Chemistry 2025

Term Paper 03

Chemistry I

One hour and 15 minutes

Instructions:

- *Answer **all** the questions.*
- ***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 **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 (×) in accordance with the instructions given on the back of the answer sheet.*

Index Number:

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 $C = 3 \times 10^{8}\ m\ s^{-1}$

01) Consider the following discoveries regarding the atomic structure.

I. Charge of an electron using oil drop test.

II. Radioactive substances release three types of radiations.

The two scientists who were involved in the discoveries I and II above, respectively, are

01. J. J. Thomson and Henry Becquerel
02. Robert Millikan and Henry Becquerel
03. Robert Millikan and Ernest Rutherford
04. J. J. Thomson and Ernest Rutherford
05. Ernest Rutherford and Henry Becquerel

02) The number of electrons in the copper atom (Cu, Z = 29) with quantum numbers $l = 0$ and $m_l = +1$ are,

01. 7 and 6 02. 8 and 6 03. 7 and 5 04. 8 and 5 05. 10 and 6

03) The total number of Lewis structures that can be drawn for the following molecule is,

01. 1 02. 2 03. 3 04. 4 05. 5

04) The relative atomic mass of a natural boron sample made up of the isotopes $^{10}_{5}B$ and $^{11}_{5}B$ only, is 10.8. The percentage of the isotope $^{11}_{5}B$ in it would be, (assume that the relative atomic mass of an isotope is equal to its mass number.)

01. 80% 02. 8% 03. 20% 04. 0.8% 05. 92%

05) 1 mol of a hydrocarbon on complete combustion gave 3 mol of water. 90 cm^3 of oxygen, measured at S.T.P., were required for the complete combustion of 20 cm^3 of the hydrocarbon measured at S.T.P.. The molecular formula of the hydrocarbon is

01. C_2H_4 02. C_2H_6 03. C_3H_8 04. C_3H_6 05. C_3H_4

Vajira N. Seneviratne PhD (Cantab)

06) What is the false statement regarding ozone?

01. The central atom of ozone is sp^2 hybridized.
02. The two bond lengths of ozone are identical.
03. O – O – O bond angle of ozone is smaller than 120º.
04. The resonance hybrid of ozone can be shown as follows.

05. All oxygen atoms of ozone lay in the same plane.

07) The electronic configuration of the valence shell of the element that has the least tendency to form a diatomic molecule is

01. s^1p^0 02. s^2p^0 03. s^2p^3 04. s^2p^4 05. s^2p^5

08) A NaOH solution contains 12.0% of NaOH by mass. The density of the solution is 1.131 g cm^{-3}. What is the volume that contains 5 mol of NaOH? (Na = 23, H = 1, O = 16)

01. 0.024 dm^3
02. 0.177 dm^3
03. 1.00 dm^3
04. 1.47 dm^3
05. 1.67 dm^3

09) Consider the following molecules:

NF_3, CF_2Cl_2, OCl_2

When H atoms are substituted instead of the other atoms around the central atoms of all the above molecules, the oxidation number of the central atom of each molecule, respectively is,

01. increasing, not changing, decreasing
02. not changing, not changing, changing
03. decreasing, increasing, not changing
04. decreasing, decreasing, not changing
05. decreasing, decreasing, increasing

10) MnO_2 reacts with conc. HCl to form $MnCl_2$, Cl_2, and H_2O. When 43.5 g of pure MnO_2 and 1.2 mol HCl solution are subjected to react, the reactant consumed completely (i.e., the limiting reagent) and the amount of Cl_2(g) formed, respectively are,
(Mn = 55, O = 16, H = 1, Cl = 35.5)

01. MnO_2 and 21.3 g
02. HCl and 21.3 g
03. MnO_2 and 35.5 g
04. HCl and 35.5 g
05. HCl and 85.2 g

11) 250 cm^3 of oxygen was collected by the downward displacement of water at a temperature of 25 ºC and a pressure of 750 mm Hg. If the oxygen thus collected is dried at a temperature of 25 ºC and 750 mm Hg pressure, what volume will it occupy?
(Saturated vapour pressure of water at 25 ºC = 50 mm Hg)

