



First Term Test November - 2016

Year 13

General English I  
Chemistry I

02 E I

Two hours

Name: ..... Index No.: ..... Grade: .....

- This paper consists of 02 pages.
- Answer all the questions.
- Use of calculators is not allowed.
- Write your Index Number in the space provided in the answer sheet.
- Follow the instructions given on the back of the answer sheet carefully.
- In each of the questions 1 to 30, pick one of the alternatives from (1), (2), (3), (4), (5) which is correct or most appropriate and mark your response on the answer sheet with a cross (X) in accordance with the instructions given on the back of the answer sheet.

$$\begin{array}{ll} \text{Universal gas constant} & R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1} \\ \text{Avogadro constant} & N_A = 6.022 \times 10^{23} \text{ mol}^{-1} \\ \text{Planck's constant} & h = 6.626 \times 10^{-34} \text{ Js} \\ \text{Velocity of light} & C = 3 \times 10^8 \text{ m s}^{-1} \end{array}$$

Answer all the questions.

- 01) A sample of H atoms, excited by an electric method contains electrons distributed in first six energy levels. Which of the following gives the number of different wave lengths belongs to Lyman, Balmer and Paschen series respectively, according to the Bohr theory ?
- 1) 3, 5 , 4      2) 2, 4, 6      3) 5, 2, 3  
4) 5, 4 , 3      5) 6, 4, 2
- 02) Which of the following reactions form a molecule which acts as a Lewis acid and has a zero dipole moment?
- 1) S + Cl<sub>2</sub> → SCl<sub>2</sub>      2) 2 Al + 3 Cl<sub>2</sub> → 2AlCl<sub>3</sub>  
3) 2P + 3Cl<sub>2</sub> → 3PCl<sub>3</sub>      4) Xe + F<sub>2</sub> → XeF<sub>2</sub>  
5) Cl<sub>2</sub> + 3F<sub>2</sub> → 2ClF<sub>3</sub>
- 03) Which of the following pairs of solutions gives the same colour upon mixing with each other?
- 1) FeCl<sub>3</sub>(aq) + conc. HCl(aq) and CuSO<sub>4</sub>(aq) + conc. HCl(aq)  
2) NiCl<sub>2</sub> (aq) + conc. HCl(aq) and CuSO<sub>4</sub>(aq) + conc. HCl(aq)  
3) Cr<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>(aq) + NH<sub>4</sub>OH and NiSO<sub>4</sub>(aq) + NH<sub>4</sub>OH  
4) FeCl<sub>3</sub>(aq) + NH<sub>4</sub>OH(aq) and MnSO<sub>4</sub>(aq) + conc. HCl(aq)  
5) FeCl<sub>3</sub>(aq) + NH<sub>4</sub>SCN(aq) and NiSO<sub>4</sub>(aq) + KCN(aq)
- 04) Which of the following molecules / ions have the same shape?
- 1) ClF<sub>3</sub>; BF<sub>3</sub>      2) PCl<sub>3</sub>; BCl<sub>3</sub>      3) SOCl<sub>2</sub>; NH<sub>3</sub>  
4) H<sub>3</sub>O<sup>+</sup>; NH<sub>4</sub><sup>+</sup>      5) NO<sub>3</sub><sup>-</sup>; SO<sub>3</sub><sup>2-</sup>

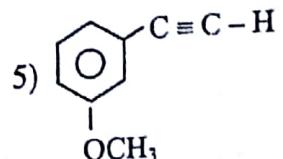
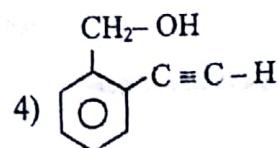
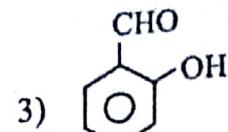
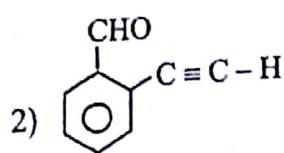
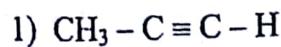
- (05) Which of the following statements is correct?
- The radius of  $K^+$  is less than that of  $Na^+$ .
  - Addition of an electron to a Cl atom is easier than that of N.
  - According to the Pauling's scale, Sulfur is more electronegative than Nitrogen.
  - The first ionization energy of S is greater than that of P.
  - The radius of  $O^{2-}$  is greater than that of  $N^{3-}$ .
- (06) The solubility product of  $Fe(OH)_3$  at  $25^\circ C$  is  $1 \times 10^{-38} \text{ mol}^3 \text{ dm}^{-3}$ . The concentration of  $Fe^{2+}$  ions of  $0.05 \text{ mol dm}^{-3}$  solution of NaOH which is saturated with  $Fe(OH)_3$  in  $\text{mol dm}^{-3}$  units is,
- $2 \times 10^{-15}$
  - $1 \times 10^{-48}$
  - $2 \times 10^{-24}$
  - $4 \times 10^{-14}$
  - $4 \times 10^{-48}$
- (07) Which of the following statements is not true?
- Phenol shows nucleophilic substitution reactions.
  - $CH_3OCH_3$  is more volatile than  $C_2H_5OH$ .
  - $CH_3 - CH = CH - CHO$  is an unsaturated aldehyde.
  - $CH_2 = CH - CH_2Cl$  shows nucleophilic substitution reactions.
  - Benzene does not decolorize bromine water.
- (08) Which of the following compounds forms two gases when treated with concentrated  $H_2SO_4$ ?
- $Na_2SO_3$
  - KBr
  - KCl
  - $NH_4Cl$
  - $Fe(NO_3)_2$
- (09) 12.5 g sample of a mixture containing  $K_2CO_3$  and  $CaCO_3$  was heated to  $900^\circ C$ . The volume of  $CO_2$  produced in this reaction at standard temperature and pressure was  $1.568 \text{ dm}^3$ . The mass percentage of  $K_2CO_3$  in the original mixture is,
- 56
  - 44
  - 40
  - 35
  - 65
- (10) Which of the following compounds has the highest solubility in water?
- $CH_3CH_2Cl$
  - $CH_3CH = CH_2$
  - $CH_3CH_2OH$
  - $CH_3OCH_3$
  - $(CH_3)_3CCl$
- (11) The products formed by reduction of  $KMnO_4$  under strongly basic conditions is,
- $MnO_2$  and  $H_2O$
  - $MnO_2$  and  $O_2$
  - $K_2MnO_4$  and  $H_2O$
  - $K_2MnO_4$  and  $O_2$
  - $MnO_2$  and  $Mn(OH)_2$
- (12) Which of the following aqueous solutions gives sulfur (S) as a product when treated with  $SO_2$ ?
- $FeCl_3$
  - $H_2S$
  - $KMnO_4$
  - $Cl_2$
  - $Pb(NO_3)_2$
- (13) A sample of 9.60 mg of pure  $MgSO_4$  was dissolved in distilled water to prepare an aqueous solution of  $500.0 \text{ cm}^3$ , in a volumetric flask. The content of  $Mg^{2+}$  ions of the solution in  $\text{mg dm}^{-3}$  units is, ( $Mg = 24$   $S = 32$   $O = 16$ )
- 3.84
  - 1.92
  - 0.96
  - $1.6 \times 10^{-4}$
  - $8 \times 10^{-3}$
- (14) The equilibrium constant of the equilibrium  $M^{+}(aq) + 4Cl^-(aq) \rightleftharpoons [MCl_4]^{3-}(aq)$  at  $25^\circ C$  is  $5.0 \times 10^{20} \text{ mol}^{-4} \text{ dm}^{12}$ .  $50.0 \text{ cm}^3$  of an aqueous solution of  $0.4 \text{ mol dm}^{-3}$   $M^{+}(aq)$  is mixed with  $50.0 \text{ cm}^3$  of  $4 \text{ mol dm}^{-3}$  solution of  $Cl^-$  ions. What is the concentration of  $[MCl_4]^{3-}(aq)$  after the reaction?
- 0.2
  - 0.4
  - 0.04
  - 0.02
  - 4

