

Candidate's Name:

.....Manding gude. Ocan Nelson.....

Signature: .....HP Rutland.....

Random No.					Personal No.		

0741903056/0784975248

(Do not write your School/Centre Name or Number anywhere on this booklet)

P525/1

CHEMISTRY

Paper 1

2 ¾ hours

Uganda Advanced Certificate of Education

CHEMISTRY

Paper 1

2 hours 45 minutes

**INSTRUCTIONS TO CANDIDATES:**

Answer **all** questions in section A and **six** questions in section B

All questions must be answered in the spaces provided

The Periodic Table, with relative atomic masses, is supplied.

Mathematical tables(3 – figure tables) are adequate or non-programmable scientific electronic calculators may be used

Illustrate your answers with equations where applicable.

Where necessary, use the following:

Molar gas constant  $R = 8.31 \text{ JK}^{-1} \text{ mol}^{-1}$

Molar volume of a gas at s.t.p is 22.4 litres.

Standard temperature = 273 K

Standard pressure =  $101325 \text{ N m}^{-2}$

For Examiner's Use Only																	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
					4	6			9	9	9	9	9	9	9	9	100%

Turn Over

### 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  $25^\circ\text{C}$ . Calculate the molecular mass of the polymer. (2 ½ marks)

$$\pi V = \frac{nRT}{M_r} \quad \checkmark$$

$$(3.6 \times 10^{-4} \times 101325)(100 \times 10^{-6}) = \left( \frac{1.5 \times 8.31 \times 298}{M_r} \right) \quad \checkmark$$

reject Ans without correct formula and substitution;  
(2)

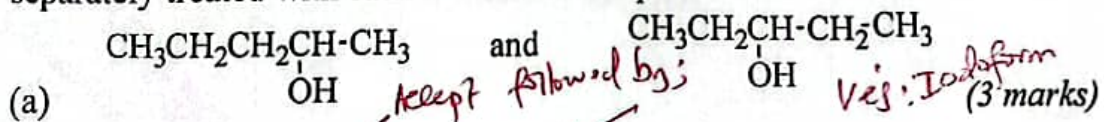
$$M_r = 101,833.2 \text{ g} \quad \checkmark$$

deny 1/2 mark if units not indicated;

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

Accept Macro molecules  
Polymers have a very high molecular mass; thus produces very few particles in soln; causing a very small values of boiling point elevation and freezing point depression which can not be accurately measured; But exerts a very high osmotic pressure which can be accurately measured. (2)

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.



Iodine solution and sodium hydroxide solution.

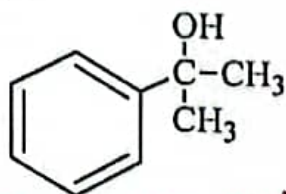
$\text{CH}_3\text{CH}_2\text{CH}_2\underset{\text{OH}}{\text{CH}}\text{CH}_3$  - Yellow precipitate

$\text{CH}_3\text{CH}_2\underset{\text{OH}}{\text{CH}}\text{CH}_2\text{CH}_3$  - No observable change;

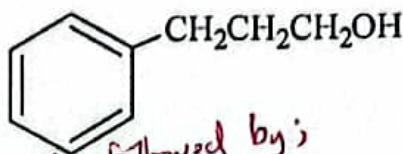
rej: formulae  
rej: iodine "I"  
rej: without soln.



(b)



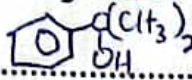
and

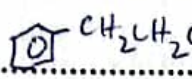


reject observation for wrong reagents (3 marks)

reject; soln "not that"

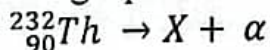
reject wrong spellings;   
 Anhydrous Zinc chloride and Concentrated hydrochloric acid.

 - cloudy solution formed immediately at room temp; 03

 - No observable change at room temperature;

rej: without room temp; for observations

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



Calculate:

- (i) the atomic number of X.

(1 mark)

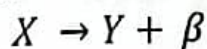
88 ✓ 07

- (ii) the mass number of X.

(1 mark)

228 ✓ 07

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



Calculate:

- (i) the atomic number of Y.

(1 mark)

89 ✓ 07

- (ii) the mass number of Y.

(1 mark)

228 ✓ 07

- (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)

$$\ln\left(\frac{N}{N_0}\right) = -\lambda t \quad \checkmark$$

$$\ln\left(\frac{240}{250}\right) = -\lambda \times 40 \quad \checkmark$$

$$\lambda = 1.02054 \times 10^{-3} \text{ s}^{-1} \quad \checkmark$$

follow the strict logical computation  
- deny mark for wrong formulae

$$\text{Then, } T_{1/2} = \left(\frac{\ln 2}{\lambda}\right) \quad \checkmark$$

$$T_{1/2} = \left(\frac{\ln 2}{1.02054 \times 10^{-3}}\right) \quad \checkmark$$

(03)

$$T_{1/2} = 679 \text{ seconds.} \quad \checkmark$$

- deny mark if units not included;

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

reject: enthalpy change; heat change;

is the energy given out when one mole of a gaseous ion is

completely surrounded by water molecules to form hydrated ion. 07

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

Ionic charge of the ion 01 mark

(01 mark)

Ionic radius of the ion 07

reject ionic emphasis "I"

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

Ion	Enthalpy of hydration ( $\text{kJ mol}^{-1}$ )
$\text{Ca}^{2+}$	1577
$\text{Cl}^-$	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. 07

reject: because its exothermic (1 1/2 mark)

It's Negative 07 due to attractive forces of positively charged and negatively charged ions to the water molecule; 07 res: energy given out

