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Manasa Sanvitha Dheera

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LEVI BALIKA VIDYALAYA – COLOMBO

13 වන ශ්‍රේණිය සඳහා වාර පරීක්ෂණය - 2017 නොවැම්බර්
Grade 13 First Term Test November 2017

රසායන විද්‍යාව I
Chemistry I

පැය දෙකයි
Two hours

Important

- This paper consist of 9 pages
- Answer all the questions
- The use of calculators is not allowed
- Write your index number in the space provided in the answer sheet
- In each of the questions 1 to 50, pick one of the alternatives (1) (2) (3) (4) (5) which is correct as most appropriate and shade its number on the answer sheet provided

Universal gas constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
Avergadro's constant	N_A	=	$6.022 \times 10^{23}\ mol^{-1}$
Speed of light	C	=	$3.0 \times 10^{8}\ ms^{-1}$
Planck's constant	h	=	$6.626 \times 10^{-34}\ Js$

1) Number of different values possible for magnetic quantum number (m_l), if azimuthal quantum numbe is l for a given quantum number,

1) $2l$ 2) $2l - 1$ 3) $2(l + 1)$ 4) $2l + 1$ 5) $2(l - 1)$

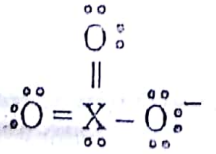
2) Which of the following species shows the highest electronegativity for N,

1) NO_2Cl 2) NH_2OH 3) NO_4^{3-} 4) NO_2^- 5) NH_3

3) Increasing order of C – O bond length of species CH_3CH_2OH, CH_3COO^-, HCHO and CO_3^{2-} is,

1) $CH_3CH_2OH < CH_3COO^- < HCHO < CO_3^{2-}$
2) $HCHO < CH_3COO^- < CO_3^{2-} < CH_3CH_2OH$
3) $CO_3^{2-} < CH_3COO^- < CH_3CH_2OH < HCHO$
4) $CH_3CH_2OH < CH_3COO^- < CO_3^{2-} < HCHO$
5) $CH_3CH_2OH < CO_3^{2-} < CH_3COO^- < HCHO$

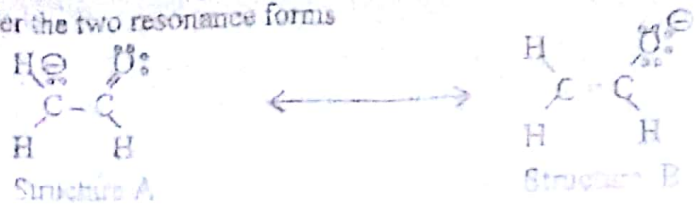
4) Resonance structure of XO_3^- is given below.



To which group of the periodic table does element X belong to?

1) 14 2) 15 3) 16 4) 17 5) 18

5) Consider the two resonance forms



Structure A ⟷ Structure B

Which of the following is correct regarding structures A and B?

1) Structure A is more stable.
2) Structure B is more stable.
3) All atoms of structure A and B lie on one plane.
4) Both C atoms in structure B are sp^3 hybridized.
5) Respective bond angles in structure A and B are equal.

6) Increasing order of oxidation no of C in HCHO, HCOOH, CCl_4 and CH_3NH_2 are

1) $HCHO < CH_3NH_2 < CCl_4 < HCOOH$
2) $CH_3NH_2 < HCHO < HCOOH < CCl_4$
3) $CCl_4 < HCOOH < HCHO < CH_3NH_2$
4) $CH_3NH_2 < HCOOH < HCHO < CCl_4$
5) $HCHO < CH_3NH_2 < HCOOH < CCl_4$

7) Number of photons in a beam of visible light with 700 nm wave length emitting an energy of 4 J

1) 1.41×10^{19}
2) 1.41×10^{28}
3) 1.43×10^{-19}
4) 1.41×10^{-28}
5) 6.022×10^{23}

8) Increasing order of stability of following carbocation is,

a) $CH_3 - \overset{+}{C}H - C_2H_5$

b) $CH_3 - \overset{+}{C}(CH_3) - CH = CH_2$

c) $CH_3 - \overset{+}{C}(CH_3) - C_2H_5$

d) $H - \overset{+}{C} = C(CH_3) - CH_3$

1) d < b < a < c
2) d < a < c < b
3) a < c < d < b
4) a < d < b < c
5) a < d < c < b

9) IUPAC name of the following organic compound is,

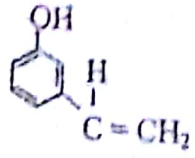
$CH_3 - \underset{C_2H_5}{\underset{|}{C}}(OH) - CH(H) = C(H) - C(=O) - H$

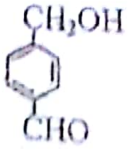
1) 4 – methyl – 4 – hydroxy – 3 – pentenal
2) 4 – methyl – 4 – ol – 2 - hexenal
3) 4 – ethyl – 4 – hydroxy – 2 - pentenal
4) 4 – hydroxy – 4 – methylhex – 2 - enal
5) 4 – ethyl – 4 – hydroxy – 3 – pentenal

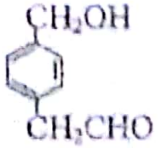
10) Observations given by compound A with some reagents are given below.

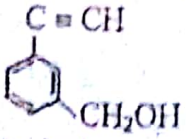
a) Decolorize acidic $KMnO_4$
b) Forms a gas with Na metal.
c) Forms a white precipitate with tollen's reagent.

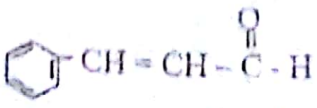
Compound A can be,

1) 

2) 

3) 

4) 

5) 

11) $CH_3CHO \xrightarrow[2)\ H_2O]{1)\ LiAlH_4} P$

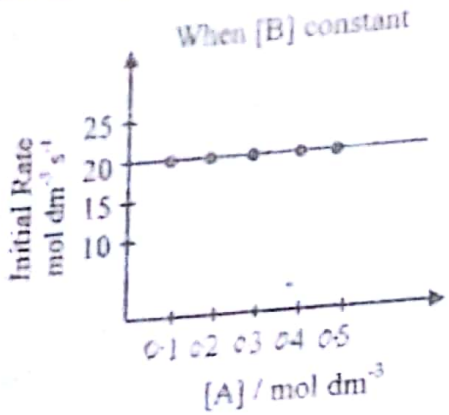
$CH_3CHO \xrightarrow{H^+/KMnO_4} Q$

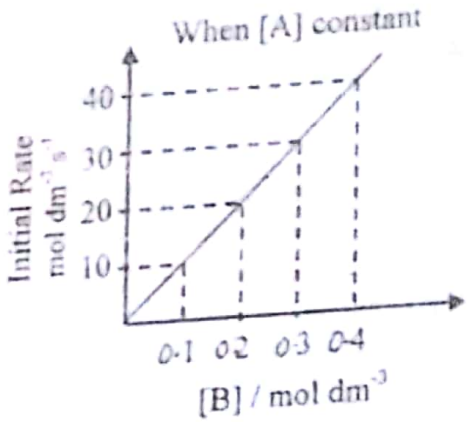
$P \xrightarrow{\text{con. } H_2SO_4} R$

