

SECTION A

Answer all questions from this section

1. The standard reduction electrode potentials (
- E^0
-) for some half cells are given in the table below

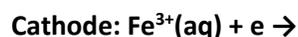
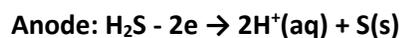
Half cell	$E^0(V)$
$\text{Fe}^{3+}(\text{aq}) \rightarrow \text{Fe}^{2+}(\text{aq})$	+ 0.77
$\text{S}(\text{s}) + \text{H}_2(\text{g}) \rightarrow \text{H}_2\text{S}(\text{g})$	+0.14

(a) Write

- (i) Cell notation (1mark)



- (ii) Equation of reaction that takes place at the anode and cathode (2marks)



- (iii) Equation for the overall cell reaction (1 ½ marks)



- (b) State whether the reaction is feasible or not and give a reason for your answer. (1mark)

$$E_{\text{cell}} = E_{\text{LHE}} - E_{\text{RHE}}$$

$$= 0.77 - 0.14$$

$$= 0.63\text{V}$$

The reaction is feasible because emf is positive

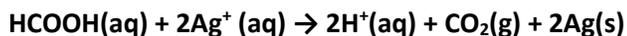
2. State what is observed and write equation of reaction in each case when the following compounds are mixed.

- (a) Methanoic acid and ammoniacal silver nitrate solution is heated

Observation

Black precipitate or silver mirror

Equation



- (b) Benzoic acid and aqueous sodium bicarbonate solution

Observation

Effervescence

Equation

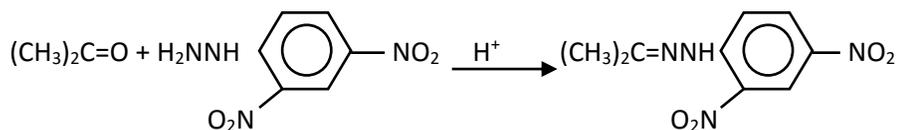


- (c) Propanone and Brady's solution

Observation

Yellow precipitate

Equation



3. Calculate the boiling point of a solution formed by mixing 8g of glucose with 120g of water. K_b for water = $5.2^\circ\text{Cmol}^{-1}\text{kg}^{-1}$)

Solution

Mass of glucose in 1000g of water

120g of water contain 8g of glucose

1000g of water contain $\frac{8 \times 1000}{120} = 66.7\text{g}$

Formula mass of glucose, $\text{C}_6\text{H}_{12}\text{O}_6 = 180$

Boiling point elevation

180g of glucose cause an elevation of 5.2°C

66.6g of glucose cause elevation of $\frac{5.2 \times 66.7}{180} = 1.9^\circ\text{C}$

Boiling point of solution = boiling point of water + boiling point elevation

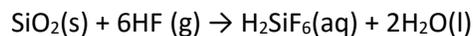
$$= 100 + 1.9 = 101.9^\circ\text{C}$$

4. (a) State three reasons for the difference in properties between fluorine and other group (VII) elements. (3marks)

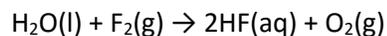
- High electronegativity
- Low F-F bond energy
- Small atomic radius

- (b) Write equation for the reaction that takes place between the following compounds

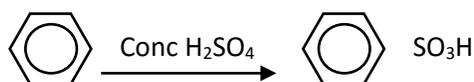
- (i) Silicon (IV) oxide and hydrofluoric acid (1 ½)



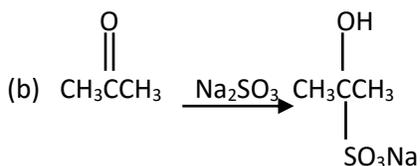
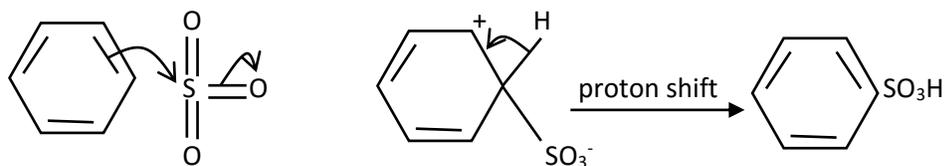
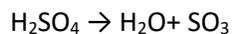
- (ii) Fluorine and water (1 ½ mk)



