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P525/1
CHEMISTRY
Paper 1
June /July. 2024
2¾ hours

Uganda Advanced Certificate of Education

CHEMISTRY

PAPER 1

TIME: 2hours 45minutes

INSTRUCTIONS TO CANDIDATES;

Answer all questions in Section A and any six in Section B.

All questions must be answered in spaces provided.

Illustrate your answers with equations where applicable.

Molar gas constant, $R=8.314jk^{-1}mol^{-1}$

Molar volume for a gas at s.t.p is $22400cm^3$

Standard temperature =273k

Standard pressure =101325 Nm^{-2}

FOR EXAMINERS USE ONLY																	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
04½	05	06	06½	04½	05	04½	04½	06	09	09	09	09	09	09	09	09	

SECTION A

Answer all questions from this section

1. (a) Polonium, $^{216}_{84}Po$ undergoes nuclear decay to give element M according to the following equation

$$^{216}_{84}P_0 \longrightarrow M + \alpha$$

State

(i) the atomic number of M 82 ✓ .....(½mark)

(ii) the mass number of M 212 ✓ .....(½mark) 01

(b) M decays further to form R as shown below

$M \longrightarrow R + \beta$ -½

State

(i) the atomic number of R 83 ✓ .....(½mark) 01

(ii) the mass number of R 212 ✓ ..... (½mark)

(c) A sample of M had an initial activity of 104 counts per second. After 12 minutes the activity had reduced to 100 counts per second. Calculate the half-life of M. **(2½ marks)**

From $\ln \frac{N_0}{N_t} = \lambda t$ ✓

$\ln \frac{104}{100} = 12 \times 60 \times \lambda$ ✓

$\lambda = \frac{0.039221}{12 \times 60}$ ✓

$= 0.000054473$ ✓

or $5.4473 \times 10^{-5}\ sec^{-1}$

$t_{½} = \frac{\ln 2}{\lambda}$

$= \frac{0.693}{5.4473 \times 10^{-5}}$ ✓

$= 12,724.55$ seconds ✓

or 212.08 minutes

212 minutes

$2.303(00)\left(\frac{104}{100}\right) = \lambda t$

$\lambda = \frac{0.039221}{12 \times 60}$

$= 0.000054483$

$t_{½} = \frac{0.693}{0.000054483}$

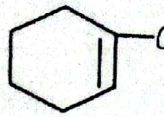
$= 12,719.55$ sec

or 211.99 minutes

$= 212$ minutes

02½

State what would be observed and write equation(s) for the reaction(s) that would take place when the following pairs of substances are mixed.

(a)  and bromine water

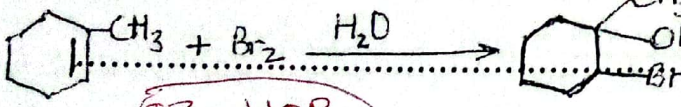
Reject red solution turns colourless brown.

Observation *(01 mark)*

The reddish brown solution turns colourless ✓

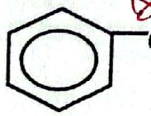
sp

Equation *(01 mark)* ✓ 02



$+ HBr$ deny ½ if HBr is missing

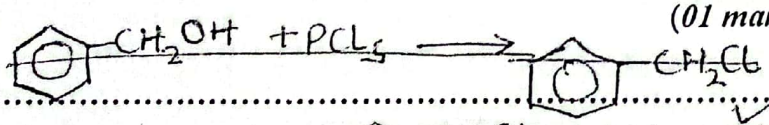
OR $HOBr$ Allow $Br_2(aq)$ Ignore states

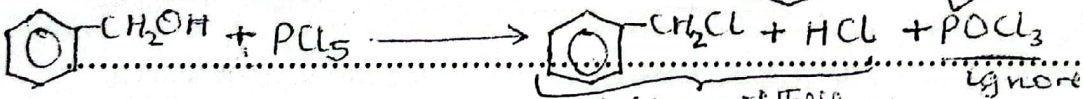
(b)  and phosphorus pentachloride.

Observation *(½ mark)* ½

White fumes ✓

Equation *(01 mark)*





$+ HCl + POCl_3$ 01 ignore

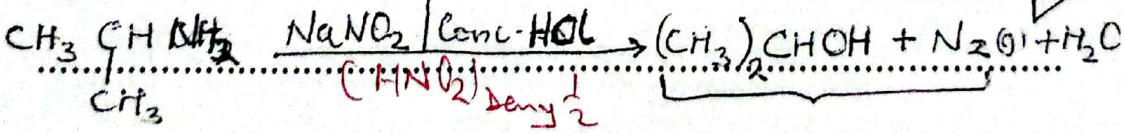
rej if any of these if missing

(c) $^{*}CH_3CHNH_2$ and sodium nitrite in concentrated hydrochloric acid
CH_3

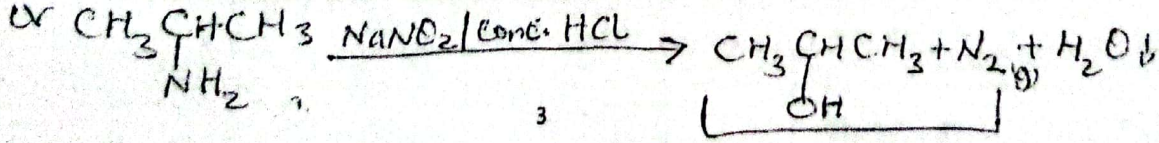
Observation *(½ mark)* ½

Bubbles of a colourless gas. ✓

Equation *(01 mark)* 01



$(CHNO_2)$ deny ½



Rej if one of these 2 Products is missing

3. The table below shows the trend in the melting points of group IV dioxides.

Formula of oxide	CO_2	SiO_2	GeO_2	SnO_2	PbO_2
Melting points (°C)	−18	1700	1120	1830	752

