Royal College — Colombo 07

First Term Test - April 2023
Grade 13

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Chemistry   I

02 E I

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Two hours

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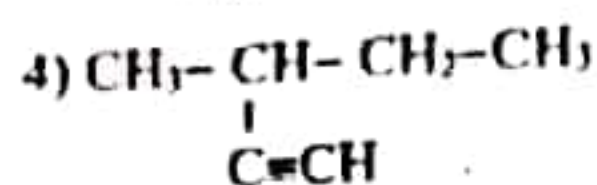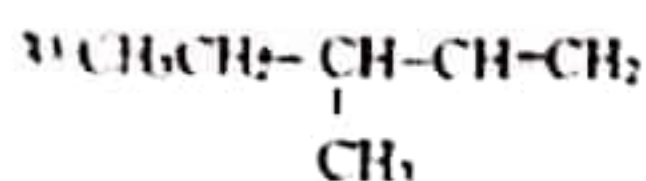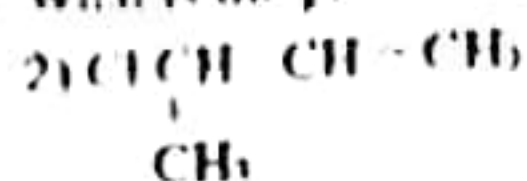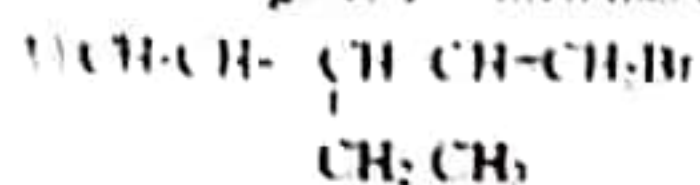
- This paper consists of 08 pages.
- Answer all the questions.
- Use of calculators is not allowed.
- Write your Index Number in the space provided in the answer sheet.
- Follow the instructions given on the back of the answer sheet carefully.
- In each of the questions 1 to 30, pick one of the alternatives 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.

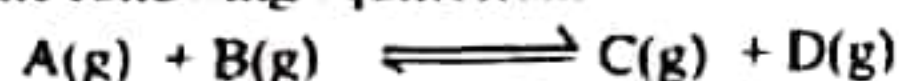|			
Universal gas constant	R	=	$8.314 \, J \, K^{-1} \, mol^{-1}$
Avogadro constant	N_A	=	$6.022 \times 10^{23} \, mol^{-1}$
Planck's constant		=	$6.626 \times 10^{-34} \, J \, s$
Velocity of light		=	$3 \times 10^8 \, m \, s^{-1}$

1) X, Y and Z are three elements which belong to the fourth period of the periodic table. All three have one unpaired electron each. Azimuthal quantum number of each of their respective unpaired electron is different from one another. X,Y and Z are indicated correctly by,

   1) Na, Sc, Al
   2) K, Ga, Ca
   3) K, Sc, Ga
   4) Cr, Cu, Ga
   5) K, Sc, Cu

2) The correct response which indicates the ascending order of the ionic radius of the ions F^-, Ca^{2+}, N^{3-} and Cl^- is,

   1) $Ca^{2+} < Cl^- < F^- < N^{3-}$
   2) $F^- < N^{3-} < Ca^{2+} < Cl^-$
   3) $Cl^- < N^{3-} < F^- < Ca^{2+}$
   4) $N^{3-} < F^- < Cl^- < Ca^{2+}$
   5) $N^{3-} < Ca^{2+} < F^- < Cl^-$

3) In a simple molecule, the possible electron pair geometry around the central atom and the shape of the molecule respectively given by,

   1) trigonal bipyramidal and tetrahedral.
   2) trigonal planar and trigonal pyramidal
   3) Tetrahedral and T shape
   4) Trigonal bipyramidal and linear
   5) Octahedral and see – saw shaped.

4) Which statement from the following is incorrect?

   1) When the temperature of a gas is increased, its maximum probable speed increases.
   2) When equal masses of gases at the same temperature were considered, the pressure of an ideal gas is greater than the pressure of a real gas.
   3) In a given volume of a gas, kinetic energy of all molecules is equal.
   4) Mean kinetic energy of a gas molecule is directly proportional to the absolute temperature.
   5) Molecular kinetic theory is only limited to a gaseous system.

5) The optically active organic compound X has a one chiral carbon atom. The compound Y which is obtained by the hydrogenation of X is not optically active. When X was reacted with HBr in a polar medium it gives Z which has 2 chiral carbon atoms. What is the probable structure of X?