- 15) Consider the following reactions.
- $X + H^+(aq) + NO_3^-(aq) + PbO_2 \longrightarrow$  purple coloured solution + other products
- purple solution + conc. HCl  $\longrightarrow$  greenish yellow gas + other products
- $X + BaCl_2 \longrightarrow$  white ppt + other products
- X could be,
- 1)  $CuSO_4$
  - 2)  $MnSO_4$
  - 3)  $FeSO_4$
  - 4)  $ZnSO_3$
  - 5)  $Cr_2(SO_4)_3$
- 16) Which of the following pairs of cations can be distinguished between them using a dilute aqueous solution of KOH?
- 1)  $Cd^{2+}; Zn^{2+}$
  - 2)  $Cd^{2+}, Mg^{2+}$
  - 3)  $Al^{3+}; Zn^{2+}$
  - 4)  $Zn^{2+}; Pb^{2+}$
  - 5)  $Ca^{2+}, Mg^{2+}$
- 17) Which of the following species can not act as a nucleophile?
- 1)  $C_2H_5O^-$
  - 2)  $CH_3MgBr$
  - 3)  $CH_3CH_2Cl$
  - 4)  $CH_3NH_2$
  - 5)  $\ddot{N}H_2OH$
- 18) Which of the following intermediates is most stable.
- 1)
  - 2)  $CH_2 = CH - \overset{\oplus}{C}H_2$
  - 3)  $CH_2 = CH - \overset{\oplus}{C}H_3$
  - 4)  $CH_2 = C - \overset{\oplus}{C}H_3 - CH_3$
  - 5)  $CH_3 - \overset{\oplus}{C}H_3$
- 19) The mole fraction of A in an ideal solution of A and B liquids at a particular temperature is 0.4. At this temperature  $P_A^0 = 3P_B^0$ . What is the total pressure of this system if  $P_A^0 = 3 \times 10^3$  Pa?
- 1)  $1.8 \times 10^2$  Pa
  - 2)  $1.8 \times 10^3$  Pa
  - 3)  $6.6 \times 10^3$  Pa
  - 4)  $1.2 \times 10^2$  Pa
  - 5)  $1.2 \times 10^3$  Pa
- 20) The inorganic compound A forms a gas when treated with dilute HCl. This gas turns lime water milky. This gas does not decolorise an aqueous solution of  $KMnO_4$ . The compound A forms a green precipitate when dissolved in  $HNO_3$  followed by addition of  $NH_4OH$ . This precipitate did not dissolve in excess  $NH_4OH$ . The compound A could be,
- 1)  $NiCO_3$
  - 2)  $CuCO_3$
  - 3)  $FeCO_3$
  - 4)  $FeSO_3$
  - 5)  $NiSO_3$
- 21) The compound X was dissolved in pure water at constant temperature to obtain an ideal solution. During this process of dissolution of X, it was observed that the vapour pressure of water decreased from  $1.03925 \times 10^4$  Pa to  $8.314 \times 10^3$  Pa. The concentration of X in this solution was  $4 \text{ mol dm}^{-3}$  and the density of this solution was  $0.56 \text{ g cm}^{-3}$ . What is the molar mass of X? ( $H = 1$   $O = 16$ )
- 1)  $104 \text{ g mol}^{-1}$
  - 2)  $52 \text{ g mol}^{-1}$
  - 3)  $26 \text{ g mol}^{-1}$
  - 4)  $208 \text{ g mol}^{-1}$
  - 5)  $68 \text{ g mol}^{-1}$

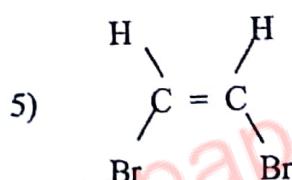
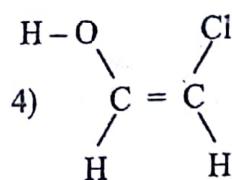
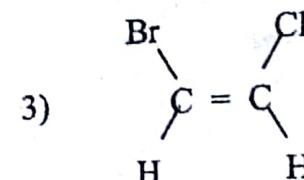
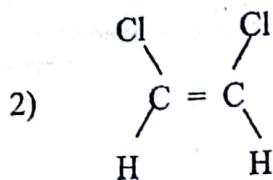
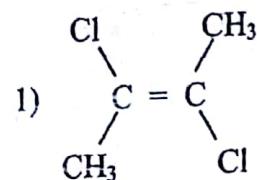
22) Consider the following tests and observations regarding an organic compound.

	Test	Observation
i)	Addition of ammonical $\text{Cu}_2\text{Cl}_2$	Brown precipitate
ii)	Addition of Brady's reagent	Orange precipitate
iii)	Addition of $\text{Br}_2$	Decolourization of the Brown colour

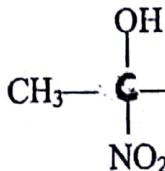
Which of the following compound is correct according to the tests and observations given above?



23) Which of the following compounds does not have a dipole moment?