- (ii) Calculate the enthalpy of hydration of calcium chloride

$$\text{Enthalpy of hydration of } \text{CaCl}_2 = \text{Enthalpy of hydration of } \text{Ca}^{2+} + 2 \times \text{Enthalpy of hydration of } \text{Cl}^-$$

$$= -1577 + (2 \times -381) \quad \checkmark$$

$$= -2339 \text{ kJ mol}^{-1} \quad \checkmark$$

res: Ans for wrong formulae

deny mark without units



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)

Green precipitate insoluble in excess turns to a brown precipitates on standing; Eqn:  $\text{Fe}^{2+} + 2\text{OH}^- \rightarrow \text{Fe}(\text{OH})_2(\text{s})$  ✓ (1½)

den + note for eqn states  $4\text{Fe}(\text{OH})_2(\text{s}) + \text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow 4\text{Fe}(\text{OH})_3(\text{s})$  ✓ (1)

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

Green solution turns to brown solution; (2½ marks)

Eqn:  $3\text{Fe}^{2+} + 4\text{HNO}_3(\text{aq}) \rightarrow \text{Fe}^{3+} + 4\text{NO}(\text{g}) + 2\text{H}_2\text{O}(\text{l})$  ✓ (1½)

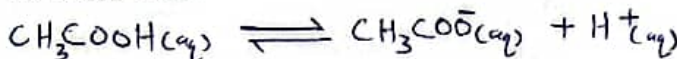
Accept:  $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+} + \text{e}^-$  ✓ (1½) (2½)

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

$$K_a = \frac{[\text{CH}_3\text{COO}^-][\text{H}^+]}{[\text{CH}_3\text{COOH}]}$$

✓ (1) reject if ionization eqn is not correct Accept  $[\text{H}_3\text{O}^+]$

(ii) Write an expression for the acid dissociation constant,  $K_a$ , of ethanoic acid. (01 mark)



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

$$\text{pH} = -\log_{10} [\text{H}^+] \quad \checkmark$$

$$2.9 = -\log_{10} [\text{H}^+] \quad \checkmark$$

$$[\text{H}^+] = 1.259 \times 10^{-3} \text{ mol dm}^{-3} \quad \checkmark$$

$$\text{But: } K_a = \frac{[\text{H}^+]^2}{\text{C}} \quad \checkmark$$

$$\text{Thus: } K_a = \frac{(1.259 \times 10^{-3})^2}{0.1} \quad \checkmark$$

$$K_a = 1.58 \times 10^{-5} \text{ mol dm}^{-3} \quad \checkmark$$

Accept other logical work out of this computation

den + note if units missing;



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
1 <sup>st</sup> ionization energy $\text{kJ mol}^{-1}$	738	590	549	505
Melting point of chlorides	708	772	873	967

Briefly explain the variation in trends of:

- (a) the first ionization energy.

✓ reject for Mg + Ba  
✓ reject explanation for wrong trend  
(2 ½ marks)

✓ The first I.E. decreases from Magnesium to Barium; From Magnesium to barium; atomic radius increases; due to a greater increase in screening effect than increase in the nuclear charge; thus the effective nuclear attraction for the outermost electrons decreases; hence outermost electrons experiences low nuclear attraction; making it easy to remove them with even little energy; (2h)

- (b) melting points of the chlorides

✓ reject for Mg to Ba + no symbols  
✓ res. Use of formula  
(2 ½ marks)

✓ The melting point increases from Magnesium chloride to barium chloride; from magnesium ion to barium ion ionic radius increases with constant ionic charge; resulting to decrease in the charge density and decrease in polarising power of the cations; this leading to an increase in the ionic character and a decrease in the covalent character; thus much and high amount of energy is required to break ionic bonds than covalent bonds; (2h)

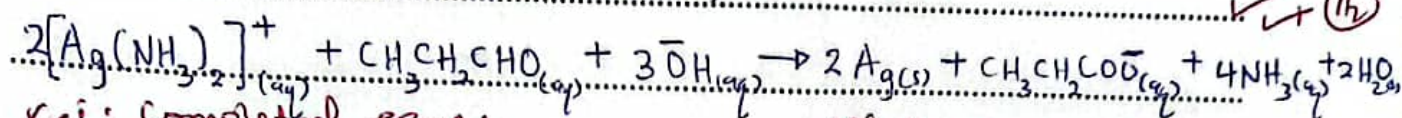
✓ deny reasons for explanation of wrong trends.



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)

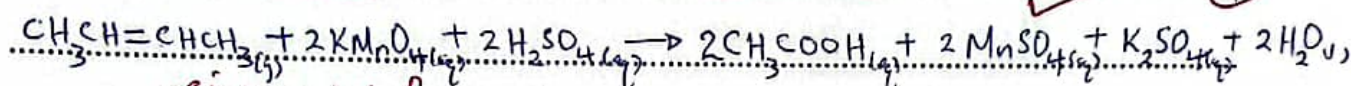
Silver mirror formed; ✓ (1/2)



rej: completed eqns;

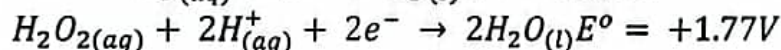
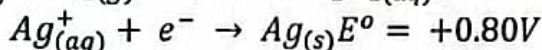
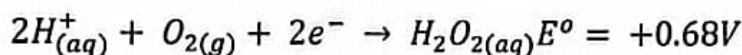
(b) But-2-ene and acidified potassium manganate(VII) solution. (2 marks)

Purple solution turns to colourless solution ✓

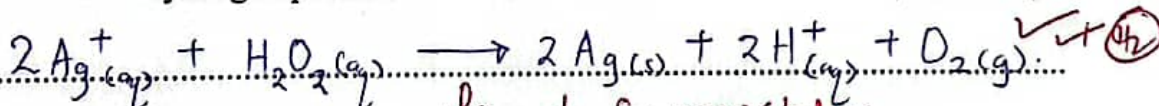


rej: completed eqns;

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



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



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

$$E_{\text{cell}} = E_{\text{right}} - E_{\text{left}} = +0.80 - (+0.68) = +0.12\text{V}$$

rej: with ⊕ and units is (V)

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

Reducing Agent; ✓ (1/2)

## SECTION B: (54 MARKS)



Answer six questions from this section.  
Additional questions answered will not be marked.