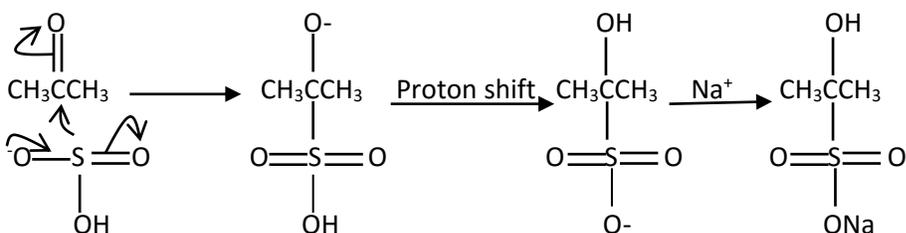
5. (a)



Mechanism



Mechanism



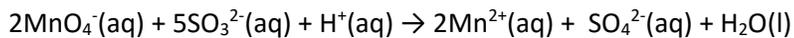
6. State what would be observed and write equation(s) for the reactions that would take place:

(a) When aqueous sodium sulphite solution is added to acidified potassium manganite (VII) solution.

Observation

Potassium permanganate (VII) decolorized

Equation

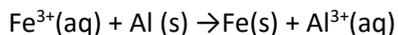


(b) When aluminium powder is added to Iron (III) chloride

Observation

Yellow solution decolorize with formation of grey crystals

Equation



7. (a) write the electron configuration of

(i) Nitrogen: $1s^2 2s^2 2p^3$

(ii) Phosphorous: $1s^2 2s^2 2p^6 3s^2 3p^3$

- (b) Explain why nitrogen only forms (NCl₃) whereas phosphorus forms the chlorides PCl₃ and PCl₅.

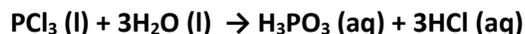
Nitrogen forms chloride of valence -3 only because it lacks a vacant d-orbital. Phosphorus, unlike nitrogen, can form chloride of valences 3 and 5; to form compounds of valence 5, one 3s electrons is promoted to a vacant 3d- orbital to give five unpaired electrons.

- (c) Write equation(s) for the hydrolysis of phosphorus chlorides by water

(i) Phosphorus (V) chloride (3marks)



(ii) Phosphorus (III) chloride

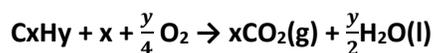


8. (a) When 20 cm³ of a hydrocarbon Z was exploded in 200cm³ of oxygen (excess), it completely burnt with a sooty flame. The volume of residual gas after cool to room temperature was 160cm³. On addition of aqueous potassium hydroxide to residual gas, the final volume of the gas was 20cm³. Calculate the molecular formula of Z. (3marks)

Combustion equation

$$\text{Oxygen used} = 200 - 20 = 180\text{cm}^3$$

$$\text{Volume of carbon dioxide} = 160 - 20 = 140\text{cm}^3$$



Volume	20	180	140
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Volume ratio	1	9	7
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$$x = 7$$

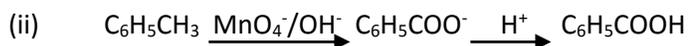
$$x + \frac{y}{4} = 9$$

$$y = 8$$

Molecular formula = C₇H₈

- (b) When Z was heated with alkaline potassium manganite (VII) solution forms a colorless solution which cooled in the presence of dilute sulphuric acid to form a crystalline solid P.

- (i) Identify
 Z- methylbenzene, C₆H₅CH₃
 P- benzoic acid



9. (a) Explain why diffusion in solution is very much slower than in gases

Because particles in liquid move much slower than gas molecules

- (b) 141.4cm^3 of gas X diffused through a porous plug in the same time as it took 50cm^3 of oxygen to diffuse through the same plug under identical condition.
Calculate the relative molecular mass of X.

$$\frac{\text{Rate of X}}{\text{Rate of O}_2} = \sqrt{\frac{\text{RFM of O}_2}{\text{RFM of X}}}$$

$$\frac{\frac{141.4}{t}}{\frac{50}{t}} = \frac{32}{\text{RFM of X}}$$

$$x = 4$$

Molecular mass of X = 4

SECTION B

Attempt only six questions in this section

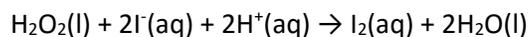
10. State what is observed and write equation for the reaction that takes place when

- (a) Potassium iodide is added to acidified hydrogen peroxide solution

Observation

Dark brown solution formed

Equation

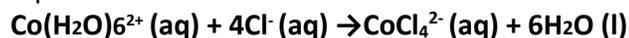


- (b) Concentrated hydrochloric acid is added drop wise until in excess to aqueous solution containing cobalt (II) ions

Observation

Forms deep blue solution with concentrated hydrochloric acid.