24) The IUPAC name of compound



- 1) methoxy-4-nitro-4-hydroxypent-2-enoate
- 2) methyl 4-nitro-4-hydroxy-2-oxopentanoate
- 3) methyl 4-hydroxy-4-nitropent-2-enoate
- 4) methyl 4-hydroxy-4-nitropentenoate
- 5) 4-nitro-4-hydroxymethoxypentenoate

25) The IUPAC name of  $[\text{Co}(\text{CN})_2\text{Cl}_2(\text{NO})_2]^{2-}$  is,

- 1) dichloridodicyanidodinitrosylcobaltate(II) ion
- 2) dicyanidodichloridodinitrosylcobaltate(III) ion
- 3) dicyanidodichlorodinitritocobaltate(II) ion
- 4) dichloridodicyanodinitritocobaltate(II) ion
- 5) dicyanidodichlorodinitrocobaltate(IV) ion

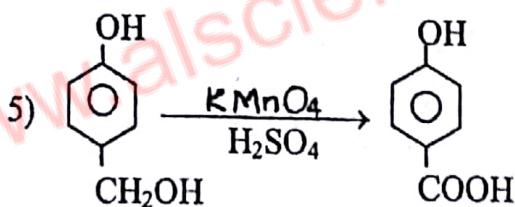
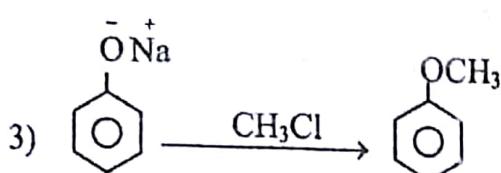
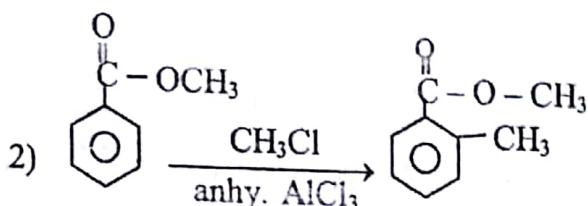
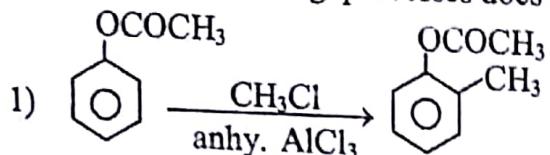
26) The average speed of an ideal gas at 27°C is 0.8 ms<sup>-1</sup>. The average speed at 627°C is (in ms<sup>-1</sup> units)

- 1) 0.24      2) 1.92      3) 2.40      4) 1.38      5) 1.83

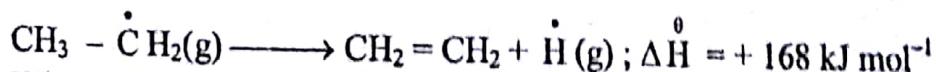
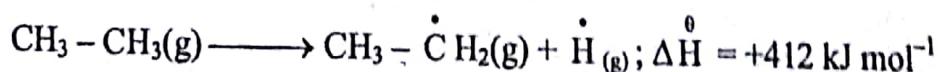
27) Which of the following statements is false?

- 1) Dilute acids can be used to distinguish between SO<sub>3</sub><sup>2-</sup> and SO<sub>4</sub><sup>2-</sup> ions.  
 2) Cl<sub>2</sub>/CCl<sub>4</sub> can not be used to distinguish between Br<sup>-</sup> and Cl<sup>-</sup> ions.  
 3) <sup>Dilute</sup> acids can be used to distinguish between CO<sub>3</sub><sup>2-</sup> and S<sub>2</sub>O<sub>3</sub><sup>2-</sup> ions.  
 4) H<sub>2</sub>SO<sub>4</sub> can be used to distinguish between NO<sub>2</sub><sup>-</sup> and NO<sub>3</sub><sup>-</sup> ions.  
 5) H<sup>+</sup>/KMnO<sub>4</sub> can be used to distinguish between S<sup>2-</sup> and CO<sub>3</sub><sup>2-</sup> ions.

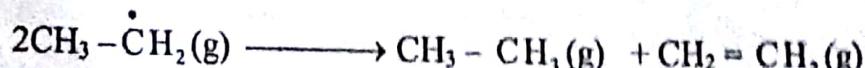
28) Which of the following processes does not take place?



29) Consider the following enthalpy changes



What is the enthalpy change in kJmol<sup>-1</sup> of the following reaction



- 1) -580      2) -244      3) -122      4) +244      5) +580

30) Consider the following dissociation reaction  $\text{NH}_3(\text{g})$ .



The equilibrium mixture at a particular temperature and pressure contains 20%  $\text{NH}_3(\text{g})$  by moles. What is the initial amount (in mols) of  $\text{NH}_3$ , if the total number of moles at the equilibrium is 100?

1) 80

2) 40

3) 60

4) 20

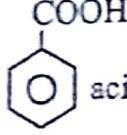
5) 100

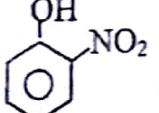
The instructions for the questions 31 to 40 are given below.

Summary of above instructions				
1	2	3	4	5
Only (a) and (b) correct	Only (b) and (c) correct	Only (c) and (d) correct	Only (d) and (a) correct	Any other response or combination of responses correct

31) Which of the following statement / statements is/are true?

a)  $\text{C}_2\text{H}_5\text{OH}$  reacts with Na to form  $\text{H}_2$  gas more easily compared to  $\text{C}_2\text{H}_2$ .

b)  acid is formed when  is oxidized by  $\text{OH}^-/\text{KMnO}_4$

c)  as well as  give a colour with neutral solution of  $\text{FeCl}_3$

d) In the reaction between  $\text{CH}_3\text{CHO}$  and  $\text{CH}_3\text{NH}_2$ , a nucleophilic addition as well as an elimination occurs.

32) Which of the following compound(s)  $\xrightarrow{\text{act+G}}$  as a bleaching agent in water.

a)  $\text{NCl}_3$       b)  $\text{SO}_2$       c)  $\text{PCl}_5$       d)  $\text{KMnO}_4$

33) Which of the following reaction/s is/are disproportionation?

a)  $\text{Cl}_2 + \text{KOH} \longrightarrow$  products

b)  $\text{NO}_2 + \text{H}_2\text{O} \longrightarrow$  products

c)  $\text{SO}_2 + \text{H}_2\text{S} \longrightarrow$  products

d)  $\text{H}_2\text{O}_2 \xrightarrow{h\nu} \longrightarrow$  products

34) Which of the following species form two gaseous products upon heating (ignore the vaporization of  $\text{H}_2\text{O}$ )

a)  $\text{Ca}(\text{NO}_3)_2$       b)  $\text{NH}_4\text{NO}_2$       c)  $\text{KHCO}_3$       d)  $\text{Ag}_2\text{CO}_3$

35) Which of the following is/are true regarding atomic lattices?

a) Graphite is a giant three dimensional lattice.

b) Iodine is a homoatomic lattice.

c) Ionic lattices do not conduct electricity in solid state as well as in liquid state.

d) Atomic lattices do not tend to get dissolved as the covalent bonds exist in them are very strong.