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

Is a solution that resists pH changes when a small quantity of an acid or a base is added to it; or on little/small dilution; (02)

rejet;  
without  
small quantity

- (b) Calculate the mass of sodium propanoate that should be added to 1 dm<sup>3</sup> 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,  $K_a = 1.4 \times 10^{-5} \text{ mol dm}^{-3}$ ) (05 marks)

Deny all marks for wrong formulae? rejet

$$\text{pH} = -\log_{10} K_a + \log_{10} \left( \frac{[\text{Salt}]}{[\text{Acid}]}\right)$$

Molar mass of  $\text{CH}_3\text{CH}_2\text{COONa}$

$$= 12 \times 3 + 5 + 16 \times 2 + 23$$

$$= 96 \text{ g}$$

MX (5)

$$4.5 = -\log_{10} (1.4 \times 10^{-5}) + \log_{10} \left( \frac{[\text{Salt}]}{0.1}\right)$$

1 mole of  $\text{CH}_3\text{CH}_2\text{COONa}$  weighs 96g

$$4.5 = 4.85387 + \log_{10} [\text{Salt}] - \log_{10} 0.1$$

0.0437M of  $\text{CH}_3\text{CH}_2\text{COONa}$  weighs  $(96 \times 0.0437) \text{ g}$

$$4.5 = 4.85387 + \log_{10} [\text{Salt}] + 1$$

$$= 4.1952 \text{ g}$$

$$\log_{10} [\text{Salt}] = -1.3587$$

The mass of sodium propanoate

$$[\text{Salt}] = 0.0437 \text{ M}$$

that shd be added is 4.1952g  
Keep round to 2 d.p.s

kept any  
alternative  
approaches

- (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)

pH remains constant; (1/2)

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

rejet: explanation  
for wrong obser

The hydrogen ion from ionisation of HCl; react with the  $\text{CH}_3\text{CH}_2\text{COO}^-$  (propanoate ions) from the complete ionisation of the sodium propanoate to form propanoic acid; thus more salt ( $\text{CH}_3\text{CH}_2\text{COONa}^+$ ); ionises to restore the pH;

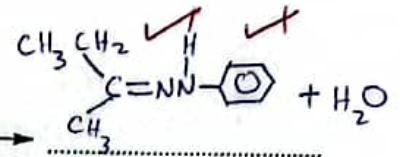
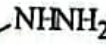
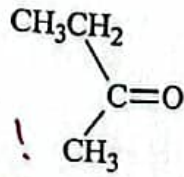
(1½)



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

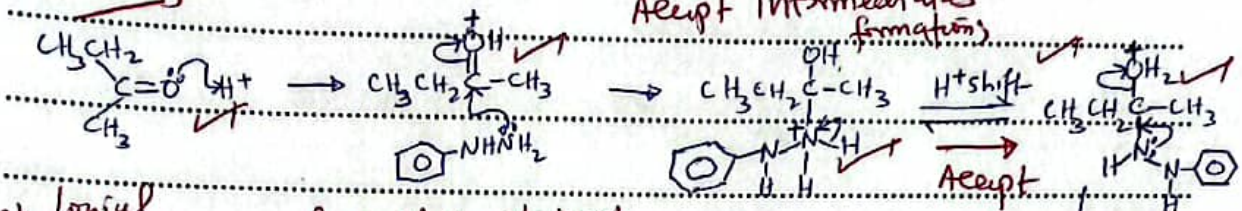
(a)

- deny marks  
if bonds not touching!



(4 marks)

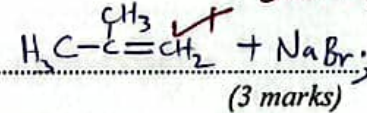
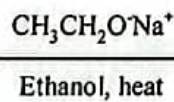
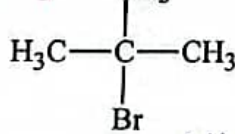
Accept intermediates formation



Accept logical flow; deny minus at point of confusion;

Note: All arrows must be touchings

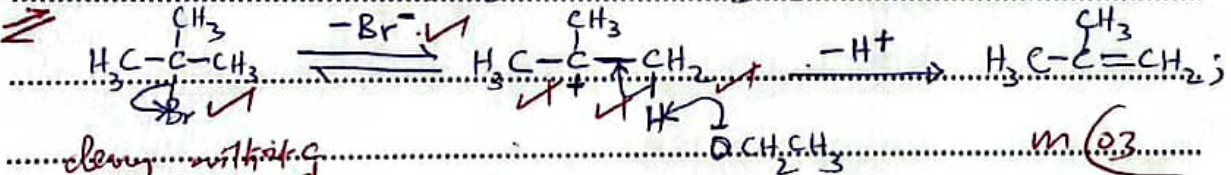
(b)



(3 marks)

