.80
$Cu^{2+}_{(aq)} + 2e^-$	$\longrightarrow Cu_{(s)}$	+0.34
$Pb^{2+} + 2e^-$	$\longrightarrow Pb_{(s)}$	−0.13
$Zn^{2+} + 2e^-$	$\longrightarrow Zn_{(s)}$	−0.76

(a) Select two half-cells which when combined give the lowest workable cell (lowest emf). (1mark)

$Pb^{2+} + 2e^- \rightleftharpoons Pb_{(s)}$ and $Cu^{2+}_{(aq)} + 2e^- \rightleftharpoons Cu_{(s)}$ half cell.

(b) Calculate the emf of the cell formed by combining the two half-cells in (a) above. (1mark).

$E_{red} - E_{oxd}$

$0.34 + 0.13$

$+0.47V$.

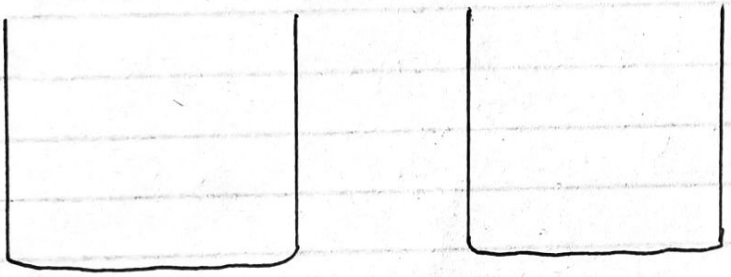
(c) (i) Select the strongest oxidising agent (½ mark)

Ag^+

(ii) Strongest reducing agent. ½.

$Zn_{(s)}$.

(d) A cell was set up using lead and zinc electrodes as shown bellow.



a(i) Write down the half equation for the half-cell in which oxidation occurs. (1mark)

$Zn_{(s)} \rightleftharpoons Zn^{2+} + 2e^-$

(ii) Write down the overal cell equation (1mark)

$Zn_{(s)} + Pb^{2+}_{(aq)} \rightleftharpoons Zn^{2+}_{(aq)} + Pb_{(s)}$

(iii) What is the role of the salt bridge. (2marks)

- To complete the circuit
- To remove any oxide layer that might interfere with the electroplating process.

(e) An iron cup was electroplated using chromium. The Chromium electrode and the iron cup was thoroughly cleaned and weighed before being dipped into the electrolyte.

(i) Why was it necessary to clean the metals before dipping them into the electrolyte.? (1mark)

- To remove any oxide layer that might interfere with electroplating process

(06)

(ii) A current of 0.75A was passed through the solution for one hour and four minutes. The mass of chromium deposited on the cup was 0.52g (1 Faraday = 96500C, ~~xo~~ Cr = 52).

I Calculate the quantity of electricity (1mark)

$$Q = It$$
$$= 0.75 \times 3,840$$
$$= 2,880C$$

II How many moles of chromium were deposited (1mark)

$$\text{Moles} = \frac{\text{Mass}}{\text{RAm}} \qquad \frac{0.54}{52} = 0.01 \text{ moles}$$

III Calculate the quantity of electricity to deposit one mole of chromium. (2marks).

0.01 moles requires 2,880C

1 mole " " x

$$\left(\frac{1 \times 2880C}{0.01}\right) = 288,000C$$

(iv) Calculate the number of faradays required to deposite one mole of chromium and hence deduce the charge of ion. (2marks)

1F ⟶ 96,500C

xF ⟶ 288,000C

$$x\left(\frac{1F \times 288000C}{96500C}\right)$$

x = 2.98 F

Charge = 3^+

(04)

6 Nitrogen and hydrogen reacts to form ammonia gas as shown in the following equation.

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} \quad \Delta H = -97\ kJ/mol.$$

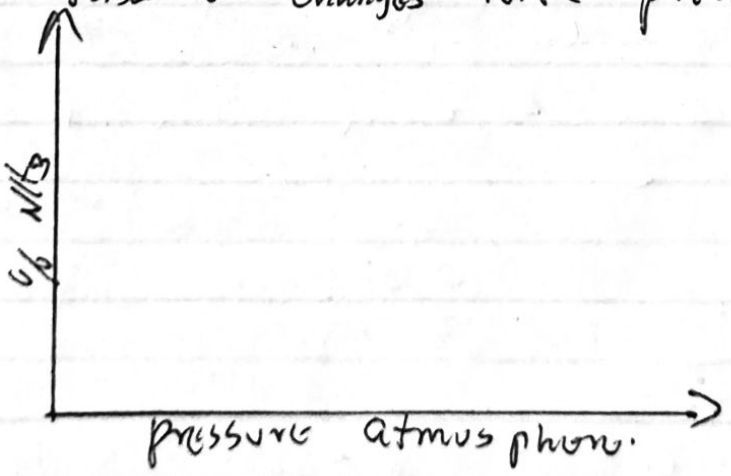
(a) The figure below shows how the percentage of ammonia gas in the equilibrium mixture changes with temperature.

(a)

(a) Explain why the percentage of ammonia gas changes as shown in the figure above. (2 marks).

- As temperature increases, the yield of ammonia gas decreases since forward reaction is exothermic.

(b) On the following axis, sketch a graph showing how the percentage of ammonia gas in the equilibrium mixture changes with pressure. (1 mark)



(c) Bismuth chloride ($BiCl_3$) reacts with water according to the equation given below.

$$BiCl_{3(aq)} + H_2O_{(l)} \rightleftharpoons BiOCl_{(s)} + 2HCl_{(aq)}$$

White.

(i) State what would happen when a few drops of dilute hydrochloric acid are added to the mixture at equilibrium. (1 mark).

- Equilibrium shifts to the left

(ii) Give a reason for your answer in (a)(i) above (1 mark)
- In order to reduce the concentration of HCl and restore the equilibrium.

(d) In the harber process, the industrial manufacture (I) of ammonia is given by the following equation.

$$N_{2(g)} + 3H_2 \rightleftharpoons 2NH_{3(g)} \quad \Delta H = -97 \text{ kJ/mol}$$

(i) Name one source of hydrogen used in the process (1 mark)
- Cracking of long chain alkanes

(ii) Name the catalyst used in the above reaction (1 mark)
finely divided iron / iron powder.

(iii) What is the effect of increasing temperature on yeild of ammonia. Explain (2 marks)
- Yeild decreases;
- high temperature favours backward reaction.

(ii) The curves bellow were obtained when equal volumes of 2M HCl were reacted with 3.0 g of marble chips ($CaCO_3$). In one of the reactions, the acid was warmed before adding the marble chips.

(i) Write down the equation for the reaction (2 marks)

$$CaCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CaCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$$

(ii) Identify the curve representing the reaction where the acid was warmed. (1 mark)
Curve I

answer for (g). 2 (g)