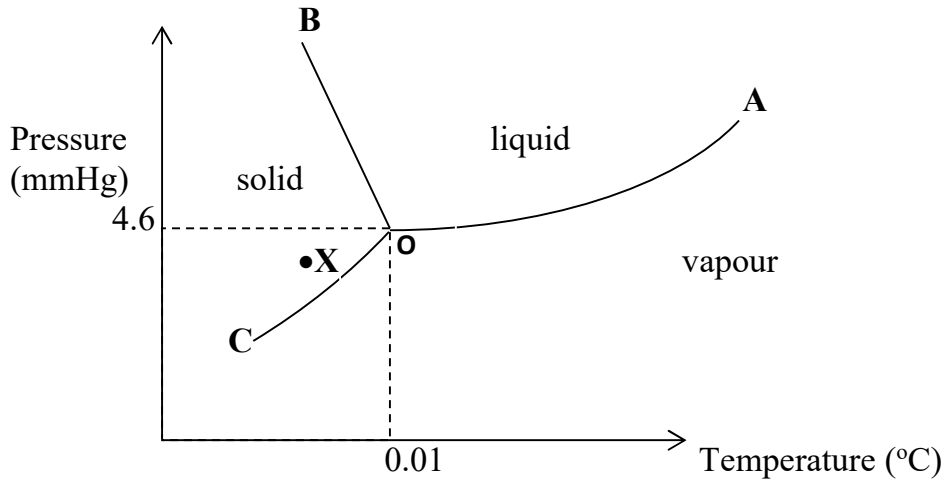
CHEMISTRY 1

SECTION A

Attempt all questions in this section (46marks)

1. The figure below shows the pressure temperature curves for water



(a) State the;

(i) equilibrium represented by point **O** (01 mark)

……

……

(ii) significance of point **A** (01 mark)

……

……

(b) Comment on the slope of line **OB** (02 marks)

……

……

……

(c) State what will happen to ice at point **X** if it's gently heated while keeping the pressure constant.

……

……

(01 mark)

2. (a) Write equation(s) of reaction(s) between water and

(i) Phosphorus (III) chloride

……

……

(ii) Phosphorus (V) chloride

……

……

(b) Explain why phosphorus (V) chloride can be formed but not nitrogen (V) chloride.

……

……

……

……

……

……

……

……

……

……

(3½ marks)

3. Complete the following equations and write the systematic name of the organic product.

(a) $(CH_3CH_2)_2NH \xrightarrow[O^oC]{NaNO_2/HCl}$ ……

Name of product:

……

(01 mark)

(b) $CH_3CH_2CHO \xrightarrow{NH_2OH/H^+}$ …….

Name of product:

……

(01 mark)

(c) $CH_3\underset{\underset{CH_3}{|}}{C}HCH_2COO^-Na^+ \xrightarrow[heat]{CaO}$ ……..

Name of product:

……

(01 mark)

(d) $(CH_3)_2C = CH_2 + HCl \longrightarrow$ …….

Name of product:

…….

(01 mark)

(e) $n(CH_2 = \underset{\underset{CH_3}{|}}{C}CH = CH_2) \longrightarrow$ …….

Name of product:

……..

(01 mark)

4. (a) 0.6g of iron (III) chloride in the gaseous state was found to occupy 200cm^3 at 4.60 x 10^{-4} Pa and 327^{o}C. Determine the molar mass of iron (III) chloride in the gaseous phase and comment on your value
(Fe = 56 Cl = 35.5)

……

……

……

……

(02 marks)

(b) Draw the structural formula of iron (III) chloride in the gaseous phase

……

……

……

(01 mark)

(c) Write equation of reaction which takes place when iron (III) chloride is added to water.