1) CH₃-CH₂- CH CH-CH₂Br
   |
   CH₂ CH₃

2) ClCH CH CH₃
   |
   CH₃

3) CH₃CH₂- CH-CH-CH₂
   |
   CH₃

4) CH₃- CH- CH₂-CH₃
   |
   C≡CH

5) CH₃CH₂- CH-CH=CH₂
   |
   CH₂ CH₃
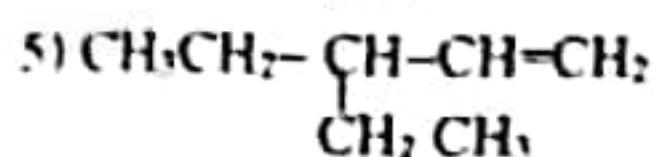
6) Consider the following equilibrium.

$$A(g) + B(g) \rightleftharpoons C(g) + D(g)$$

When two gases A and B were inserted into the system 2 moles each and were left to attain an equilibrium, 50% of A has been decomposed. Then substances C and D were added in amounts equal to 40% of the amount of substance of A which was inserted earlier into the system and was allowed to reach the equilibrium at the same temperature. What is the amount of A in mol in the new equilibrium mixture?

1) 1.8   2) 1.4   3) 0.4   4) 1.0   5) 1.2

7) Which statements from the following are the most accurate regarding the compound $CH_2 = \overset{\overset{|}{H}}{C} - C \equiv C - H$?

a) All C atoms lie on the same line.
b) By reacting with $NaNH_2$ releases a basic gas.
c) Decolourizes bromine water.
d) A white precipitate is formed when reacted with ammoniacal $AgNO_3$

1) a and b true   2) b and c true   3) c and d true
4) b, c and d true   5) a, b, c and d true

8) When strongly heated decomposes giving ohly one (01) gaseous product by,

1) $LiNO_3$ 2) $CsNO_3$ 3) Ag_2CO_3 4) $(NH_4)_2CO_3$ 5) NH_4Cl

9) Total number of isomers that can have for the molecular formula C_4H_7Br without the group $\overset{}{C} = \overset{}{C}\overset{}{Br}$ is

1) 2   2) 3   3) 4   4) 5   5) 6

10) The H^+ ion concentration obtained when 25.0 cm³ volume of 0.9 mol dm⁻³ HCl solution was reacted with 25.0 cm³ of a $Ba(OH)_2$ solution was 0.2 mol dm⁻³. When H_2SO_4 solution in excess was added to 25.0 cm³ of the given $Ba(OH)_2$ solution, what is the mass of $BaSO_4$ precipitate formed?
   (Ba = 137 S = 32   O =16)

1) 2.62 g   2) 2.15 g   3) 1.46 g   4) 1.25 g   5) 0.85 g

11) The decreasing order of boiling points of the following compounds is given by,
   A) pentane   B) 2-methylbutane   C) 2,2-dimethylpropane   D) hexane

1) C > A > D > B   2) D > B > A > C   3) D > A > B > C
4) C > B > A > D   5) A > B > C > D

12) Which one from the following statements is true regarding the effect of a catalyst on a particular chemical reaction?

1) Activation energy of a reaction is decreased.
2) Increases the negativity of Gibbs energy
3) Increases the fraction of effective collisions.
4) Changes the mechanism
5) Increasing the amount of product formed

13) Which one/s from the following cations can be precipitated as sulfides in the basic medium?

1) Pb^{2+} 2) Zn^{2+} 3) Co^{2+} 4) Mn^{2+} 5) All of the above

14) Identify the statement which is always true with respect to the reaction given

$$3X(g) + 2Y(g) \rightarrow Z(g)$$
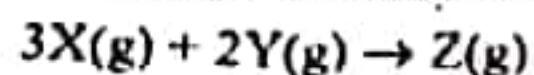
1) When the concentration of X was increased, rate of the reaction increases drastically.

2) Rate of the reaction is $-\dfrac{1}{3}\dfrac{\Delta C_x}{\Delta t}$

3) The reaction occurs in several steps to form Z
4) Rate of the reaction is directly proportional to $[X(g)]^3 [Y(g)]^2$
5) When the reaction occurs, the entropy of the system is positive (+)

15) 0.1 mol of the chloride of an element X was dissolved in water to form a solution with a volume of 500.00 cm³. In order to completely react with 50.00 cm³ of that solution, 100.00 cm³ of 0.4 mol dm⁻³ $AgNO_3$ solution was required. What is the valency of X?