Accept without showing proton loss how it occurs;

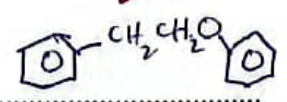
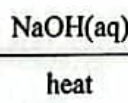
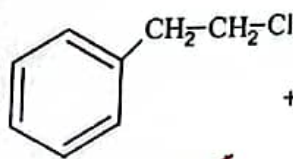
- deny with 1/2 name



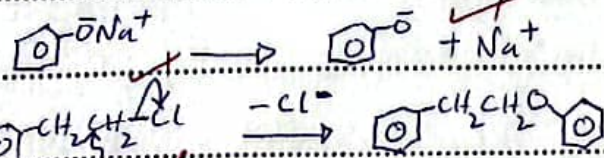
deny all

deny all minus without SN1 rxn

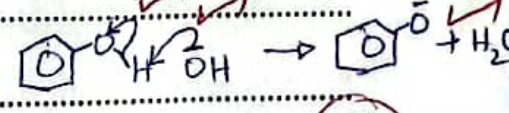
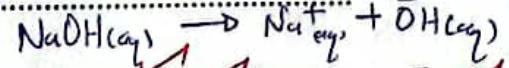
(c)



deny minus without format



Accept ALL



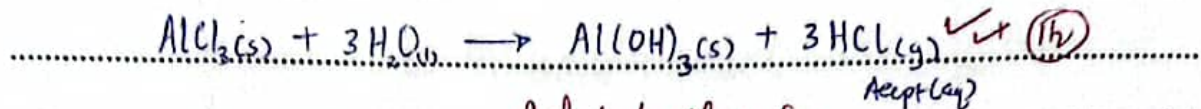
m(03)

etc

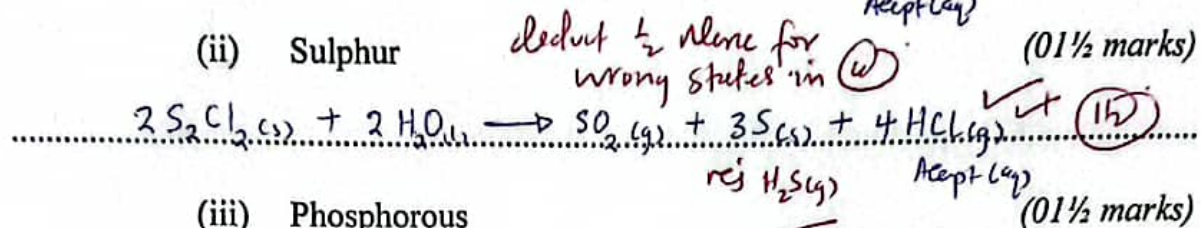
ALL



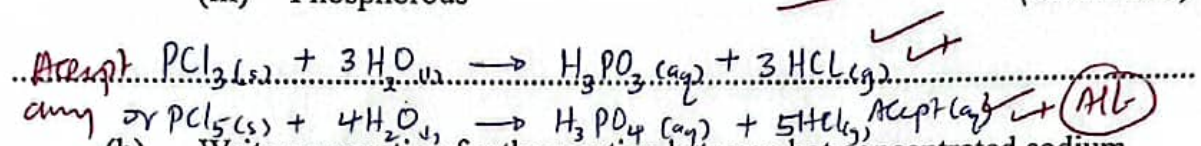
12. (a) Write an equation for the reaction between water and the chloride of:  
(i) Aluminium (01½ marks)



- (ii) Sulphur (01½ marks)

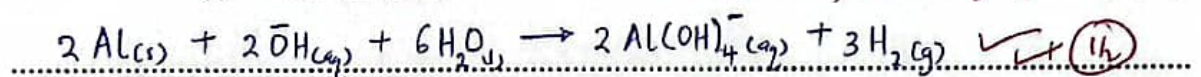


- (iii) Phosphorous (01½ marks)

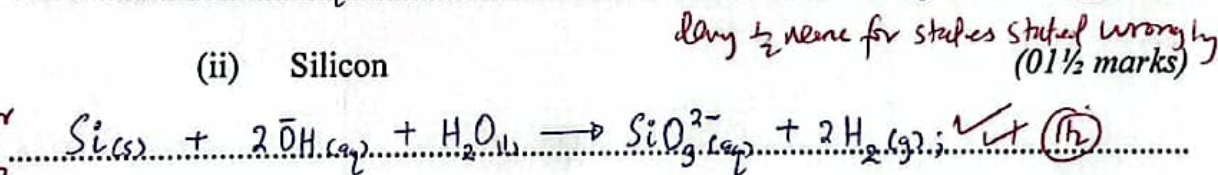


- (b) Write an equation for the reaction between hot concentrated sodium hydroxide solution and:

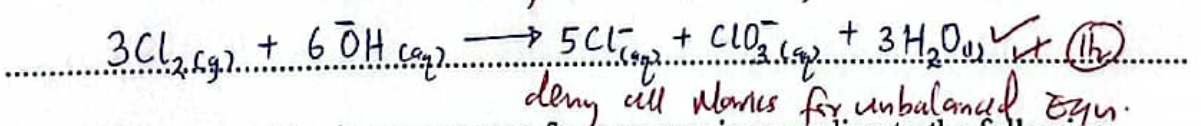
- (i) Aluminium (01½ marks)



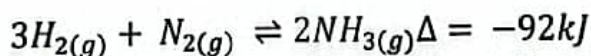
- (ii) Silicon (01½ marks)



- (ii) Chlorine - deny all marks for wrong chemical symbols (01½ marks)



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



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

rej: Iron cat ✓  
Finely divided Iron Catalyst; ✓  
rej: iron catalyst;

High pressure (200-100 atm) ✓  
Accept quotation?