Structures P, Q and R in the above reaction scheme are,

	P	Q	R
1)	$CH_3 - CH_2 - OH$	$CH_3CH_2 - O^-$	$CH_3CH_2O - CH_2CH_3$
2)	CH_3CH_2OH	$CH_3 - \overset{O}{\overset{\|}{C}} - OH$	$CH_3 - \overset{O}{\overset{\|}{C}} - O - C_2H_5$
3)	CH_3CH_2OH	$CH_3 - \overset{O}{\overset{\|}{C}} - OH$	$C_2H_5 - \overset{O}{\overset{\|}{C}} - O - CH_3$
4)	$CH_2 = CH_2$	$CH_3 - CH_2O^-$	$CH_3 - CH_2 - O - C_2H_5$
5)	$CH_3 - \overset{O}{\overset{\|}{C}} - OH$	CH_3CH_2OH	$CH_3 - \overset{O}{\overset{\|}{C}} - O - C_2H_5$

12) The following graphs show the results of an experiment done to find the order of the reaction $A + B \rightarrow C + D$





Orders with respect to A and B respectively are,

1) 1, 0 2) 1, 2 3) 0, 1 4) 0, 2 5) 2, 1

13) Enthalpy of bond dissociation of bonds S = O (g) and S – O(g) are x kJ mol^{-1} and y kJ mol^{-1} respectively. S – O(g) mean bond dissociation enthalpy of S – O in SO_3^{2-} anion is,

1) $\frac{x+y}{3}$ 2) $\frac{x}{2}$ 3) $\frac{2y+x}{3}$ 4) y 5) $\frac{3y+x}{3}$

14) Which of the following statement is correct?

1) Density of a gas at a given temperature is always directly proportional to its molar mass.
2) Density of each of the gases of a mixture of gases under constant temperature and pressure, is directly proportional to its mean square speed.
3) Density ratio of different gases with similar masses in a closed container is equal to the ratio of relative molecular masses.
4) Mass of a gas inversely proportional to universal gas constant.
5) Rate of diffusion of a gas is directly proportional to its molar mass.

15) Molar ratio of $CaCO_3$, $MgCO_3$ in a mixture containing only $CaCO_3$, $MgCO_3$ and SiO_2 is 1 : 1. 2.00 g of this mixture is heated until a constant mass is obtained mass of the residue is 1.12 g. Mass percentage of $CaCO_3$ in the mixture is, (Ca = 40, Mg = 24, C = 12, O = 16)

1) 25% 2) 50% 3) 40% 4) 35% 5) 30%

16) Volume of 0.6 mol dm^{-3} $Na_2S_2O_8$ required to react with 25.00 cm^3 of 0.8 mol dm^{-3} Cr^{3+} (aq) solution in neutral medium is (in cm^3), (Cr^{3+} is oxidized to $Cr_2O_7^{2-}$ and S_2O_8 is reduced to SO_4^{2-}).

1) 10 2) 50 3) 20 4) 25 5) 30

17) $2KNO_3(s) \longrightarrow 2KNO_2(s) + O_2(g)$

The above reaction is non spontaneous 25°C but spontaneous above 25°C.

Correct statement about the above reaction at 25°C is,

1) ΔG, ΔH and ΔS are equal.
2) ΔG, ΔH and ΔS are positive.
3) ΔG and ΔH are negative and ΔS is positive.
4) ΔG and ΔS are negative and ΔH is positive.
5) ΔG and ΔH are positive and ΔS is negative.

18) IUPAC name of $[CoCl(NH_3)_5]Br_2$ is,

1) pentaamminechloridocobalt(III) bromide.
2) pentamminechlorocobalt (III) bromite.
3) chloropentaammineconalt (III) bromide.
4) pentaaminochloridocobalt (II) bromide.
5) pentaminechloridocobaltate (III) bromide.

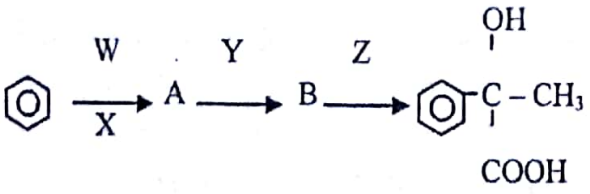
19) Salt A reacts with dil. HCl forming a gas which decolourizes the colour of $KMnO_4$. When NaOH is added to the above solution a precipitate is formed first and then it dissolves. A can be,

1) $Zn(NO_3)_2$ 2) $Cr_2(SO_3)_3$ 3) MnS 4) $NiSO_3$ 5) $Cr(NO_3)_3$

20) MI and MF_2 are two sparingly soluble salts, derived from the transition element M having two different oxidation numbers. The solubility of MI and MF_2 are S_1 and S_2 respectively and solubility products are Ksp_1 and Ksp_2 respectively. When each salt is in equilibrium with its saturated solution if $\frac{Ksp_1}{[M^+(aq)]} = \frac{Ksp_2}{[M^{2+}(aq)]}$. Which of the following is correct.

1) $S_1 = S_2$ 2) $S_1 = S_2^2$ 3) $S_1^2 = S_2$ 4) $S^1 = 4S_2^2$ 5) $S^1 = 2S_2^2$

21)



W, X, Y and Z reagents respectively are,

	W	X	Y	Z
1)	CH_3CH_2COCl	Anh. $AlCl_3$	CH_3MgBr	H_3O^+
2)	$CH_3-\overset{O}{\overset{\|\|}{C}}-Cl$	Anh. $AlCl_3$	HCN	H_3O^+
3)	CH_3CH_2Cl	Anh. $AlCl_3$	HCN	H_3O^+
4)	HCN	H_3O^+	Anh. $AlCl_3$	CH_3COCl
5)	CH_3MgBr	H_3O^+	HCN	H_3O^+

22)  $-CH = CH_2$

Most suitable reaction scheme for the above conversion is,

1)  $\xrightarrow[\text{Anhydrous } AlCl_3]{CH_2 = CHCl}$

2)  $\xrightarrow[\text{Anhydrous } AlCl_3]{CH_3CH_2Cl}$ $\xrightarrow{\text{conc. } H_2SO_4}$