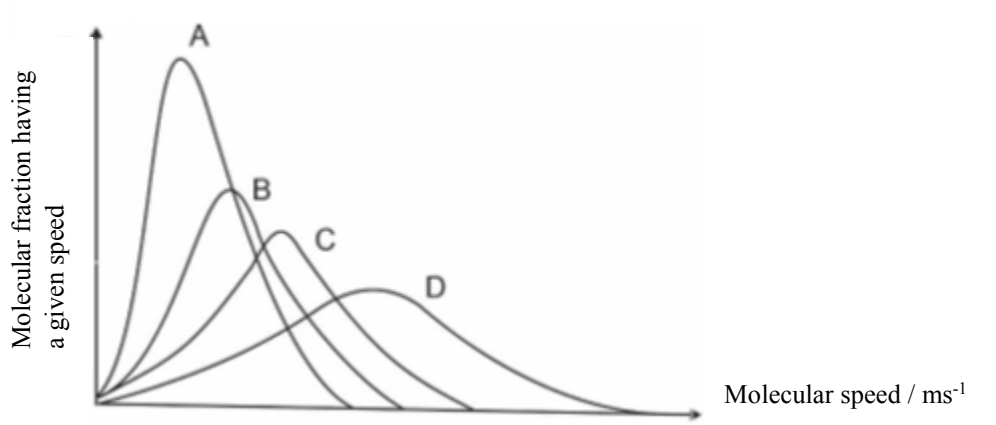
01. 233 cm^3 02. 244 cm^3 03. 250 cm^3 04. 255 cm^3 05. 266 cm^3

12) A solution prepared by dissolving 1 g of a sample containing KIO_3 is treated with an acidic solution containing excess KI. The released iodine is reacted with 0.003 mol dm^{-3} $Na_2S_2O_3$ solution. The required volume of $Na_2S_2O_3$ is 25 cm^3. The mass percentage of KIO_3 present in the sample is, (KIO_3 = 214)

01. 1.605×10^{-2}
02. 1.605
03. 3.21
04. 2.675×10^{-3}
05. 2.675×10^{-1}

13) 3.92 g of a mixture containing Fe_3O_4 and Fe_2O_3 was completely dissolved in dilute H_2SO_4 and a solution of 100 cm^3 was prepared. To titrate 25 cm^3 of this solution, 25 cm^3 of 0.02 mol dm^{-3} $KMnO_4$ was used. The mass percentage of Fe_3O_4 in the initial mixture is, (Fe_3O_4 = FeO. Fe_2O_3) (Fe=56, O=16)
01. 59% 02. 50% 03. 34% 04. 36% 05. 23%

14) At 300 K, the Maxwell - Boltzmann speed distribution of four gases is given below.



These A, B, C, D gases respectively are,
01. $H_2(g)$, $N_2(g)$, $O_2(g)$, $Cl_2(g)$
02. $Cl_2(g)$, $O_2(g)$, $N_2(g)$, $H_2(g)$
03. $H_2(g)$, $N_2(g)$, $Cl_2(g)$, $O_2(g)$
04. $H_2(g)$, $Cl_2(g)$, $N_2(g)$, $O_2(g)$
05. $O_2(g)$, $Cl_2(g)$, $N_2(g)$, $H_2(g)$

15) He gas is in a 5 dm^3 vessel at 300 K and at 1×10^5 Pa. What is the amount of He that should be removed from the initial amount to keep pressure at the same value (1×10^5 Pa) at 450 K temperature if the volume of the vessel remains constant?
01. $\frac{1}{4}$ 02. $\frac{1}{2}$ 03. $\frac{1}{3}$ 04. $\frac{3}{4}$ 05. $\frac{2}{3}$

16) $CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$ $\Delta H = -890$ kJ mol^{-1}
The false statement according to the above reaction is,
01. When one mole of $CH_4(g)$ is combusted, 890 kJ of heat is released.
02. When one mole of $CO_2(g)$ is formed, 890 kJ of heat is absorbed.
03. The enthalpy of $CO_2(g) + 2H_2O(l)$ is less than that of $CH_4(g) + 2O_2(g)$.
04. ΔS of this reaction is (-).
05. When forming 160 g of the products 1780 kJ of heat is released.