Low temperature or 450-500°C ✓  
temp within the range and pressure as well;

(1½)



- (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.

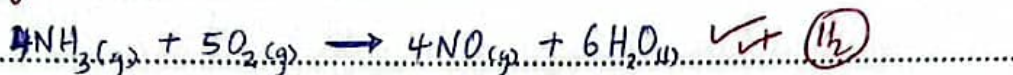
(i) Name P and Q

P is.....Nitrogen monoxide; ✓ *long marks if the words are separated* (½ marks)

Q is.....Nitrogen dioxide; ✓ *(9)* (½ marks)

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

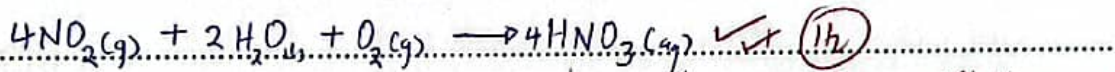
Equation for the formation of P: (01½ marks)



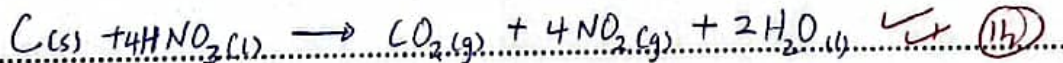
*long all marks for unbalanced Eqn; long ½ mark for wrong states;*  
 Equation for the formation of Q: (01½ marks)



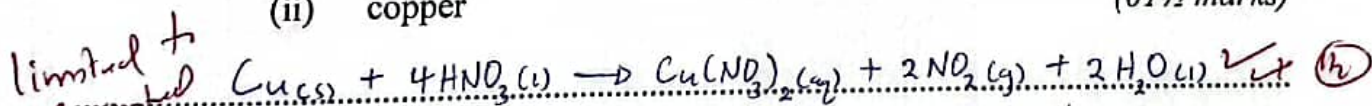
*long ½ for wrong state; And All for unbalanced;*  
 Equation for the formation of nitric acid: (01½ marks)



(c) Write equations for the reaction of concentrated nitric acid and  
 (i) carbon *Follow still the same Rules above* (01½ marks)



(ii) copper (01½ marks)

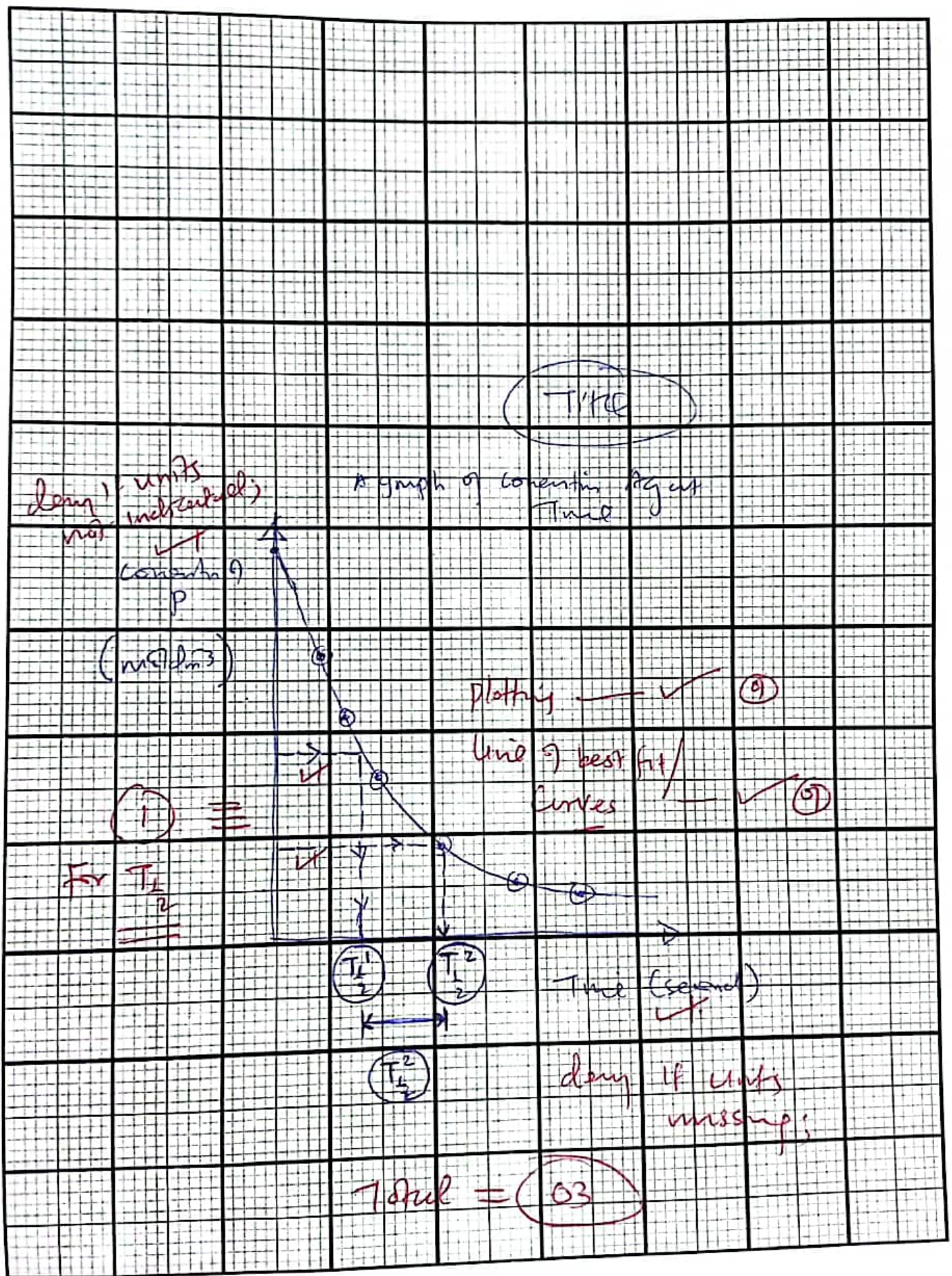


*not negative.*  
 The kinetic data for the reaction between P and sodium hydroxide is shown in the table below. *The above Rules still apply*