50) Which of the following is/are incorrect (X = Cl/Br/I)

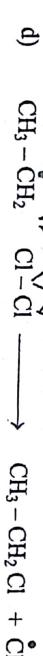
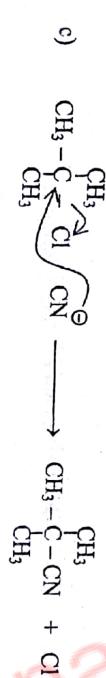
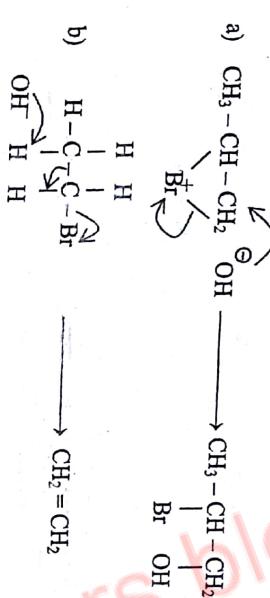
- a)  $R-C \equiv C - H + RMgX \longrightarrow R-C \equiv C-R + MgXH$   
b)  $R-X + RNH_2 \longrightarrow R_4N^+X^- + HX$   
c)  $RCOR + RNH_2 \longrightarrow R_2C=N-R + H_2O$   
d)  $ROH + RMgX \longrightarrow RH + ROMgX$

37)

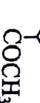
- Which of the following is/are property / properties of primary standards ?
- Stable for a longer period.
  - High purity.
  - High volatility
  - Absorption of water vapour or  $CO_2$  in atmosphere.

38)

Which of the following mechanistic step/s is/are not correct.



39)



Which of the following is/are most accurate regarding the above molecule?

- It reacts with dilute  $KOH$
- It shows diastereomerism.
- It gives a silver mirror with ammonical silver nitrate.
- It forms a dicarboxylic acid on oxidation under strong conditions.

40)

Which of the following is/are true regarding the equilibrium constant?

- the equilibrium constant changes when the concentrations of reactants or products of a system in an equilibrium is changed.
- the equilibrium constant increases when temperature is increased of a reaction whose forward reaction is endothermic.
- the equilibrium constant can be changed only by temperature.
- the equilibrium constant changes when the pressure of a gaseous system is changed at constant temperature.



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Royal College - Colombo Royal College- Colombo 07 Royal College

First Term Test November 2016  
Grade 13

රුකායන විද්‍යාව II  
Chemistry II

02 E II

පැය තුනක්  
Three hours

name : ..... Index No. ..... Grade : .....

- \* Use of calculators is not allowed.
- \* Universal gas constant       $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$
- \* Avogadro constant       $N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$
- \* Planck constant       $h = 6.626 \times 10^{-34} \text{ Js}$
- \* Velocity of light       $C = 3.0 \times 10^8 \text{ ms}^{-1}$

Part A – Structured Essay (pages 2 – 8)

- \* Answer all the questions on the question paper itself.
- \* Write your answer in the space provided for each question. Please note that the space provided is sufficient for the answer and that extensive answers are not expected.

Part B Essay (pages 10 – 15)

- \* At the end of the time allotted for this paper, tie the answers to the three Parts A, B, C together so that Part A is on top and hand them over to the Supervisor.
- \* You are permitted to remove only Parts B and C of the question paper from the Examination Hall.

For Examiner's Use Only

Instruction for question No. 41 to 50

Response	first statement	second statement
(1)	True	true and correctly explain the 1 <sup>st</sup> statement
(2)	True	true, but does not explain the 1 <sup>st</sup> statement correctly
(3)	True	False
(4)	False	True
(5)	False	False

	first statement	second statement
41)	The $[\text{Cu}(\text{NH}_3)_2]^+$ ion undergoes oxidation in air.	The geometry of $[\text{Cu}(\text{NH}_3)_4]^{2+}$ complex ion is square planar.
42)	AgCl gets precipitated when an aqueous solution of $[\text{Ag}(\text{NH}_2)_2]\text{Cl}$ is diluted with distilled water.	The position of the equilibrium, of $[\text{Ag}(\text{NH}_3)_2]^+ \rightleftharpoons \text{Ag}^+(\text{aq}) + 2\text{NH}_3(\text{aq})$ is shifted towards products side when the volume is increased.
43)	NH <sub>3</sub> gas can be liquefied at room temperature by compression.	The critical temperature of NH <sub>3</sub> gas is greater than that of room temperature.
44)	When a solution of NH <sub>4</sub> SCN is added after Fe <sup>2+</sup> ions are exposed to air for a while; it turns red.	$[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ ion remains stable in air.
45)	The hydration enthalpy of Li <sup>+</sup> (g) ions is less than that of the Na <sup>+</sup> (g) ion.	Na <sup>+</sup> has the configuration similar to Ar.
46)	Esters are formed by phenol with carboxylic acids in presence of acid catalysts.	Phenol shows acidic properties and liberates CO <sub>2</sub> when treated with Na <sub>2</sub> CO <sub>3</sub> .
47)	The - NHCOC <sub>2</sub> H <sub>5</sub> acts as a meta directing group when bonded to benzene.	-CONHCH <sub>2</sub> decreases the electron density of the aromatic ring.
48)	Dipole-dipole interaction are present between the molecules of CH <sub>2</sub> = CHCl.	CH <sub>2</sub> = CHCl is a polar molecule.
49)	The compressibility factor(Z) is a measure of the ideal behavior of a gas.	Only pressure, volume and the amount of the substance affect for the behaviour of a gas.
50)	Br acts as an electrophile during the bromination of alkenes.	An induced dipole of the Br <sub>2</sub> molecule is created by the $\pi$ electron cloud of Alkene.