17) $O^-(g) + e \longrightarrow O^{2-}(g)$ $\Delta H^\ominus = +844$ kJ mol^{-1}
$O(g) + 2e \longrightarrow O^{2-}(g)$ $\Delta H^\ominus = +702$ kJ mol^{-1}
What is the electron gain enthalpy of O(g)?
01. -142 kJ mol^{-1} 03. +560 kJ mol^{-1} 05. +986 kJ mol^{-1}
02. +142 kJ mol^{-1} 04. -560 kJ mol^{-1}

18) A gaseous rocket fuel is produced by the thermal decomposition of a liquid hydrocarbon. One mole of the liquid hydrocarbon gives three molecules of gaseous rocket fuel. What is the volume of liquid hydrocarbon required to produce 25 m^3 of gaseous fuel under pressure 1×10^5 Pa and temperature 100 K? (molar volume of liquid hydrocarbon is 125 cm^3 mol^{-1})
01. 0.125 m^3 02. 0.375 m^3 03. 0.008 m^3 04. 0.024 m^3 05. 0.048 m^3

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

The above reaction is thermodynamically spontaneous at 298 K but not at higher temperatures. Which of the following is true regarding the reaction at 298 K?

01. ΔG, ΔH and ΔS are all positive.
02. ΔG, ΔH and ΔS are all negative.
03. ΔG and ΔH are negative, and ΔS is positive.
04. ΔG and ΔS are negative, and ΔH is positive.
05. ΔG and ΔH are positive, and ΔS is negative.

20) Select the reaction step which does not include in the Born -Haber cycle relevant to the formation of MgO (s).

01. $Mg(s) \longrightarrow Mg(g)$
02. $\frac{1}{2} O_2(g) \longrightarrow O(g)$
03. $Mg^{2+}(aq) + O^{2-}(aq) \longrightarrow MgO(s)$
04. $O(g) + e \longrightarrow O^-(g)$
05. $Mg(s) + \frac{1}{2} O_2(g) \longrightarrow MgO(s)$

- For each of the questions **21** to **25**, one or more responses out of the four 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)	(2)	(3)	(4)	(5)
Only *(a)* and *(b)* are correct	Only *(b)* and *(c)* are correct	Only *(c)* and *(d)* are correct	Only *(d)* and *(a)* are correct	**Any other** number or combination of responses is correct

21) Which of the following statements concerning the process of the formation of the bond between BF_3 and $N(CH_3)_3$ are/is true?

a. It could be assumed that initially an electron is temperately transferred from the N atom to the B atom.
b. It could be assumed that initially an electron is temperately transferred from the B atom to the N atom.
c. The B atom supplies a pair of electrons for the ionization of the bond.
d. The N atom supplies a pair of electrons for the formation of the bond.

22) Which of the following statements is/are true regarding ideal gases?

a. At constant temperature, the mean kinetic energy of the gas differs according to the molar mass.
b. At constant temperature, the mean kinetic energy of the gas does not differ based on the number of gas moles.
c. At constant temperature, the speed distribution of molecules differs according to the molar masses.
d. At constant temperature, the mean speed of a gas does not differ according to the molar mass of the gas.