1) 1   2) 2   3) 3   4) 4   5) 5

16) By using equal number of moles in both situations, the gases H_2 and Cl_2 were mixed inside a rigid container at two (02) different temperatures which were kept constant throughout the reaction to form two separate samples of HCl. The moles of HCl formed was plotted against time in both situations.
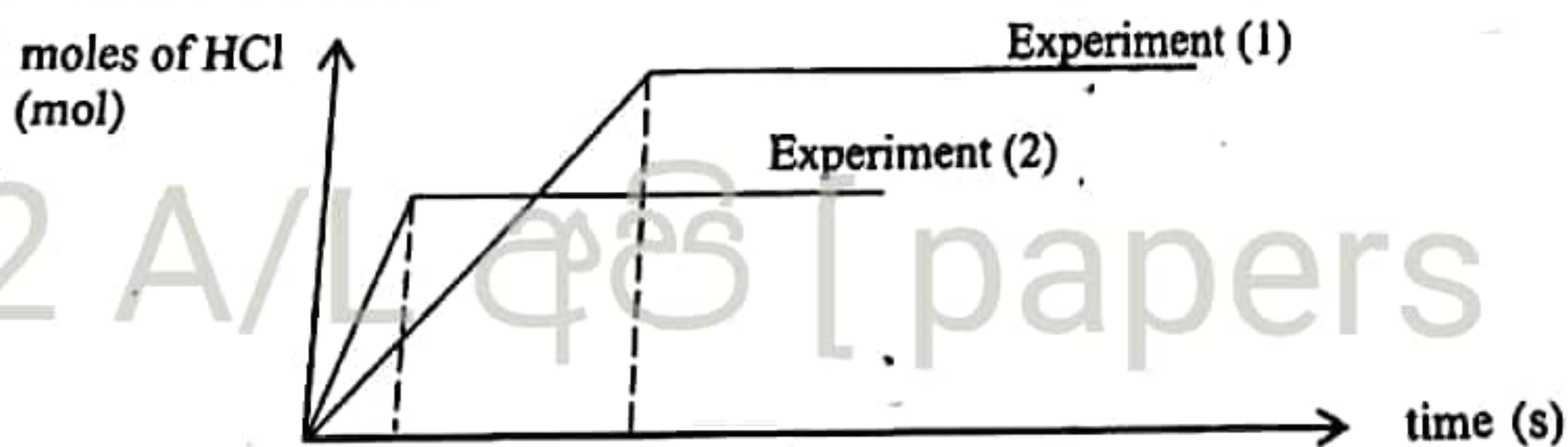
Based on the results the second experiment is,
1) unaffected by the temperature difference.
2) carried out at a higher temperature than the first experiment and forward reaction is exothermic.
3) carried out at a higher temperature than that of the first experiment and forward reaction is endothermic.
4) carried out at a lower temperature than that of the first experiment and forward reaction is exothermic.
5) carried out at a lower temperature than that of the first experiment and forward reaction is endothermic.

17) In a solution which contains only the compounds $Al(NO_3)_3$ and $Mg(NO_3)_2$, concentration of Al^{3+} ions is 270 ppm and concentration of NO_3^- ions is 3100 ppm. What are the concentrations of $Al(NO_3)_3$ and $Mg(NO_3)_2$ in mol dm⁻³ respectively?

(Density of water at this temperature is 1 g cm⁻³)
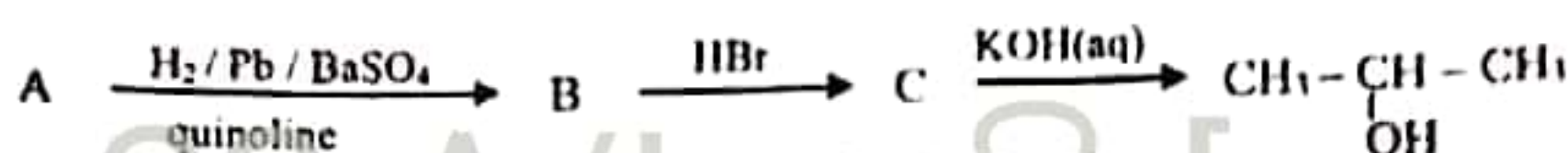
1) 0.03 and 0.02   2) 0.01 and 0.02   3) 0.01 and 0.01   4) 10.0 and 20.0   5) 10.0 and 10.0

18) Standard enthalpies of formation of $H_2O(l)$ and $H_2O(g)$ are -286 kJ mol^{-1} and -242 kJ mol^{-1} respectively. Standard bond dissociation enthalpies of $H_2(g)$ and $O_2(g)$ are 436 kJmol^{-1} and 498 kJ mol^{-1}. The mean bond dissociation enthalpy of $O-H$ bond and the enthalpy of vapourization of liquid water in kJ mol^{-1} respectively are?

1) $+927.0$ and $+44.0$

2) $+927.0$ and $+88.0$

3) $+463.5$ and $+44.0$

4) $+463.5$ and $+88.0$

5) $+927.0$ and -44.0

19) When the organic compound A was subjected to the following sequence of reactions, compound D was obtained as the product.