3)  $\xrightarrow[\text{Anhydrous } AlCl_3]{CH_3 - \overset{O}{\overset{\|}{C}} - Cl}$ $\xrightarrow{Zn(Hg)\ \text{conc.HCl}}$ $\xrightarrow{\text{conc. } H_2SO_4}$

4)  $\xrightarrow[\text{Anhydrous } AlCl_3]{CH_3 - \overset{O}{\overset{\|}{C}} - Cl}$ $\xrightarrow[2)\ H_3O^+]{1)\ LiAlH_4}$ $\xrightarrow[\Delta]{\text{conc. } H_2SO_4}$

5)  $\xrightarrow[\text{Anhydrous } AlCl_3]{CH_3CH_2Cl}$ $\xrightarrow{NaBH_4}$ $\xrightarrow{PCl_3}$ $\xrightarrow[\Delta]{\text{Alcoholic KOH}}$

23) When excess HCl is added to an aqueous solution a brown gas was formed while the solution turned dark blue. When excess NH_3 (aq) was to another portion of the initial solution a yellow – brown solution was formed which turned darker after some time. When dilute HCl was added to the initial solution it turned brown. The initial solution contains,

1) $Cu(NO_2)_2$ 2) $Cu(NO_3)_2$ 3) $Fe(NO_2)_3$ 4) $Co(NO_2)_2$ 5) $Co(NO_2)_3$

24) 25.0 cm^3 of 0.1 mol dm^{-3} HCl(aq) is added to 0.1 g of a sample containing NaOH. When the above solution is diluted to 100.0 cm^3 using distilled water, pH of the resultant solution was 2. Mass percentage of NaOH in the sample is, (Na – 23, H – 1, O -16)

1) 25% 2) 40% 3) 56% 4) 60% 5) 80%

25) The system which does not form a buffer solution when mixing is,

1) 0.2 mol dm^{-3} HCOONa 50.0 cm^3 + 0.1 mol dm^{-3} HCl 50.0 cm^3
2) 0.5 mol dm^{-3} CH_3COOH 50 cm^3 + 0.2 mol dm^{-3} NaOH 50.0 cm^3
3) 0.2 mol dm^{-3} HCOOH 50.0 cm^3 + 0.5 mol dm^{-3} NaOH 50.0 cm^3
4) 0.2 mol dm^{-3} NH_4OH 50.0 cm^3 + 0.2 mol dm^{-3} CH_3COOH 50.0 cm^3
5) 0.2 mol dm^{-3} Na_2CO_3 50.0 cm^3 + 0.2 mol dm^{-3} HCl 50.0 cm^3

26) A saturated solution of $Ca(OH)_2$ is prepared by dissolving $Ca(OH)_2$ powder in 100.0 cm^3 of water at 25 °C. This was filtered and 25.0 cm^3 of the filtrate was titrated against 0.01 mol dm^{-3} HCl solution. Volume of HCl required for the end points is 12.5 cm^3. The solubility product (Ksp) of $Ca(OH)_2$ at 25 °C in $mol^3\ dm^{-9}$.

1) 1.25×10^{-18} 2) 6.25×10^{-8} 3) 2.5×10^{-5} 4) 8×10^{-4} 5) $4 \times 10^{-}$

27) Which of the following statement is correct regarding a strong acid strong base titration,

1) Any indicator can be used for these titrations under any condition.
2) Equivalence point pH does not depend on the concentration of acid or base.
3) Equivalent point pH is 7 for any acid or base.
4) Solution in the flask at half equivalence point shows properties of a buffer.
5) The vertical portion of the pH curve decreases as the concentration of the acid and base increases.

28) $N_2(g)$ and $H_2(g)$ are mixed in a mole ratio of 1 : 3 and allowed to reach the following equilibrium.

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

Mole percentage of N_2 remaining in the system at equilibrium is 50%

If equilibrium pressure is P, partial pressure of H_2 gas is,

1) $\frac{P}{2}$ 2) $\frac{P}{3}$ 3) $\frac{2P}{3}$ 4) $\frac{3P}{5}$ 5) $\frac{2P}{5}$

29) The following equilibrium is established when ethanoic acid and ethanol are heated with conc. H_2SO_4

$CH_3COOH\,(l) + CH_3CH_2OH(l) \rightleftharpoons CH_3COOC_2H_5\,(l) + H_2O\,(l)$; $\Delta H < O$

Number of moles of $CH_3COOC_2H_5$ in the mixture of equilibrium can be increased by,

1) Adding water to the mixture at equilibrium.
2) Increasing the temperature of the system.
3) Adding excess conc H_2SO_4 to the mixture
4) Adding dilute NaOH to the mixture.
5) Number of moles of $CH_3COOC_2H_5$ cannot be increased by any of the above.

30) Consider the following equilibrium for dissolving AgCl(s) in dilute NH_3

$AgCl(s) + 2NH_3\,(aq) \rightleftharpoons [Ag(NH_3)_2]^+\,(aq) + Cl^-\,(aq)$ $K = 3.2 \times 10^{-3}$

The equilibrium for the formation of $[Ag(NH_3)_2]^+$ is as follows,

$Ag^+\,(aq) + 2NH_3\,(aq) \rightleftharpoons [Ag(NH_3)_2]^+\,(aq)$ $Kf = 1.6 \times 10^7\ mol^{-2}\ dm^6$

Calculate Ksp of AgCl (s) in the above temperature. $(mol^2\ dm^{-6})$

1) 5.12×10^{-4} 2) 2×10^{-10} 3) 5×10^9 4) 4×10^3 5) 8×10^{-7}

Instructions for question No 31 to 40

For each of the questions 31 to 40, one or more responses (a), (b) , (c) and (d) given is/are correct. Select the correct response/responses. In accordance with the instructions given on your answer sheet, mark

(1) if only (a) and (b) are correct
(2) if only (b) and (c) are correct
(3) if only (c) and (d) are correct
(4) if only (d) and (a) are correct
(5) if any other number or combination of responses is correct.

Summary of above information				
(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	If any other number or combination of responses correct

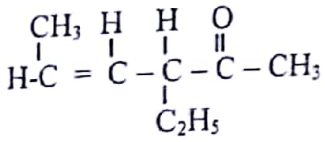
31) Correct statement/s regarding NH_3 is.

a) NH_3 can be formed by heating any ammonium salt with a strong base
b) NH_3 reacts with excess Cl_2 forming NCl_3
c) NH_3 is liberated when $NaNO_3$ is heated with Fe powder.
d) NH_3 reacts with Na forming metal nitride and H_2 gas.

