# A'LEVEL SEMINAR QUESTIONS

1. (a) 1.22g of a dicarboxylic aliphatic acid **Y** is dissolved in water and the solution made up to 250$cm^3$. A 25.0$cm^3$portion of the solution required 21.0$cm^3$ of 0.1M sodium hydroxide solution for complete neutralisation.
   (i) Determine the molecular formula of **Y**.
   (ii) Write the structural formulae and IUPAC names of the possible isomers of **Y**.
   (iii) one of the isomers of **Y** has a higher melting point? Give a reason for your answer.

   (b) An organic compound **Z** , contains carbon , hydrogen and oxygen only. When vaporized at 101kPa and 373K , 0.10g of **Z** occupied a volume of 66.7$cm^3$. On combustion in excess oxygen , 1 mole of **Z** produced 2 moles of carbon dioxide and 3 moles of water.
   (i) Calculate the relative molecular mass of **Z**.
   (ii) Determine the molecular formula of **Z**.
   (iii) Write the structural formulae and names of the possible isomers of **Z.**
   (iv) Using equations only show how each of the isomers in (iii) above can be synthesised from chloromethane.

   (c) An organic compound , **P** , on complete combustion yielded 8.8g of carbon dioxide and 1.8g of water. 0.1g of **P** when vaporised at 273$^oC$ and 734mmHg occupied a volume of 4.46x $10^{-2}dm^3$.
   (i) Calculate molecular formula of **P**
   (ii) Write the structure and IUPAC name of **P.**
   (iii) Discuss the reactions of **P** with
   - sulphuric acid
   - bromine

   (iv) When **P** was ozonolysed followed hydrolysis compound **Q** formed. **Q** gave no observable change with Fehling's solution.

Write equation and suggest a mechanism for the reaction between **Q** and Brady's reagent.

2. (a) Define the term **isotopes.** (01mark)

(b) One of the factors that affect the stability of the isotopes is neutron to proton ratio.

(i) State the other factor. (01mark)

(ii) Sketch a graph of number of neutrons versus number of protons and on it indicate

- the line in which n/p = 1
- the stability region
- three points in the unstability region (03½marks)

(c) Describe briefly how the isotopes in the unstability region in the three points indicated in b(ii) can gain stability. (04marks)

(d) Gallium has two isotopes of mass numbers 69 and 71 in the ratio x:y. If the relative atomic mass of gallium is 69.8, determine the values of x andy. (03marks)

(e) The table below shows the results of the radioactive decay of $^{234}_{91}Pa$

| Time(seconds) | 20 | 40 | 60 | 80 | 100 | 120 |
|---|---|---|---|---|---|---|
| Mass of $^{234}_{91}Pa$ (g) | 48.2 | 38.5 | 31.5 | 26.0 | 21.0 | 17.2 |

Plot a graph of $\log_{10}$(mass) against time and use it to determine the

(i) initial mass of $^{234}_{91}Pa$ (01mark)

(ii) decay constant of $^{234}_{91}Pa$ (02marks)

(iii) half- live of $^{234}_{91}Pa$ (02marks)

**3.** (a) Define the terms

(i) electrolytic conductivity (01mark)

(ii) molar conductivity. (01mark)

(b) Conductivity measurement is one of the methods of determining solubility product of a sparingly soluble salt.

(i) Describe how the method is carried out. (05marks)

(ii) The electrolytic conductivity of a saturated solution of calcium phosphate at 25$^{o}$C is 3.1219x $10^{-5}$ $\Omega^{-1}$ $cm^{-1}$ . The electrolytic conductivity of pure water is 1.519 x $10^{-6}$ $\Omega^{-1}cm^{-1}$.The molar ionic

conductivities of calcium ions and phosphate ions at infinite dilution at 25$^{o}$C are 119.0$\Omega^{-1}$ cm$^{2}$mol$^{-1}$ and 240.0$\Omega^{-1}$ cm$^{2}$mol$^{-1}$ respectively. Calculate the solubility product of calcium phosphate at 25$^{o}$C and state its units (05marks)

(b) Explain each of the following observations

(i) In the conductimetric titration of copper(II) sulphate solution against ammonia solution , the electrolytic conductivity of the mixture decreases to minimum value and then increases gradually and finally almost levels off with excess ammonia . (04marks)

(ii) The molar conductivity decreases with increase in concentration for both ethanoic acid and sodium chloride. (04marks)

4. (a) Write the outer most electronic configuration of group(IV) elements. (01marks)

(b) Describe the reactions of :

(i) carbon , silicon , tin and lead with sulphuric acid. (6½marks)

(ii) lead with ethanoic acid (2½marks)

(i) chlorides of lead with sodium hydroxide solution. (04marks)

(ii) Silicon with acids. (03marks)

(c) carbon **does not** react with chlorine but reacts readily with fluorine. Explain this observation. (03marks)

5. (a) Explain what is meant by the term enthalpy of displacement. (01marks)

(b) Describe an experiment that can be used to determine the enthalpy of displacement reaction between zinc and copper(II) sulphate. (09marks)

(c) State what would be observed and write equation for the reaction when:

(i) copper metal is added to silver nitrate solution. (03marks)

(ii) aluminium metal is added to iron(III) sulphate solution. (2½marks)

(d) Calculate the Gibbs free energy in (c)(ii) above given that the standard reduction potential of aluminium half cell is -1.66V and that of iron(III) half cell is +0.77V. (03marks)

(e) Write the cell notation for the cell formed by combining the half cells in (d) above. (1½marks)

**6.** Using equations only show how the following compounds can be synthesized.

(a) phenylethaoate from aminobenzene (04marks)

(b) 2,2-dichloropropane from propan-1- ol (04marks)

(c) 1,3,5-tribromobenzene from benzene diazonium chloride. (04marks)

(d) $CH_3CH=N-OH$ from but-2- ene (04marks)

(e) ethyl amine from propanoic acid. (04marks)

