Chemistry   I | 02 E I |

Two hours

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

- This paper consists of 08 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.

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

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 Paschan 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) $S + Cl_2 \longrightarrow SCl_2$ 2) $2Al + 3Cl_2 \longrightarrow 2AlCl_3$
3) $2P + 3Cl_2 \longrightarrow 3PCl_3$ 4) $Xe + F_2 \longrightarrow XeF_2$
5) $Cl_2 + 3F_2 \longrightarrow 2ClF_3$

03) Which of the following pairs of solutions gives the same colour upon mixing with each other?

1) $FeCl_3(aq) + conc. \, HCl(aq)$ and $CuSO_4(aq) + conc. \, HCl(aq)$
2) $NiCl_2(aq) + conc. \, HCl(aq)$ and $CuSO_4(aq) + conc. \, HCl(aq)$
3) $Cr_2(SO_4)_3(aq) + NH_4OH$ and $NiSO_4(aq) + NH_4OH$
4) $FeCl_3(aq) + NH_4OH(aq)$ and $MnSO_4(aq) + conc. \, HCl(aq)$
5) $FeCl_3(aq) + NH_4SCN(aq)$ and $NiSO_4(aq) + KCN(aq)$

04) Which of the following molecules / ions have the same shape,

1) $ClF_3 ; BF_3$ 2) $PCl_3 ; BCl_3$ 3) $SOCl_2 ; NH_3$
4) $H_3O^+ ; NH_4^+$ 5) $NO_3^- ; SO_3^{2-}$

(05) Which of the following statements is correct?
1) The radius of K^+ is less than that of Na^+.
2) Addition of an electron to a Cl atom is easier than that of N.
3) According to the Pauling's scale, Sulfur is more electronegative than Nitrogen.
4) The first ionization energy of S is greater than that of P.
5) The radius of O^{2-} is greater than that of N^{3-}.

(06) The solubility product of $Fe(OH)_2$ at 25 °C is 1×10^{-15} mol^3 dm^{-9}. The concentration of Fe^{2+} ions of 0.05 $moldm^{-3}$ solution of NaOH which is saturated with $Fe(OH)_2$ in $mol\ dm^{-3}$ units is,
1) 2×10^{-15} 2) 1×10^{-15} 3) 2×10^{-14}
4) 4×10^{-14} 5) 4×10^{-13}

(07) Which of the following statements is not true?
1) Phenol shows nucleophilic substitution reactions.
2) CH_3OCH_3 is more volatile than C_2H_5OH.
3) $CH_3 - CH = CH - CHO$ is an unsaturated aldehyde.
4) $CH_2 = CH - CH_2Cl$ shows nucleophilic substitution reactions.
5) Benzene does not decolurize bromine water.

(08) Which of the following compounds forms two gases when treated with concentrated H_2SO_4 ?
1) Na_2SO_3 2) KBr   3) KCl   4) NH_4Cl 5) $Fe(NO_3)_2$

(09) 12.5 g sample of a mixture containing K_2CO_3 and $CaCO_3$ was heated to 900 °C. The volume of CO_2 produced in this reaction at standard temperature and pressure was 1.568 dm^3. The mass percentage of K_2CO_3 in the original mixture is,
1) 56   2) 44   3) 40   4) 35   5) 65

(10) Which of the following compounds has the highest solubility in water.?
1) CH_3CH_2Cl 2) $CH_3CH = CH_2$ 3) CH_3CH_2OH
4) CH_3OCH_3 5) $(CH_3)_3CCl$

(11) The products formed by reduction of $KMnO_4$ under strongly basic conditions is,
1) MnO_2 and H_2O 2) MnO_2 and O_2 3) K_2MnO_4 and H_2O
4) K_2MnO_4 and O_2 5) MnO_2 and $Mn(OH)_2$

(12) Which of the following aqueous solutions gives sulfur (S) as a product when treated with SO_2?
1) $FeCl_3$ 2) H_2S 3) $KMnO_4$ 4) Cl_2 5) $Pb(NO_3)_2$

(13) A sample of 9.60 mg of pure $MgSO_4$ was dissolved in distilled water to prepare an aqueous solution of 500.0 cm^3, in a volumetric flask. The content of Mg^{2+} ions of the solution in $mgdm^{-3}$ units is, (Mg = 24   S = 32   O = 16)
1) 3.84   2) 1.92   3) 0.96   4) 1.6×10^{-4} 5) 8×10^{-5}