(a) Explain the trend in melting points of the dioxides. *(4½ marks)*

Melting points generally increase from CO_2 to PbO_2 with the melting points of GeO_2 and PbO_2 being lower than expected. Carbon dioxide exhibits a simple molecular structure with Vandervaals forces; that so weak. Both SiO_2 and GeO_2 exhibit giant molecular structures, with strong covalent bonds between respective atoms; the atomic radius of Silicon is smaller than Germanium so the covalent bond is stronger in SiO_2 than GeO_2. Tin dioxide and lead dioxide exhibit giant ionic structures; the cationic radius of Tin(IV) is smaller than Lead(IV) so the ionic bond in Tin(IV) oxide is stronger than Lead(IV) some more energy is needed to break it.

(b) Write equation for the reaction between lead (IV) oxide and aqueous sodium hydroxide. *(1½ marks)*

$PbO_2(s) + 2\bar{O}H(aq) + 2H_2O(l) \longrightarrow Pb(OH)_6^{2-}(aq)$

or

$PbO_2(s) + 2\bar{O}H \longrightarrow PbO_3^{2-}(aq) + H_2O(l)$

4. 1.38g of a compound **Q** made up of carbon, oxygen and hydrogen atoms only was burnt, 672cm³ of carbondioxide measured at s.t.p and 0.54g of water were formed.

(a) (i) Calculate the empirical formula of **Q**. *(03 marks)*

22400cm³ of CO_2 weighs 44g (molar)

672cm³ $\left(\frac{44 \times 672}{22400}\right) = 1.32g$

Mass Carbon $= \left(\frac{12}{44} \times 1.32\right) = 0.36g$

Mass Hydrogen $= \left(\frac{2 \times 0.54}{18}\right) = 0.06g$

Mass Oxygen $= 1.38 - (0.36 + 0.06)$

$= 0.96g$

	C	H	O
	$\frac{0.36}{12}$	$\frac{0.06}{1}$	$\frac{0.96}{16}$
	0.03	0.06	0.06
	$\frac{0.03}{0.03}$	$\frac{0.06}{0.03}$	$\frac{0.06}{0.03}$
	1	2	2

Q is CH_2O_2

(ii) Determine the molecular formula of Q, given that its relative molecular mass is 46. *(01 mark)*

Molecular mass of Q = 46

$(CH_2O_2)_n = 46$

$12n = 46$

$n = 1$

Molecular formula of Q is CH_2O_2

(b) Compound Q reacts with a saturated solution of sodium hydrogen carbonate liberating carbondioxide gas. Identify Q. *(½ marks)*

$HC(=O)-OH$ or Methanoic acid

(c) A hot solution of Q was added to acidified potassium manganate (VII) solution.

(i) State what was observed. *(½ marks)*

The purple solution turned colourless, bubbles of a colourless gas.

(ii) Write equation for the reaction that took place. *(1½ marks)*

$5HCOOH_{(aq)} + 2MnO_{4(aq)}^- + 6H_{(aq)}^+ \longrightarrow 2Mn_{(aq)}^{2+} + 5CO_{2(g)} + 8H_2O_{(l)}$

In Bal. all right

5. The standard electrode potentials for some half cells are shown below;

	E^θ/V
$O_{2(g)} + 4H_{(aq)}^+ + 4e \longrightarrow 2H_2O_{(l)}$	+1.23
$FeO_{4(aq)}^{2-} + 8H_{(aq)}^+ + 3e \longrightarrow Fe_{(aq)}^{3+} + 4H_2O_{(l)}$	+2.20

(a) Write

(i) The cell notation for the cell formed when the half cells are combined. *(1½ mark)*

$Pt_{(s)} | H_2O_{(l)}, H_{(aq)}^+ | O_{2(g)} || FeO_{4(aq)}^{2-}, H_{(aq)}^+, Fe_{(aq)}^{3+} | Pt_{(s)}$

$Pt | H_2O_{(l)} | O_{2(g)} | H_{(aq)}^+ || FeO_{4(aq)}^{2-}, Fe_{(aq)}^{3+}, H_{(aq)}^+ | Pt_{(s)}$

Rej: if H_2O is included on right side

(ii) The equation for overall cell reaction. *(01 mark)*

$4FeO_4^{2-}(aq) + 20H^+(aq) \longrightarrow 4Fe^{3+}(aq) + 10H_2O(l) + 3O_2$ ✓

(b) (i) Calculate Gibb's free energy for the cell in (a). *(01 mark)*

$\Delta G^\ominus = -nFE^\ominus$ ✓ $E^\ominus = (+2.2 - 1.23) = 0.97$

$= -12 \times 96500 \times +0.97$

$= -1123260\ J\,mol^{-1}$ ✓

or $-1123.26\ kJ\,mol^{-1}$

(ii) State whether the cell reaction is feasible or not. Give a reason for your answer. *(01 mark)*

The reaction is feasible ✓; because Gibbs free energy ✓ has a negative (sign)

~~or~~ exothermic ~~for~~ negative.