32) Yellow coloured complexes are,

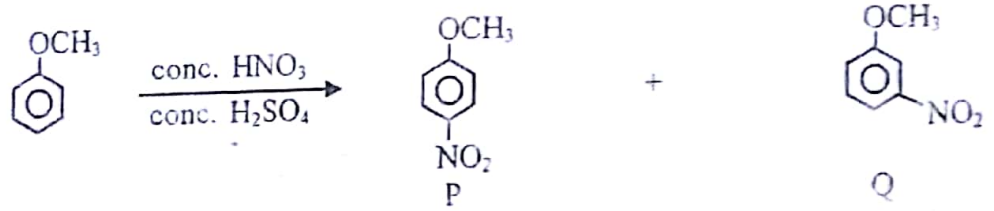
a) $[Ni(NH_3)_6]^{2+}$ and $[MnCl_4]^{2-}$
b) $[NiCl_4]^{2-}$ and $[FeCl_4]^-$
c) $[CuCl_4]^{2-}$ and $[FeCl_4]^-$
d) $[Ni(H_2O)_6]^{2+}$ and $[Cu(OH_2)Cl_2]$

33) Which of the following statement/s is/are correct regarding the molecule given below.



a) It shows stereoisomerism but does not show geometrical isomerism
b) It is optically active
c) The product formed by Zn / (Hg) with conc HCl shows optical isomerism.
d) The product formed by the above compound with HBr has two optically active isomers.

34) Which of the following statement/s is/are correct regarding the reaction given below.



P Q

a) Major product is P.
b) Major product is Q.
c) It is an electrophilic addition reaction.
d) A carbocation is formed during the first step of the reaction.

35) Which of the following statement/s is/are correct

a) Unit of rate constant of a reaction does not depend on order of the reaction.
b) Order with respect to a given reactant in a chemical reaction is not charged, even if the concentration of one reactant is comparatively greater than the other.
c) A catalyst does not affect the activation energy of the reaction.
d) When concentration of reactants are increased under constant temperature, Rate of reaction increases due to the increase of the fraction of molecules greater than the activation energy

36) $P(s) \rightarrow 2X(g) + Y(s)$ for the above reaction $\Delta H^\theta = +180\ kJ\ mol^{-1}$ $\Delta S^\theta = +160\ J\ K^{-1}\ mol^{-1}$ Which of the following is/are correct regarding the above reaction.

a) Reaction is spontaneous at 25^0C
b) ΔG^θ of the reaction at 25^0C is $-132.32\ kJ\ mol^{-1}$
c) ΔS^θ is positive above 1000 K
d) At temperature above 1125 K of this reaction becomes negative and decomposition occurs spontaneously.

37) Which of the following is true regarding chemical kinetics?

a) Order and molecularity of an elementary reaction is equal.

b) When a reaction proceeds under constant temperature rate of reaction decreases due to the reduction of the fraction of molecules that have exceeded the activation energy.

c) Molecularity of the rate determining step of a multi step reaction is equal to the number of steps.

d) Catalyst increases the rates of both forward and reverse reactions.

38) Which of the following cation/s,

I) Form a precipitate which is insoluble in excess NH_4OH

II) Form a precipitate which is insoluble in excess NaOH

a) Fe^{3+} b) Mg^{2+} c) Al^{3+} d) Cu^{2+}

39) Which of the following is/are correct regarding H_2O_2 ,

a) It undergoes disproportionation when heated

b) It is a bleaching agent and reduces coloured surfaces

c) It is a non polar molecule.

d) It is reduced to water by SO_2

40) n moles of O3 was allowed to reach equilibrium in a rigid container at T K and 1×10^5 Pa. The molar dissociation was 0.4 .

$$O_3(g) \rightleftharpoons \frac{3}{2} O_2(g)$$

Which of the following statement is/are true regarding the above equilibrium system,

a) The number of moles of O_3 and O_2 are equal.

b) The density of the system changes as it reaches equilibrium

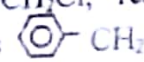
c) equilibrium pressure is 1.5×10^5 Pa

d) The density of the equilibrium mixture is given by $\frac{48 \times 10^5}{RT}$

* **Instructions for question No. 41 to 50**

In question no. 21 to 25, two statements are given in respect of each question.
From the table given below, select the response out of the responses (1), (2), (3), (4), (5) that best fits the two statements given for each of the questions and mark appropriately on your answer sheet.

Response	First statement	Second statement
(1)	True	True and correctly explains the first statement.
(2)	True	True but does not explain the first statement correctly.
(3)	True	False
(4)	False	True
(5)	False	False

	First statement	Second statement
41)	If all carbon atoms lie on one plane, they have same hybridization.	All C atoms of the compound $(CH_3)_3\,CCH_2O\overset{O}{\overset{\|}{C}}\,CH_2Cl$ which lie on same plane have sp^2 hybridization.
42)	Reactions having a positive entropy change occur always spontaneously under high temperature.	A chemical reaction to be spontaneous, enthalpy change should be always negative.
43)	pH of pure water is always 7.	Always $[H_3O^+] = [OH^-]$ in pure water.
44)	$CH_3COONH_4(aq)$ solution is neutral at 25^0C.	Cation or anion formed by the weak base or weak acid do not undergo hydrolysis.
45)	The concentration of chlorides can be determined by titrating against acidic $K_2Cr_2O_7$	$K_2Cr_2O_7$ is a primary standard and also a strong oxidizing agent.
46)	Zn has the lowest melting point among the transitional elements.	Contribution to the mobile electron reservoir is less by the elements which contain a stable electronic configuration.
47)	Solubility of hydroxides of group 2 increase down the group.	Hydration enthalpy of cations of group 2 increases down the group.
48)	 reacts with dilute NaOH and forms  by a single step nucleophilic substitution mechanism.	 is a primary carbocation.
49)	An aqueous solution of $AlCl_3$ is acidic.	$AlCl_3$ can act as a lewis acid.
50)	Compressibility factor of CO_2 under low pressures is less than 1. ($Z < 1$)	CO_2 molecules have dipole interactions.

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Grade 13 First Term Test November 2017

රසායන විද්‍යාව II
Chemistry II

02 E II

පැය තුනයි
Three hours

Name: ..... Grade : .....