(14) The equilibrium constant of the equilibrium $M^+(aq) + 4Cl^-(aq) \rightleftharpoons [MCl_4]^{3-}(aq)$ at 25 °C is 5.0×10^{20} $mol^{-4}dm^{12}$.
50.0 cm^3 of an aqueous solution of 0.4 mol dm^{-3} $M^+(aq)$ is mixed with 50.0 cm^3 of 4 mol dm^{-3} solution of Cl^- ions. What is the concentration of $[MCl_4]^{3-}(aq)$ after the reaction.
1) 0.2   2) 0.4   3) 0.04   4) 0.02   5) 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) $Cr_2(SO_4)_3$
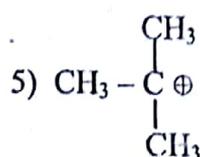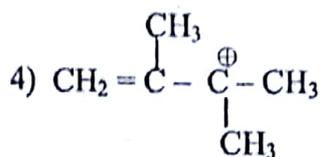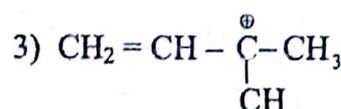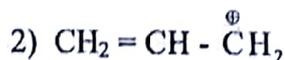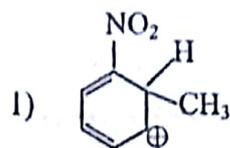
16) Which of the following pairs of cations can be distinguished between them using a dilute aqueous solution of KOH?

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 acts 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) $CH_2 = CH - \overset{\oplus}{\underset{CH}{C}} - CH_3$

4) $CH_2 = \overset{CH_3}{\underset{}{C}} - \overset{\oplus}{C} - CH_3$ (with CH_3 below)

5) $CH_3 - \overset{CH_3}{\underset{CH_3}{C}} \oplus$

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) 1.8×10^2 Pa   2) 1.8×10^3 Pa   3) $6.6 \ 10^3$ Pa

4) $1.2 \ 10^2$ Pa   5) $1.2 \ 10^3$ Pa

20) The inorganic compound A forms a gas when treated with dilute HCl. This gas turns lime water milky. This gas does not decolourise 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) $Fe\ CO_3$ 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 x 10^4 Pa to 8.314 x 10^3 Pa. The concentration of X in this solution was 4 mol dm^{-3} and the density of this solution was 0.56 g cm^{-3}. What is the molar mass of X ? (H = 1 O = 16)

1) 104 g mol^{-1} 2) 52 g mol^{-1} 3) 26 g mol^{-1}

4) 208 g mol^{-1} 5) 68 g mol^{-1}

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

	Test	Observation
i)	Addition of ammonical Cu_2Cl_2	Brown precipitate
ii)	Addition of Brady's reagent	Orange precipitate
iii)	Addition of Br_2	Decolourization of the Brown colour

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

1) $CH_3 - C \equiv C - H$

2)
CHO
$C \equiv C - H$

3)
CHO
OH

4)
$CH_2 - OH$
$C \equiv C - H$

5)
$C \equiv C - H$
OCH_3
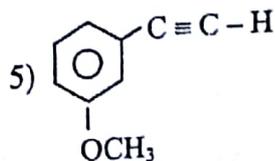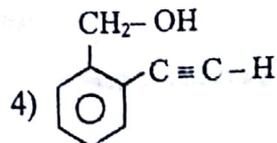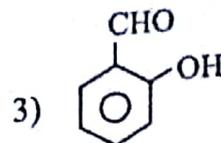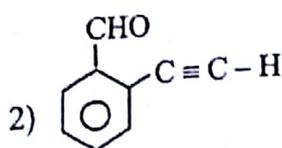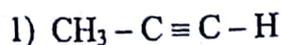
23) Which of the following compounds does not have a dipole moment.?

1)
Cl CH_3
$C = C$
CH_3 Cl

2)
Cl Cl
$C = C$
H H

3)
Br Cl
$C = C$
H H

4)
$H - O$ Cl
$C = C$
H H

5)
H H
$C = C$
Br Br
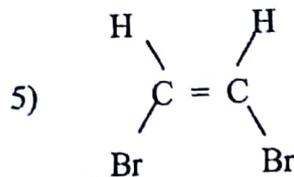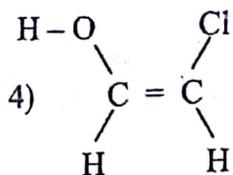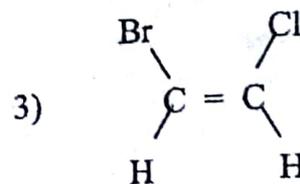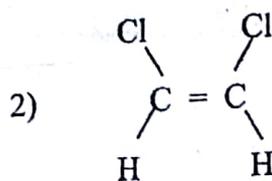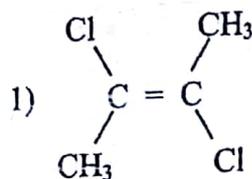
24) The IUPAC name of compound

$$CH_3 - \underset{\underset{NO_2}{|}}{\overset{\overset{OH}{|}}{C}} - CH = CH - \overset{\overset{O}{||}}{C} - O - CH_3 \text{ is,}$$

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 $[Co (CN)_2 Cl_2(NO)_2]^{2-}$ 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⁻¹. The average speed at 627°C is (in ms⁻¹ 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_3^{2-} and SO_4^{2-} ions.

2) Cl_2/ CCl_4 can not be used to distinguish between Br^- and Cl^- ions.

3) Dilute acids can be used to distinguish between CO_3^{2-} and $S_2O_3^{2-}$ ions.