A $\xrightarrow[\text{quinoline}]{H_2 \,/\, Pb \,/\, BaSO_4}$ B $\xrightarrow{HBr}$ C $\xrightarrow{KOH(aq)}$ CH$_3$–CH–CH$_3$
                                                                                                                                $\overset{|}{OH}$
                                                                                                                                D

What would be the compound A?

1) $CH_2 = CH\ CH_3$

2) $CH_3CH = CH_2$

3) $CH_3\ CH_2\ CH_2OH$

4) $CH_3CH_2CH_2Cl$

5) $CH_3C \equiv CH$

20) CH$_3\overset{a}{-}$CH$\overset{b}{=}$CH$\overset{c}{-}$C$\overset{d}{\equiv}$C$\overset{e}{-}$CH$_3$ Of this molecule, the variation in bond lengths from a to e are correctly indicated by.

1) $a > b > c > d > e$

2) $d > b > c > e > a$

3) $b > d > c > e > a$

4) $a > e > c > b > d$

5) $c > e > a > b > d$

21) Which one from the following is correct about hybridization?

   1) All the atoms undergo hybridization when forming bonds.

   2) Overlapping of orbitals is a must for the formation of bonds.

   3) Hybridized orbitals can contain lone pair electrons.

   4) The terminal C – H bonds of ethyne formed by the overlapping of two hybridized orbitals.

   5) Sigma (σ) or pi (π) bonds are formed by the overlapping of hybridized orbitals.

22) Which statement from the following is incorrect about electromagnetic radiation?

   1) Travels at the speed of light in a vacuum.

   2) Waves propagate perpendicular to both electric and magnetic fields.

   3) Wave length is inversely proportional to its frequency.

   4) Visible light is a type of electromagnetic radiation.

   5) Energy of a mole of photons is given by $E = h\nu$

23) Reaction order with respect to X in the balanced chemical reaction $X(g) + Y(g) \longrightarrow Z(g)$ is equal to one (1). n number of moles of X and n' number of moles of Y are mixed in a vessel with a volume V and n' is significantly higher than that of n (n' >> n). If the amount of moles of Z formed after a time 't' was 'a' and the rate of reaction at time t was R, the value of 'a' is indicated by, (K' – Rate constant under these conditions)

1) $nn' - \dfrac{R}{K'}$

2) $n' - \dfrac{RV}{K'}$

3) $n - \dfrac{\sqrt{RV}}{\sqrt{K'}}$

4) $n - \dfrac{RV}{K'}$

5) $n - \dfrac{n'RV}{K'}$

24) The K_P/K_C ratio relevant to system at equilibrium is 6.2×10^6 J^2 mol^{-2} at $27°C$. Which reaction from the following indicates this correctly?

1) $A(g) + B(g) \rightleftharpoons C(g) + 2D(g)$

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

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

4) $A(g) + B(g) \rightleftharpoons 2C(g) + 2D(g)$

5) $3A(g) + 2B(g) \rightleftharpoons 2C(g) + D(g)$

25) A volume of 12.00 cm³ of acidified $KMnO_4$ solution was required to completely react with 25.00 cm³ of an aqueous solution containing Fe^{2+} and Fe^{3+} ions. To another 25.00 cm³ sample of the initial mixture stated above, SO_2 gas was bubbled in excess. When the reaction was completed, the mixture was heated to remove the excess SO_2, then this sample was titrated with the same $KMnO_4$ solution mentioned earlier. What is the ratio of $Fe^{2+} : Fe^{3+}$ in the initial mixture, if the burette reading was 27.00 cm³ ?

   1) 5:4   2) 6:5   3) 2:5   4) 5:6   5) 4:5

26) Out of the compounds given below, which ones can be used to produce I_2 from KI under specific conditions?

   A) $CuCl_2$ B) $FeCl_3$ C) $ZnSO_4$ d) $KMnO_4$

   1) A and B only   2) A, B and C only

   3) B, C and D only   4) A, B and D only

   5) A, B, C and D all

27) What is the IUPAC name of the compound $HO-\overset{O}{\overset{\|}{C}}-CH_2-\underset{OH}{\overset{H}{\underset{|}{C}}}H-\overset{\cdot}{C}=CH_2$

   1) 3 – hydroxypent – 4 – eneoic acid
   2) 3 – hydroxypent – 1 – enoic acid
   3) 3 – hydroxypent – 1 – en – 5 – oic acid
   4) 3 – hydroxypent – 4 – enoic acid
   5) 3 – hydroxy – 5 – oxopent – 1– en – 3, 5 – diol

28) Which one is incorrect about chlorine?
   1) Acts as an oxidizing agent.
   2) Acts as a bleaching agent.
   3) Undergoes disproportionation with NaOH
   4) During the reaction with water, oxidation number changes from 0 to +1 as well as to – 1.
   5) $HClO_3$ is the most acidic oxoacid formed by chlorine.