- A periodic table is provided
- Use of calculators is not allowed.

rt 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.

t B and Part C Essay (pages 10 – 15)

- Answer four questions selecting two questions from each part. Use the papers supplied for this purpose.
- At the end of the time allotted for this paper, tie the answers to the three Parts A, B and 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
- Universal gas constant $R = 8.314\ JK^{-1}\ mol^{-1}$
- Avogadro constant $N_A = 6.022 \times 10^{23}\ mol^{-1}$

For Examiner's Use Only

Part A – Structured Essay

Answer all questions. (Each question carry 10 marks)

1) a) Arrange the following in decreasing order of the property given in parenthesis.

i) CaO, MgO, SrO, BaO (Solubility in water)

.....

ii) CO, CH_4, HCHO, $C_2O_4^{2-}$ (Electronegativity of C)

.....

iii) NO, NO_2^-, NH_2OH, NO_3^- (Bond length of N – O)

.....

iv) COS, $\overset{+}{C}H_3$, $\overline{C}H_3$, CH_4 (Bond angle)

.....

v) NO_2^+, ICl_4^-, I_3^-, IO_3^- (Total number of lone pairs in the ion)

.....

(2.0 marks)

b) The ester Methyl carbomate can be prepared by the reaction of methanol with urea. This carsinogenic as well as used to synthesize certain medicines and pesticides. The molecular formula of methyl carbamate is $C_2H_5NO_2$. Its skeletal structure is given below. No H atoms are attached to O atoms.

$$\begin{array}{c} O^5 \\ | \\ N^1 - C^2 - O^3 - C^4 \end{array}$$

i) Draw the most acceptable lewis structure for the above molecule.

.....

.....

.....

ii) Find the formal charges and oxidation numbers of the atoms N^1, C^2, O^3 and C^4, and write them in the table provided.

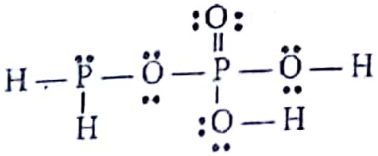
Atom	N^1	C^2	O^3	C^4
Formal Charge				
Oxidation number				

iii) Draw resonance structures for the above molecule except lewis structure drawn in part (i) above.

iv) In the lewis structure drawn in (i) above, arrange the atoms labelled as N^1, C^2, O^3 and C according to the order of increasing electronegetivity.

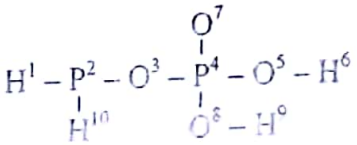
.....

v) The lewis structure of an oxo acid of phospherous is given below.



Based on the above lewis structure, state the followings of the atoms P and O mentioned in the table below.

i) the VSEPR pairs around the atom.
ii) the electron pairs geometry around the atom.
iii) shape around the atom.
iv) the hybridization of the atom.
v) bond angle.



		P^2	O^3	P^4	O^5
I.	VSEPRpairs				
II.	electron pair geometry				
III.	shape				
IV.	hybridization				
V.	bond angle.				

iv) Identify the atomic / hybrid orbitals involved in the formation of the sigma (σ) bonds given below for the lewis structure given in (v) above.

I. $P^2 - O^3$; P^2 _____ , O^3 _____

II. $O^3 - P^4$; O^3 _____ , P^4 _____

III. $P^4 - O^5$; P^4 _____ , O^5 _____

IV. $O^5 - H^6$; O^5 _____ , H^6 _____

(6.0 marks)

c) i) Arrange the following species in increasing order of their boiling points and state the type of inter molecular interaction in each species in the table given below.

CH_3CH_3, CH_3CHO, CH_3CH_2OH, HCOOH

increasing order of boiling point (from left to right)				
intermolecular attraction				

ii) State the type of lattice structure, primary interaction and secondary interaction for each of the species given in the following table.

	Lattice structure	Primary interaction	secondary interaction
SiC (s)			
Na (s)			
Ice			
Dry ice			

(2.0 marks)

2) a) The following question is based on the non consecutive elements X, Y and Z in the 3rd period of the periodic table. X does not show a colour in the flame test but burns with a bright flame in air. X does not show a considerble reaction with cold water. Y burns with a blue flame in air and forms a gas with a pungent smell. Z exists as a diatomic molecule at room temperature and shows bleaching properties.

i) Identify X, Y and Z.

X ..... Y ..... Z .....

ii) Write balanced chemical equations for the reactions of X with warm water and with air

.....

.....

.....

iii) Y shows variable oxidation states. Write all stable oxidation states formed by Y and give one example for each.

.....

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iv) An oxide of Y shows both oxidizing and reducing properties. Write half reactions to show oxidizing & reducing properties of it in acidic medium.

Oxidation .....

Reduction .....

v) Write a test in brief, to identify the oxide in (iv) above.

.....

.....

vi) Write the balanced chemical equation for the reaction of Z with water.

.....

ii) Draw possible structures for B and C.

When heated with concentrated H_2SO_4, P, Q and R gave V, W and X respectively. W shows diastereoisomerism.

iii) Draw the structures of B, C, P, Q and R.

B

C

P

Q

R

iii) Draw the structures of the diasteriomers of W

iii) On heating with conc. H_2SO_4, S gave Y. When reacted with HBr, V and Y form the same product. Draw the structures of D, E, S and T.

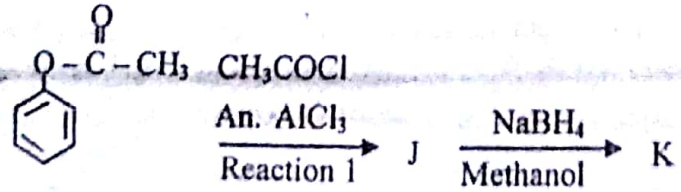
D

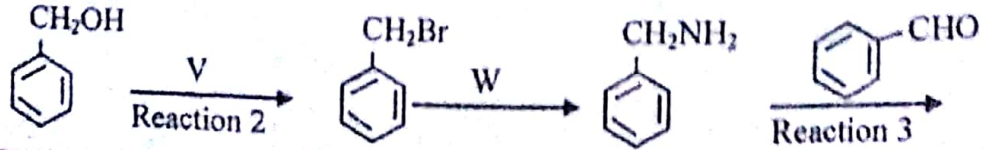
E

S

T

b) Consider the following two reaction schemes.





iii) If the temperature of the system was increased to 400 K, how would it affect the rate constant.

.....

(c) Consider the following reaction.

$2X + Y \rightarrow Z$

The following data were collected inorder to determine the overall order of the above reaction.

Experiment	Initial concentrations / moldm^{-3}		Initial rate / mol dm^{-3} s^{-1}
	X	Y	
1	1×10^{-2}	1×10^{-2}	2×10^{-6}
2	2×10^{-2}	1×10^{-2}	8×10^{-6}
3	2×10^{-2}	2×10^{-2}	8×10^{-6}
4	3×10^{-2}	3×10^{-2}	18×10^{-6}

i) Calculate the order with respect to X.

.....

.....

.....

ii) Calculate the order with respect to Y.