4) H_2SO_4 can be used to distinguish between NO_2^- and NO_3^- ions.

5) $H^+/KMnO_4$ can be used to distinguish between S^{2-} and CO_3^{2-} ions.

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

1)
OCOCH₃ ⟶ (CH₃Cl / anhy. AlCl₃) ⟶ OCOCH₃, CH₃

2)
$\overset{O}{\overset{\|}{C}}$–OCH₃ ⟶ (CH₃Cl / anhy. AlCl₃) ⟶ C–O–CH₃, CH₃

3)
$\overset{- \ +}{O Na}$ ⟶ (CH₃Cl) ⟶ OCH₃

4) $CH_2 = CH - CH_2 - Cl \xrightarrow{KOH(aq)} CH_2 = CH - CH_2 OH$

5)
OH / CH₂OH ⟶ (KMnO₄ / H₂SO₄) ⟶ OH / COOH
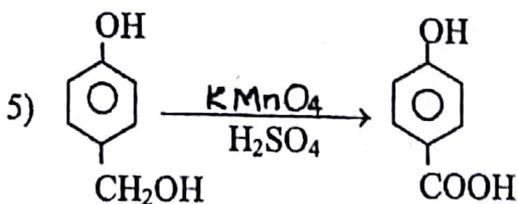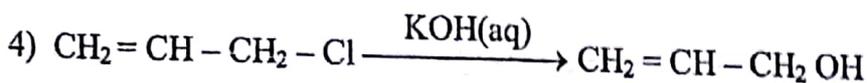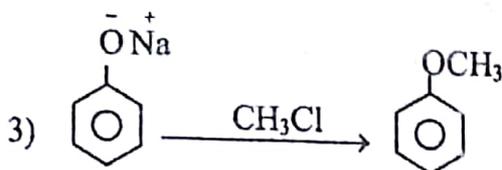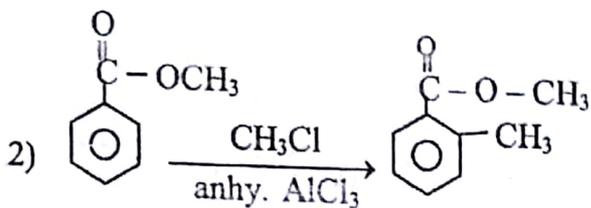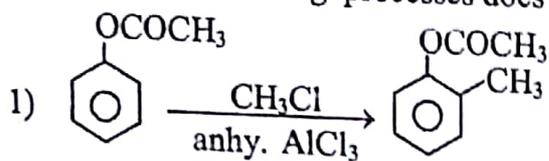
29) Consider the following enthalpy changes

$CH_3 - CH_3(g) \longrightarrow CH_3 - \overset{\bullet}{C} H_2(g) + \overset{\bullet}{H}_{(g)}$; $\Delta H^0 = +412$ kJ mol⁻¹

$CH_3 - \overset{\bullet}{C} H_2(g) \longrightarrow CH_2 = CH_2 + \overset{\bullet}{H}(g)$; $\Delta H^0 = + 168$ kJ mol⁻¹
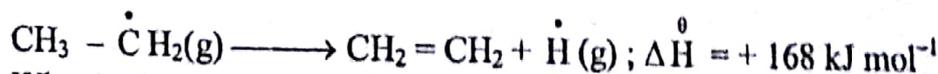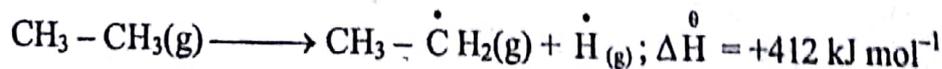
What is the enthalpy change in kJmol⁻¹ of the following reaction

$2CH_3 - \overset{\bullet}{C}H_2(g) \longrightarrow CH_3 - CH_3(g) + CH_2 = CH_2(g)$
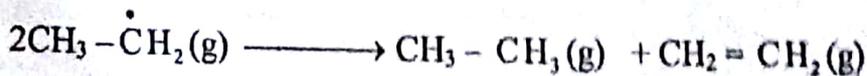
1) – 580   2) – 244   3) – 122   4) + 244   5) + 580

30) Consider the following dissociation reaction $NH_3(g)$.

$2 NH_3(g) \rightleftharpoons N_2(g) + 3 H_2(g)$

The equilibrium mixture at a particular temperature and pressure contains 20% $NH_3(g)$ by moles. What is the initial amount (in mols) of 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) C_2H_5OH reacts with Na to form H_2 gas more easily compared to C_2H_2.
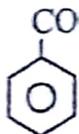
b) ⬡–COOH acid is formed when ⬡–CH_3 is oxidized by OH^- / $KMnO_4$
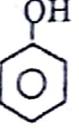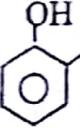
c) ⬡–OH as well as ⬡(OH)(NO_2) give a colour with neutral solution of $FeCl_3$

d) In the reaction between CH_3CHO and CH_3NH_2, a nucleophilic addition as well as an elimination occurs.