6. Using equations show how the following conversion can be brought about.

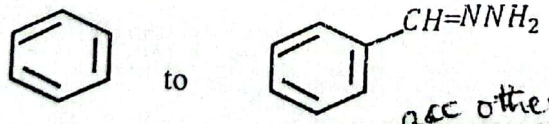
(a) * CH_3CH_2OH to $CH_3CHCOOH$ *(2½ marks)*

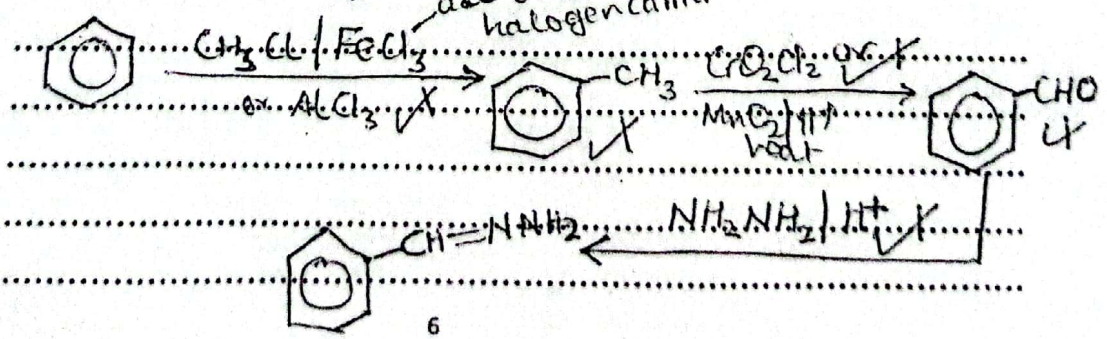
$CH_3CH_2OH \xrightarrow[heat]{Cr_2O_7^{2-}/H^+}$ ✓ CH_3CHO ✓ $\xrightarrow[(10-20^\circ C)]{KCN/H_2SO_4(dil)}$ ✓ $CH_3CH(OH)CN$ ✓

OR $\xrightarrow[300^\circ C]{MnO_2}$ $CH_3CH(OH)COOH$ $\xrightarrow[heat]{H_2O/H^+}$ ✓

"long"

(dem MnO_4^-/H^+)

(b)  to *(2½ marks)*



Write equation for the reaction that takes place when the following are mixed.

(a) Trileadtetraoxide and concentrated nitric acid. *(1½ marks)*

$Pb_3O_4(s) + 4HNO_3(aq) \longrightarrow PbO_2(s) + 2Pb(NO_3)_2(aq) + 2H_2O(l)$ ✓✓ S Bal

(b) aqueous sodium hydroxide solution and

(i) Zinc *(1½ marks)*

$Zn(s) + 2\bar{O}H(aq) + 2H_2O(l) \longrightarrow Zn(OH)_4^{2-}(aq) + H_2(g)$ ✓✓ S Bal

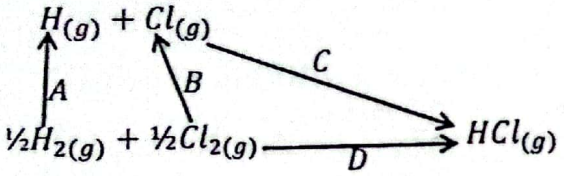
or

$Zn(s) + 2\bar{O}H(aq) \longrightarrow ZnO_2^{2-}(aq) + H_2(g)$

(ii) Silicon tetrahydride *(1½ marks)*

$SiH_4(g) + 2\bar{O}H(aq) + H_2O(l) \longrightarrow SiO_3^{2-}(aq) + 4H_2(g)$ ✓✗

8. The energy diagram for the reaction between hydrogen and chlorine is given below;



(a) Identify the energy changes

A Enthalpy of Atomisation (energy) of hydrogen gas *(½ marks)* ✓

B Enthalpy of Atomisation (energy) of chlorine gas *(½ marks)* ✓

C Bond energy (of hydrogen chloride) *(½ marks)* ✓

D Enthalpy of formation of hydrogen chloride *(½ marks)* ✓

(b) Calculate the enthalpy change for the reaction *(2½ marks)*

(The H − H, Cl − Cl and H − Cl bond energies are 435.9, 241.8 and 431.0 kJmol⁻¹)

Σ Bonds broken ($\frac{1}{2}H_2 \rightarrow H$; $\frac{1}{2}Cl_2 \rightarrow Cl$)

$= \frac{435.9}{2} + \frac{241.8}{2}$ ✓✓

$(217.95 + 120.9) = 338.85$ KJ ✓

Σ Bonds formed: (H−Cl) ✓

$= 431.0$ KJ mol⁻¹ ✓

Enthalpy change $= +338.85 - 431.0$ ✓

$= -92.15$ kJmol⁻¹ ✓

9. (a) 9.8g of an organic compound W containing carbon and hydrogen only was burnt in excess oxygen, 31.55g of carbondioxide and 10.76 of water were formed. Determine the empirical formula of W. *(03 marks)*

Mass Carbon = $\frac{12 \times 31.55}{44} = 8.6$ ✓

Mass Hydrogen = $\frac{2 \times 10.76}{18} = 1.2$ ✓

C	H
$\frac{8.6}{12}$	$\frac{1.2}{1}$
0.7167	1.2 ✓
$\frac{0.7167}{0.7167}$	$\frac{1.2}{0.72}$ ✓
(1	1.674) 3 ✓

Does Rounding off.

C H

3 5 ✓

W is C_3H_5 ✓

(b) W was steam distilled at 70^0C *and* $760\ mmHg$ and the distillate was found to contain 8.9% by mass of water.