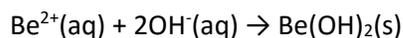
Equation



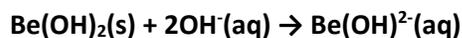
- (c) Aqueous sodium hydroxide is added drop wise to aqueous solution containing beryllium (II) ions

White precipitate soluble in excess

Equation



Then.



11. (a) A compound Y contains mass of 22.86% oxygen, 8.57% hydrogen and the rest is carbon

(i) Calculate the empirical formula of Y. ((2 ½ marks)

Percentage of carbon = $100 - (22.86 + 8.57) = 68.57$

Element	C	H	O
percentage	68.57	8.57	22.86
RAM	12	1	16
moles	5.71	8.57	1.42
Mole ratio	4	6	1

Empirical formula: C_4H_6O

(ii) When 0.30g of Y is vaporized at $80^\circ C$ and 700mmHg pressure, it occupied a volume of 134.77cm^3 . determine the molecular formula of Y. (3 ½ marks)

From $\frac{PV}{T} = \text{constant}$, volume V at stp

$$\frac{134.77 \times 700}{(273+80)} = \frac{760V}{273}$$

$$V = 97\text{cm}^3$$

Relative formula mass

96cm^3 weigh 0.3g

22400cm^3 weigh $\frac{22400 \times 0.3}{96} = 70$

Therefore, molecular mass of Y = 70

$[C_4H_6O]n = 70$

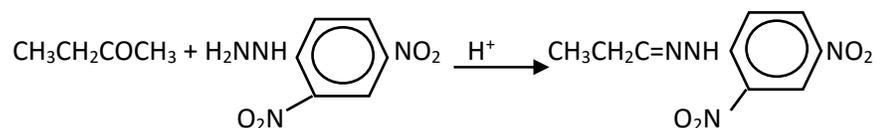
$$n = 1$$

molecular formula of Y = C_4H_6O

(b) Y forms a yellow precipitate with 2,4-dinitrophenylhydrazine and does not react with Tollen's reagent. Identify Y (1 mark)

$CH_3CH_2COCH_3$ butanone

(c) Write equation for the formation of yellow precipitate in (b)



12. (a) State three characteristics of chemical equilibrium (1 ½ mks)

- **Occurs at constant temperature**
- **Occurs in closed system**
- **It is dynamic equilibrium**

(b) Phosphorus (V) chloride when heated decomposed according to the following equation.



(i) Write the expression for the equilibrium constant K_c . (1mk)

$$K_c = \frac{[\text{PCl}_3][\text{Cl}_2]}{[\text{PCl}_5]}$$

(ii) When 1 mole of phosphorus (V) chloride was heated in a closed vessel at 350°C , the equilibrium mixture was found to contain 38.4% of chlorine. Calculate the equilibrium constant K_c at 350°C . (3 ½ mks)

$$\% \text{ of } \text{PCl}_3 = \% \text{Cl}_2 = 38.4\%$$

$$\% \text{ of } \text{PCl}_5 = 23.2\%$$

$$K_c = \frac{0.384 \times 0.384}{0.232} = 0.64 \text{ mol dm}^{-3}$$

(iii) The equilibrium constant of 250°C is 1.54. State whether the reaction is exothermic or endothermic. Give a reason for your answer. (1 ½ mks)

The reaction is endothermic because K_c increases with temperature.

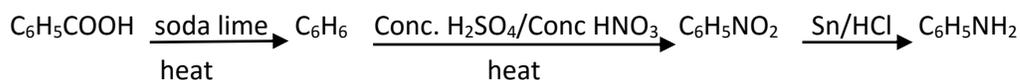
(c) State what would happen to the concentration of chlorine if the pressure in the vessel was decreased while the temperature is maintained at 350°C . Give a reason for your answer.