……

……

(01 mark)

5. **29.5cm^3** of nitric acid was gradually added to **50cm^3** of **0.72M** potassium hydroxide solution in a calorimeter of negligible heat capacity. If the temperature rise of solution was **6.4^{o}C;** calculate the heat of neutralisation of nitric acid by potassium hydroxide. State the assumptions made. ***(Density of solution is 1gcm^{-3}, specific heat capacity of solution is 4.2Jg^{-1}^{o}C^{-1})***

……

……

……

……..…

……

……

……

……

……

(5 ½ marks)

6. (a) A synthetic rubber **Q**, was made from unknown number of monomers with the structural formula $H_2C = \underset{Cl}{C} - \underset{H}{C} = CH_2$

(i) State the condition(s) for the reaction (01 mark)

……

……

(ii) Write the equation for the reaction leading to the formation of **Q**

……

……

(01 mark)

(b) Name the type of reaction in a (i)

……

(½ mark)

(c) A solution containing **5g** of **Q** in **200cm^3** of trichloro methane is found to have an osmotic pressure of **34KPa** at **17^{o}C.** Determine the number of monomers in **Q**.

……

……

……

……

……

……

(2 ½ marks)

7. (a) Define oxygen reacts with nitrogen according to the following equation

$$2NO_{(g)} + O_{2(g)} \rightleftharpoons 2NO_{2(g)}$$

The following data was obtained for the above reaction

Experiment number	$[0_2] \times 10^{-2}$ moldm^{-3}	$[NO_2] \times 10^{-2}$ moldm^{-3}	Rate of disappearance of $[NO] \times 10^{-4}$ moldm^{-3} S^{-1}
1	1.0	1.0	0.7
2	1.0	2.0	2.8
3	1.0	3.0	6.3
4	2.0	2.0	5.6
5	3.0	3.0	18.9

(a) Deduce the order of reaction with respect to

(i) O_2 (1 mark)

……

……

(ii) NO (01 mark)

……

……

(b) (i) Write the rate equation for the reaction

(01 mark)

……

……

(ii) Calculate the rate constant K and state its units

(01 mark)

……

……

……

……

(c) When the rate of disappearance of **NO** is 2.8×10^{-4} moldm^{-3} s^{-1}, determine the rate of disappearance of oxygen. (01 mark)

……

……

……

……

8. Complete the following equations and in each case outline the Mechanism for the reaction

(a) $(CH_3)_2C = O \xrightarrow{Ba(OH)_2}$

……

……..

……

……

……

……..

……..

(03 marks)

(b) $CH_3\overset{H}{\overset{|}{C}} = CH_2 \xrightarrow{Br_2/CH_3Cl}$

……

……

……

……

……

(02 marks)

9. (a) Give two properties in which boron resembles silicon

……

……..

……

……

(02 marks)

(b) Write equation(s) of reactions which take place when the chlorides of silicon and boron are separately treated with water

(03 marks)

……

……..

……

SECTION B: (54 MARKS)

Attempt only six questions in this section

10. Name the reagent that can be used to distinguish between the following pairs of organic compounds and in each case state what is observed when the reagent is separately treated with each member of a pair

(a) $HCOOCH_2CH_3$ and $CH_3COOCH_2CH_3$

Reagent:

……

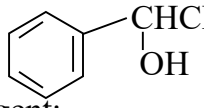
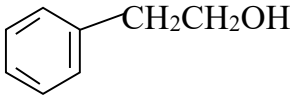
Observation

……

……

……

(03 marks)

(b)  and 

Reagent:

……

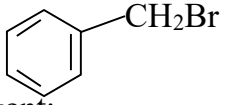
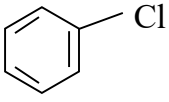
Observation

……

……

……

(03 marks)

(c)  and 

Reagent:

……

Observation

……

……

……

(03 marks)

11. Carbon is in group (IV) of the periodic table but differs from the rest of the members of group (IV)

(a) State three properties in which carbon differs from the rest of the group members.

……

……

……

……

(b) Give a reason why carbon differs from the rest of the group members

……

……

(c) When water was added to silicon (IV) chloride, white fumes were formed. Explain the observation.

……

……

……

……

(d) Write equation for the reaction which takes place when;

(i) Trilead tetra oxide is reacted with nitric acid.

……

(ii) Lead (iv) oxide is warmed with concentrated hydrochloric acid.

……

12. (a) Define an acid- base indictor

……

…….

…….