32) Which of the following compounds act(s) as a bleaching agent in water.

a) NCl_3 b) SO_2 c) PCl_5 d) $KMnO_4$

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

a) $Cl_2 + KOH \longrightarrow$ products
b) $NO_2 + H_2O \longrightarrow$ products
c) $SO_2 + H_2S \longrightarrow$ products
d) $H_2O_2 \xrightarrow{hv}$ products

34) Which of the following species form two gaseous products upon heating (ignore the vaporization of H_2O)

a) $Ca(NO_3)_2$ b) NH_4NO_2 c) $KHCO_3$ d) Ag_2CO_3

35) Which of the following is/are true regarding atomic lattices?
a) Graphite is a giant three dimentional 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 lattiés do not tend to get dissolved as the covalent bonds exist in them are very strong.

36) 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 ?
a) Stable for a longer period.
b) High purity.
c) High volatility
d) Absorption of water vapour or CO_2 in atmosphere.

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

a) $CH_3 - CH - CH_2 \quad {}^{\ominus}OH \longrightarrow CH_3 - CH - CH_2$
   with $\overset{+}{Br}$; products Br and OH

b) $H - \underset{OH}{\overset{H\ H}{C - C}} - Br \longrightarrow CH_2 = CH_2$

c) $CH_3 - \underset{CH_3}{\overset{CH_3}{C}} \quad Cl \quad {}^{\ominus}CN \longrightarrow CH_3 - \underset{CH_3}{\overset{CH_3}{C}} - CN \ + \ Cl^+$

d) $CH_3 - \overset{\bullet}{CH_2} \quad Cl - Cl \longrightarrow CH_3 - CH_2 Cl \ + \ \overset{\bullet}{Cl}$

39)

Benzene ring with $CH = CH - CH_2 - OH$ and $COCH_3$ substituents
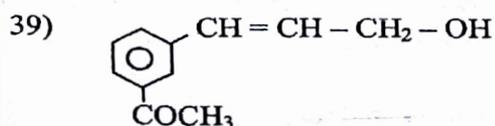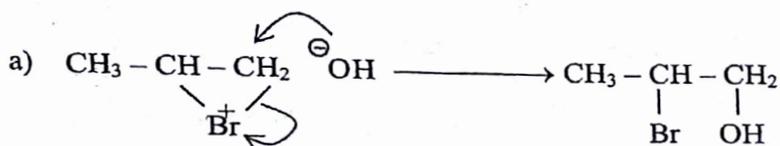
Which of the following is/are most accurate regarding the above molecule?
a) It reacts with dilute KOH
b) It shows diastereomerism.
c) It gives a silver mirror with ammonical silver nitrate .
d) It forms a dicarboxylic acid on oxidation under strong conditions.

40) Which of the following is/are true regarding the equilibrium constant?
a) the equilibrium constant changes when the concentrations of reactants or products of a system in an equilibrium is changed.
b) the equilibrium constant increases when temperature is increased of a reaction whose forward reaction is endothermic.
c) the equilibrium constant can be changed only by temperature.
d) the equilibrium constant changes when the pressure of a gaseous system is changed at constant temperature.

First Term Test November 2016

Grade 13

| රසායන විද්‍යාව II
Chemistry II | 02 E II | පැය තුනයි
Three hours |

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

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

Part A – Structured Essay (pages 2 – 9)

* 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 1st statement
(2)	True	true, but does not explain the 1st statement correctly
(3)	True	False
(4)	False	True
(5)	False	False

	first statement	second statement
41)	The $[Cu(NH_3)_2]^+$ ion undergoes oxidation in air.	The geometry of $[Cu(NH_3)_4]^{2+}$ complex ion is square planar.
42)	AgCl gets precipitated when an aqueous solution of $[Ag(NH_2)_2]Cl$ is diluted with distilled water.	The position of the equilibrium, of $[Ag(NH_3)_2]^+ \rightleftharpoons Ag^+(aq) + 2NH_3(aq)$ is shifted towards products side when the volume is increased.
43)	NH_3 gas can be liquefied at room temperature by compression.	The critical temperature of NH_3 gas is greater than that of room temperature.
44)	When a solution of NH_4SCN is added after Fe^{2+} ions are exposed to air for a while; it turns red.	$[Fe(H_2O)_6]^{3+}$ ion remains stable in air.
45)	The hydration enthalpy of $Li^+(g)$ ions is less than that of the $Na^+(g)$ ion.	Na^+ 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_2 when treated with Na_2CO_3.
47)	The - $NHCOCH_3$ acts as a meta directing group when bonded to benzene.	$-CONHCH_3$ decreases the electron density of the aromatic ring.
48)	Dipole dipole interaction are present between the molecules of $CH_2 = CHCl$.	$CH_2 = CHCl$ 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_2 molecule is created by the π electron cloud of Alkene.

Answer all the questions on this paper itself.