(1 ½ mks)

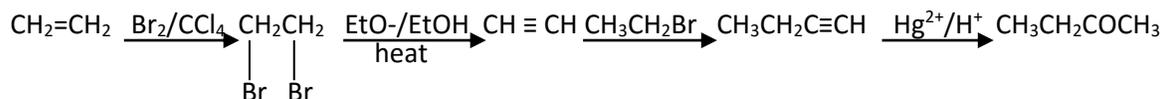
Concentration of chlorine decreases because forward reaction proceeds with increase in number of moles of gases.

13. Write equations to show the following conversions can be effected. (include conditions for reactions) (3marks each)

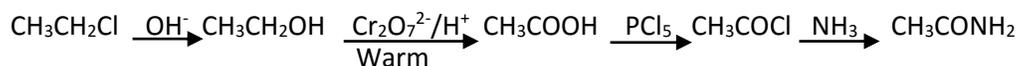
(a) Benzoic acid to phenylamine



(b) Ethene to butan-2-ol



(c) 1-chloroethane to ethanamide



14. (a)(i) Explain what is meant by an acid-base indicator (1mk)

This is a substance in aqueous solution that changes color according to H^+ concentration

(ii) Explain why titration experiments only one or two drops are used (1mk)

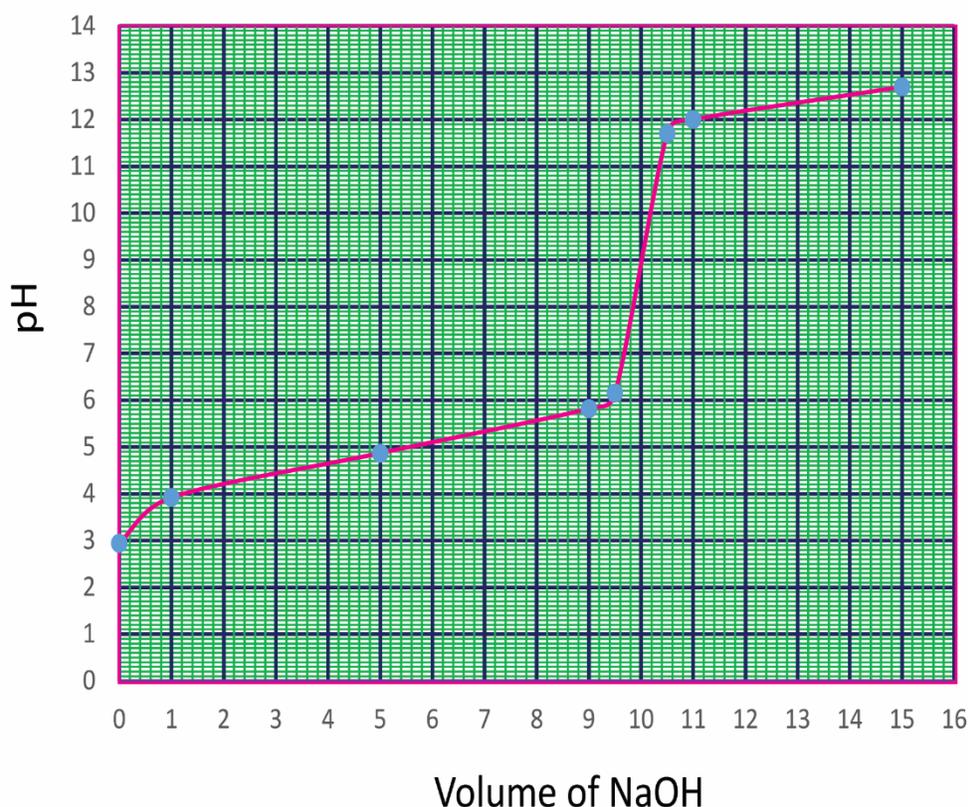
Because after the end point pH changes rapidly

(b) The table give data obtained when 10cm³ of propanoic acid was titrated with 1.0M sodium hydroxide solution

Volume of NaOH (1M) added (cm ³)	0.0	1.0	5.0	9.0	9.5	10.5	11.0	15.0
pH of solution	2.94	3.92	4.87	5.82	6.15	11.70	12.0	12.7

(i) Draw a graph of pH against the volume of sodium hydroxide (2 ½ marks)

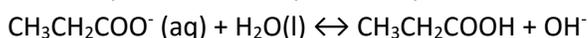
pH of solution against volume of NaOH



(ii) Explain the shape of the graph in (b)(i) (2 ½ marks)

Initially the pH is 3 (relatively high) due to partial ionization of weak acid; the pH then increases due to the removal H^+ up to the end point at pH =9 when 10cm³ of sodium hydroxide is added.