Concentration of P (mol l <sup>-1</sup> )	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) the half life of P

(03 marks)

$$T_{1/2} = \left( \frac{T_{1/2}^1 + T_{1/2}^2}{2} \right) \checkmark$$

① Distributed to the graph

$$\text{i.e. } T_{1/2} = \left( \frac{13 + 13}{2} \right) \checkmark$$

$$T_{1/2} = 13 \text{ seconds} \checkmark \text{ dem } \frac{1}{2} \text{ minus if units missing}$$

(ii) the order of the reaction.

(01 mark)

First order;  $\checkmark$  ②

(iii) the rate constant for the reaction

(02 marks)

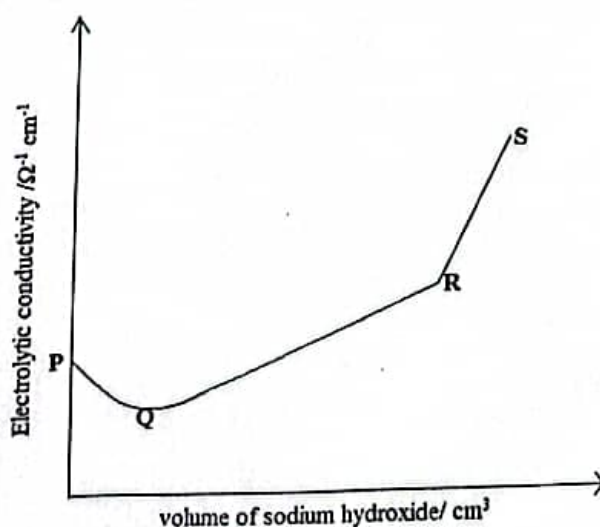
$$T_{1/2} = \frac{\ln 2}{\lambda} \checkmark$$

Accept Any logical computation using  $T_{1/2}$

$$13 = \frac{\ln 2}{\lambda} \checkmark$$

$$\lambda = 0.0533 \text{ s}^{-1} \checkmark \text{ dem } \frac{1}{2} \text{ minus if units missing}$$

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



Explain the shape of the curve. (PQRS).

order, Trend  $\equiv$  Explain why (4 marks)

At Point P,  $K$  is slightly high; due to higher concentration of  $H^+$  from ionisation of  $CH_3COOH$ ;

Along PQ;  $K$  decreases gradually, due to neutralisation rxn; thus removal of fast

conduction  $H^+$  ions from soln; At Q  $K$  is lowest; due to presence of  $Na^+$  and

$CH_3COO^-$  in the soln; we are slow conducting ions; along QR to RS;

the conductivity ( $K$ ); increases gradually then rapidly; due to the

addition of excess  $NaOH$  + resultant solution; whose complete ionisation

produces high hydroxyl ions which are fast conduction ions.

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

(i) Molar conductivity of silver chloride at infinite dilution at  $25^\circ\text{C}$ .

(01½ marks)

$$\Lambda_{\infty} AgCl = \Lambda_{\infty} KCl + \Lambda_{\infty} AgNO_3 - \Lambda_{\infty} KNO_3$$

$$= (140.8 + 134.0) - 143.2$$

$$= 131.6 \text{ S cm}^2 \text{ mol}^{-1}$$

doing all the computation if formula takes the application of Kohlrausch law, i.e.

— doing value without units

do x do

Answer no value for errors in the formulas

(ii) Solubility product,  $K_{sp}$  of silver chloride at  $25^\circ\text{C}$ . (The electrolytic conductivity of water and that of a saturated solution of silver chloride are  $5.5 \times 10^{-8}$  and  $1.934 \times 10^{-6} \text{ S cm}^{-1}$  respectively)

(3½ marks)

$$K_{AgCl} = K_{soln} - K_{H_2O}$$

$$= 1.934 \times 10^{-6} - 5.5 \times 10^{-8}$$

$$K_{AgCl} = 1.879 \times 10^{-6} \text{ S cm}^{-1}$$

$$\text{But; } \Lambda_{\infty} AgCl = \left( \frac{1000 K}{C} \right)$$

$$\text{Thus; } C = \left( \frac{1000 \times 1.879 \times 10^{-6}}{131.6} \right)$$