**Part A – Structured Essay**

**Answer all the questions on this paper itself.**

1) a) Arrange the following species in ascending order of the property mentioned within brackets.

i)  $\text{F}_{2(g)}$ ;  $\text{Br}_{2(g)}$ ,  $\text{I}_{2(g)}$ ;  $\text{Cl}_{2(g)}$  (Colour intensity)

.....  
ii) He, Ne, Xe, Ar (Boiling point)

.....  
iii)  $\text{XeF}_2$ ,  $\text{XeF}_6$ ,  $\text{XeF}_4$  (Oxidation number of Xe)

.....  
iv)  $\text{N} \equiv \text{N}$ ,  $\text{O} = \text{O}$ ,  $\text{C} - \text{C}$ ,  $\text{C} \equiv \text{C}$  (Bond strength)

.....  
v) Zn, Cr, V, Sc (Melting point)

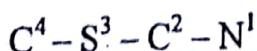
b) Atomic skeletal of methylthiocyanate ( $\text{CH}_3\text{SCN}$ ) is given below.



i) Draw the most acceptable Lewis structure of this molecule.

ii) Draw three possible resonance structures for methylthiocyanate.

iii) Considering the structure drawn in (b) (i) above, fill the table given below.



		$\text{C}^4$	$\text{S}^3$	$\text{C}^2$
i)	No. of VSEPR pairs			
ii)	Electron pair geometry			
iii)	Shape			
iv)	Hybridization			

- iv) Identify the atomic/ hybrid orbitals involved in the formation of the following  $\sigma$  bonds in the Lewis structure drawn in part (b)(i) above.



- c) Write whether true or false in front of each statement given below.

i) Oxygen does not possess positive oxidation states.

.....

ii) H – O – H bond angle of  $H_2O$  is greater than H – S – H bond angle of  $H_2S$ .

.....

iii) First ionization energy of an element depends only on its atomic radius and nuclear charge.

.....

iv) Melting point of monoclinic sulfur is higher than that of rhombic sulfur.

.....

v) The complex  $[Ni(H_2O)_6]^{2+}$  gives a blue coloured complex with conc. ammonia.

.....

- 2) a) X and Y are two elements in the p block, belong to the same group. White coloured oxide derived from the highest oxidation state of X, forms a mono basic strong acid by dissolving in water. This acid evolves a reddish brown coloured gas, dissociating slowly when exposed to sun light.

Y forms an oxide of the form  $Y_2O_3$ . An aqueous solution prepared by dissolving  $Y_2O_3$  in dil. HCl gives an orange coloured precipitate when  $H_2S$  gas is passed through it. Chloride of Y gives a white coloured turbidity with water.

- i) Identify the elements X and Y.

X ..... Y .....

- ii) Write the main oxidation numbers of Y.

.....

- iii) Write the balanced chemical equation for the hydrolysis reaction of the chloride of Y mentioned in the above.

.....

- iv) Hydrolysis of the chloride of X gives an acid and a base. Write balanced chemical equation for the relevant reaction.

.....

- v) Write two reactions as balanced chemical equations to prepare two neutral oxides of X in the laboratory.

.....  
.....

- vi) Write balanced chemical equation for the dissociation of the acid of X in (v) above in the presence of sun light.

.....

- b) A, B and C are some properties of three elements out of Na, Mg, Al, Si and P in the third period. Answer the following questions based on these observations.

\* Melting points of the oxide and the chloride of A are very high. The oxide and the chloride are soluble in water.

\* The oxide and the chloride, derived from the highest oxidation state of B give acidic solutions dissolving in water.

\* Oxide formed by the element C is a solid and shows acidic property. This oxide is insoluble in water.

- i) Identify the elements A, B and C.

A..... B..... C.....

- ii) Explain reasons for the higher melting point of the oxide of C.

.....  
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.....  
.....

- iii) Write the elements A, B, C in ascending order of the electronegativity.

.....

- iv) State the acidic/basic nature of the hydroxides derived from the highest oxidation numbers of A and B.

.....

- v) Comment on storage (how to store) of the elements A, B and C in the laboratory.

.....  
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c) Following experiments were done for a solution of ions formed by 3d transition element.

- \* Conc.  $\text{HNO}_3$  followed by a mixture of  $\text{NH}_4\text{Cl}$  and  $\text{NH}_4\text{OH}$  were added:-  
A brown coloured precipitate was obtained.
- \* Shaken with  $\text{NH}_4\text{SCN}$  solution:- The solution turned red.
- \* Reacted with acidified  $\text{KMnO}_4$  :- Brown coloured solution was obtained.

i) Identify the ion of  $\text{X}^{n+}$ .

.....

ii) What is the complex responsible for the red coloured solution obtained by the reaction with  $\text{NH}_4\text{SCN}$ .

.....

iii) Write the balanced ionic equation for the reaction with  $\text{KMnO}_4$  in the acidic medium.

.....  
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03) a) Two volatile liquids A and B form an ideal solution and the vapour phase of A and B also behave ideally.

i) Explain the matters mentioned above based on intermolecular forces.

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ii) Benzene (B) and Toluene (T) are two miscible liquids in any proportion and form ideal solutions  $P_B^0 = 3 \times 10^3 \text{ Nm}^{-2}$  and  $P_T^0 = 2 \times 10^3 \text{ Nm}^{-2}$  at  $30^\circ\text{C}$ .

Molar ratio between Benzene (B) and Toluene (T) in the liquid phase is 3 : 1 when it is in the dynamic equilibrium with its vapour phase.

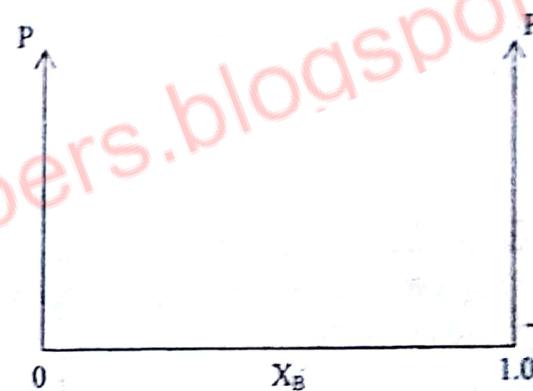
I) Calculate the partial pressures of Benzene and Toluene ( $P_B$  and  $P_T$ ) in the vapour phase.

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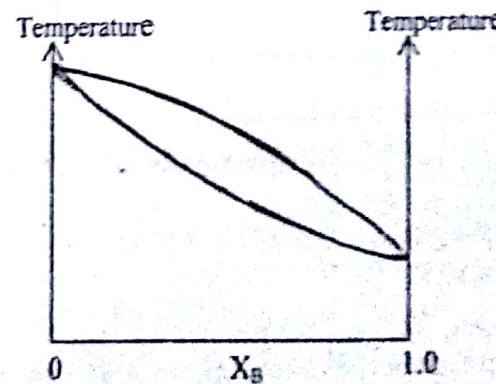
II) Write the law you used in above.

iii) Calculate the mole fraction of Benzene ( $X_B$ ) in the vapour phase.

v) Show the variation of  $P_B$ ,  $P_T$  and total pressure ( $P_{BT}$ ) with the composition in the following graph. Label the pressures  $P_B$ ,  $P_T$ ,  $P_{BT}$  relevant to the composition  $X_B = 0.75$  as P, Q and R respectively in the same graph.



vi) Temperature - composition phase diagram for the mixture of B and T is given below.