23) If ideal gas behavior is assumed 7 g of N_2 gas,

a. has 5.6 cm^3 volume at the standard temperature and pressure.
b. has 0.5 mol of N_2 gas.
c. volume can be doubled by increasing temperature from 100 ºC to 200 ºC at constant pressure.
d. gives 0.25 atm partial pressure by mixing it in a 22.4 dm^3 vessel with 4 g of hydrogen at the standard temperature and pressure.

24) Which of the following statements is / are correct regarding the electromagnetic radiation?
   a. Travel in the velocity of light through the vacuum.
   b. The oscillation of the electric and magnetic fields of them is parallel to the direction of the waves.
   c. The various electromagnetic radiations differ from each other since their speeds are different from each other.
   d. These are periodic.

25) Which of the following statements is / are correct?
   a. Enthalpy is a state function and an extensive property.
   b. Heat is a state function and an extensive property.
   c. Density is an extensive property.
   d. Molar enthalpy is a state function and an intensive property.

- In question Nos. **26** to **30**, 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), and (5) that **best** fits the two statements 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 it does **not** explain the first statement
(3)	True	False
(4)	False	True
(5)	False	False

	First statement	Second statement
26)	H_3O^+ is planar.	There are three O-H bonds in H_3O^+.
27)	Valence shell electrons participate for the chemical bond formations.	Covalent bonds are formed by sharing the electrons.
28)	Wave length of the first line of the Balmer series is longer than the wave length of the first line of the Lyman series.	When Lyman and Balmer series are considered, Lyman series belongs to a region with higher wave lengths.
29)	The enthalpy of neutralization of strong acids and strong bases is constant.	The enthalpy of neutralization of weak acids and weak bases is quite different than that of the strong acids and strong bases.
30)	The van der Waals equation is collapsed at S.T.P.	At S.T.P., all gases behave according to the equation PV=nRT.

Periodic Table

1 **H**																2 **He**
3 **Li**	4 **Be**											5 **B**	6 **C**	7 **N**	8 **O**	9 **F**	10 **Ne**
11 **Na**	12 **Mg**											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 **K**	20 **Ca**	21 **Sc**	22 **Ti**	23 **V**	24 **Cr**	25 **Mn**	26 **Fe**	27 **Co**	28 **Ni**	29 **Cu**	30 **Zn**	31 **Ga**	32 **Ge**	33 **As**	34 **Se**	35 **Br**	36 **Kr**
37 **Rb**	38 **Sr**	39 **Y**	40 **Zr**	41 **Nb**	42 **Mo**	43 **Tc**	44 **Ru**	45 **Rh**	46 **Pd**	47 **Ag**	48 **Cd**	49 **In**	50 **Sn**	51 **Sb**	52 **Te**	53 **I**	54 **Xe**
55 **Cs**	56 **Ba**	**La-** **Lu**	72 **Hf**	73 **Ta**	74 **W**	75 **Re**	76 **Os**	77 **Ir**	78 **Pt**	79 **Au**	80 **Hg**	81 **Tl**	82 **Pb**	83 **Bi**	84 **Po**	85 **At**	86 **Rn**
87 **Fr**	88 **Ra**	**Ac-** **Lr**	104 **Rf**	105 **Db**	106 **Sg**	107 **Bh**	108 **Hs**	109 **Mt**	110 **Ds**	111 **Rg**	112 **Cn**	113 **Nh**	114 **Fl**	115 **Mc**	116 **Lb**	117 **Ts**	118 **Og**

57 **La**	58 **Ce**	59 **Pr**	60 **Nd**	61 **Pm**	62 **Sm**	63 **Eu**	64 **Gd**	65 **Tb**	66 **Dy**	67 **Ho**	68 **Er**	69 **Tm**	70 **Yb**	71 **Lu**
89 **Ac**	90 **Th**	91 **Pa**	92 **U**	93 **Np**	94 **Pu**	95 **Am**	96 **Cm**	97 **Bk**	98 **Cf**	99 **Es**	100 **Fm**	101 **Md**	102 **No**	103 **Lr**