**7.** Explain the following observations

(a) When potassium iodide solution was added to copper(II) sulphate solution white precipitate and brown solution were formed ,however when was potassium bromide solution was used there no observable change. (05marks)

(b) When concentrated hydrogen peroxide solution was added to lead(II) sulphide , the black solid turned to white solid. (03marks)

(c) When concentrated ammonia solution was added to cobalt(II) chloride solution , blue precipitate was formed which dissolved in excess ammonia solution to form a pale brown solution. (05marks)

(d) When 60g of urea ($(NH_2)_2CO$ ) and 128g of naphthalene ($C_{10}H_8$) were separately added to 1000g of ethanol , both solutions boil at the same temperature and pressure. (04marks)

(e) A solution of hydrogen chloride gas in methylbenzene has no effect on litmus papers however an aqueous solution of hydrochloride turns blue litmus paper red. (03marks)

**8.** (a) Discuss the chemical properties of aluminium and iron showing

(i) similarity

(ii) differences (12marks)

(b) Explain the following observations

(i) the melting points of aluminium and iron are $660^oC$ and $1537^oC$ respectively. (04marks)

(ii) hydrogen chloride gas cannot be used to prepare anhydrous iron(III) chloride ,however hydrogen chloride gas is suitable for the preparation of anhydrous aluminium chloride. (04marks)

**9.** (a) What is meant by the terms:

(i) solubility product

(ii) common ion effect. (02marks)

` (b) Describe an experiment that can be used to determine the solubility

product of silver sulphate. (06marks)

(c) The solubility of silver sulphate in 0.1M sodium sulphate at $25^oC$ is $2.0339gdm^{-3}$. Calculate the solubility of silver sulphate in pure water at $25^oC$. (05marks)

(d) The solubility of magnesium hydroxide at $25^oC$ is $8.126 \times 10^{-3}gdm^{-3}$. Calculate the mass of magnesium hydroxide that would precipitate when 4g of sodium hydroxide pellets were shaken with 1 $dm^3$ of a saturated solution of magnesium hydroxide at $25^oC$. (05marks)

(e) State and explain the effect on the solubility of silver sulphate when the following were added to its saturated solution.

(i) silver nitrate solution.

(ii) ammonia solution. (06marks)

(e) Describe **two** applications of solubility product. (04marks)

**10.** (a) Distinguish between lattice energy and hydration energy. (02marks)

(b) Explain briefly how the two energy terms in(a) affect the solubility of ionic compounds. ( 03marks)

(c) Given the following thermodynamic data.

Standard enthalpy of formation of aluminium fluoride = $-1301kJmol^{-1}$
Standard enthalpy of atomization of aluminium = $+314kJmol^{-1}$
Standard enthalpy of bond dissociation of fluorine gas = $+158kJmol^{-1}$
First ionization energy of aluminium = $+577kJmol^{-1}$
Second ionization energy of aluminium = $+1820kJmol^{-1}$
Third ionization energy of aluminium = $+2740kJmol^{-1}$
First electron affinity of fluorine = $-348kJmol^{-1}$

(i) Define the standard enthalpy of formation. (01mark)

(ii) Draw an energy level diagram for the formation of aluminium fluoride and use it to determine the lattice energy of aluminium fluoride. (06marks)

(iii) Given that the hydration energies of aluminium ions and fluoride ions are -4690 and $-364kJmol^{-1}$ respectively. Calculate the enthalpy of solution of aluminium fluoride and hence comment on its solubility in water. (04marks)

(d) State and explain **two** factors that affect the hydration energy. (04marks)

**11.** (a) Write the electronic configuration of the outer most energy level of

group (IV) elements. (01 mark)

(b) Describe the reactions of group (IV) element with
(i) water
(ii) sodium hydroxide (09marks)

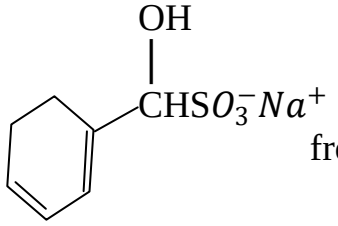
(c) Write the equation for the reaction between water and:
(i) lead(IV) chloride
(ii) tin (II) chloride
(iii) Silicon (IV) hydride (04marks)

(d) Sodium hydroxide solution was added to lead(II) nitrate solution drop- wise until in excess.
(i) State what was observed. (01 marks)
(ii) Write equation(s) for the reaction(s) that took place. (02marks)

(e) Dilute nitric acid was added to the resultant mixture in (d) above drop-wise until in excess. State what was observed and write equation(s) for the reaction(s) if any that took place. (03marks)

**12.** State what would be observed and write the mechanism for the reaction when the following were mixed.
(a) Warm fuming sulphuric acid and benzene (04marks)
(b) Benzene and bromine in the presence of hot iron (04marks)
(c) Propan- 2- ol and ethanoyl chloride (04marks)
(d) 2- methyl propene and chlorine water. (04marks)
(e) Benzene and concentrated nitric acid in presence of concentrated sulphuric acid at 60$^{o}$C. (04marks)

**13.** Write equations to show how the following compounds can be synthesized

(a)  from aminobenzene (04marks)

(b) ethanedioic acid from  (4½marks)

(c) Propene from ethanoic acid (04 marks)

(d) $CH_3CH_2\ CH_2OH$ from propanamide (4½ marks)

(e) Ethoxyethane from prop ene (04marks)

**14.** (a) Define the terms

(i) colligative property (01mark)

(ii) freezing point constant. (01mar)

(b) Describe an experiment that you would carry out to determine the relative molecular mass of a naphthalene using osmotic pressure method. (06marks)

(c) Explain the effect of association of the solute on the relative molecular mass determined by freezing point method. (02marks)

(d) (i) State the laws of osmotic pressure. (02marks)

(ii) state the conditions under which these laws are valid. (01mark)

(e) The osmotic pressure of a 1.24% solution of poly(phenylethene) is $2.356x\ 10^{-2}$ mmHg at $25^oC$.