Calculate the formula mass of W. (Vapour pressure of water at 70°C is 234 mmHg) *(03 marks)*

Let it be Mr

$\frac{\text{Vapour Pressure } H_2O}{\text{vapour Pressure W}} = \frac{\text{Moles } H_2O}{\text{Moles W}}$

$\frac{234}{526} = \frac{8.9}{18} \times \frac{Mr\ W}{91.1}$ ✓

$Mr\ W = \frac{91.1 \times 18 \times 234}{526 \times 8.9}$ ✓

$= 81.96$

$\simeq 82$ ✓

% W = 100 − 8.9

VP W = 760 − 234

= 526 mmHg

Moles $H_2O = \frac{8.9}{18} =$

$= 0.494$

moles W = $\frac{91.1}{Mr\ W}$

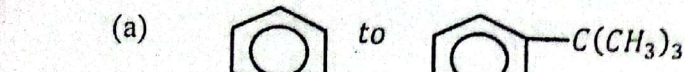
$\frac{0.445}{1} = \frac{0.494}{1} \times \frac{mr}{91.1}$

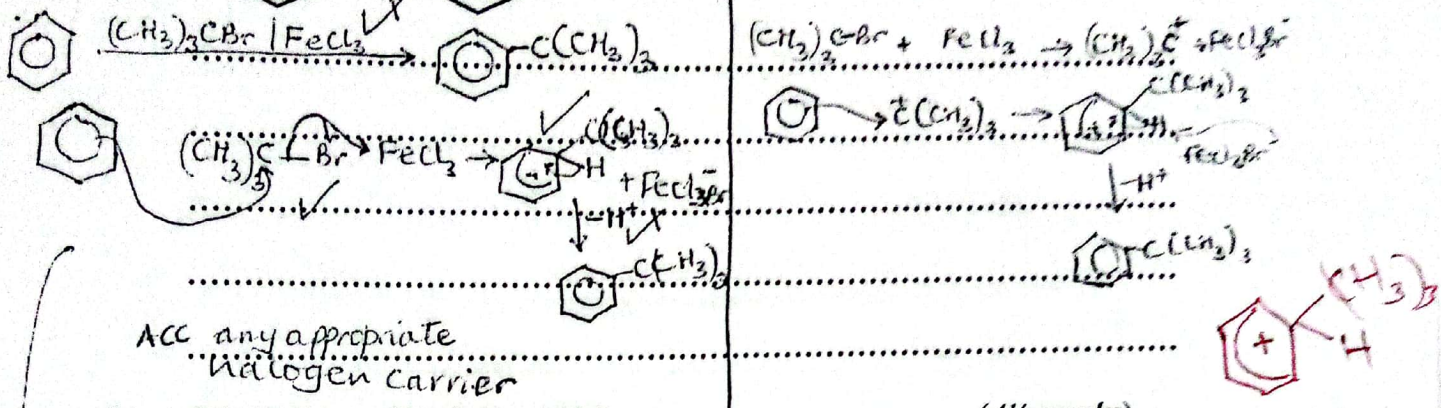
$Mr = \frac{91.1 \times 0.445}{0.494} = 91.127$