$$C = 1.4278 \times 10^{-5} \text{ M}$$

$$\text{But } K_{sp} = [Ag^+][Cl^-]$$

$$K_{sp} = (1.4278 \times 10^{-5})^2$$

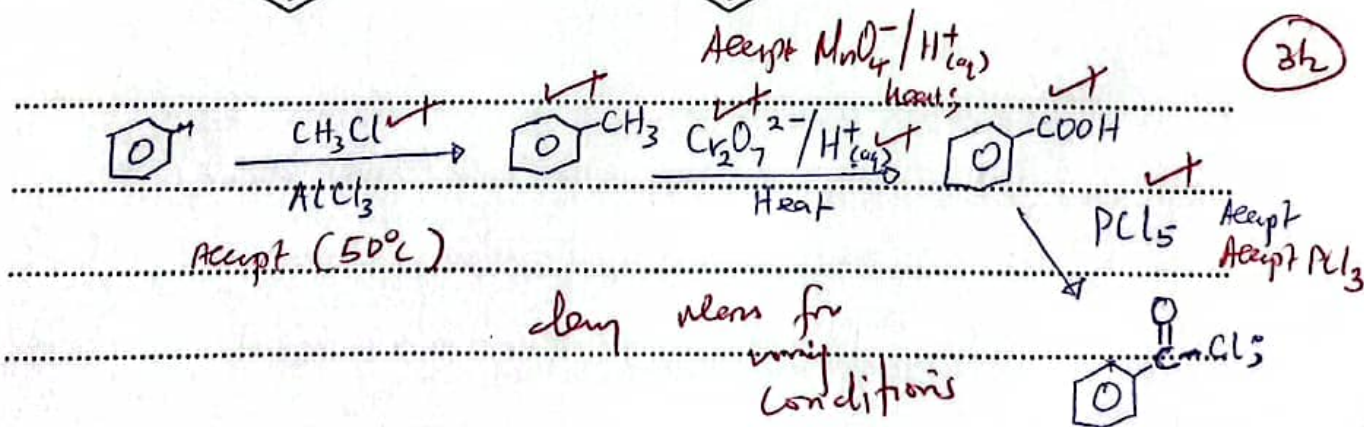
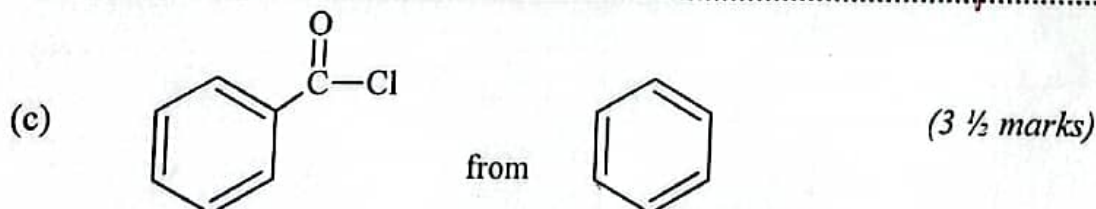
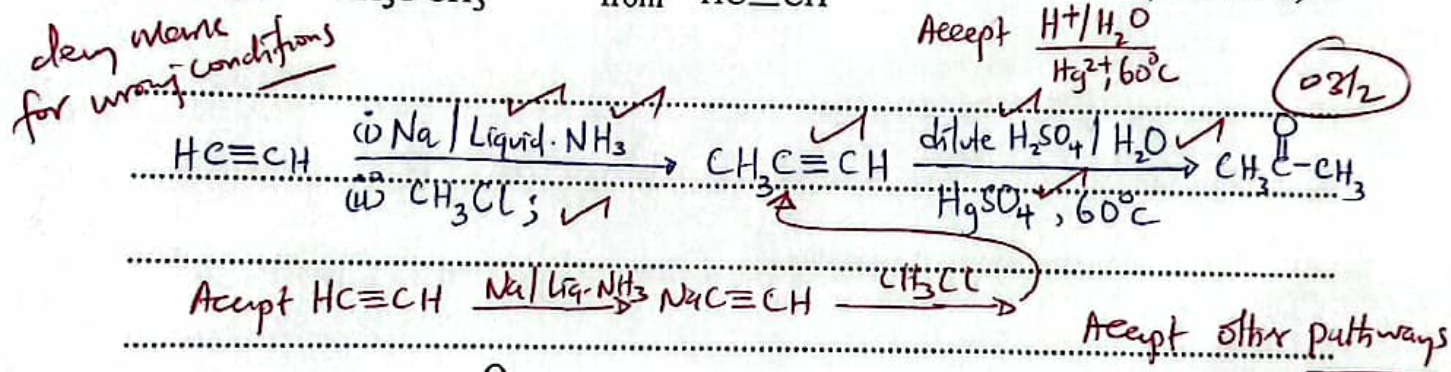
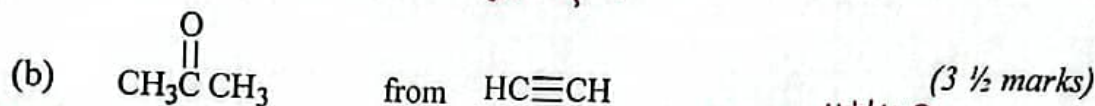
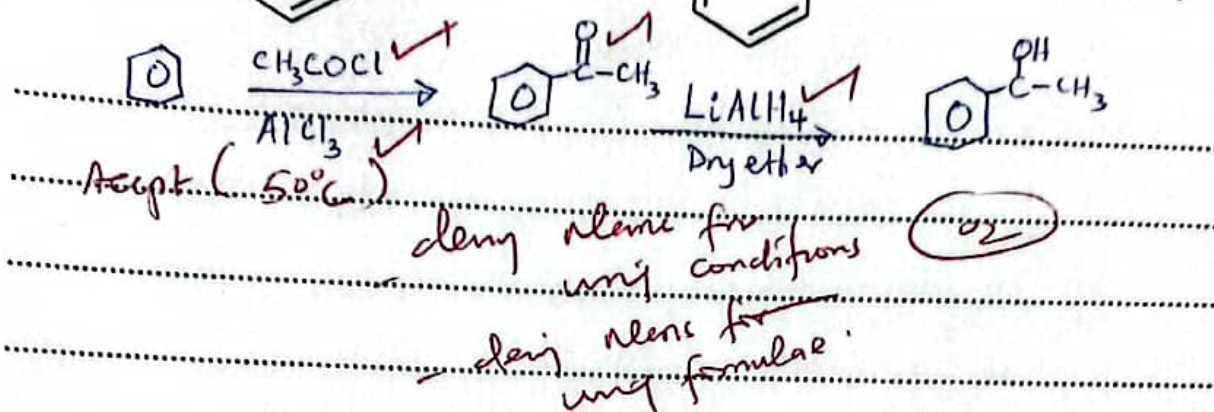
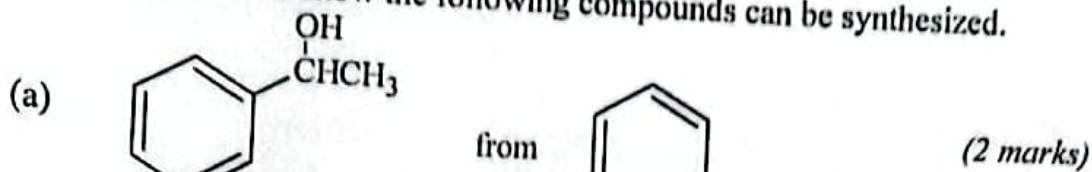
$$K_{sp} = 2.0386 \times 10^{-10} \text{ mol}^2 \text{ dm}^{-6}$$