The end point occurs at pH above pH = 7 due to hydrolysis propanoate ions to produce OH^- ions



After the end point pH increases due to excess $OH^-(aq)$

- (iii) Determine the pH of the solution at equivalence point (1mark)
9
- (iv) Which of the following indicators would be suitable for titration? Give a reason for your answer.

indicator	Methyl red	Bromothymol blue	Phenol red
pH range	4.2 – 6.3	6.0 – 7.6	6.8 – 8.4

Indicator : **phenol red** (½ mark)

Reason: **has pH range in alkaline solution of the end point of the titration (½ mark)**

15. (a) Compare the following properties of group (II) and group (I) elements. In each case give a reason for your answer. (1 ½ mark each)

- (i) First ionization energy

The first ionization energy of group (II) element is higher than that of group (I) elements because group (II) element have higher electronegativity.

- (ii) Melting points

The melting points of group (II) elements are higher than those of group I elements because group (II) elements contribute two electrons to the formation of stronger metallic bonds whereas group (I) elements contribute one electron to the formation of weaker metallic bond.

- (iii) Electropositivity

Electropositivity of group (I) elements is higher than that of group (II) elements because group (I) elements have lower electronegativity.

- (b) The decomposition temperatures of the carbonates of group (II) elements are given below

Carbonates	MgCO ₃	CaCO ₃	SrCO ₃	BaCO ₃
Decomposition temperature (°C)	404	826	1098	1370

- (i) State how the decomposition temperatures vary (1mark)

The decomposition temperatures increase from MgCO₃<CaCO₃<SrCO₃<BaCO₃

- (ii) Explain your answer in (b)(i) (3 ½ mark)

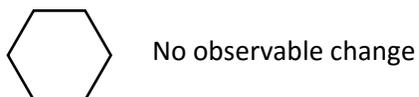
The decomposition temperature increase with molecular mass and ionic character of the carbonates.

16. Name a reagent that can be used to differentiate between the following pairs of compounds.
State what would be observed if each compound is treated with the reagent you have named



Reagent: concentrated sulphuric and concentrated nitric acid $< 50^{\circ}\text{C}$

Observation

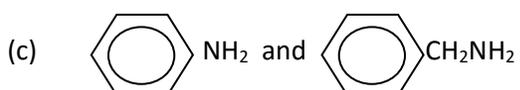


Reagent: Tollen's reagent (ammoniacal silver nitrate)

Observation

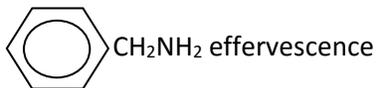
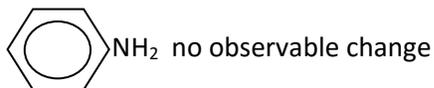
HCOOH – black precipitate or silver mirror

HOCCOOH – no observable change



Reagent: sodium nitrite, HCl $< 5^{\circ}\text{C}$

Observation

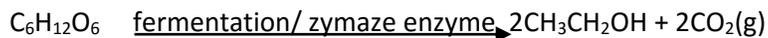


17. Ethanol can be produced by fermentation of molasses.

(a)(i) Name two other raw materials from which ethanol can be produced by fermentation

- banana juice
- cassava flour
- maize flour

(ii) Write equations to show how crude ethanol can be obtained from the materials named above



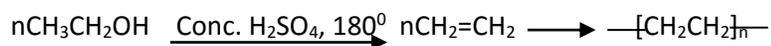
(b)(i) Describe how 100% (absolute) ethanol can be produced from crude ethanol in (a) (ii)

The crude mixture is fractional distilled to obtain rectified spirit.

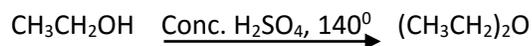
Calcium oxide is added to rectified spirit overnight to remove water and then pure ethanol is distilled off the following day.

(c) Write equation(s) to show each of the following compounds could be obtained from ethanol

(i) Polyethene (1 ½ marks)



(ii) Ethoxyethane (1 ½ marks)



Thank by Dr. Bbosa Science