SECTION B

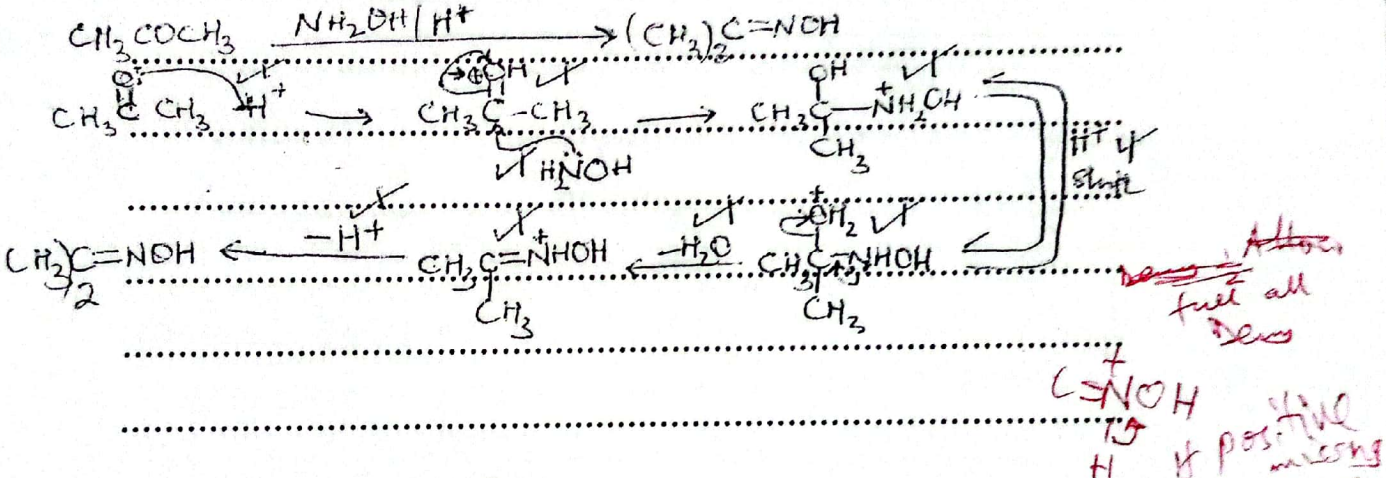
Answer six questions from this section

10. Write a mechanism to show how each of the following conversions can be effected.

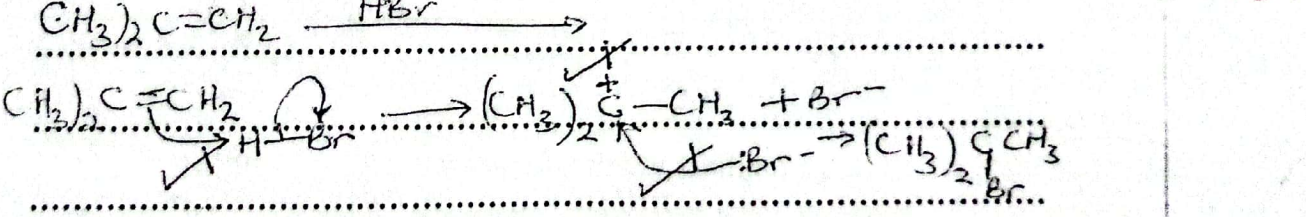
(a)  to *(03 marks)*

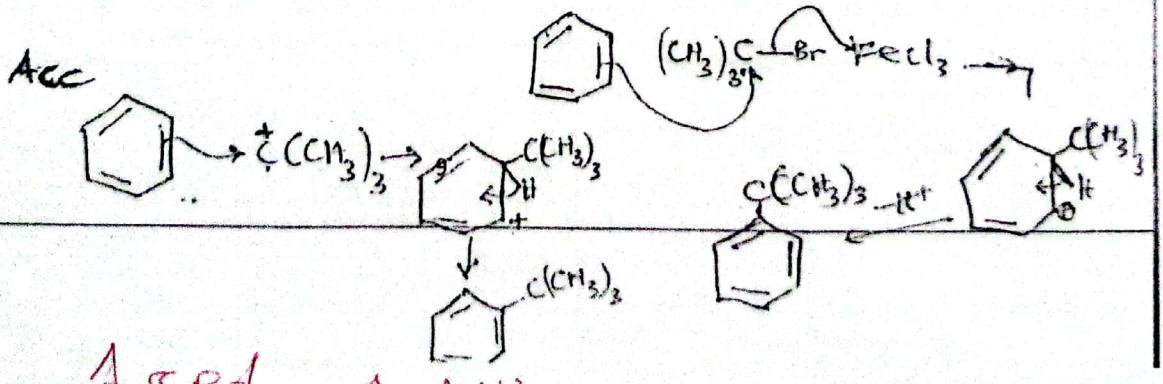


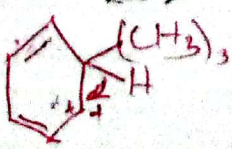
(b) CH_3COCH_3 to $(CH_3)_2C = NOH$ *(4½ marks)*



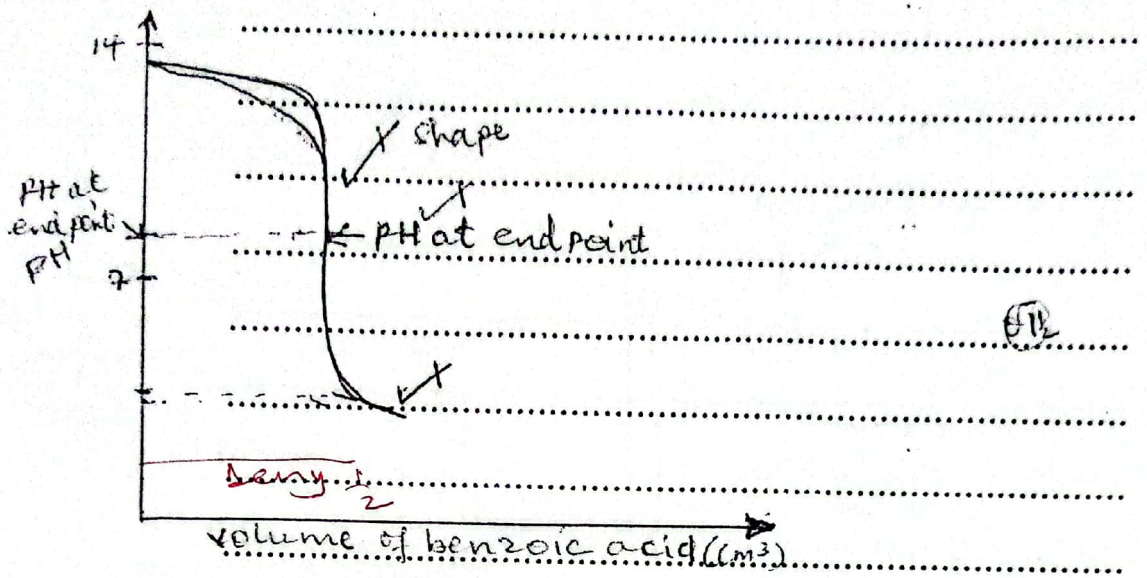
(c) $(CH_3)_2C = CH_2$ to $(CH_3)_2\overset{Br}{C}CH_3$ *(1½ marks)*







11. (a) (i) Sketch a graph to show the pH changes that take place when Benzoic acid is titrated into sodium hydroxide solution. (1½ marks)



(ii) Explain the shape of your sketch graph in (a) (i). (3½ marks)

C_6H_5COONa H_2O pH initially very high because the base is strong and is fully dissociated to form many hydroxide ions

$C_6H_5COOH + NaOH$ pH gradually decreases as hydroxide ions are neutralised by the few hydrogen ions. At the end point, addition of a small amount acid makes a sharp decrease in pH (3½)

pH ~~at end~~ at end point is above 7, since the formed salt hydrolyses to form an alkaline solution

pH, the gradually decreases due to addition of excess weak acid

four above 7.