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

   i) $F_{2(g)}$; $Br_{2(g)}$, $I_{2(g)}$; $Cl_{2(g)}$ (Colour intensity)

   ....

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

   ....

   iii) XeF_2, XeF_6, XeF_4 (Oxidation number of Xe)

   ....

   iv) $N \equiv N$, $O = O$, $C - C$, $C \equiv C$ (Bond strength)

   ....

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

   ....

   b) Atomic skeletal of methylthiocyanate (CH_3SCN) is given bellow.

   $$C - S - C - N$$

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

   ii) Draw three possible resonance structures for mthylthiocyanate.

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

   $$C^4 - S^3 - C^2 - N^1$$

		C^4	S^3	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 σ bonds in the Lewis structure drawn in part (b)(i) above.

i) $C^2 - N^1$ C^2 .... N^1 ....

ii) $S^3 - C^2$ S^3 .... C^2 ....

iii) $C^4 - S^3$ C^4 .... S^3 ....

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

i) Oxygen does not posses 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 radious 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 expose 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.

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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. HNO_3 followed by a mixture of NH_4Cl and NH_4OH were added:-
        A brown coloured precipitate was obtained.
    *   Shaken with NH_4 SCN solution:- The solution turned red.
    *   Reacted with acidified $KMnO_4$:- Brown coloured solution was obtained.

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

....

  ii)   What is the complex responsible for the red coloured solution obtained by the reaction with NH_4SCN.

....

  iii)   Write the balanced ionic equation for the reaction with $KMnO_4$ 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 $P_B^0 = 3 \times 10^3$ Nm^{-2} and $P_T^0 = 2 \times 10^3$ Nm^{-2} at 30°C.
        Molar ratio between Benzene (B) and Toluene (T) in the liquid phase is 3 : 1 when it is in the dynamic equilibrium with it's vapour phase.

    I)   Calculate the partial pressures of Benzene and Toluene (P_B and P_T) in the vapour phase.
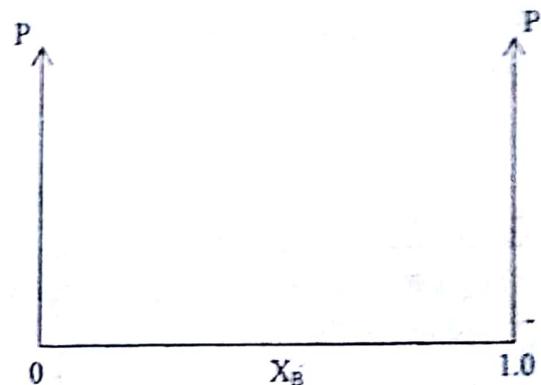
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II) Write the law you used in above.

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

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iv) Write the low you used in the calculation in (iii).

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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 bellow.
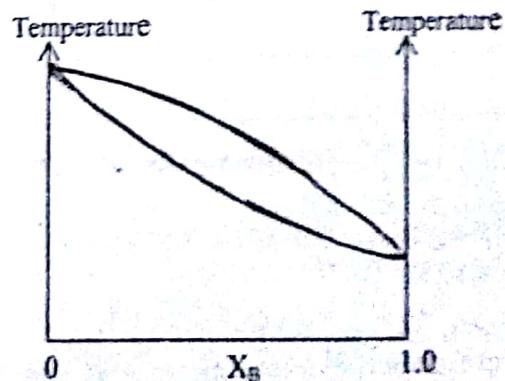
A) Label the phase diagram.

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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_1

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.

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

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

....

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

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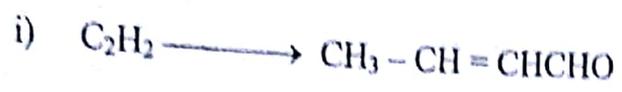
vi) Write the structure that answer for the Braydy's reagent but does not answer the pheling's reagent.

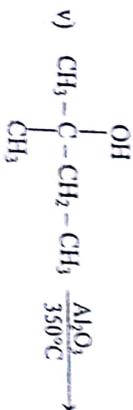..

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

i)
$$\underset{}{C_6H_5-CHO} + CH_3-\overset{O}{\underset{}{C}}-H \xrightarrow{\text{dil. NaOH}}$$

d) Do the following conversions.

i) C_2H_2 ───────→ $CH_3 - CH = CHCHO$

ii) ───────→

ii) $CH_3MgBr + (CH_3)_3 CBr \longrightarrow$

iii)

$$\xrightarrow{KOH(aq)}$$

with substituent Cl and CH_2-Cl on the ring

iv) $CH_3 - CH = CH - \overset{\overset{\displaystyle O}{\|}}{C} - H \xrightarrow[\ 2.\ H_2O\ ]{1.\ LiAlH_4}$

v) $CH_3 - \overset{\overset{\displaystyle OH}{|}}{\underset{\underset{\displaystyle CH_3}{|}}{C}} - CH_2 - CH_3 \xrightarrow[350°C]{Al_2O_3}$