.....

.....

.....

iii) What is the overall order of the reaction.

.....

iv) Calculate the initial rate of the reaction, if the initial concentration of X is 0.5 mol dm^{-3} and initial concentration of Y is 5 mol dm^{-3}.

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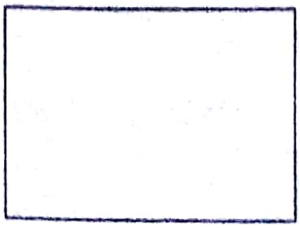
4) a) The carbonyl compounds A, B, C, D and E are structural isomers of each other, having the molecular formula $C_5H_{10}O$. Only A shows optical isomerism A, B and C react with LiAlH$_4$ followed by water, and form optically active P, Q and R respectively, where as D and E when reacted witht the same reagent form optically inactive S and T. The molecular formular of P, Q, R, S and T is $C_5H_{12}O$.

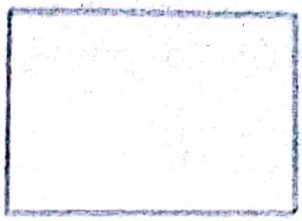
i) What is the streuture of A.



i) Draw the structures of J, K and L in the boxes provided below

J

K



L

ii) Write the reagents V and W in the boxes provided below.

V

W

iii) Writing A_E, A_N, S_E, S_N or E in the appropriate box, classify each of the reactions 1, 2 and 3 as electrophilic addition (A_E), nucleophilic addition (A_N) electrophilic substitution (S_E) nucleophilic substitution (S_N) or elemination (E) reaction.

Reaction 1 ☐ Reaction 2 ☐ Reaction 3 ☐

c) i) What is the structure of the major product of the reaction between $CH_2 = CH_2CH_2Cl$ and NaOH(aq)

.....

ii) Write the mechanism of the above reaction.

.....

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.....

.....

Part B - Essay

Answer two questions only. (Each question carries 15 marks.)

5) a) i) Define Avogadro's law.

ii) Derive the Avogadro's law using the ideal gas equation PV = nRT

b) A sample of gas X_2 was placed in a rigid container (A) with a volume of 12 dm^3 at 127°C temperature and 8.314×10^5 Pa pressure.

A sample of gas Y_2 was placed in a rigid container (B) with a volume of 6 dm^3 at 27°C temperature and 16.628×10^5 Pa pressure.

The two containers were connected by a tube of negligible volume, and the temperatures were kept unchanged, find,

i) Partial pressure of X_2 in container A.

ii) Partial pressure of Y_2 in container B.

iii) Find the total pressure of the system.

The temperature of the above combined system was raised up to 267°C, and when a small amount of a catalyst (negligible volume) was added in to the system, gas X_2 and Y_2 reacted to form XY_n. Y_2 reacted completely and the final pressure of the system was 12.471×10^5 Pa.

iv) Write the balanced chemical equation using n.

v) Calculate the total number of moles of in the combined container.

vi) Find the value of n.

c) i) At 127°C $A_3B_4(g)$ reaches the following equilibrium.

$A_3B_4(g) \rightleftharpoons A_2(g) + AB_4(g)$

At equilibrium, 20% of $A_3B_4(g)$ by volume was left, and the partial pressure of $A_{2(g)}$ was 8.314×10^5 Nm^{-2}.

i) Find the equilibrium concentration of each species in mol dm^{-3}.

ii) Find the equilibrium constant Kc of the above equilibrium reaction at 127°C.

iii) Using the Kc value calculated in (ii) above, find Kp of the equilibrium reaction at 127°C. (No marks would be awarded for the calculation of Kc using Kp)

ii) The temperature of the abvoe system is then raised to 227°C. In addition to the above equilibrium, the following equilibrium was also established by the decomposition of $AB_4(g)$

$AB_4(g) \rightleftharpoons AB_2(g) + B_2(g)$

A sample of $A_3B_4(g)$ was placed in a rigid container of volume 7.2 dm^3 and allowed to reach equlirbium at 227°C. 40% of the initial moles of $A_3B_4(g)$ was left at equilibrium and the number of moles of AB_2 was 20% of the initial moles of $A_3B_4(g)$. The total pressure at equilibrium was found to be 4.157×10^6 Pa.

i) Find the initial number of moles of $A_3B_4(g)$.

ii) Find the partial pressure of all the species at equilibrium.

iii) Find the equilirbium constants at 25°C of the two systems at equilibrium using partial pressure

6) a) i) I) Derive the Oswald dilution law for an aqueous solution of NH_3. Define the terms in it.

II) State the variations of the molar dissociation and the concentrations of OH^- (aq) and H^+ (aq) when an aqueous solution of a weak base is diluted.

ii) I) 10.0 cm^3 of a 0.1 mol dm^{-3} NaOH solution was added to 10.0 cm^3 of 0.2 mol dm^{-3} mono protic weak acid solution HA. If the pH of the resultant solution was 4.5, find the dissociation constant (Ka) of the weak acid at this temperature.

II) Calculate the pH of 0.2 mol dm^{-3} HA solution.

III) 10.0 cm^3 of the above weak acid HA was taken into a titration flask and titrated against 0.1 mol dm^{-3} NaOH solution at 25°C. Calculate the equivalence point pH of the titration.

IV) A, B and C are three acid base indicaters and their pKIn values are given below.

Indicater	pKIn
A	3.4
B	6.1
C	8.2

State which one of the above three indicators is most suitable for the titration in (iii) above.

V) Sketch a titration curve for the abvoe titration in (iii) above and mark the initial pH, half equivalence point pH and equivalence point pH.

b) i) I) Derive an expression for the solubility product (K_{sp}) of $Ca(OH)_2$

II) If the molar solubility of $Ca(OH)_2$ of 25°C is 2×10^{-3} mol dm^{-3}, find the K_{sp} of $Ca(OH)_2$

III) A 0.2 mol dm^{-3} $CaCl_2$ solution was saturated with $Ca(OH)_2$ of 25°C. Calculate the pH of the solution. State clearly any assumptions made.

ii) 25.0 cm^3 of a 0.05 mol dm^{-3} $MgCl_2$ solution was mixed with 25.0 cm^3 of 0.002 mol dm^{-3} $AgNO_3$ solution. Using a proper calculation show whether a precipitate is formed or not when the above solutions are mixed.

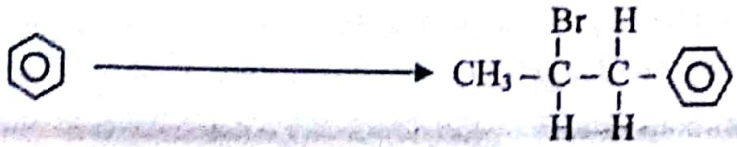
$$Ksp\ (AgCl) = 1 \times 10^{-8}\ mol^2\ dm^{-6}$$

7) a) i) Compare the acidity of alcohols and phenols.