(i) Calculate the relative molecular mass of poly(phenylethene) (2½marks)

(ii) Calculate the number of monomer units in poly(phenylethene) (1½marks)

(iii)Explain why the freezing point method is not suitable for determining the molecular mass of poly(phenylethene) (03marks)

16. (a) (i) What is meant by the term steam distillation? (1 mark)

(ii) State **three principles of steam distillation.** (3 marks)

(iii) Describe an experiment for isolating amino benzene from a reaction mixture containing non-volatile impurities. (Use a diagram to illustrate your answer) (5 marks)

(c) (i) Define the term partition coefficient. (01mark)

(ii) A solution containing 6g of Q in $50cm^3$ of an aqueous solution is in equilibrium at room temperature with 108g of Q in $100cm^3$ of ether. Calculate the mass of Q that will be extracted by shaking $100cm^3$ of the aqueous solution containing 10g of Q with two successive portions of $50cm^3$ of ether. (5marks)

(d) Ions of a metal M , $M^{2+}$, react with excess ammonia to a complex according to the following equation.

$M^{2+}(aq) + nNH_3(aq) \rightleftharpoons [M(NH_3)_n]^{2+}(aq)$

$25cm^3$ of 0.2M solution of M ions were mixed with $25cm^3$ of 1M ammonia solution followed by $50cm^3$ of trichloromethane in a separating funnel and the mixture shaken until equilibrium was

attained at $25^oC$ . It was found that 0.0002 moles of free ammonia were present in the trichloromethane layer. Given that the distribution coefficient, $K_D$ for ammonia between water and tricchloromethane at room temperature is 25, determine the value of n in the complex.
(5 marks)

**17.** Fluorine is in group(VII) of the Periodic Table but it behaves differently from the rest of the group members.

(a) (i) State **three** reasons why fluorine behaves anomalously. (1½marks)

(ii) Describe **three** chemical properties of fluorine which are different from the rest of the group members.(Illustrate your answer with equations) (6marks)

(b) Fluorine and chlorine are separately bubbled through aqueous silver nitrate solution.

(i) State what was observed in each case. (02marks)

(ii) Write equation(s) for the reaction(s) that took place. (02marks)

(c) Describe briefly how chlorine

(i) Can be manufactured on a large scale.

(ii) Can be used to prepare potassium chlorate(V) crystals.

(Diagrams **not** required.) (8½marks)

**18.** (a) Define the term weak acid. (01 mark)

(b) A 0.1M solution of ethanoic acid has a pH of 2.8.

Calculate the

(i) degree of ionization of ethanoic acid. (02 marks)

(ii) acid ionisation constant Ka for ethanoic acid. (02marks)

(iii) pKa for ethanoic acid. (01mark)

(c) 0.02 moles of sodium ethanoate were added to 1 litre of the solution in (b) . Calculate the pH of the resultant solution. (03mark)

(d) $0.5cm^3$ of 2M hydrochloric acid was added to the resultant mixture in (c) above. Calculate the pH of resultant mixture. (03marks)

(e) Explain your answer in (c) and (d). (04marks)

(f) Discuss the effect of concentration on pH of weak acids. (04marks)

**19.** (a) Write the formulae of the possible oxides of Period 3 elements of the Periodic Table. (05 marks)

(b) Describe the reactions of the oxides in (a) with
(i) water
(ii) sodium hydroxide (15marks)

**20.** State what would be observed and write the mechanism for the reaction when the following were mixed.

(a) Warm fuming sulphuric acid and benzene (04marks)

(b) Benzaldehde(phenylmthanal) and 2,4-dinitrophenylhydrazine in acidic medium. (04marks)

(c) Propan- 2- ol and concentrated sulphuric acid at $160^{o}C$ (04marks)

(d) Ethanal and a saturated solution of sodium hydrogen sulphite. (04marks)

(e) Benzene and concentrated nitric acid in presence of concentrated sulphuric acid at $60^{o}C$. (04marks)

## SECTION A (46 MARKS)

1. (a) A solution containing 1.5% of a polymer was found to have an osmotic pressure of $3.6 \times 10^{-4}$ atmospheres at $25^{o}C$. Calculate the molecular mass of the polymer. *(2 ½ marks)*

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(b) Explain why in the determination of molecular mass of polymers, osmotic pressure is used instead of ebullioscopic and cryoscopic methods. *(2 marks)*

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2. Name one reagent that can be used to distinguish between each of the following pairs of compounds. In each case, state what is observed if the reagent is separately treated with each member of the pair.

(a) $CH_3CH_2CH_2\underset{\displaystyle OH}{\underset{|}{C}}H\cdot CH_3$ and $CH_3CH_2\underset{\displaystyle OH}{\underset{|}{C}}H\cdot CH_2\cdot CH_3$ *(3 marks)*

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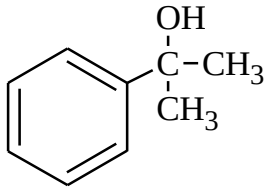
(b)

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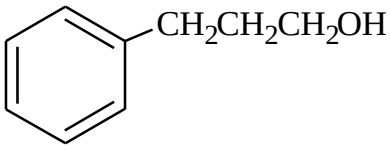


*(3 marks)*

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3. (a) Thorium $^{232}_{90}Th$ undergoes radioactive decay to give element X according to the following equation:

$$^{232}_{90}Th \rightarrow X + \alpha$$

Calculate:

(i) the atomic number of X. *(1 mark)*

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(ii) themass number of X. *(1 mark)*

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(b) X decays further to form Y as shown by the equation below.

$$X \rightarrow Y + \beta$$

Calculate:

(i) the atomic number of Y. *(1 mark)*

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(ii) the mass number of Y. *(1 mark)*

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(c) A radioactive isotope of X had an initial activity of 250 counts per second on a Geiger counter. After 40 minutes the activity had declined to 240 counts per second. Calculate the half-life of X. *(3 marks)*

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4. (a) Define the term **hydration energy**. *(02 marks)*

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(b) State **two** factors which affect the magnitude of hydration energy. *(01 mark)*

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(c) The table below shows enthalpies of hydration of $Ca^{2+}$ and $Cl^{-}$ ions.

| **ion** | **Enthalpy of hydration (kJ mol$^{-1}$)** |
|---|---|
| $Ca^{2+}$ | 1577 |
| $Cl^{-}$ | 381 |

(i) State whether the values of enthalpies of hydration given in the table above are positive or negative. Give a reason for your answer. *(1 ½ mark)*

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(ii) Calculate the enthalpy of hydration of calcium chloride

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5. (a) State what would be observed and write an equation(s) for the reaction(s) that would take place when to a solution of iron(II) sulphate was added.