A) Label the phase diagram.

B) Label the boiling points of B and T as  $T_B^0$  and  $T_T^0$  respectively.

C) Label the boiling point of the solution ( $T_1$ ) where mole fraction of B in the liquid phase is 0.75 and the relevant composition in the vapour phase is  $Y$ .

- 4) a) i) Molecular formula of an organic compound is  $C_3H_6O$ . Write suitable structural formula for each of following observation.

.....  
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- ii) Write the geometrical isomer which gives  $H_2$  gas, reacting with Na.

.....  
.....

- iii) Write structure / structures for the product form when it reacts with Na that does not show geometrical isomerism.

.....  
.....

- iv) What is the structure which does not react with Na but reacts with  $Br_2(aq)$  decolorizing it.

.....  
.....

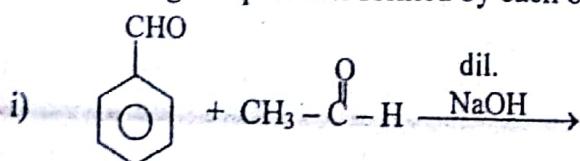
- v) Write the structure which answer the Brady's reagent but does not answer the silver mirror.

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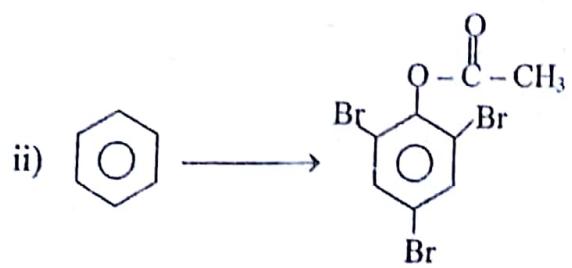
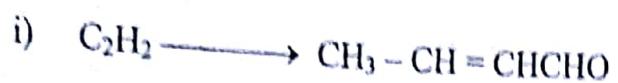
- vi) Write the structure that answer for the Braydy's reagent but does not answer the pheling's reagent.

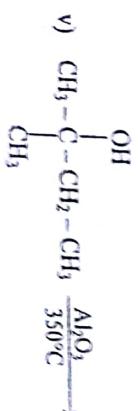
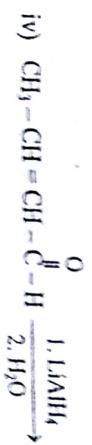
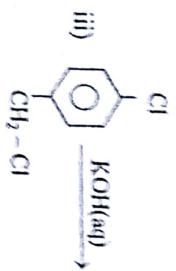
.....  
.....  
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- b) Write the organic products formed by each of the following reactions.



d) Do the following conversions.





Write the mechanism for the reaction given above.

ii) Give an experiment to confirm the presence of  $\text{Cl}^-$  in 



Part B – Essay

- 05) a) Consider the gases A, B, C and D are in the following equilibrium.



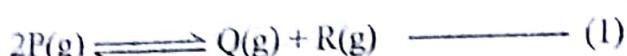
Above dynamic equilibrium is in a constant volume container at constant temperature. After a time t small amount of more B was introduced to the same system, at constant temperature.

Represent the variation of

- i) rate of forward reaction
- ii) rate of backward reaction  
in a same graph.

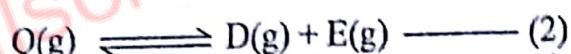
- iii) What is the effect on point of the equilibrium? Explain.

- b) The gas P attains the following equilibrium in the temperature range 100°C - 200°C.



Four moles of P were placed in a rigid vessel and allowed the equilibrium to attain at 127 °C. Degree of dissociation of P was 20%.

- i) Calculate the value of  $K_p$  for the above equilibrium at 127 °C.
- ii) When temperature was increased up to 227 °C the following equilibrium also attained other than the above equilibrium partially dissociating the gas Q too.



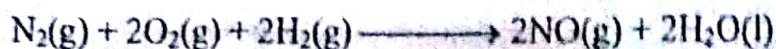
The degree of dissociation of P(g) was 80%. Total pressure and partial pressure were  $2.6 \times 10^5 \text{ Nm}^{-2}$  and  $6 \times 10^4 \text{ Nm}^{-2}$  respectively. Calculate the partial pressure and the degree of dissociation of Q.

- iii) Calculate the values of  $K_p$  for the equilibrium (1) and equilibrium (2) at 227 °C.
- iv) State whether the above equilibrium (1) is exothermic or endothermic. Explain your answer.



Standard enthalpy change for the above reaction at 25 °C is  $-985 \text{ kJ mol}^{-1}$ .

Calculate standard enthalpy change for the reaction given below



Standard enthalpy of formation of  $\text{H}_2\text{O(l)}$  at  $25^\circ\text{C}$  is  $-286 \text{ kJ mol}^{-1}$ .

- d) i) Define the standard enthalpy of neutralization.  
 ii) You are provided the following solutions and normal laboratory facilities. Prepare an experimental procedure to determine the standard enthalpy of neutralization at room temperature. (Calculations are not required.)  
 $1 \text{ mol dm}^{-3} \text{ Ba(OH)}_2 \text{ (aq)}, 1 \text{ mol dm}^{-3} \text{ H}_2\text{SO}_4 \text{ (aq)}, 1 \text{ mol dm}^{-3} \text{ BaCl}_2 \text{ (aq)}$

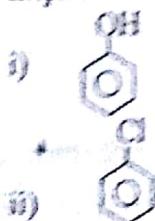
- 6) a) The partition coefficient of iodine between chloroform and water may be determined by the following procedure.

$100 \text{ cm}^3$  portions of chloroform and water were placed, together with certain amount of finely powdered iodine, in a reagent bottle. The contents were shaken for  $10 - 15$  minutes.  $10 \text{ cm}^3$  of the chloroform layer was titrated with  $0.1 \text{ mol dm}^{-3} \text{ Na}_2\text{S}_2\text{O}_3$ .  $10 \text{ cm}^3$  of aqueous layer was titrated with  $0.1 \text{ mol dm}^{-3} \text{ Na}_2\text{S}_2\text{O}_3$ . The whole experiment was repeated using two different amounts of iodine. The following result were obtained from the experiment.