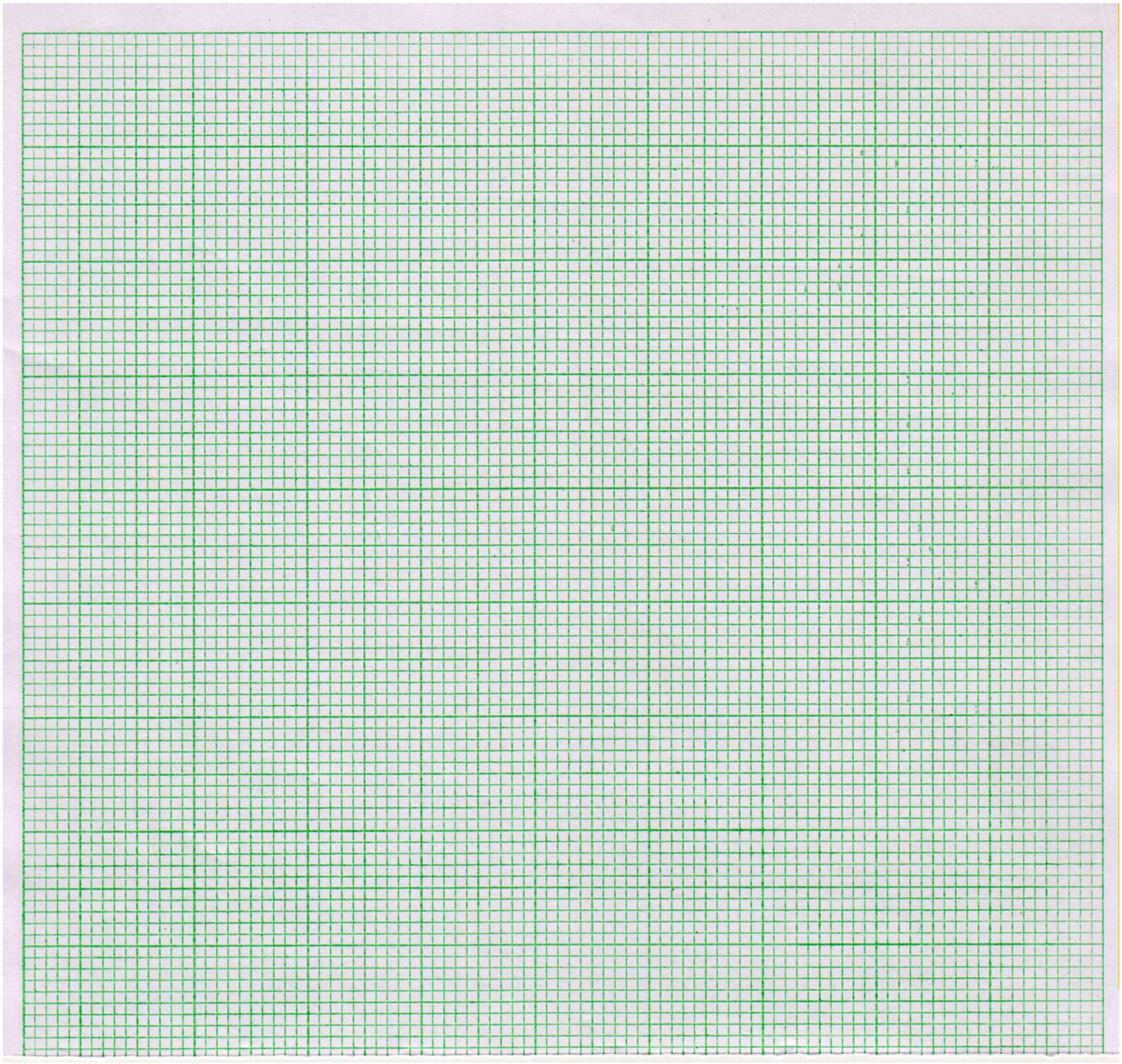
…….

(01 mark)

(b) Sodium hydroxide was added in portions to **25cm^3** of **0.1M** ethanoic acid and P^H was measured at intervals giving the following results.

Volume of NaOH (cm^3)	0.0	4.0	8.0	12.0	16.0	18.0	20.0	22.0	22.5	23.0	23.5	24.0	28.0
PH	2.8	3.5	4.0	4.5	5.1	5.5	5.8	7.0	9.0	10.5	11.0	11.4	12.3

Plot the P^H curve for the reaction (03 marks)



(c)Use the graph in (b) above to determine

(i) the P^H at end point

……

……....