(i) aqueous sodium hydroxide dropwise until in excess. *(3½ marks)*

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(ii) a few drops of concentrated nitric acid and the mixture boiled. *(2½ marks)*

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6. (a) (i) Write the equation for the ionization of ethanoic acid in aqueous solution *(01 mark)*

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(ii) Write an expression for the acid dissociation constant, $K_{a,}$ of ethanoic acid. *(01 mark)*

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(b) The pH of a 0.1M aqueous ethanoic acid is 2.9. Calculate the dissocation constant of ethanoic acid. *(03 marks)*

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7. The first ionization energies of some group II metals of the periodic table and melting points of their chlorides are given in the table below

| **Metal** | **Mg** | **Ca** | **Sr** | **Ba** |
|---|---|---|---|---|
| **1st ionization energy kJ mol$^{-1}$** | 738 | 590 | 549 | 505 |
| **Melting point of chlorides** | 708 | 772 | 873 | 967 |

Briefly explain the variation in trends of:

(a) the first ionization energy. *(2 ½ marks)*

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(b) melting points of the chlorides *(2 ½ marks)*

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8. State what would be observed and write equation for the reaction that would take place when the following pairs of compounds are reacted.

(a) Propanal and silver nitrate in aqueous ammonia. *(2 marks)*

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(b) But-2-ene and acidified potassium manganate(VII) solution. *(2 marks)*

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9. Equations and electrode potentials for some reactions are given below:

$$2H^{+}_{(aq)} + O_{2(g)} + 2e^{-} \rightarrow H_2O_{2(aq)} E^{o} = +0.68V$$
$$Ag^{+}_{(aq)} + e^{-} \rightarrow Ag_{(s)} E^{o} = +0.80V$$
$$H_2O_{2(aq)} + 2H^{+}_{(aq)} + 2e^{-} \rightarrow 2H_2O_{(l)} E^{o} = +1.77V$$

a) (i) Write an ionic equation for the reaction between silver nitrate and hydrogen peroxide. *(1½ marks)*

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(ii) Calculate the $E_{cell}$ for the reaction in a) (i) *(1½ marks)*

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b) State the property shown by hydrogen peroxide in the reaction in a) (i). *(01 mark)*

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**10.** (a) What is meant by the term **buffer solution**? *(02 marks)*

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(b) Calculate the mass of sodium propanoate that should be added to 1 $dm^3$ of a 0.1 M propanoic acid in order to give a solution whose pH is 4.5. State any assumptions made. *(The dissociation constant for propanoic acid, $K_a = 1.4 \times 10^{-5} mol\ dm^{-3}$)* *(05 marks)*

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(c) Few drops of dilute hydrochloric acid were added to the solution in (b)

(i) State what happened to the pH of the solution *(½ marks)*

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(ii) Give a reason for your answer in c(i) *(01½ marks)*

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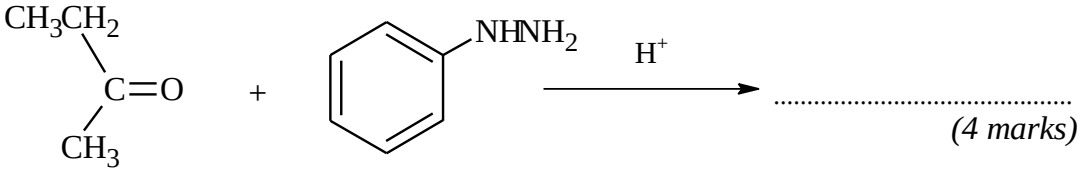
11. Complete each of the following equations and write a mechanism for the reaction in each case.

(a)

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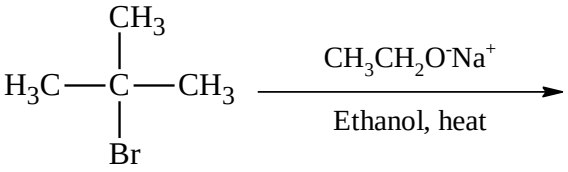
(b) 

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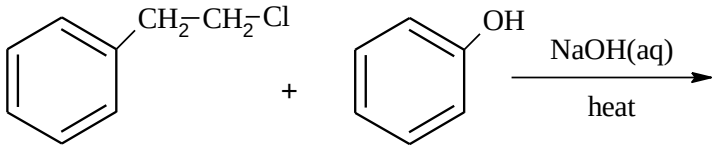
(c) 

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**12.** (a) Write an equation for the reaction between water and the chloride of:

(i) Aluminium *(01½ marks)*

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(ii) Sulphur *(01½ marks)*

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(iii) Phosphorous *(01½ marks)*

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(b) Write an equation for the reaction between hot concentrated sodium hydroxide solution and:

(i) Aluminium *(01½ marks)*

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(ii) Silicon *(01½ marks)*

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(ii) Chlorine *(01½ marks)*

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13. Nitrogen and hydrogen react to form ammonia according to the following equation.

$$3H_{2(g)} + N_{2(g)} \rightleftharpoons 2NH_{3(g)} \Delta = -92kJ$$

(a) State the industrial conditions used to obtain maximum yield of ammonia. *(01½ marks)*

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(b) During the manufacture of nitric acid ammonia is catalytically oxidized to P which is further oxidized to Q. Q is then reacted with water to produce nitric acid.