d) i) $CH_3 - \overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle Br}{|}}{C}} - CH_3 \xrightarrow{CH_3-CH_2-O^-Na^+} CH_3 - \overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle CH_3}{|}}{C}} - O - C_2H_5$
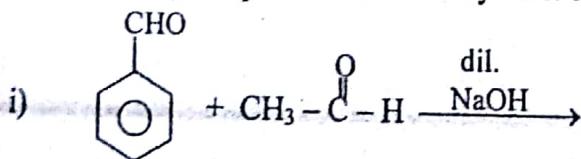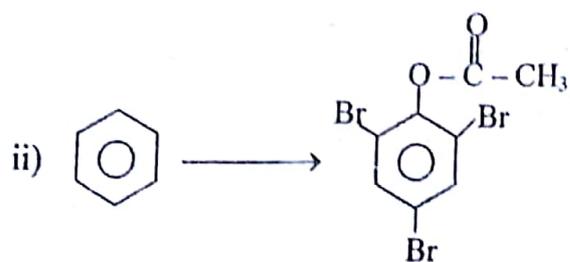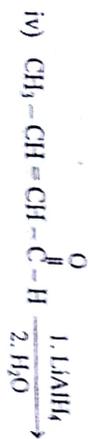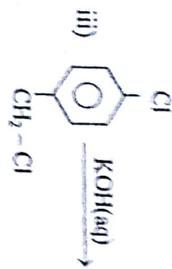
Write the mechanism for the reaction given above.

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ii) Give an experiment to confirm the presence of Cl^- in

$\overset{+}{N}H_3Cl^-$

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First Term Test November 2016
Grade 13

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Chemistry II

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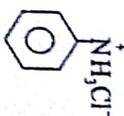
Part B – Essay

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

$$2A\,(g) + B(g) \rightleftharpoons 3C(g) + D\,(s)$$

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.

$$2P(g) \rightleftharpoons Q(g) + R(g) \quad\text{———— (1)}$$
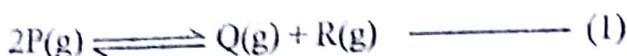
Four moles of P were placed in a rigid vessel and allowed the equilibrium to attain at 127 °C. Degree of dissociation of P was 20%.

i) Calculate the value of Kp 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.

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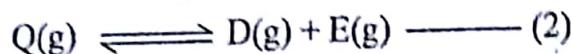
The degree of dissociation of P(g) was 80%. Total pressure and partial pressure were 2.6×10^5 Nm^{-2} and 6×10^4 Nm^{-2} respectively. Calculate the partial pressure and the degree of dissociation of Q.

iii) Calculate the values of Kp for the equilibrium (1) and equilibrium (2) at 227 °C.

iv) State whether the above equilibrium (1) is exothermic or endothermic. Explain your answer. .

c) $$4\,NH_{3(g)} + 5O_{2(g)} \longrightarrow 4NO_{(g)} + 6H_2O(l)$$

Standard enthalpy change for the above reaction at 25 °C is – 985 kJ mol^{-1}.
Calculate standard enthalpy change for the reaction given bellow

$$N_2(g) + 2O_2(g) + 2H_2(g) \longrightarrow 2NO(g) + 2H_2O(l)$$

Standard enthalpy of formation of $H_2O(l)$ at 25 °C is -286 kJ mol^{-1}.

d) i) Define the standard enthalpy of neutralization.

   ii) You are provided the following solutions and normal laboratory facilities. Propose an experimental procedure to determine the standard enthalpy of neutralization at room temperature. (Calculations are not required.)

     1 $moldm^{-3}$ $Ba(OH)_2$ (aq), 1 $moldm^{-3}$ H_2SO_4 (aq), 1 $moldm^{-3}$ $BaCl_2$ (aq)

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

100cm^3 portions of chloroform and water were placed, together with certain amount of finally powdered iodine, in a reagent bottle. The contents were shaken for 10 – 15 minutes. 10cm^3 of the chloroform layer was titrated with 0.1 mol dm^{-3} $Na_2S_2O_3$, 10cm^3 of aqueous layer was titrated with 0.1 mol dm^{-3} $Na_2S_2O_3$. The whole experiment was repeated using two different amounts of iodine. The following result were obtained from the experiment.

Eperiment No.	Titration volume/cm^3	
	CHCl₃ 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 $Na_2S_2O_3$

   ii) Calculate the partition coefficient of iodine between $CHCl_3$ and water.

   iii) Calculate the values of x and y in the table.

b) i) Derive an expression for the solubility product of BaF_2 at constant temperature.

   i) Solubility product of BaF_2 at 300 k is 1.08×10^{-7} mol^3 dm^{-9}. 500 cm^3 of 0.03 mol dm^{-3} KF solution is added to a 500 cm^3 of saturated solution of BaF_2 how much BaF_2 precipitated?

c) 0.02 mol dm^{-3} $Pb(NO_3)_2$ is added to 500 cm^3 of a solution which is containing 0.14 $moldm^{-3}$ KI and 0.02 $moldm^{-3}$ K_2CO_3 500 ml.

