



- This paper consists of **04** pages.
- 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 10**, pick one of the alternatives from (1), (2), (3), (4), (5) which is **correct or most appropriate** and underline the your response.

Index Number:

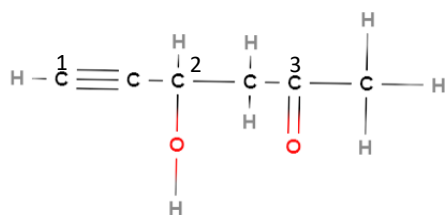
Universal gas constant $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

Planck's constant $h = 6.626 \times 10^{-34} \text{ J s}$

Avogadro constant $N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$

Velocity of light $c = 3 \times 10^8 \text{ m s}^{-1}$

- 1) Which of the following pairs of elements, have an equal number of unpaired electrons in their ground state?
- | | |
|-----------|-----------|
| 1. Cr, Co | 4. V, Cr |
| 2. V, Co | 5. Mn, Cr |
| 3. Fe, Co | |
- 2) There is a spectral line in the atomic spectrum of strontium at 662 nm. The energy of a photon at this radiation and the region of the electromagnetic spectrum are,
- | | |
|---|--|
| 1. $3 \times 10^{-19} \text{ J}$, Infrared | 4. $3 \times 10^{-28} \text{ J}$, Ultraviolet |
| 2. $3 \times 10^{-28} \text{ J}$, Visible | 5. $3 \times 10^{-19} \text{ J}$, Ultraviolet |
| 3. $3 \times 10^{-19} \text{ J}$, Visible | |
- 3) Correct order of ionic radius of Na^+ , Mg^{2+} , O^{2-} and F^-
- | | |
|--|--|
| 1. $\text{O}^{2-} > \text{F}^- > \text{Na}^+ > \text{Mg}^{2+}$ | 4. $\text{Mg}^{2+} > \text{F}^- > \text{Na}^+ > \text{O}^{2-}$ |
| 2. $\text{O}^{2-} < \text{F}^- < \text{Na}^+ < \text{Mg}^{2+}$ | 5. $\text{O}^{2-} > \text{Na}^+ > \text{F}^- > \text{Mg}^{2+}$ |
| 3. $\text{Na}^+ > \text{Mg}^{2+} > \text{O}^{2-} > \text{F}^-$ | |
- 4) Hybridization of labeled C atoms in the following molecule,



- | | |
|---|---|
| 1. $\text{C}_1 - \text{sp}^2$, $\text{C}_2 - \text{sp}$, $\text{C}_3 - \text{sp}^3$. | 4. $\text{C}_1 - \text{sp}$, $\text{C}_2 - \text{sp}$, $\text{C}_3 - \text{sp}^3$. |
| 2. $\text{C}_1 - \text{sp}^3$, $\text{C}_2 - \text{sp}$, $\text{C}_3 - \text{sp}^2$. | 5. $\text{C}_1 - \text{sp}^2$, $\text{C}_2 - \text{sp}^2$, $\text{C}_3 - \text{sp}^3$. |
| 3. $\text{C}_1 - \text{sp}$, $\text{C}_2 - \text{sp}^3$, $\text{C}_3 - \text{sp}^2$. | |

5) What is the mole fraction of 40% KMnO_4 solution by mass?

(Molar mass of $\text{KMnO}_4 = 158.0 \text{ g mol}^{-1}$)

1. 0.11
2. 0.93
3. 0.62
4. 0.07
5. 0.7

6) What is the pressure of a 5 liter/mole ideal gas at temperature 27°C ?

1. $2.52 \times 10^5 \text{ Pa}$
2. $3.84 \times 10^5 \text{ Pa}$
3. $4.44 \times 10^5 \text{ Pa}$
4. $4.99 \times 10^5 \text{ Pa}$
5. $5.3 \times 10^5 \text{ Pa}$

- For each of the questions 7 to 8, 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) 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 Instructions

(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

7) Which of the following statements is/are **false** regarding the increase of polarizing power in isoelectronic series?

- a) The size of the cation increases.
- b) The charge of the cation decreases.
- c) Charge density increases.
- d) The size of the cation decreases.

8) Which of the following reactions have a **balanced** chemical equation,

- a) $2\text{NH}_3(\text{g}) + 3\text{CuO}(\text{s}) \longrightarrow 3\text{Cu}(\text{s}) + \text{N}_2(\text{g}) + 3\text{H}_2\text{O}(\text{l})$
- b) $\text{H}_2\text{SO}_4(\text{aq}) + \text{NaOH}(\text{aq}) \longrightarrow \text{Na}_2\text{SO}_4(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$
- c) $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \longrightarrow \text{NH}_3(\text{g})$
- d) $3\text{Al}(\text{s}) + 3\text{NH}_4\text{ClO}_4(\text{aq}) \longrightarrow \text{Al}_2\text{O}_3(\text{s}) + \text{AlCl}_3(\text{s}) + 3\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{l})$

- In question Nos. 9 to 10, 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 does not explain the first statement
(3)	True	False
(4)	False	True
(5)	False	False

First Statement	Second Statement
9) The partial positive charge on hydrogen atom (δ^+) is much higher when it is bonded to a N, O or F atom.	The electronegativity difference between hydrogen and these atoms (N, O or F) are relatively higher.
10) The first ionization energy of P is greater than S.	The electron configuration of S is relatively stable than that of P.

Part A - Essay

01.

- a. X, Y, and Z are three adjacent, non-transition elements in the periodic table. X is a metal which has positive electron gain energy, and Y has 7 electrons with an angular quantum number equal to 1.
- I. Identify the X, Y, and Z elements.
 - II. Write the electron configuration for Z.
 - III. Y reacts with the HCl acid and forms YCl_3 and H_2 . Write the balanced equation for this reaction.
 - IV. Briefly explain why X has positive electron gain energy.
- b. A sample of oxygen gas of mass 6.4 g is contained in a rigid container of volume V at a temperature of 300 K and a pressure of 1.0×10^5 Pa. Another rigid vessel of volume V is connected to this vessel, and the gas is allowed to diffuse between the two vessels. After that, the temperature of connected vessels is increased to 400 K. Then X gas is added to the connected vessels at the same temperature until the pressure rises to 2.0×10^5 Pa. The required mass of X is 11.2 g. (O=16)
- I. Write the ideal gas law.
 - II. Calculate the relative molecular mass of X. Assume that the above two gases do not react with each other.
 - III. Write down another assumption you made in the calculation.
- c. A commercial HNO_3 aqueous solution with a density of 1.51 g/cm^3 has a purity of 53%. Calculate the volume of the above commercial solution required to prepare 500 cm^3 of a HNO_3 acid of concentration 1 mol dm^{-3} . (H=1, N=14, O=16)