Experiment No.	Titration volume/cm <sup>3</sup>	
	$\text{CHCl}_3$ layer	Aqueous layer
1	12.5	X
2	8.5	3.4
3	y	8.2

- i) Write down the balanced equation for the reaction between iodine and  $\text{Na}_2\text{S}_2\text{O}_3$ .  
 ii) Calculate the partition coefficient of iodine between  $\text{CHCl}_3$  and water.  
 iii) Calculate the values of x and y in the table.
- b) i) Derive an expression for the solubility product of  $\text{BaF}_2$  at constant temperature.  
 ii) Solubility product of  $\text{BaF}_2$  at  $300 \text{ K}$  is  $1.08 \times 10^{-10} \text{ mol}^2 \text{ dm}^{-6}$ .  $500 \text{ cm}^3$  of  $0.03 \text{ mol dm}^{-3}$   $\text{KF}$  solution is added to a  $500 \text{ cm}^3$  of saturated solution of  $\text{BaF}_2$  how much  $\text{BaF}_2$  precipitated?  
 c)  $0.02 \text{ mol dm}^{-3} \text{ Pb}(\text{NO}_3)_2$  is added to  $500 \text{ cm}^3$  of a solution which is containing  $0.14 \text{ mol dm}^{-3}$   $\text{KI}$  and  $0.02 \text{ mol dm}^{-3} \text{ K}_2\text{CO}_3$ ,  $500 \text{ ml}$ .  
 $K_{\text{sp}}(\text{PbI}_2) = 1.5 \times 10^{-8} \text{ mol}^2 \text{ dm}^{-6}$        $K_{\text{sp}}(\text{PbCO}_3) = 1.5 \times 10^{-15} \text{ mol}^2 \text{ m}^{-6}$   
 Calculate the following of equilibrium.  
 i) Amount of  $\text{PbI}_2$  precipitate formed.  
 ii) The concentration of  
 i)  $\text{I}_{(\text{aq})}$       ii)  $\text{Pb}^{2+}_{(\text{aq})}$       iii)  $\text{IO}_3^-_{(\text{aq})}$

- 7) a) A) Explain the following statements.



is more acidic than  $\text{C}_2\text{H}_5\text{OH}$

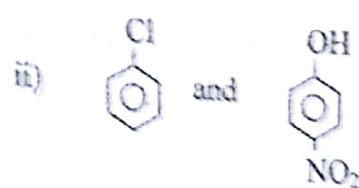
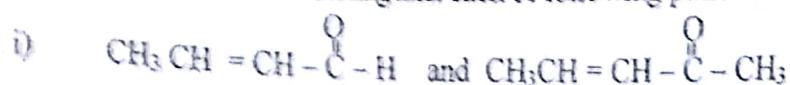


can not be converted to

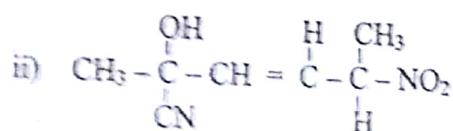
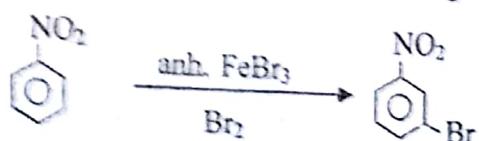


with alcoholic  $\text{KCN}$ .

B) State a chemical test to distinguish each of following pairs of organic compounds.



b) i) Write the mechanism for the following reaction.

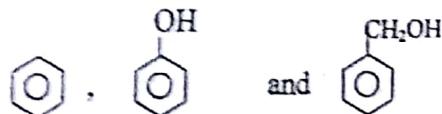


Comment on the isomerism of the above compound giving reasons.

c) A) Do the following conversions.



B) Make a flow chart to separate each component from a mixture of



(You are provided the reagents NaOH, Na and dil. HCl and other laboratory facilities)

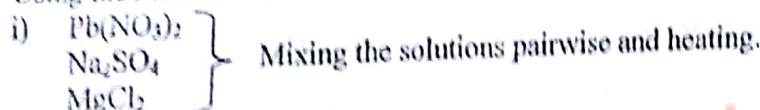
### Part C – Essay

- 8) a) P, Q and R are aqueous solutions of ionic salts having the same anion and three different cations of s-block elements. Several tests were carried out to identify these ions. Tests and relevant observations are given below.

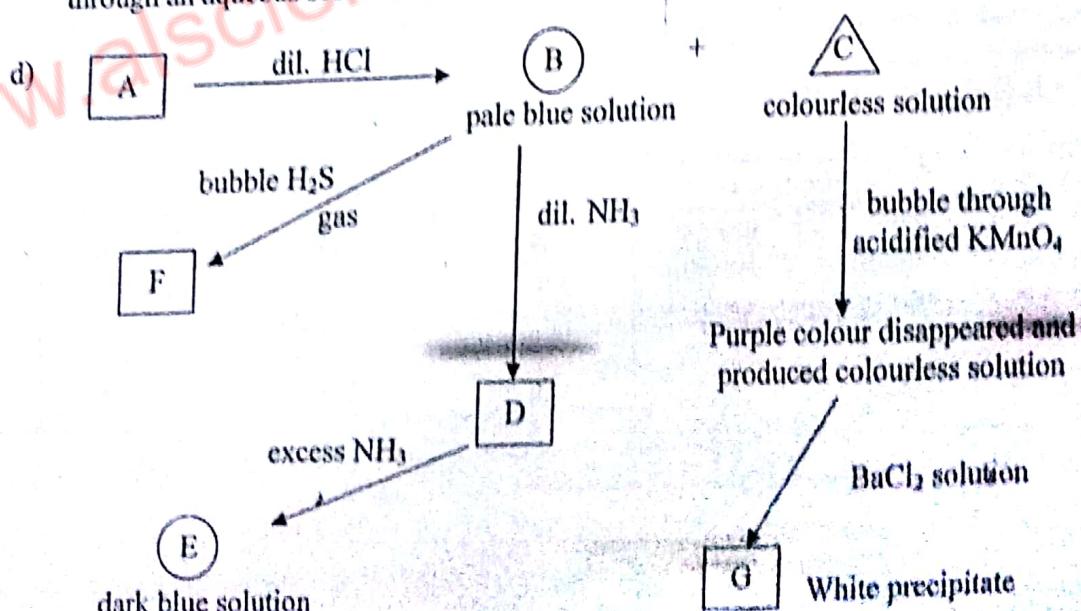
	Test	Observation
i)	Added $(\text{NH}_4)_2\text{CO}_3$ to the solution of salts.	White precipitate.
ii)	Added $\text{CH}_3\text{COOH}$ acid followed by $\text{K}_2\text{CrO}_4$ to the above precipitates.	Yellow precipitate.
iii)	Added $(\text{NH}_4)_2\text{SO}_4$ to the filtrate of test (ii) above.	White precipitate.
iv)	Added $(\text{NH}_4)_2\text{C}_2\text{O}_4$ to the filtrate of test (iii) above.	White precipitate.
v)	Added Cu turnings and cone. $\text{H}_2\text{SO}_4$ to the initial solution of salts.	Brown coloured gas.