29) Mass of 3.011×10^{24} number of molecules of a gas X_3 is 50.0 g. What will be the root mean square speed of X_3 gas at 27°C in ms^{-1} ?

   1) 499.4   2) 15.8   3) 57.5   4) 865   5) 704

30) What is the IUPAC name of $K_3[Fe(CN)_5NO]$
   1) potassium(I) pentacyanidonitrosylferrate(III)
   2) potassium pentacyanidonitrosylferrate(II)
   3) potassium nitrosylpentacyanidoferrate(I)
   4) potassium(I) pentacyanidonitrosylferrate(II)
   5) potassium pentacyanidonitrosyliron(II)

- For each of the questions 31 to 40, one or more responses out of four responses (a), (b), (c) and (d) given is/are correct. select the instructions given on your answer sheet, mark.

		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

31) Which statement/s is/are true regarding the addition of water into the product formed when an alloy which is consisting only of aluminium and sodium was reacted with NH_3 ?
 a) A precipitate is obtained.
 b) Two different types of gases are formed.
 c) Both types of metals form amides by the reaction with ammonia.
 d) The solution obtained at the end is neutral.

32) Information on kinetics of the reaction, $A + 2B \rightarrow C$ are indicated below.
 - Rate of the reaction had doubled when the concentration of A was doubled while maintaining the concentration of B constant under a constant temperature.
 - At 25°C the rate constant relevant to the reaction is 25 $dm^6mol^{-2}s^{-1}$.

 Based on the information about the reaction given, what are the necessary conclusions that can be made from the following?
 a) It is a fundamental reaction.
 b) Reaction is of second order.
 c) Order of the reaction relative to B is 2.
 d) At 25°C temperature, when concentrations of A and B become 0.1 mol dm^{-3} each, the rate of the reaction takes the value of 2.5×10^{-2} mol $dm^{-3} s^{-1}$.

33) Select the endothermic reactions from the following.
 a) $O^-(g) + e \longrightarrow O^{2-}(g)$
 b) $2K^+(g) + O^{2-}(g) \longrightarrow K_2O(s)$
 c) $H_2SO_4(aq) \longrightarrow H^+(aq) + HSO_4^-(aq)$
 d) $N(g) + e \longrightarrow N^-(g)$

34) Consider the following balanced reaction which occurs inside a closed rigid container.
 $$C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g) \qquad \Delta H < 0$$

 Which method/s from the following can be used to increase the concentrations of $CO(g)$ and $H_2(g)$?
 a) By increasing the pressure at constant temperature.
 b) By decreasing the temperature under a constant pressure.
 c) By increasing the partial pressure of water vapour.
 d) By the addition of a small amount of carbon powder into the equilibrium system.

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35) Which of the following statements is/are true regarding the solution formed when a mass of 14.2 mg of Na_2SO_4 was dissolved in a 1 kg mass of water? (Density of water at this temperature is 1 g cm^{-3})

   a) Composition of Na_2SO_4 is 14.2 ppm

   b) Mass fraction of Na_2SO_4 is 1.42×10^{-5}

   c) Composition of Na^+ is 4.6 ppm

   d) Concentration of Na_2SO_4 is 1×10^{-3} mol dm^{-3}

36) What are the factors which affect the increase in ionic character of a bond?

   a) Increase in the electronegativity difference between the atoms involved.

   b) Increase in the polarizing power of a cation.

   c) Increase in the polarizability of an anion

   d) Increase in the radius of a cation.

37) $P(s) + Q(g) \rightarrow R(g) + S(g)$

   Standard enthalpy change of the reaction given is -400 kJmol^{-1}.

   Which statement/s is/are true regarding the reaction given?

   a) Reaction is spontaneous at higher temperatures.

   b) Standard Gibbs free energy takes a negative value.

   c) Standard entropy change is positive.

   d) In order for the reaction to be spontaneous, the condition must be $\Delta H > T.\Delta S$

38) Which of the following statements is/are ture?

   a) Lime water can be used to separate SO_2 from CO_2 .

   b) In order to separately identify SO_2 and H_2S gases, $H^+ / KMnO_4$ solution can be used.

   c) To identify SO_3^{2-} ions from SO_4^{2-} ions separately, $BaCl_2$ in acidic medium can be used.

   d) A dil. H_2SO_4 solution can be used to identify NO_3^- ions from Br^- ions.