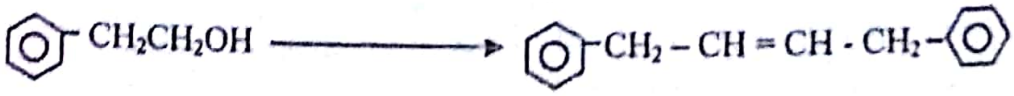
ii) I) Write the balanced equation for the reaction of $CH_3\ CH_2\ OH$ with Na.

II) The organic product formed in (I) above, reacts with $CH_3\ CH_2$ Br in two different ways and form two different products. Write the mechanisms for the formation of the two different products and state the type of mechanism for each path.

b) i) Using $CH_3\ CH_2OH$ and benzene as the only organic compounds show how you would carry out the following conversions. s



ii)

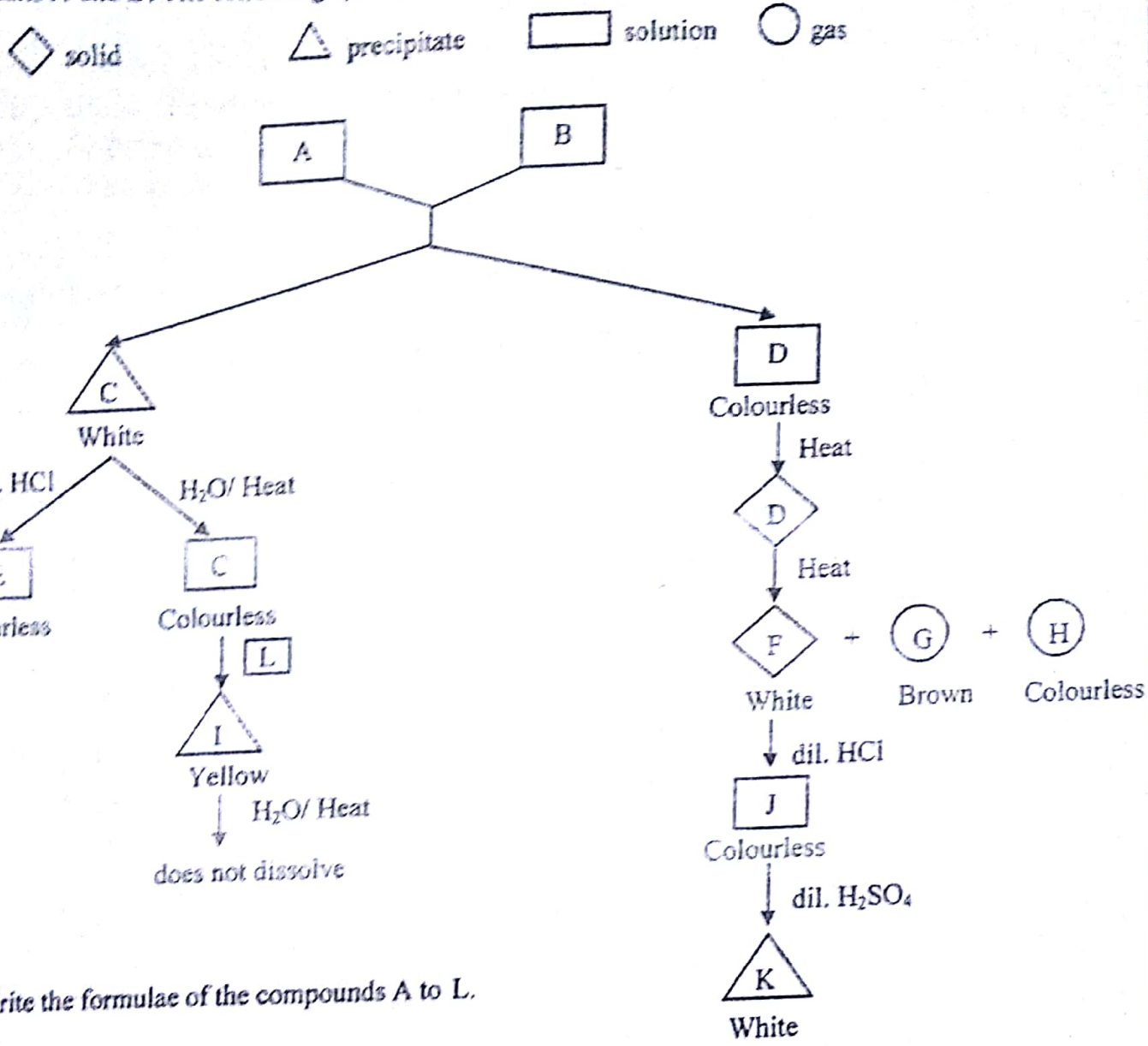


c) Using CH_3CH_2OH as the only organic compound how would you synthesize $CH_3CH = CH - \overset{\overset{C_2H_5}{|}}{\underset{\underset{H}{|}}{C}} - Br$

Part C

Answer two questions only. (Each question carries 15 marks.)

(8) a) The following reaction scheme is provided to you regarding the mixing of two aqueous solutions of salts A and B. The following symbols are used to show solid liquid and gas.



Write the formulae of the compounds A to L.

b) Metal "M" forms two salts X and Y.

The following experiments and observations are made to identify aqueous solutions of salts X and Y.

	Test	Observation
I	X was dissolved in dilute HCl	No gas was formed and a clear solution was formed.
II.	Concentrated H_2SO_4 was added to X.	A coloured gas evolved.
III.	Excess dilute NH_3 was added to the solution obtained in (I)	A white precipitate was first formed and then a clear solution was obtained.
IV.	Dilute HCl was added to Y.	No gas was formed.
V.	NaOH (aq) was added to Y and heated with metal M.	A gas wth a pungent smell was evolved

i) Explaining the observations identify metal M.

ii) Giving reasons identify anions which can be present in salt X.

iii) Write another experiment to confirm the anion present in X.

iv) Giving reasons identify Y.

c) The following experiments are carried out to determine the concetractions of Cr^{3+} and CrO_4^{2-} in a solution

A volume of 25.0 cm^3 of a solution containing Cr^{3+} and CrO_4^{2-} was diluted to 250.0 cm^3 using distilled water. (Solution A)

Experiment 1

Excess $BaCl_2$ (aq) was added to 100 cm^3 of the solution A. The dry mass of the precipitate formed was 1.012 g.