(b) Calculate the pH of the resultant solution formed when $20cm^3$ of 0.1M potassium hydroxide solution was added to $40cm^3$ of 0.05M benzoic acid at 25°C. ($Ka = 6.3 \times 10^{-5} moldm^{-3}$, $kw = 1.0 \times 10^{-14} moldm^{-3}$) (04 marks)

moles KOH $= \left(\frac{20 \times 0.1}{1000}\right) = 0.002$ mol

moles $C_6H_5COOH = \left(\frac{40 \times 0.05}{1000}\right) = 0.002$

Total volume $= (20+40) = 60cm^3$

Molar concentration:

KOH $= \left(\frac{0.002 \times 1000}{60}\right) = 0.0333M$ (10)

$C_6H_5COOH = 0.0333M$

Molar concentration of salt $= 0.0333M$

$C_6H_5CO_2^- + H_2O \rightleftharpoons C_6H_5COOH + OH^-$

$Kh = \frac{[OH]^2}{[C_6H_5CO_2^-]}$ $\left(Kh = \frac{Kw}{Ka} = \frac{10^{-14}}{6.3 \times 10^{-5}}\right)$

$= 1.587 \times 10^{-10}$

$[OH] = \sqrt{1.587 \times 10^{-10} \times 0.0333}$

$= 2.3 \times 10^{-6}$ (04)

$POH = -\log(2.3 \times 10^{-6}) = 5.6$

$PH = (14 - 5.6) = 8.4$

2. Briefly explain what would be observed when the following are mixed.

(a) chlorine and sulphurous acid. *(03 marks)*

The green-ish yellow gas dissolved to form a colourless solution; sulphurous acid reduces chlorine to chloride ions (03)

$Cl_{2(g)} + SO_3^{2-}{}_{(aq)} + H_2O_{(l)} \longrightarrow 2Cl^-_{(aq)} + SO_4^{2-}{}_{(aq)} + 2H^+_{(aq)}$

$H_2SO_{3(aq)} + H_2O_{(l)} + Cl_{2(g)} \longrightarrow 4H^+_{(aq)} + 2Cl^-_{(aq)} + SO_4^{2-}{}_{(aq)}$

(b) ~~Hot solution of oxalic acid and potassium manganate (VII) solution.~~ Hydrogen sulphide gas and acidified potassium dichromate(VI) solution *(03 marks)*

~~The yellow~~ orange solution turns green and a yellow solid/precipitate; Hydrogen sulphide reduces dichromate(VI) to chromium(III) and hydrogen sulphide oxided to sulphur. (03)

Reject (III)

$3H_2S_{(g)} + Cr_2O_7^{2-}{}_{(aq)} + 8H^+_{(aq)} \longrightarrow 2Cr^{3+}_{(aq)} + 3S_{(s)} + 7H_2O_{(l)}$

(c) Acidified solution of hydrogen peroxide and iodine solution. *(03 marks)*

The brown solution turned colourless and bubbles of a colourless gas. Iodine oxidises hydrogen peroxide to oxygen and its reduced to 03 iodide ions

$I_{2(aq)} + H_2O_{2(aq)} \longrightarrow 2I^-_{(aq)} + 2H^+_{(aq)} + O_{2(g)}$

13. (a) State why transition elements form complexes. *(1½ marks)*

~~Their cations~~

- They form cations with high charge ✓✓
- Their cations have small cationic radii/radius
- the ions have empty 3d-orbitals ✓
- 3d subshell. 1 - Total deny.

(b) Iron (III) sulphate was dissolved in water and the resultant solution tested with litmus paper. State what was observed and explain your answer. *(3½ marks)*

The blue litmus paper turned red. ✓

Iron(III) ions have a high charge density (small radius) and in aqueous solution get heavily hydrated, so undergo hydrolysis to release hydroxonium/hydrogen ions/acidic medium ✓✓✓

$Fe^{3+}_{(aq)} + 3H_2O_{(l)} \rightleftharpoons Fe(OH)_{3(s)} + 3H^+_{(aq)}$ ✓✓ or

$Fe(H_2O)_6^{3+}_{(aq)} + 3H_2O_{(l)} \rightleftharpoons Fe(H_2O)_3(OH)_{3(s)} + 3H_3O^+_{(aq)}$

(c) State what would be observed and write equation for the reaction that would take place when the following solutions are added to the solution in (b).

(i) Ammonium thiocyanate solution. *(02 marks)*

A blood red colouration/solution ✓

$Fe^{3+}_{(aq)} + 6SCN^-_{(aq)} \longrightarrow Fe(SCN)_6^{3-}{}_{(aq)}$ ✓✓

(ii) Potassium hexacyanoferrate (II) solution *(02 marks)*

A deep (dark) blue precipitate/colouration ✓

$Fe^{3+}_{(aq)} + Fe(CN)_6^{4-}{}_{(aq)} \longrightarrow Fe_4(CN)_6^-{}_{(s)}$ ✓✓

- Acc. $Fe(H_2O)_6^{3+}{}_{(aq)} + H_2O_{(l)} \rightleftharpoons [Fe(H_2O)_5OH]^{2+}_{(aq)} + H_3O^+_{(aq)}$

$Fe(H_2O)_6^{3+}{}_{(aq)}{}^{12} \rightleftharpoons [Fe(H_2O)_5OH]^{2+}_{(aq)} + H^+_{(aq)}$

14. (a) A mixture of 86cm³ of a gaseous hydro carbon Y was exploded with 1015cm³ of oxygen which was in excess. The volume after explosion and cooling to room temperature was 800cm³. After addition of concentrated potassium hydroxide solution there was a contraction in volume of 774cm³.