39) Which of the following statements is/are true regarding the reaction between Propene and HBr

   a) This is an electrophilic addition reaction.

   b) 2-bromopropene is formed as the product.

   c) This is a free radical substitution reaction.

   d) The reaction proceeds by forming a secondary carbocation as an intermediate.

40) Which compound/s from the following can be used to produce a basic gas by thermal decomposition?

   a) NH_4NO_3 b) NH_4Cl c) $(NH_4)_2CO_3$ d) $(NH_4)_2Cr_2O_7$

Instruction for question No. 40 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 reaction $H_2(g) + Cl_2(g) \xrightarrow{UV} 2HCl(g)$ is a zeroth order reaction.	All photochemical reactions are of zeroth order.
42)	Upon heating NaOCl undergoes disproportionation.	NaOCl is a bleaching agent.
43)	Reaction between MnO_4^- and $C_2O_4^{2-}$ occurs rapidly at room temperature.	Acidified MnO_4^- is a strong oxidizing agent.
44)	Catalysts increase the amount of products formed in a unit time of a given reaction.	When the activation energy of a reaction is lower, molecular fraction which has exceeded the activation energy is greater even at low temperatures.
45)	All homoatomic molecules are non-polar.	Atoms of the same element in a molecule show equal oxidation states.
46)	Addition of water to ethyne occurs via an enol intermediate.	Addition of water to ethyne gives an alcohol.
47)	Enthalpy of sublimation of iodine solid is equal to its enthalpy of atomization.	Atomization results in the formation of gaseous atoms.
48)	$C_2H_2Cl_2$ molecule shows isomerism.	All isomers of $C_2H_2Cl_2$ are polar.
49)	Pressure of an ideal gas is directly proportional to its concentration at constant temperature.	Concentration of two different ideal gases at same temperature and same pressure are equal.
50)	Ammonia forms a white precipitate with Zn^{2+} ions which does not dissolve in excess ammonia.	$Zn(OH_2)$ is an amphoteric hydroxide.

22 A/L රසා [papers grp]

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First Term Test   April 2023
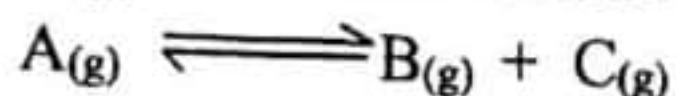Grade 13

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Chemistry   II

02 E II

Part B – Essay

Answer two questions.

(5) a) Gas A is in a rigid container at 47^0C and 8×10^4 Pa pressure.

  (i)   What would be the pressure of the gas if the temperature raises to 127^0C?

  (ii)   A(g) dissociates as in the following reaction above 100^0C.

   $A_{(g)} \rightleftharpoons B_{(g)} + C_{(g)}$

   Calculate the partial pressure of each gas at an instance when the total presure of the system is 1.2×10^5 Pa .

  (iii) Given that the Kp of the above system at 127^0C is 5×10^4 Pa. Explain whether the system given in part (ii) is at equilibrium or not under the given condition.

  (iv)   Calculate the K_c of the above system at 127^0C.

  (v)   State the factors effect on an equilibrium system.

  (vi)   Explain a simple experiment for each of above factor which can be performed in laboratory.

  (vii) Consider the dynamic equilibrium $A_{(g)} \rightleftharpoons B_{(g)} + C_{(g)}$, explain the effect on the equilibrium position if a small amount of B(g) at constant pressure and volume was added.

  (viii) Sketch a graph to depict the variation of the rate of forward and reverse reactions.

   2 mol   2 mol

 (b) 0.4 dm³ of solution has been prepared by mixing only $A_{(aq)}$ and $B_{(aq)}$. Concentration of $C_{(aq)}$ at equilibrium is 2.0 mol dm⁻³

   $A_{(aq)} + B_{(aq)} \rightleftharpoons 2C_{(aq)} + D_{(s)}$

  (i)   Calculate the amount of A(aq) dissociated to reach equilibrium.

  (ii)   Calculate the K_C for the above reaction under given condition.

  (iii) Explain the effect on the equilibrium constant and the equilibrium position of the reaction if 1.0 dm³ of water is added to the above dynamic equilibrium system at constant temperature.

  (iv)   Calculate the amount of A dissociated if 0.5 mol of $C_{(aq)}$ is added to the above equilibrium system.

  (v)   Explain the effect on the equilibrium position when 0.2 mol of D(s) is added to the equilibrium system given in part (iv).

  (vi)   Deduce the sign (+/-) of the enthalpy change (ΔH) of the reaction if value of K_c changes to 4.0 when temperature increases by 100 K.

(6) a)   Consider the following thermo-chemical data.

