

SECTION A: ANSWER ALL QUESTIONS -30 MARKS

1. (a) Molybdenum metal must absorb radiation with a minimum frequency of $1.09 \times 10^{15} \text{ S}^{-1}$ before it can eject an electron from its surface via the photoelectric effect.
- (i) What is the minimum energy needed to eject an electron? (6 marks)
- (ii) What wavelength of radiation will provide a photon of this energy? (7marks)
- (b) List the quantum numbers associated with an electron in an atom. Which of the quantum numbers governs (i) the shape of an orbital, (ii) the energy of an orbital. (6 marks)
- (c) Why does the Bohr model of the hydrogen atom violate the uncertainty principle? (4 marks)
- (d) What is the physical significance of the square of the wave function, Ψ^2 ? (3 marks)
- (e) State Hund's rule. (2 marks)

SECTION B: ANSWER ANY TWO QUESTIONS

Question 2

20 MARKS

- a. Write the electron configuration of:-
- Cr
 - Fe^{2+}
 - S^{2-}
 - Ga
- (8 marks)
- b. Briefly explain the following terms:
- Electron affinity
 - Ionization energy
- (4 marks)
- c. Using appropriate examples, give the definition of a base using both the theories of Brønsted-Lowry and Solvay systems. (6 marks)

- d. While the electron affinity of bromine is a negative quantity, it is positive for Kr. Use the electron configurations of the two elements to explain the difference. (4 marks)
- f. How do the sizes of atoms change as we move from left to right across a row in the periodic table? Explain your answer. (2 marks)

Question 3

20 MARKS

Indicate the type of hybridization of oxygen's, carbon's, chlorine's and silicon's AO's in the particles: H_2O , C_2H_2 , ClF_3 and SiF_6^{2-} , respectively. Evaluate your answer. Sketch the shape of the particles CH_4 , H_2O and ClF_3 . (20 marks)

Question 4

20 MARKS

- a) The configuration of the valence electron layer of an atom of an element is
- $5s^25p^3$
 - $4d^55s^1$

Determine the atomic numbers and names of the elements

(3 marks)

- (b) Sketch the shape and orientation of the following types of orbitals.

- P_x
- dz^2

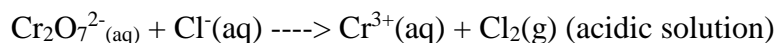
(4 marks)

- (c) In atoms of which elements is the first ionization energy higher-of nitrogen or oxygen?

Explain. What is the trend of I of elements down the groups in the periodic table of elements?

(4 marks)

- (d) Complete and balance this equation by the method of half-reactions:



(6 marks)

Question 5

20 MARKS

5. (a) What is the oxidation state of chromium in the following compounds?

(i) Cr_2O_3 (ii) $\text{K}_2\text{Cr}_2\text{O}_7$ (iii) $\text{Fe}(\text{CrO}_2)_2$ (3 marks)

(b) Indicate in which of the following skeleton reactions hydrogen peroxide is an iodizing agent and in which it is a reducing agent:

- i. $\text{I}_2 + \text{H}_2\text{O}_2 \text{ ----> HIO}_3 + \text{H}_2\text{O}$
- ii. $\text{PbO}_2 + \text{H}_2\text{O}_2 \text{ ----> Pb(OH)}_2 + \text{O}_2$
- iii. $\text{KClO}_3 + \text{H}_2\text{O}_2 \text{ ----> KCl} + \text{O}_2 + \text{H}_2\text{O}$
- iv. $\text{KMnO}_4 + \text{H}_2\text{O}_2 \text{ ----> MnO}_2 + \text{KOH} + \text{O}_2 + \text{H}_2\text{O}$

(4 marks)

(c) The hydrogen sulfite ion (HSO_3^-) is amphoteric.

- i. Write an equation for the reaction of HSO_3^- with water, in which the ion acts as an acid.
- ii. Write an equation for the reaction of HSO_3^- with water, in which the ion acts as a base.

In both cases identify the conjugate acid-base pairs.

(6 marks)

(d) A state inspector selected a bottle of vinegar suspected of being below the legal standards and sent it to you to analyze. Using 0.09594 M NaOH, you found that 5.00 mL sample of vinegar required 29.20 mL of the standard base to be fully neutralized. What was the molarity of the vinegar?

(The acceptable concentration of household vinegar is 0.7 to 0.8 M acetic acid). (2 marks)

.....

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

Speed of light, $c = 3.0 \times 10^8 \text{ ms}^{-1}$.