- i) Explain the above observations.  
 ii) Identify the cations in P, Q and R salts.  
 iii) What is the anion in the above salts?

- b) Using the method mentioned only, identify the solutions in each group given below.



- c) Write balanced chemical equations for the observations you expect when  $\text{H}_2\text{S}$  gas is passed through an aqueous solutions of  $\text{Na}_3\text{AsO}_4$  and  $\text{Na}_3\text{AsO}_3$  in  $\text{HCl}$  medium separately.



- Identify A, B, C, D, E, F and G above and label them.
- 9) a) A is a colourless crystalline solid. It is soluble in water. A white precipitate (B) is obtained when  $(\text{NH}_4)_2\text{S}$  was added to an aqueous solution of A. Small amount of  $\text{NH}_4\text{OH}$  solution was added to a warmed solution prepared by dissolving the above precipitate in HCl solution. A white precipitate (C) was obtained. This precipitate was dissolved in excess  $\text{NH}_3$  and a colourless solution (D) was produced. Furthermore a reddish brown coloured gas was evolved when the compound A was heated with conc.  $\text{H}_2\text{SO}_4$ . This gas produced  $\text{H}_2\text{O}$ , G and H by reacting with conc.  $\text{NaOH}$ . G and H as well as an aqueous solution of A produced white precipitates with  $\text{Pb}(\text{NO}_3)_2$  solutions.
- Write the electronic configuration of the cation formed by the metallic element in A.
  - Identify the crystalline inorganic compound A.
  - Identify B, C, D, E, G and H.
  - Write balanced chemical equation for the reaction between E and conc.  $\text{NaOH}$ .
  - Give one use of the metallic element in the salt A.
- b) A  $12 \text{ dm}^3$  sample of air at  $27^\circ\text{C}$  under  $16.628 \times 10^5 \text{ Nm}^{-2}$  pressure containing chlorine gas was bubbled through an excess of KI solution. The solution obtained was diluted up to  $250 \text{ cm}^3$  and  $25.0 \text{ cm}^3$  portion of it was titrated with  $0.05 \text{ mol dm}^{-3}$   $\text{Na}_2\text{S}_2\text{O}_3$  solution. Volume of  $\text{Na}_2\text{S}_2\text{O}_3$  solution consumed was  $20 \text{ cm}^3$ . What is the chlorine content in the sample of air in ppm.
- c) You are provided with an aqueous solution of  $\text{CO}_3^{2-}$  and  $\text{C}_2\text{O}_4^{2-}$ . Propose a method to determine the concentrations of  $\text{CO}_3^{2-}$  and  $\text{C}_2\text{O}_4^{2-}$  separately in the laboratory. (Calculations are not required.)
- 10) a) i) Write an experiment to show the effect of temperature on rate of a reaction.
- ii) Rate of a reaction is increased by a considerable amount even for the small increase in temperature. Using an energy profile and Maxwell – Boltzmann distribution explain this.
- iii) An experiment done by a group of students to determine order of the reaction between  $\text{Fe}^{3+}$  and  $\text{I}^-$  with respect to  $\text{Fe}^{3+}$  and  $\text{I}^-$  and relevant data are given below.  
A and C solutions were taken into one beaker and B and D solutions were taken into another beaker as shown in the table. Solutions in the two beakers were mixed and the time taken for the blue colour to appear was measured.  
Use the rate law as  

$$R = K [\text{Fe}^{3+}(\text{aq})]^m [\text{I}^-(\text{aq})]^n$$

	A	B	C	D	Taken the blue colour to appear
	$0.2 \text{ moldm}^{-3}$ $\text{Fe}^{3+}$ solution / $\text{cm}^3$	$0.2 \text{ moldm}^{-3}$ $\text{I}^-$ solution / $\text{cm}^3$	water / $\text{cm}^3$	$0.2 \text{ moldm}^{-3}$ $\text{Na}_2\text{S}_2\text{O}_3$ and starch / $\text{cm}^3$	
1	15	10	20	5	12
2	10	15	20	5	18
3	15	15	15	5	8
4	10	10	25	5	27

- i) Calculate the values of m and n using the suitable data.
- ii) Calculate the rate of this reduction in  $\text{mol dm}^{-3} \text{ s}^{-1}$  in the trial no. 4
- iii) Calculate rate constant (K) of this reaction.
- iv) Is this reaction an elementary reaction? Explain your answer.
- v) If the volumes of A, B and D solutions and water were  $7.5 \text{ cm}^3$ ,  $7.5 \text{ cm}^3$ ,  $5 \text{ cm}^3$  and  $30 \text{ cm}^3$  respectively used in the trial no. 5, what would be the time taken for the blue colour to appear in the solution?
- b) The reaction  $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g}) \Delta H < 0$  occurs more rapidly in the presence of NO gas. NO acts as a catalyst for the reaction. This reaction takes place in two steps and first step is the fast step.
- Write two steps for the above reaction.
  - Draw an energy profile for this reaction in the presence of NO. Reactants, products, intermediates/ energy should be labeled clearly in the diagram.
- c)  $250 \text{ cm}^3$  of an aqueous solution was prepared by dissolving  $3.0 \text{ g}$  of a solid mixture containing  $\text{KNO}_3$ ,  $\text{KNO}_2$  and inert impurity. Volume of  $0.2 \text{ mol dm}^{-3}$  acidified  $\text{KMnO}_4$  solution, required to react completely with  $25.00 \text{ cm}^3$  of the above solution was  $20 \text{ cm}^3$ . The solution in the titration flask at the end point was treated with excess of  $\text{NaOH}$  and Al powder and heated. The gas evolved was completely absorbed into a  $25 \text{ cm}^3$  of  $1.0 \text{ mol dm}^{-3}$   $\text{NaOH}$  solution in the presence of phenolphthalein indicator. The burette reading was  $23.00 \text{ cm}^3$ . ( $K = 39$ ,  $N = 14$ ,  $O = 16$ )
- Write the balanced ionic equation for the reaction with  $\text{KMnO}_4$ .
  - Write the balanced ionic equation for the reaction occurred when heated with  $\text{NaOH}$  and A.
  - Calculate the number of moles of  $\text{NO}_2^-$  and  $\text{NO}_3^-$  separately.
  - Calculate the percentages of  $\text{KNO}_3$  and  $\text{KNO}_2$  by mass in the sample.

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