(i) Determine the molecular formula of Y (03 marks)

$C_xH_y + (y/4 + x)O_2 \longrightarrow xCO_2 + y/2\ H_2O$

unreacted $O_2 = 800 - 774 = 26$

used $O_2 = 1015 - 26 = 989cm^3$

$86x = 774 \Rightarrow x = 9$

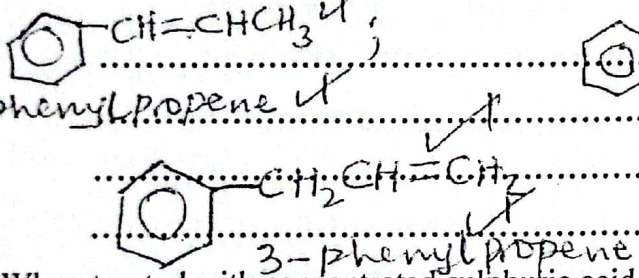
$86(y/4 + 9) = 989 \Rightarrow y/4 + 9 = 11.5$

$y/4 = (11.5 - 9) = 2.5$

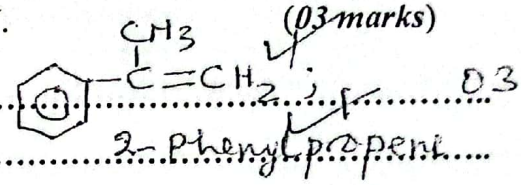
$y = (2.5 \times 4) = 10$

Molecular formula is C_9H_{10} (03)

(ii) Y burns with a sooty flame. Write the structural formulae and IUPAC names of all possible isomers of Y. (03 marks)



1-phenylpropene

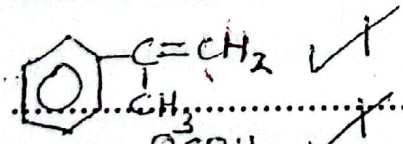


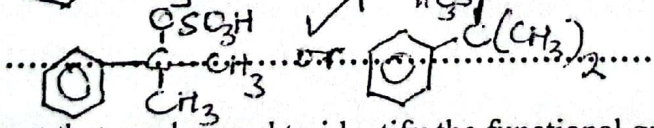
2-Phenylpropene

3-phenylpropene

(b) When treated with concentrated sulphuric acid at 25°C compound Y formed another compound Z. When warmed with water compound Z gave compound X that gave no observable change when treated with hot acidified potassium dichromate solution.

identify

(i) Y  (01½ mark) (01)

(ii) Z  (01½ mark)

(c) Name a reagent that can be used to identify the functional group in compound X and state what is observed when this reagent is reacted with X.

carboxylic acid (02 marks)

Ethanoic acid and concentrated sulphuric acid (and heat) (02)

A sweet fruity smell

13

Lucas' reagent, immediate cloudy solution

15. (a) Define the term **solubility product**. (01 mark)

The product of equilibrium molar concentrations of the ions in a saturated solution of a sparingly soluble salt/compound with each ion raised to the appropriate powers ✓01 at a given temperature.

(b) Manganese (II) sulphide is a sparingly soluble salt.
Write the expression for;

(i) the solubility of manganese (II) sulphide in water. *(01 mark)*

$MnS_{(s)} + (aq) \rightleftharpoons Mn^{2+}_{(aq)} + S^{2-}_{(aq)}$ ✓ (02)

or $MnS_{(s)} \rightleftharpoons Mn^{2+}_{(aq)} + S^{2-}_{(aq)}$

(ii) the solubility product of manganese (II) sulphide. *(01 mark)*

$K_{sp} = [Mn^{2+}][S^{2-}]$ ✓

(c) The solubility product of manganese (II) sulphide is $2.5 \times 10^{-13} mol^2 dm^{-6}$ at 25^0C. Calculate its solubility in water. *(02 marks)*

Let it be x ✓

$K_{sp}\ MnS = x^2$ ✓ (02)

$x^2 = 2.5 \times 10^{-13}$ ✓

$x = \sqrt{2.5 \times 10^{-13}}$ ✓

solubility $= 5.0 \times 10^{-7}$ ✓ $mol\ dm^{-3}$ ✓

(d) $10cm^3$ of $0.01M$ silver nitrate solution was mixed with $20cm^3$ of $0.0005M$ of potassium chloride solution.

(i) Determine whether precipitation of silver chloride will take place or not. *(02½ marks)*

Moles $AgNO_3 = \left(\frac{0.01 \times 10}{1000}\right) = 1.0 \times 10^{-4}$

Moles $KCl = \left(\frac{20 \times 0.0005}{1000}\right) 1.0 \times 10^{-5}$

Total volume $= 30cm^3$ ✓

$[Ag^+] = \left(\frac{1 \times 1 \times 10^{-4}}{30} \times 1000\right) = 3.3 \times 10^{-3} M$

$[Cl^-] = \left(\frac{1 \times 10^{-5}}{30} \times 1000\right) = 3.3 \times 10^{-4} M$ ✓

Ionic product $= [Ag^+][Cl^-]$ ✓

$= (3.3 \times 10^{-4} \times 3.3 \times 10^{-3}) = 1.1 \times 10^{-6} mol\ dm^{-6}$ ✓

∴ Precipitation occurs ✓ (03)

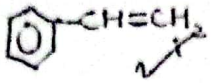
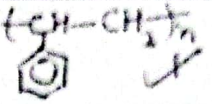
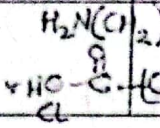
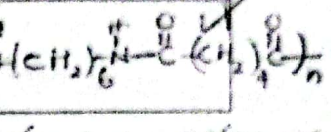
The ionic product is greater than K_{sp}.

(ii) State any **two** applications of solubility product. *(01 mark)*

- During manufacture of soap / precipitation / salting out soap
- Predicting precipitation of salts ✓ 01
- Determination of formula of complexes
- Fractional crystallization.