(i) Name P and Q

P is.....*(½ marks)*

Q is.....*(½ marks)*

(ii) Write equations for the formation of P, Q and nitric acid.

Equation for the formation of P: *(01½ marks)*

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Equation for the formation of Q: *(01½ marks)*

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Equation for the formation of nitric acid: *(01½ marks)*

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(c) Write equations for the reaction of concentrated nitric acid and

(i) carbon *(01½ marks)*

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(ii) copper *(01½ marks)*

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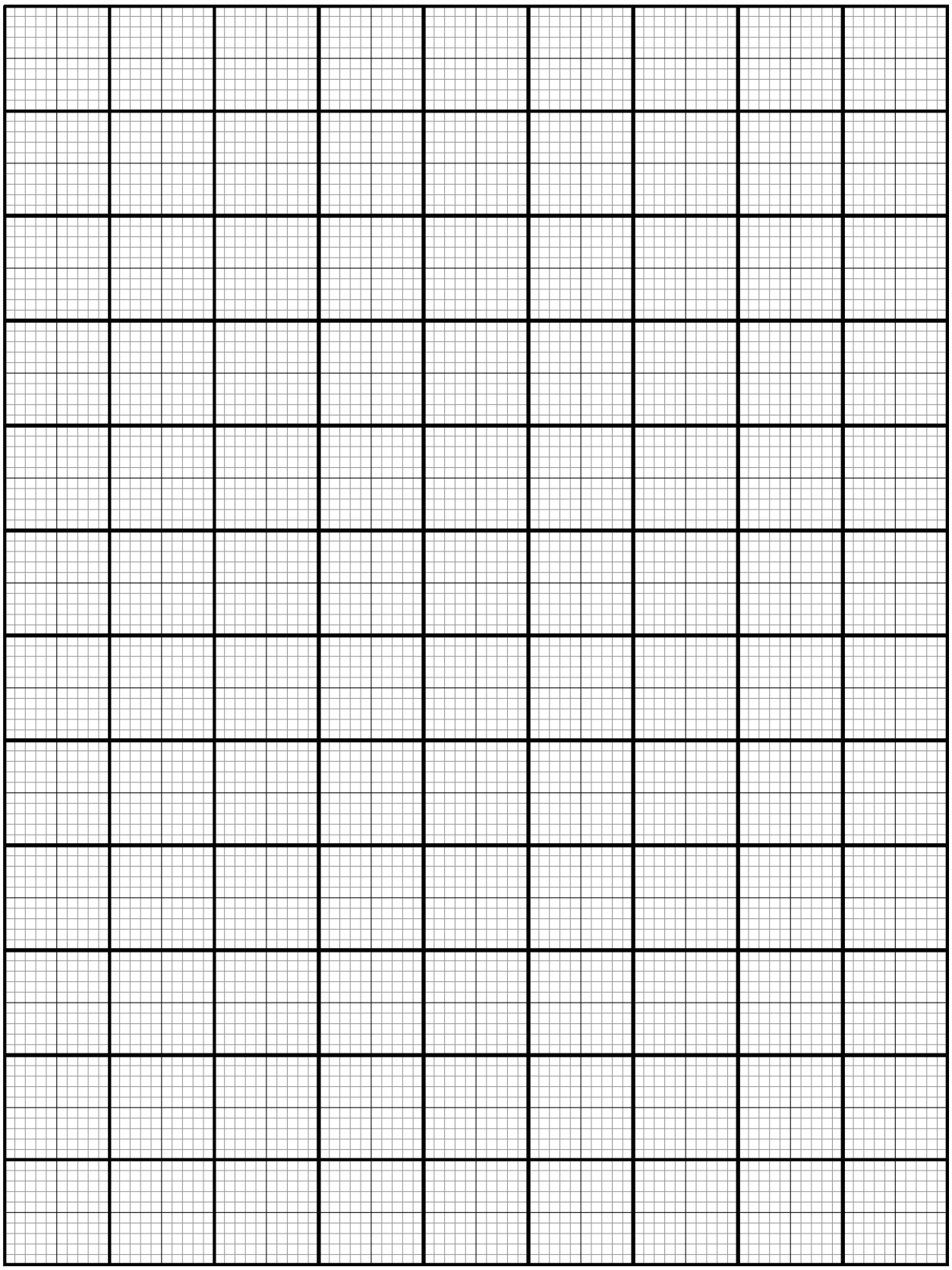
14. The kinetic data for the reaction between P and sodium hydroxide is shown in the table below.

| **Concentration of P (mol $l^{-1}$)** | 1.05 | 0.88 | 0.74 | 0.51 | 0.37 | 0.26 | 0.16 | 0.10 |
|---|---|---|---|---|---|---|---|---|
| **Time** | 0.0 | 3.5 | 7.0 | 14.5 | 20.0 | 27.0 | 35.5 | 45.0 |

(a) Plot a graph of Concentration of P against Time *(03 marks)*



Determine

(i) thehalf life of P *(03 marks)*

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(ii) the order of the reaction. *(01 mark)*

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(iii) the rate constant for the reaction *(02 marks)*

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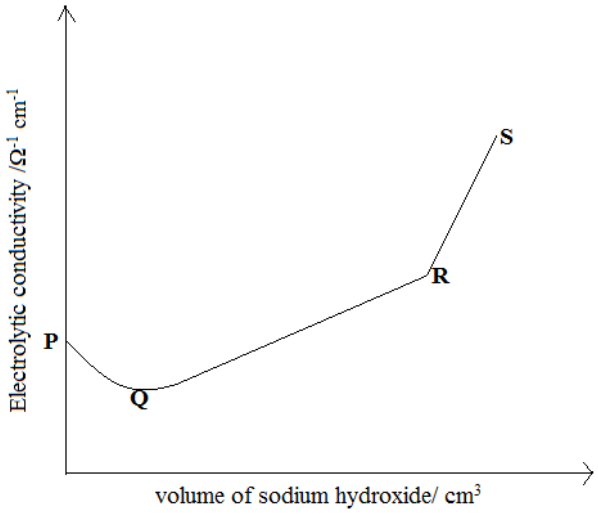
15. a) The conductimetric curve for the titration of ethanoic acid and sodium hydroxide is given below.