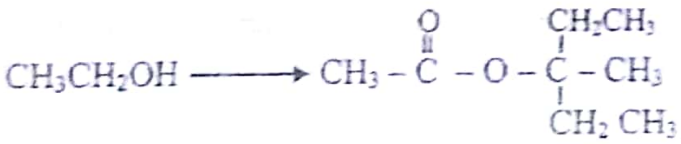
Experiment 2

NaOH and excess H_2O_2 was added to 25.0 cm^3 of solution A. This was acidified and titrated against 0.5 mol dm^{-3} Fe^{2+} solution. The volume of Fe^{2+} (aq) required for the titration was 18.0 cm^3

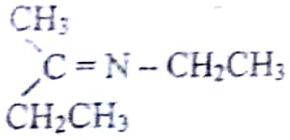
I) Write balanced chemical equations for all the reactions taking place above.

II) Calculate the concentrations of Cr^{3+} and CrO_4^{2-} in the initial solution.

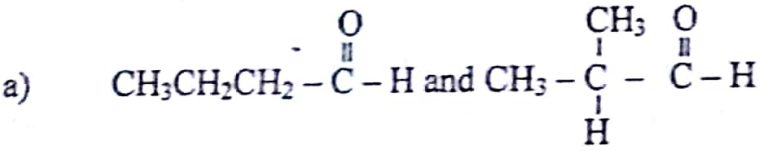
9) a) i) Using CH_3CH_2OH as the only organic compound, show how you would do the following conversion in minimum number of steps.



ii) Using CH_3CH_2Br as the only organic compound show how you would synthesize the following compound.



i) Show how you would distinguish the following compounds without using the Lucas reagent.

a) 

b) $CH_2 = CH_2$ and $CH_3CH = CH_2$

b) When sample of $FeCl_3$ and $FeCl_2$ was dissolved separately in water, two hydrated species A and B are formed (Not in order)

A and B are coordination compounds of Iron with a octahedral geometry containing H_2O and Cl^- as ligands.

A and B were separated and their atomic compositions were determined. The compounds were further analysed using the procedures given below.

Analysis of A

When excess $AgNO_3$ (aq) was added to 100.00 cm^3 of a 0.015 $moldm^{-3}$ solution of A, a white precipitate, soluble in dilute ammonia, was obtained. The dry mass of this precipitate was 4.305 g.

Analysis of B

When excess $AgNO_3$ (aq) was added to 100.00 cm^3 of a 0.1 mol dm^{-3} solution of A, a white precipitate that was soluble in dilute ammonia was obtained. The dry mass of the precipitate was 4.305 g.

(H – 1, O – 16, Cl – 35.5, Fe – 56, Ag – 108)

i) Deduce the structure of hydrated complexes possible for A.
ii) Deduce the structure of hydrated complex for B.
iii) Out of the structures named in (i) above, find the correct structure of A.
iv) Write the electronic configurations of metal cations in compounds A and B above.

10) a) i) Consider the following reaction taking place at 25° C.

N_2 (g) + 3 H_2 (g) ⟶ 2 NH_3 (g)

The following thermo chemical data regarding the above reaction are provided to you.

	ΔH_f^θ / kJ mol^{-1}	S^θ / Jk^{-1} mol^{-1}
NH_3 (g)	-46	193
N_2 (g)	0	191.5
H_2 (g)	0	130.6

I) Show whether is the above reaction is spontaneous or not at this temperature.
II) Calculate the temperature at which the above reaction reaches equilibrium.
III) State any assumptions made in the above calculation.

i) I) Define "Enthalpy of solution"

II) Below are the data gathered for the experiment to find the enthalpy of solution of KCl at room temperature. (K = 39, Cl-35.5)

Mass of KCl	= 3.725 g
Volume of the solution	= 300 cm^3
Temperature change	= 1.05°C
Specific heat capacity of the solution	= 4200 J kg^{-1} k^{-1}

i) Find the standard enthalpy of solution of KCl.
ii) State any assumptions made in the above calculation.

b) In order to determine the enthalpy change for the reaction,
$2KHCO_{3\,(s)} \longrightarrow K_2CO_3(s) + H_2O(l) + CO_2$ (g) the following experiment consisting of two steps was carried out at room temperature.

Step I

1.98 g of solid K_2CO_3 was added to 30.00 cm^3 of 2.0 mol dm^{-3} HCl acid solution. The temperature rise was 5.2° C.

$$K_2CO_3 + 2HCl\ (aq) \longrightarrow 2KCl_{(aq)} + H_2O_{(l)} + CO_{2\,(g)}$$

Step II

1.50 g of solid $KHCO_3$ was added to 30.00 cm^3 of 2.0 mol dm^{-3} HCl acid solution. The temperature fall was found to be 3.7 ° C.

$$KHCO_{3(s)} + HCl_{(aq)} \longrightarrow KCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$$

Specific heat capacity and density of HCl at constant pressure is $4Jg^{-1}k^{-1}$ and $1g\ cm^{-3}$ respectively.

i) Calculate the enthalpy changes (in kJ mol^{-1}) of the reactions in steps I and II.

ii) Using thermochemical cycle and the values obtained in (i) above calculate the enthalpy change of the reaction.

$$2\ KHCO_{3\,(s)} \longrightarrow K_2CO_{3\,(s)} + CO_{2\,(g)} + H_2O_{(l)}$$

iii) State assumptions and experimental errors that may occur during the experiment.

iv) State if there is a difference between the heat change and the enthalpy change of a given reaction at a given temperature. Explain your answer.

c) A fungicide shampoo contains Se. The experimental procedure of an experiment conducted to find the composition of Se, is given below.

45.0 cm^3 (excess) of 0.02 mol dm^{-3} ammoniacal $AgNO_3$ was added to 5.0 cm^3 of the fungicide. Under the above conditions Se forms two precipitates as follows. .

$$Se_{(s)} + AgNO_3(aq) + NH_4OH\,(aq) \rightarrow Ag_2Se(s) + Ag_2SeO_3(s) + NH_4NO_3(aq) + H_2O(l)$$

When excess HNO_3 is added to the above mixture containing the two precipitates, Ag_2Se does not dissolve whereas Ag_2SeO_3 does.

The above resultant solution was then titrated with 0.04 mol dm^{-3} KSCN solution in order to find the remaining Ag^+ concentration. Then Ag^+ is precipitated as, $Ag^+(aq) + SCN^-(aq) \rightarrow AgSCN(s)$

The volume of KSCN required for this was 16.0 cm^3.

i) Write balanced chemical equation for the reaction taking place between Ag^+ and Se in Ammonium hydroxide medium.

ii) Calculate the composition of Se in the fungicide in mol dm^{-3}.