Part B- Structured Essay (110 marks)

1. (a)(i) Calculate the EAN of the metal centre in each of the following complexes
   I. $[Mn(CO)_5]^{2-}$
   II. $[Pt(NH_3)_4]^{2+}$ (10 marks)

   (ii) Co^{3+} forms stable complexes with the ligands NH_3, en and dien.
   I. Draw the structures of these complexes.
   II. List the complexes in the ascending order of stability. Give reasons for your answer. (en: $H_2N\text{-}CH_2\text{-}CH_2\text{-}NH_2$; dien : $H_2N\text{-}CH_2\text{-}NH\text{-}CH_2\text{-}CH_2\text{-}NH_2$) (15 marks)

   (iii) Identify the type of isomerism(s) in each of the following complexes. Draw the structures of the isomers.
   I $[Fe(NH_3)_3(H_2O)_3]^{3+}$
   II $[Fe(H_2O)5(NCS)]^{2+}$
   III $[Co(en)_2Cl_2]^{+}$ (15 marks)

   (b)(i) List the main assumptions made in the Crystal Field Theory (CFT).
   (ii) Crystal Field Splitting Energy (Δ) for $[IrCl_6]^{3-}$ is 27,600 cm^{-1}[Ir = $6s^25d^7$]. What is the wavelength of maximum absorption (λ_{max}) ? (h = 6.63×10^{-34}Js; c = 3×10^8 ms^{-1}).
   (iii) Using Crystal Field Theory, calculate the magnetic moment (μ) of the complex $[Rh(CN)_6]^{3-}$. Indicate whether it is diamagnetic or paramagnetic.
   ($\mu = [n(n+2)]^{1/2}$ B.M. where n is the number of unpaired electrons, atomic number of Rh = 45) (25 marks)

2.(a)(i) What is meant by the 'activity' of a radioactive sample?
   (ii) A Curie (Ci) is defined as the disintegration rate of 1g of radium-226.
   Show that 1 Curie = 3.7×10^{10} Bq.
   (Half- life of radium-226 is 1622 years). (15 marks)

   (b) Write complete nuclear equations for the nuclear reactions represented by the following:
   (i) ${}^{27}_{13}Al(\alpha, \ ){}^{30}_{15}P$ (ii) ${}^{10}_{5}B$(n, 2α) (iii) ${}^{6}_{3}Li$(, α) ${}^{3}_{1}H$ (15 marks)

   (c) Identify the following reactions as radioactive decay, fission, fusion and chain reactions.
   (i) ${}^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n$
   (ii) ${}^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e$
   (iii) ${}^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{135}_{53}I + {}^{97}_{39}Y + 4({}^{1}_{0}n)$ (15 marks)

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