16. Polyphenylethene and nylon–6,6 are both synthetic polymers.

(a) In each case write the structural formula(e) of the monomer(s); indicate the polymer is formed by addition or condensation polymerization and write the structural formula of the polymer. *(03 marks)*

Polymer	Structural formula of monomer	Method of formation of polymer	Structural formula of polymer
Polyphenylethene	 ✓ ✗	addition ✓ polymerization	 ✗
Nylon–6,6	$H_2N(CH_2)_6NH_2$ ✓ ✗ 	condensation ✓ polymerisation	 ✓

03

$+HN(CH_2)_6NH-CO(CH_2)_4CO+_n$

(b) State **one** use of

(i) polyphenylethene ✗ *(½ mark)*

Packaging ✓

..... (01)

(ii) Nylon–6,6 ✗ *(½ mark)*

Fishing nets ; Fabrics/clothes, Mosquito nets

~~ropes~~ ~~hose~~, ~~tyres~~, ~~curtains~~.

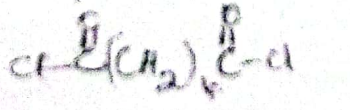
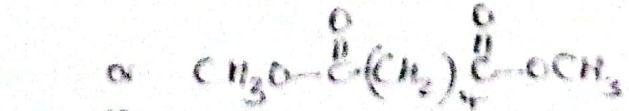
(c) Neoprene is an addition polymer of structure

$$\left\{CH_2 - \overset{Cl}{\overset{|}{C}} = CH - CH_2\right\}_n$$

(i) Define the term **addition polymer.** *(01 mark)*

A high molecular weight compound formed from combination of small unsaturated molecules with no loss of small molecules. (01)

* Accept three monomers

 or 

(ii) A solution containing 1.4% of neoprene was found to exert an osmotic pressure of 3.5×10^{-4} atmospheres at 25°C. Calculate the molecular mass of neoprene. ($R = 8.314 jK^{-1}mol^{-1}$) *(2½ marks)*

1 Atm — 101325
3.5×10^{-4} →

From, $\pi V = \frac{m}{Mr} RT$ ✓ ½

$Mr = \frac{mRT}{\pi V}$ ✓ $Mr = \frac{1.4 \times 8.314 \times 298}{3.5 \times 10^{-4} \times 101325 \times 100 \times 10^{-6}}$ ✓

$= 9.8 \times 10^5$ ✓

Mj P for π

$Mr = \frac{1.4 \times 0.0821 \times 298}{3.5 \times 10^{-4} \times 100 \times 10^{-3}}$

$= 9.8 \times 10^5$

978632 (2½)

(iii) Determine the number of monomers(n) that formed neoprene. *(1½ marks)*

$n(C_6H_5CH=CH_2) = 9.8 \times 10^5$ ✓

$n = 9.8 \times 10^5$ ✓ $n = 11086$

$(96+8)n = 9.8 \times 10^5$ ✓ or $n = 11070$

$n = 9423.08$ ✓

$n \approx 11073$ Monomers

$n = 9423$ monomers. (1½)

17. Nitrogen monoxide combines with oxygen to form nitrogen dioxide according to the equation $2NO_{(g)} + O_{2(g)} \rightleftharpoons 2NO_{2(g)}$

(a) Write the expression for the equilibrium constant, Kc. *(01marks)*

$K_c = \frac{[NO_2]^2}{[NO]^2[O_2]}$ ✓ (01)

(b) (i) 3 moles of nitrogen monoxide and 1.5 moles oxygen were put into a vessel which was heated to 40°C .When equilibrium was established the vessel found to contain 0.5 moles of oxygen. Calculate the value of kc at this temperature. *(02 marks)*

	$2NO_{(g)}$	+ $O_{2(g)}$	$\rightleftharpoons 2NO_{2(g)}$
Initially	3	1.5	0
x reacted	−2x	−x	+2x
Eqm moles	3−2x	1.5−x	2x

$1.5 - x = 0.5$

$x = 1.5 - 0.5$ ✓ 1s

$x = 1$ mole ✓

Moles at equ ✓

$NO = 3 - (2 \times 1) = 1$ mole ✓

$NO_2 = (2 \times 1) = 2$ Moles ✓

$K_c = \frac{2^2}{1^2 \times 0.5}$ (02)

$= 8\ mol^{-1}$ ✓

(Ignore units).
Rej: If wrong unit given

Mpungu

(ii) When the temperature was raised to 500°C the mixture in (i) was found to contain 25% of the initial nitrogen monoxide. Calculate the equilibrium constant at this temperature. *(03 marks)*

Moles NO = $(\frac{25}{100} \times 3) = 0.75$ ✓

$3 - 2x = 0.75 \Rightarrow x = 1.125$ moles ✓

Concentrations of

$\Sigma NO = 0.75$ moles ✓

$\Sigma O_2 = 1.5 - 1.125 = 0.375$ moles ✓

$\Sigma NO_2 = 2 \times 1.125 = 2.25$ moles ✓

$K_c = [NO_2]^2 / [O_2].[NO]^2$

$K_c = (2.25)^2$ ✓

$(0.75)^2 \times 0.375$ ✓ 03

$= 24 \text{ mol}^{-1}$ ✓

(c) From your answer to (b) (i) and (ii) deduce whether the process is endothermic or exothermic and explain how you arrive at this deduction. *(02 marks)*

The process is Endothermic for the foward reaction

Because an increase in temperature leads 02

to an increase in value of Kc

(d) What would be the effect on *kc* when a catalyst is added to the reaction mixture? *(01 mark)*

The value of Kc remains constant / 01

or a Catalyst has no effect on Kc value.