     $Ksp_{(PbI_2)} = 1.5 \times 10^{-8}$ mol^3 dm^{-9} $Ksp_{(PbCO_3)} = 1.5 \times 10^{-14}$ mol^2 m^{-6}

Calculate the following of equilibrium.

   i) Amount of PbI_2 precipitate formed.

   ii) The concentration of

     i) $I^-_{(aq)}$ ii) $Pb^{2+}_{(aq)}$ iii) $IO_3^-{}_{(aq)}$

7) a) A) Explain the following statements.
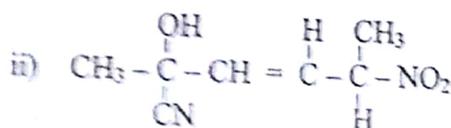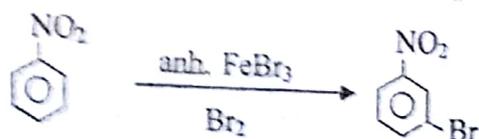
   i)   is more acidic than C_2H_5OH

   ii)   can not be converted to   with alcoholic KOH.

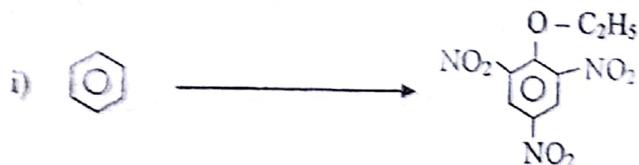B) State a chemical test to distinguish each of following pairs or organic compounds.

i) $CH_3\ CH = CH - \overset{\overset{O}{\|}}{C} - H$ and $CH_3CH = CH - \overset{\overset{O}{\|}}{C} - CH_3$

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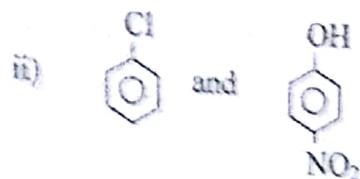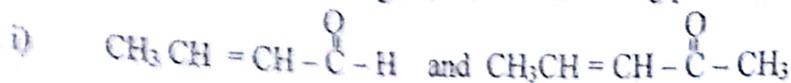
b) i) Write the mechanism for the following reaction.

$\xrightarrow[\text{Br}_2]{\text{anh. FeBr}_3}$

ii) $CH_3 - \overset{\overset{OH}{|}}{\underset{\underset{CN}{|}}{C}} - CH = \overset{\overset{H}{|}}{\underset{\underset{H}{|}}{C}} - \overset{\overset{CH_3}{|}}{C} - NO_2$

Comment on the isomerism of the above compound giving reasons.

c) A) Do the following conversions.

i) $\longrightarrow$

ii) C_2H_5OH $\longrightarrow$ $C_2H_5 - \overset{\overset{C_2H_5}{|}}{\underset{\underset{C_2H_5}{|}}{C}} - C_2H_5$

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

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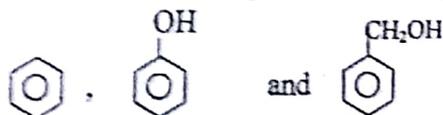
(You are provided the reagents NaOH, Na and dil. HCl and other laboratory facilities)

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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 $(NH_4)_2CO_3$ to the solution of salts.	White precipitate.
ii)	Added CH_3COOH acid followed by K_2CrO_4 to the above precipitates.	Yellow precipitate.
iii)	Added $(NH_4)_2SO_4$ to the filtrate of test (ii) above.	White precipitate.
iv)	Added $(NH_4)_2C_2O_4$ to the filtrate of test (iii) above.	White precipitate.
v)	Added Cu turnings and conc. H_2SO_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 bellow.
   i) $Pb(NO_3)_2$
        Na_2SO_4 ⎱ Mixing the solutions pairwise and heating.
        $MgCl_2$

   ii) $Ba(OH)_2$
        $Zn(NO_3)_2$ ⎱ Mixing the solutions pairwise.
        $CuCl_2$
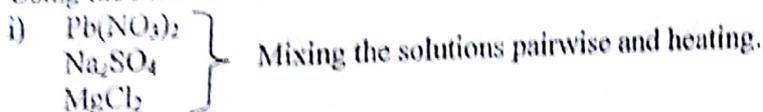
c) Write balanced chemical equations for the observations you expect when H_2S gas is passed through an aqueous solutions of Na_3AsO_4 and Na_3AsO_3 in HCl medium separately.