doing ½ value for units missing

3h



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



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

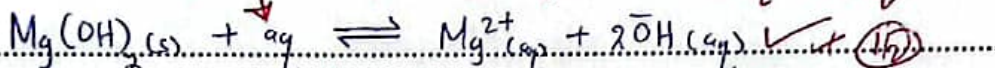
Is the precipitation of a sparingly soluble ionic compound (salt) from its saturated soln by addition of a more soluble salt containing one of the similar ion in the saturated soln at constant temp.

(b) Magnesium hydroxide is sparingly soluble in water.

Write:

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

reject (aq)  $\rightarrow$  Accept  $\text{Mg(OH)}_2(\text{s}) \rightleftharpoons \text{Mg}^{2+}(\text{aq}) + 2\text{OH}^{-}(\text{aq})$  (1 1/2 marks)



deduct 1/2 mark for without  $\rightleftharpoons$

(ii) the expression for the solubility product,  $K_{sp}$ , of magnesium hydroxide. (01 mark)

$K_{sp} = [\text{Mg}^{2+}][\text{OH}^{-}]^2$  ✓ (1 mark) deny if b(i) is wrong

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

(i) water

Let solubility of  $\text{Mg(OH)}_2$  be  $x$  in water;

Thus;  $[\text{Mg}^{2+}] = x$ ;  $[\text{OH}^{-}] = 2x$ ;

$K_{sp} = x(2x)^2$  ✓

$4.2 \times 10^{-12} = 4x^3$  ✓

$x = 1.0164 \times 10^{-4} \text{ mol dm}^{-3}$

∴ the solubility of  $\text{Mg(OH)}_2$  in water is  $1.0164 \times 10^{-4} \text{ mol dm}^{-3}$  (0 1/2)

deny marks for wrong (ii) 0.01 M sodium hydroxide

Let solubility of  $\text{Mg(OH)}_2$  in  $\text{NaOH}(0.01\text{M})$  be  $y$ ;

$[\text{Mg}^{2+}] = y$ ;  $[\text{OH}^{-}] = (2y + 0.01)^2$  ✓

But since solubility of  $\text{Mg(OH)}_2$  is very small; thus

(iii) Comment on your answer in (c) above.

For Assumption (2 marks) ✓  
 $2y$  is very small; thus  $(2y + 0.01) \approx 0.01\text{M}$

$4.2 \times 10^{-12} = y(0.01)^2$  ✓

$y = 4.2 \times 10^{-8} \text{ mol dm}^{-3}$

∴ solubility of  $\text{Mg(OH)}_2$  in  $0.01\text{M NaOH}$  is  $4.2 \times 10^{-8} \text{ mol dm}^{-3}$  (1 mark)

Magnesium hydroxide is more soluble in water than in

0.01 M sodium hydroxide; ✓ (1)



# PERIODIC TABLE

1	2											3	4	5	6	7	8
1 H 1.0																1 H 1.0	2 He 4.0
3 Li 6.9	4 Be 9.0											5 B 10.8	6 C 12.0	7 N 14.0	8 O 16.0	9 F 19.0	10 Ne 20.2
11 Na 23.0	12 Mg 24.3											13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.4	18 Ar 40.0
19 K 39.1	20 Ca 40.1	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc 98.9	44 Ru 101	45 Rh 103	46 Pd 103	47 Ag 108	48 Cd 112	49 In 115	50 Sn 119	51 Sb 122	52 Te 128	53 I 127	54 Xe 131
55 Cs 133	56 Ba 137	57 La 139	72 Hf 178	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 Tl 204	82 Pb 207	83 Bi 209	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)															
			57 La 139	58 Ce 140	59 Pr 141	60 Nd 144	61 Pm (145)	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 162	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
			89 Ac (227)	90 Th 232	91 Pa 231	92 U 238	93 Np 237	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf 251	99 Ea (254)	100 Fm (257)	101 Mv (256)	102 No (254)	103 Lw 260

1. **H** – indicates Atomic number
2. **H** – indicates relative Atomic mass  
1.0