  (i)   Standard combustion enthalpy of $CH_3-CH_{3(g)}$ -1569 kJ mol

       Standard formation enthalpy of $CO_{2(g)}$ -395 kJ mol

       Standard formation enthalpy of $H_2O_{(l)}$ -286 kJ mol

       Standard combustion enthalpy of $CH_3-CH-CH_2$ -2069 kJ mol^{-1}

       Standard combustion enthalpy of $CH_3-CH_2-CH_3$ -2220 kJ mol^{-1}

       Calculate the formation enthalpies of $CH_3-CH_{3(g)}$ and $CH_3-CH_2-CH_{3(g)}$

  (ii) Calculate the $C-C$ and $C-H$ bond enthalpies separately in $CH_3CH_{3(g)}$ and $CH_3CH_2CH_{3(g)}$ using above and following data.

         Standard sublimation enthalpy of carbon   = 717 kJ mol^{-1}

         Standard bond dissociation enthalpy of $H_{2(g)}$ = 436 kJ mol^{-1}

  (iii) Calculate the Standard Gibbs free energy change and standard entropy changes of the following reaction at 25^0C using given data.

$$C_3H_{8(g)} + 5O_{2(g)} \longrightarrow 3CO_{2(g)} + 4H_2O_{(g)}$$

	$C_3H_{8(g)}$	$O_{2(g)}$	$CO_{2(g)}$	$H_2O_{(g)}$
ΔG^0 at 25^0C / kJ mol^{-1}	-245	0.0	-394.4	-228.6

(b) Molecular formulae of four compounds A, B, C and D are $CoN_5H_{15}Cl_3$, $CrO_4H_8Cl_3$, $CoN_4H_{12}Cl_3$, $CrO_5H_{10}Cl_3$ (not in order)

- When the cation found in B reduced and conc. HCl was added, the solution turned blue.

- Aqueous solution of C and D compound are green.

- 0.01 moldm^{-3} solutions were separately prepared and 100.0 cm^3 of each solution was treated with excess of $AgNO_3$. A and D gave 0.287 g of precipitate while B and C gave 0.1435 g of precipitate.

- Each of above coordination sphere contains two types of ligands. One is neutral and other one is an ionic ligand.

- Coordination sphere of all compounds are octahedral. (Ag = 108 , Cl = 35.5)

  (i)   Identify the ligands present in compounds A, B, C and D

  (ii) Deduce the structural formula of all compounds A, B, C and D

  (iii) Write-down the IUPAC names of compounds A and C.

Answer two questions.

(7) (a) This question is based on a set of experiments carried out to identify the cations in a mixture and their respective observations. Experiments were performed on an aqueous solution of the cation mixture.

Experiment (1) : Addition of HCl to a portion of the aqueous solution.
There is no change observed in the solution.

Experiment (2) : The acidic solution prepared in experiment (1) was diluted and H_2S (g) was bubbled through it.
A <u>yellow precipitate</u> was obtained which is insoluble in NaOH but is soluble in dil. HCl.

Experiment (3) : The solution obtained in experiment (2) was <u>boiled</u> and to a portion of it, a few drops of $K_3[Fe(CN)_6]$ solution was added.
A <u>blue precipitate</u> was formed.
To the remaining portion of it, NH_4Cl and NH_4OH solutions were added. A <u>green precipitate</u> was formed.
Upon addition of H_2O_2 in basic medium to the precipitate a <u>yellow solution</u> was obtained when it was acidified an <u>orange solution</u> was formed.

Experiment (4) : To a portion of the initial aqueous solution a small amount of DMG solution was added which resulted in a light red/pink precipitate.
No positive results were obtained for any of the other experiments performed.

(i) By providing reasons for the observations obtained in the experiments from (1) to (4) stated above, identify the cations.

(ii) Write the balanced chemical equations for the reactions which were responsible for the underlined observations.

(iii) Give reasons for the solution to be <u>boiled</u> in experiment (3).

(iv) What are the expected observations if H_2S gas was bubbled through the second solution obtained in experiment (3)? Give reasons for your answer.

(v) Write the IUPAC names of the reagent used for the formation of blue precipitate and the blue precipitate formed in experiment (3).

b) Based on an experiment which was carried out to calculate the mass percentages of the compounds $Fe(NO_3)_2$ and $Fe_2(SO_4)_3$ in a mixture containing water soluble inert substances, answer the questions given.

Procedure I :

A 100.00 cm³ solution was prepared by dissolving 16.0 g of the above mixture in distilled water. To a 25.00 cm³ sample of it, a NaOH solution and Al powder in sufficient quantities were added. All the gas released was absorbed into a 40.00 cm³ sample of 1.0 mol dm⁻³ HCl solution. When the resulted solution was titrated with 1.0 mol dm⁻³ NaOH solution, 20.00 cm³ was used up.