d)
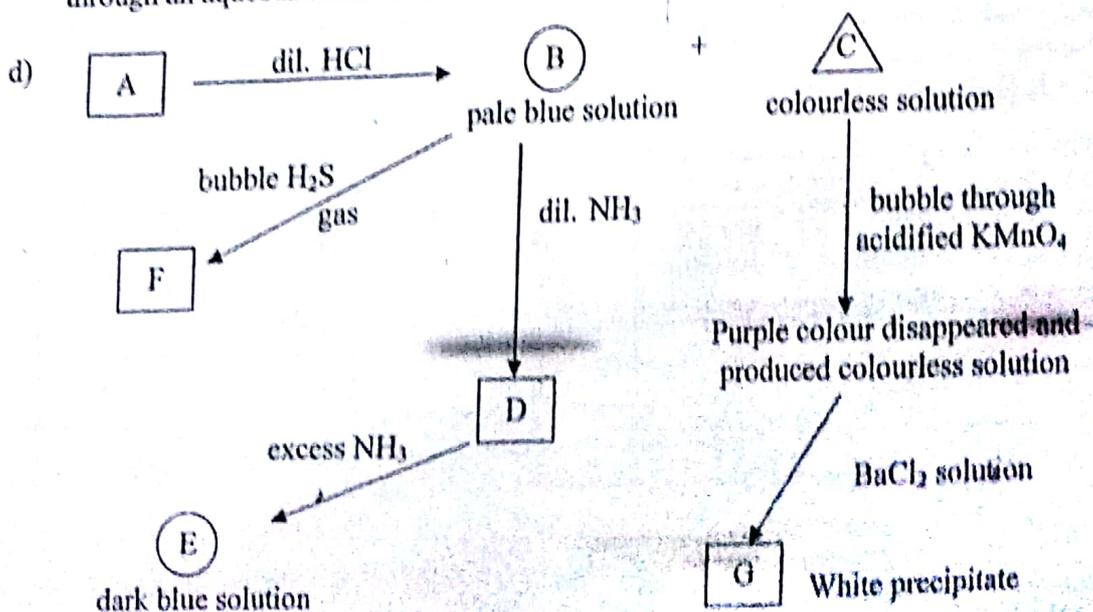
Identify A, B, C, D, E, F and G above and label them.

9) a) A is a colourless crystalline solid. It is soluble in water. A white precipitate (B) is obtained when $(NH_4)_2S$ was added to an aqueous solution of A. Small amount of NH_4OH 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 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. H_2SO_4. This gas produced H_2O, G and H by reacting with conc. NaOH. G and H as well as an aqueous solution of A produced white precipitates with $Pb(NO_3)_2$ solutions.

i)   Write the electronic configuration of the cation formed by the metallic element in A.
ii) Identify the crystalline inorganic compound A.
iii) Identify B, C, D, E, G and H.
iv) Write balanced chemical equation for the reaction between E and conc. NaOH.
v)   Give one use of the metallic element in the salt A.

b) A 12 dm^3 sample of air at 27°C under 16.628×10^5 Nm^{-2} pressure containing chlorine gas was bubbled through an excess of KI solution. The solution obtained was diluted up to 250 cm^3 and 25.0 cm^3 portion of it was titrated with 0.05 mol dm^{-3} $Na_2S_2O_3$ solution. Volume of $Na_2S_2O_3$ solution consumed was 20 cm^3. What is the chlorine content in the sample of air in ppm.

c) You are provided with an aqueous solution of CO_3^{2-} and $C_2O_4^{2-}$. Propose a method to determine the concentrations of CO_3^{2-} and $C_2O_4^{2-}$ 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 Fe^{3+} and I^- with respect to Fe^{3+} and 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 the blue colour to appear was measured.
Use the rate law as
$R = K [Fe^{3+}(aq)]^m [I^-(aq)]^n$

	A 0.2 $moldm^{-3}$ Fe^{3+} solution / cm^3	B 0.2 $moldm^{-3}$ I^- solution / cm^3	C water cm^3	D 0.2 $moldm^{-3}$ $Na_2S_2O_3$ and starch / cm^3	Taken the blue colour to appear
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 mol $dm^{-3} s^{-1}$ 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 cm^3, 7.5 cm^3, 5 cm^3 and 30 cm^3 respectively used in the trail no. 5, what would be the time taken the blue colour to appear in the solution?

b) The reaction $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ $\Delta H < 0$
occurs more rapidly in the presence of NO gas. NO acts as a catalyst for the reaction. This reaction take place in two steps and first step is the fast step.

i)   Write two steps for the above reaction.
ii)   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 cm^3 of an aqueous solution was prepared by dissolving 3.0 g of a solid mixture containing KNO_3, KNO_2 and inert impurity. Volume of 0.2 mol dm^{-3} acidified $KMnO_4$ solution, required to react completely with 25.00 cm^3 of the above solution was 20 cm^3. The solution in the titration flask at the end point was treated with excess of NaOH and Al powder and heated. The gas evolved was completely absorbed into a 25 cm^3 of 1.0 $moldm^{-3}$ NaOH solution in the presence of phenolphthalein indicator. The burette reading was 23.00 cm^3.   (K = 39, N = 14, O = 16)

i)   Write the balanced ionic equation for the reaction with $KMnO_4$.
ii)   Write the balanced ionic equation for the reaction occurred when heated with NaOH and A.
iii) Calculate the number of moles of NO_2^- and NO_3^- separately.
iv)   Calculate the percentages of KNO_3 and KNO_2 by mass in the sample.