Explain the shape of the curve. (PQRS). *(4 marks)*

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(b) The molar conductivity of silver nitrate, potassium nitrate and potassium chloride are 134.0, 143.2 and 140.8 S $cm^2$ $mol^{-1}$ respectively at infinite dilution at 25$^o$C. Calculate the:

(i) Molar conductivity of silver chloride at infinite dilution at 25$^o$C. *(01½ marks)*

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(ii) Solubility product, *Ksp* of silver chloride at 25$^o$C. *(The electrolytic conductivity of water and that of a saturated solution of silver chloride are 5.5 x $10^{-8}$ and 1.934 x $10^{-6}$ S $cm^{-1}$ respectively)* *(3 ½ marks)*

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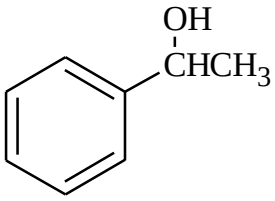
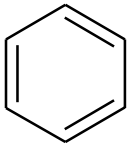
16. Write equations to show the following compounds can be synthesized.

(a)  from  *(2 marks)*

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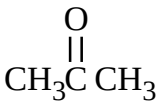
(b)  from $HC \equiv CH$ *(3 ½ marks)*

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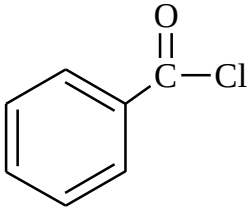
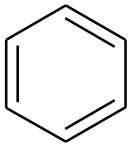
(c)  from  *(3 ½ marks)*

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17. (a) What is meant by the term **common ion effect**? *(02 marks)*

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(b) Magnesium hydroxide is sparingly soluble in water.
Write:

(i) the equation for the solubility of magnesium hydroxide in water *(1½ marks)*

.....

(ii) the expression for the solubility product, *Ksp*, of magnesium hydroxide. *(01 mark)*

.....

(c) If the solubility product of magnesium hydroxide at $25^oC$ is $4.2 \times 10^{-12}$ $mol^3\ dm^{-9}$. Calculate the solubility in moles per litre at $25^oC$ of magnesium hydroxide in

(i) water *(1½ marks)*

.....

.....

(ii) a 0.01 M sodium hydroxide *(2 marks)*

.....

.....

(iii) Comment on your answer in (c) above. *(1 mark)*

.....

.....

**1.** (a) State **two** factors that affect enthalpy of a reaction. *(1 mark)*

.....

.....

(b) Ammonia reacts with fluorine according to the following equation

$$NH_{3(g)} + 3F_{2(g)} \rightarrow 3HF_{(g)} + NF_{3(g)}$$

The enthalpies of formation of $NH_3$, HF and $NF_3$ are -46, -269 and -114 kJ $mol^{-1}$ respectively.

(i) Calculate the enthalpy of reaction. *(2 marks)*

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.....

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(ii) State **one** assumption made in (a)(i) above. *(½ mark)*

.....

(c) State whether the reaction in (b) is feasible or not. Give a reason for your answer. *(1½ marks)*

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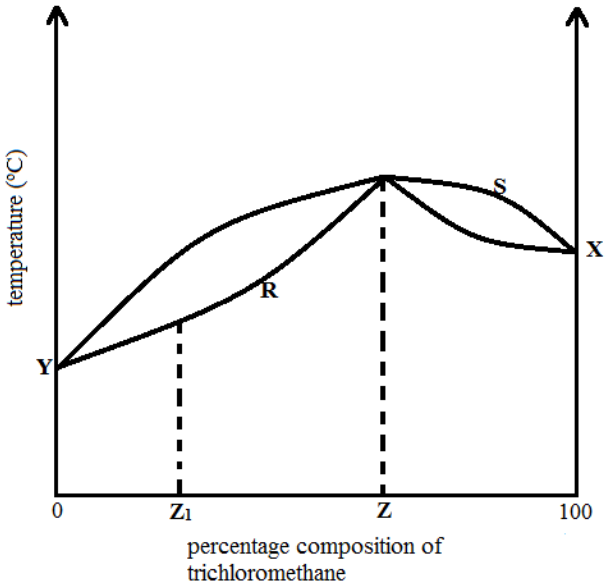
**2.** The boiling point composition diagram for a mixture of propanone and trichloromethane is shown below.




(a) Label points **X**, **Y** and **Z** *(1½ marks)*

**X**.....

**Y**.....

**Z**.....

(b) State what curves **R** and **S** represent *(2 marks)*

**R**.....

**S**.....

(c) Briefly explain what happens when a mixture of composition $\mathbf{Z_1}$ is distilled. *(2½ marks)*

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3. Write equations to show how the following conversions can be effected.

(a) Calcium carbonate to ethanol *(2½ marks)*

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(b) ethanol to propane-1,2-diol *(2½ marks)*

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4. (a) Write equations to show how lead(IV) oxide can be prepared from
(i) lead(II) nitrate solution *(1½ marks)*

.....

(ii) trilead tetraoxide *(1½ marks)*

.....

(b) Sulphur dioxide gas was passed over heated lead(IV) oxide
State what is observed and write equation of reaction that takes place.
*(2½ marks)*

***Observation***

.....

***Equation***

.....

5. Name the reagent(s) that can be used to distinguish between each of the following pairs of compounds/ions and in each case state what would be observed if each member of the pair is separately treated with the reagent

(a) $Ba^{2+}(aq)$ and $Pb^{2+}(aq)$ *(2½ marks)*

***Reagent(s)***

.....

***Observations***

.....

.....

(b) $CH_3C{\equiv}CCH_3$ and $CH_3CH_2C{\equiv}CH$ *(2½ marks)*

***Reagent(s)***

.....