Another 25.00 cm³ sample was taken from the 100.00 cm³ solution prepared earlier mentioned in procedure I. All Fe^{3+} ions were reduced to Fe^{2+} ions by using a reducing agent and then was titrated with 0.2 mol dm⁻³ $KMnO_4$ solution. Volume of $KMnO_4$ solution used up at the end point was 20.00 cm³. (Consider that during reduction, NO_3 gets converted to NO)

(i) Write balanced equations/ balanced ionic equations to indicate the reactions that occur during procedures I and II.

(ii) State an indicator which can be used in procedure I.

(iii) State the colour change at the end point during the titration in procedure II.

(iv) Calculate the mass percentages of $Fe(NO_3)_2$ and $Fe_2(SO_4)_3$ in the above sample.

(8) a) Show how the following conversions are done.

(i) $CH_3CH_2CH_2Cl \longrightarrow CH_3CH_2\underset{Br}{CH} - \underset{Br}{CH} - CH_3$
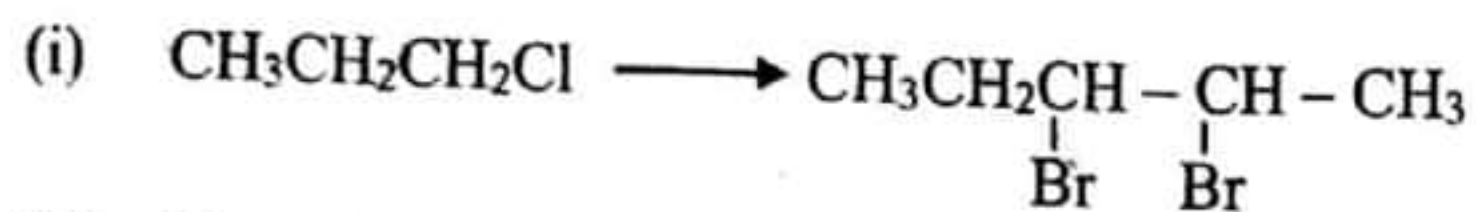
(ii) Show that how the $CH_3CH_2CH_2 - COOMgBr$ is synthesized using $CH_3CHBrCH_3$ as the only starting organic material.

(iii)

(iv)

(v) $CH_3CH_2CH_2CH_2Br \longrightarrow CH_3\underset{OH}{CH} - \underset{OH}{CH} - CH_3$

b) Show that how you are going to distinguish each from the following pairs of compound.

(i) $CH_3CH_2CH=CH_2$ and $CH_3CH=CHCH_3$

(ii)
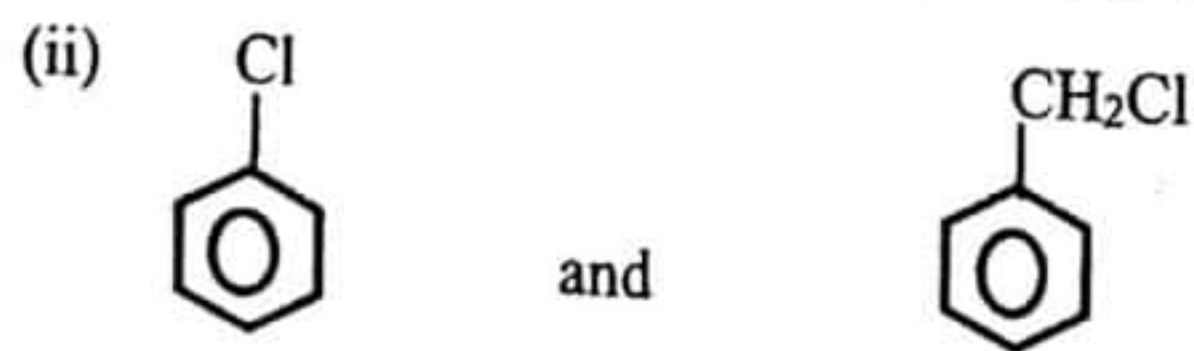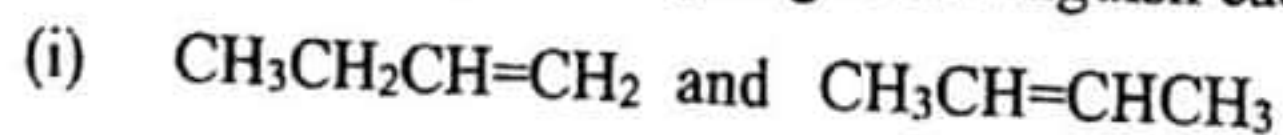
c) Consider the reaction between $CH_3CH_2CH_2Cl$ and $CH_3O^-Na^+$

(i) Draw the structures of two products which can be formed in the above reaction.

(ii) Write – down the mechanisms for the reactions relevant to products.