(ii) Molarity of sodium hydroxide solution (03 marks)

……

……

……

……

……

……

……

……

……

……

13. **4.1g** of a bromo alkane **Y**, was boiled with excess sodium hydroxide solution and the resultant mixture acidified with dilute nitric acid and diluted to **250cm^3** of solution. **25.0cm^3** of the resultant solution required **16.64cm^3** of **0.2M** silver nitrate solution for complete reaction

(a) (i) Determine the molecular formula of **Y**

……

……

……

……

……

……

……

……

……

(iii) Write the structural formulae and **IUPAC** names of all the possible isomers of **Y**

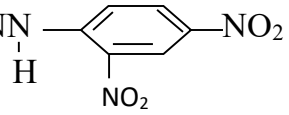
……

……

……

……

……

(b) Using equations only, stating reagents and conditions, show how **Y** can be converted to $(CH_3)_2C = NN$  NO_2

……

……

……

……

……

……

……

14. The equilibrium constant for the Haber process at **472°C**, K_c is **47.2mol^{-2}dm^6**. A **2** litre flask was filled with **0.5** moles of ammonia and allowed to reach equilibrium at **472°C**

(a) Write an expression for the equilibrium constant K_c of the reaction taking place in the flask

……

……

(01 mark)

(b) State the effects of the following changes on the position of equilibrium and equilibrium constant;

(i) Adding more ammonia form outside the reaction flask (02marks)

……

……

……

(ii) Adding Helium gas at constant volume (02 marks)

……

……

……

(iii) Reducing temperature to **450°C**. (02 marks)

……

……

……

(c) Dichloride sulphur dioxide decomposes according to the following equation;

$$SO_2Cl_{2(g)} \rightleftharpoons SO_{2(g)} + Cl_{2(g)}$$

At a pressure of **1 atmosphere** and a temperature of **100°C,** a sample of dichloride sulphur dioxide in the gas phase was found to contain 34% of chlorine. Calculate the value of Kp

……

……

……

……

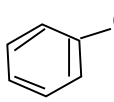
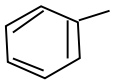
……

……

……

……

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

(a)  from 

……

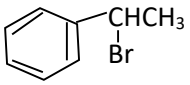
……

……

……

……

……

(b)  from 

……

……

……

……

……

……

(c) $CH_3\overset{\overset{O}{\|}}{C}CH_3 \quad from \quad CH_3CH_2OH$

……

……

……

……

……

……

16. (a) A compound **J** contained **19.1%** nitrogen **43.6%** oxygen and the rest being manganese.

(i) Calculate the empirical formula of **J**

……

……

……

……

……

……

……

……

……

(ii). **10g** of **J** in **1000g** of water lowered the freezing point of water by **0.127°C.** Calculate the molecular formula of **J** ***(Kf water is 1.86°Cmol^{-1} Kg^{-1})***

……

……

……

……

……

(b) When **J** was strongly heated brown fumes were given off. **J** dissolved in water to form a pink solution. Identify **J**

……

……

(c) State what is observed and write equations for the reactions which take place when;

(i) Concentrated nitric acid is added and lead (IV) oxide was added to **J** and the mixture boiled

Observation

……

……

Equation

……

……

(ii) Potassium carbonate solution was added

Observation

……

……

Equation

……

17. (a) Explain what is meant by the term synthetic detergent

……

……

……

(b) Using dodeconol $CH_3(CH_2)_{10}CH_2CO$, explain how a synthetic detergent is made.

……

……

……

……

……

……

……

……

(c) Give a reason why the following substances are used during manufacture of synthetic detergents

(i) Sodium phosphate

……

……

(ii) Sodium peroxo borate

……

……

(d) Give **one** advantage and disadvantage of synthetic detergents.

……

……

……

……

THE 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 65.7	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 106	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 152	63 Sm 150	64 Eu 152	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 Es (254)	100 Fm (257)	101 Mv (256)	102 No (254)	103 Lw

1. 1 H ← Indicates atomic number.

2. H 1.0 ← Indicates relative atomic mass.

END