***Observations***

.....

.....

6. (a) (i) Draw the structure and name the shape of hydrogen sulphide molecule. *(1½ marks)*

| structure | shape |
|---|---|
| | |

(ii) Explain why hydrogen sulphide adopts the shape named in (a) (i) above. *(1½ marks)*

.....

.....

(b) In each case state what is observed and write equations of reaction that takes place when hydrogen sulphide gas is passed through the acidified solution of

(i) potassium permanganate *(2 marks)*

***Observation***

.....

***Equation***

.....

(ii) potassium dichromate *(2 marks)*

***Observation***

.....

***Equation***

.....

7. Complete the following reactions and write the accepted mechanism(s)

(a) $CH_3CH_2Br + CH_3CO\bar{O}Ag^+ \xrightarrow{\text{reflux}}$ ..... *(2 marks)*

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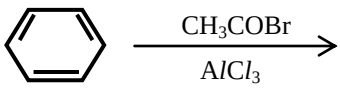
(b)  ..... *(2 marks)*

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8. (a) State **three** properties of alpha particles. *(1½ marks)*

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(b) Complete the following nuclear transformations

(i) $^{239}_{94}Pu + {}^{1}_{0}n \longrightarrow {}^{86}_{34}Se + {}^{150}_{60}Nd +$ ..... *(½ mark)*

(ii) $^{242}_{96}Cm + {}^{4}_{2}He \longrightarrow$ ..... *(½ mark)*

(iii) $^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{148}_{57}La +$ ..... $+ 3{}^{1}_{0}n$ *(½ mark)*

(c) The rate of emission of radioisotope reduced from 14.0 to 7.5 counts per second in 80 seconds. Calculate the half-life of the radioisotope.*(2marks)*

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9. (a) State **three** properties in which beryllium and aluminium are similar. *(1½ marks)*

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(b) Write equation(s) for the reaction(s) between the following

(i) Aluminium and sodium hydroxide. *(1½ marks)*

.....

(ii) Beryllium carbide and water. *(1½ marks)*

.....

**SECTION B: (54 MARKS)**

*Answer* **six** *questions from this section.*

*Additional questions answered will* **not** *be marked.*

10. (a) (i) Explain what is meant by the term **osmotic pressure**.*(01 mark)*

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(ii) State **two** factors that can affect osmotic pressure of solutions. *(01 mark)*

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(iii) Under what conditions are osmotic pressure laws valid? *(1½ marks)*

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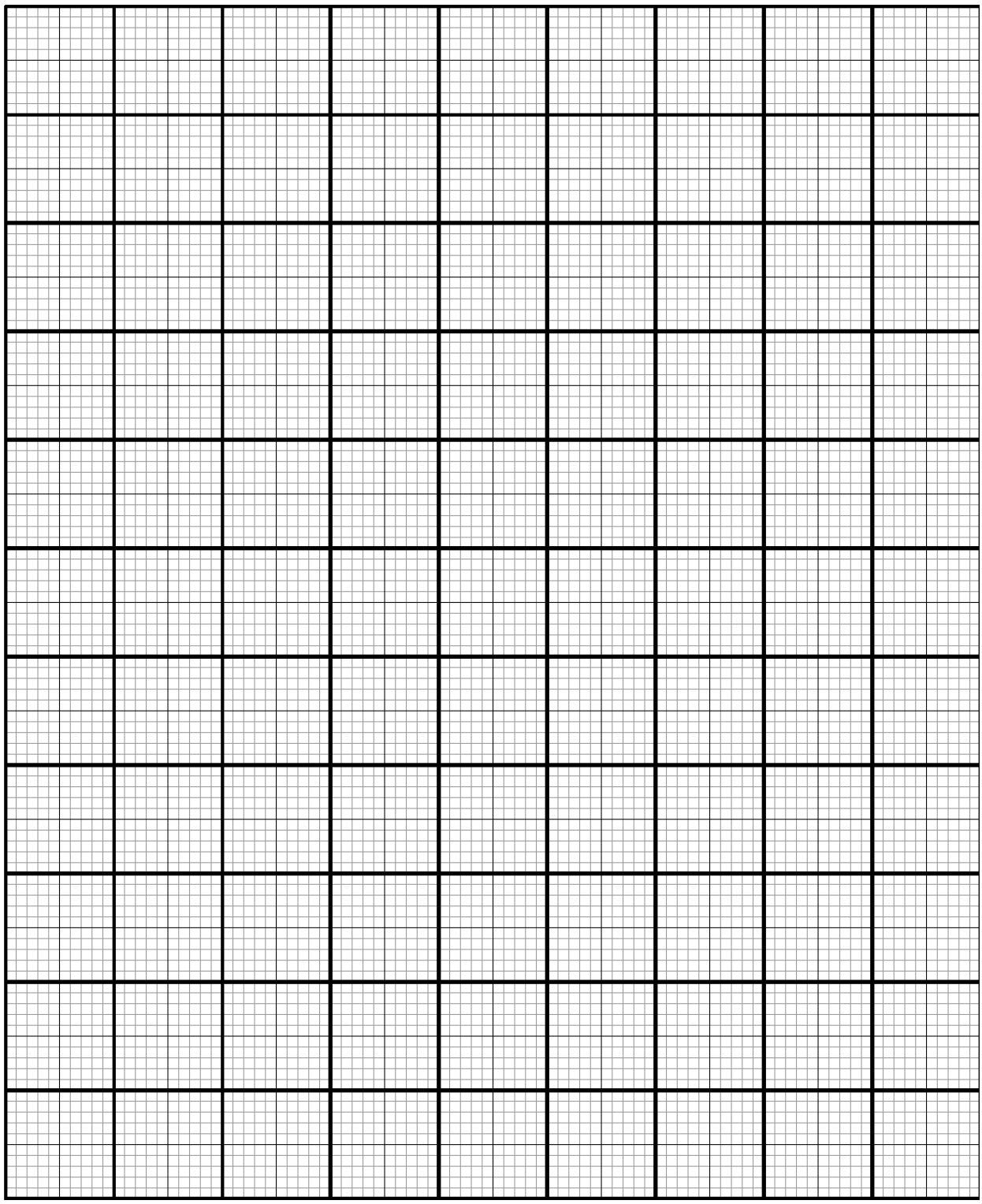
(b) The osmotic pressure of solutions of different concentrations measured at 298 K for a polymer are given in the table below.

| **Osmotic pressure/ Pa** | **Concentration /g dm$^{-3}$** |
|---|---|
| 118 | 2.0 |
| 480 | 6.0 |
| 1000 | 10.0 |
| 1680 | 14.0 |

(i) Plot a graph of osmotic pressure against concentration. *(03 marks)*



(ii) Using the graph you have drawn calculate the molar mass of polymer. *(2½ marks)*

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11. (a) Write the general outermost shell electronic configuration of group(II) elements. *(01 mark)*

.....

(b) The decomposition temperature of the carbonates of group(II) elements are given below.

| **Carbonate** | $MgCO_3$ | $CaCO_3$ | $SrCO_3$ | $BaCO_3$ |
|---|---|---|---|---|
| **Decomposition Temperature($^oC$)** | 404 | 826 | 1098 | 1370 |

(i) State the trend in variation of decomposition temperatures of the carbonates. *(01 mark)*

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(ii) Explain your answer in (a) (i) above *(3 marks)*

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(c) Explain why an aqueous solution of beryllium chloride is acidic.
*(4 marks)*

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12. 20 $cm^3$ of solution K containing chlorine was diluted to 250 $cm^3$ with distilled water. 25 $cm^3$of the dilute solution was pippeted. 10 $cm^3$ of potassium iodide solution was added followed by 10 $cm^3$ of ethanoic acid. This mixture was titrated with 0.05 M sodium thiosulphate solution using starch indicator. 24.5 $cm^3$ were required for complete reaction.

(a) Write equations of reactions that took place. *(3 marks)*

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(b) Calculate the

(i) number of moles of iodine that would be liberated by 25 $cm^3$ of the dilute solution of K. *(2marks)*

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(ii) mass of chlorine in the original solution. *(2marks)*

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(iii) percentage of chlorine in K. *(2marks)*

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13. (a) State **three** reasons why fluorine differs in some of its properties from the rest of the group(VII) elements. *(3 marks)*

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(b) Write equation for ionisation of hydrogen fluoride in an aqueous solution that is

(i) dilute *(1½ marks)*

.....

(ii) concentrated *(1½ marks)*

.....

(c) Write equation for the reaction between

(i) silicon(IV) oxide and hydrogen fluoride *(1½ marks)*

.....

(ii) the hydride of silicon and sodium hydroxide *(1½ marks)*

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14. (a) Sodium, aluminium and silicon are some of the elements in period three of the periodic table. For each element, write the chemical formula, nature and structure adopted by the oxide in the table below.*(4½ marks)*

| Element | Sodium | Aluminium | Silicon |
|---|---|---|---|
| **Formula of oxide** | | | |
| **Chemical nature** | | | |
| **Structure** | | | |

(b) Write equation(s) of reaction of the oxides of aluminium and silicon with aqueous sodium hydroxide.

(i) Oxide of aluminium. *(1½ marks)*

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(i) Oxide of silicon. *(1½ marks)*

.....

(c) State conditions for the reaction of the oxide of silicon with water and write equation for reaction that takes place. *(1½ marks)*

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15. (a) Explain what is meant by the term **partition coefficient**. *(1 mark)*

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(b) Silver ions react with ammonia according to the equation below:

$$Ag^{+}_{(aq)} + nNH_{3(aq)} \rightleftharpoons Ag(NH_3)^{+}_{n(aq)}$$

In an experiment to determine the coordination number, *n*, of silver ions in the complex ion, 25 $cm^3$ of ammonia solution (in excess) was added to 25 $cm^3$ of 0.1 M silver nitrate in water. 50 $cm^3$ of trichloromethane was then added and the mixture allowed to reach equilibrium at 20$^o$C. Calculate the molar concentration of silver ions that reacted.*(2 marks)*

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(c) The layers of the mixture in (b) were separated and each was titrated with standard nitric acid. The aqueous layer required 27.5 $cm^3$ of 0.1 M nitric acid and the organic layer 18.0 $cm^3$ of 0.05 M nitric acid. Calculate the molar concentration of ammonia that is

(i) free in the aqueous layer. *[the partition coefficient for ammonia between water and trichloromethane at 20$^o$C is 25] (2 marks)*

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(ii) fixed in aqueous layer *(2 marks)*

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(d) hence determine the value of *n* *(2 marks)*

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16. Write equations to show how the following conversions can be effected.

(a) $CH_3Cl$ to $CH_3COOCH_2CH_3$ *(3 marks)*

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(b) $CH_3CONH_2$ to $(CH_3)_2O$ *(3 marks)*

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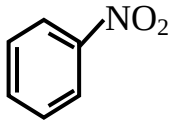
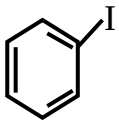
(c)  to  *(3 marks)*

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17. 1.64 g of a bromo alkylhalide **Q**, $C_nH_{2n+1}Br$ was refluxed with aqueous sodium hydroxide. The resultant solution was cooled and acidified with excess nitric acid and diluted to 100 $cm^3$. 10 $cm^3$ of solution required 13.0 $cm^3$ of 0.1 M silver nitrate for complete precipitation of silver bromide.

(a) Write equations of reaction(s) that take place. *(2 marks)*

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(b) Calculate the molecular formula of **Q** *(2½ marks)*

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(c) Write the structural formulae and IUPAC names of all the possible isomers of **Q**. *(2 marks)*

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(d) Write equation and mechanism for the reaction between any one isomer of **Q** and hot potassium hydroxide in ethanol. *(2½ marks)*

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