

SEAT No. \_\_\_\_\_

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48J

Sardar Patel University Examination, January-2021  
M.Sc. (Inorganic Chemistry) Semester-III  
Nuclear Chemistry and Reaction Mechanism (PS03CINC22)  
2<sup>nd</sup> January 2021 (Saturday)  
Time: 10.00 am to 12.00 noon

Note: Numbers at the right show full marks.

Total Marks: 70

Q.1 [A]. Answer the followings:

[8]

- Which of the following elements is not radioactive in nature?  
(a) Radium (b) Osmium  
(c) Hassium (d) Actinium
- The last element of Uranium decay chain is \_\_\_\_\_.  
(a) Polonium (b) Bismuth  
(c) Lead (d) Thorium
- The radioactive isotope of Copper is easily separated by dissolving the target in \_\_\_\_\_.  
(a) dil. HCl (b) dil. H<sub>2</sub>SO<sub>4</sub>  
(c) dil CH<sub>3</sub>COOH (d) dil. HNO<sub>3</sub>
- The rate of exchange for Co/Co<sup>+2</sup> depends strongly on \_\_\_\_\_.  
(a) anion (b) ionization potential  
(c) solvent (d) none of these
- The following substitution reaction is an example of \_\_\_\_\_.  
$$ML_nX \rightarrow ML_n + X$$
$$ML_n + Y \rightarrow ML_nY$$
  
(a) dissociative mechanism (b) associative mechanism  
(c) interchange mechanism (d) interconversion mechanism
- Bulky ligands in an octahedral complex favor \_\_\_\_\_ during substitution reaction.  
(a) associative activation (b) dissociative activation  
(c) interchange mechanism (d) isomerization
- The d- or l- complex M(A-A)<sub>3</sub> \_\_\_\_\_.  
(a) can undergo racemisation via dissociation into M(A-A)<sub>2</sub> and free ligand A-A  
(b) can undergo racemisation via formation of M(A-A)<sub>4</sub>  
(c) can undergo racemisation via an intramolecular mechanism  
(d) cannot undergo racemisation
- The redox reaction of [CoCl(NH<sub>3</sub>)<sub>5</sub>]<sup>2+</sup> and Cr<sup>2+</sup>(aq) gives Co<sup>2+</sup>(aq) and [CrCl(OH<sub>2</sub>)<sub>5</sub>]<sup>2+</sup>. The addition of <sup>36</sup>Cl<sup>-</sup> in reaction did not give <sup>36</sup>Cl containing Cr-complex, which indicates involvement of \_\_\_\_\_ in redox reaction.  
(a) inner-sphere mechanism (b) outer-sphere mechanism  
(c) intramolecular ligand exchange (d) free radical mechanism

**Q.1 [B]. Answer the followings:**

[16]

- 1) Isotopes of certain unstable elements that spontaneously emit particles and energy from the \_\_\_\_\_.
- 2) Small amount of masses are converted into enormous amount of energy. State true or false.
- 3) Give the reaction for beta decay of Phosphorous-32.
- 4) What is Super Critical Mass of fissile material?
- 5) Isomer Shift in Mossbauer spectra \_\_\_\_\_ as oxidation state of metal ion increases.
- 6) The theoretical separation factor is \_\_\_\_\_ for the separation of Uranium isotopes using Mass Spectrograph.
- 7) The normal half-life of T<sub>2</sub>O in human is in between 9-14 days. State true or false.
- 8) For the separation of radioactive elements, \_\_\_\_\_ is a method which involves carriers.
- 9) Very small ions often form less labile complexes. State true or false.
- 10) In the following substitution reaction, the use of I<sup>-</sup> instead of Br<sup>-</sup> greatly increases the rate constant.  
$$[\text{PtCl}(\text{dien})]^+(\text{aq}) + \text{I}^-(\text{aq}) \rightarrow [\text{PtI}(\text{dien})]^+(\text{aq}) + \text{Cl}^-(\text{aq}) \quad \text{dien} = \text{diethylenetriamine}$$

It indicates that the rate determining step is dissociative. State true or false.
- 11) Suppose the value of nucleophilic discrimination factor (S) is high for the nucleophilic substitution reactions of a square planar complex. This indicates that the rate of the reaction is less sensitive to changes in the nucleophilicity of the entering group. State true or false.
- 12) The replacement of H<sub>2</sub>O in [Cr(OH<sub>2</sub>)<sub>6</sub>]<sup>3+</sup> by Cl<sup>-</sup>, Br<sup>-</sup> and NCS<sup>-</sup> is slower than the analogous reactions of [Cr(NH<sub>3</sub>)<sub>5</sub>(OH<sub>2</sub>)]<sup>3+</sup>. This is because of σ-donor of NH<sub>3</sub> ligands in [Cr(NH<sub>3</sub>)<sub>5</sub>(OH<sub>2</sub>)]<sup>3+</sup>. State true or false.
- 13) Small reorganization energy (λ) of a redox reaction indicates fast electron self-exchange in the reaction. State true or false.
- 14) If reductant and oxidant complexes are inert, the redox reaction proceeds through outer-sphere mechanism. State true or false.
- 15) The trans-[CoCl<sub>2</sub>(en)<sub>2</sub>]<sup>+</sup> complex (where, en = ethylenediamine) is chiral. State true or false.
- 16) In a redox reaction, oxidant and reductant change their oxidation state by an equal number of units. This is called as non-complementary electron transfer reaction. State true or false.

**Q.2. Answer any SEVEN of the followings:**

[14]

- 1) List out the differences between chemical reactions and nuclear reactions.
- 2) How the spent nuclear fuel is reprocessed?
- 3) Give two examples of electrochemical displacement.
- 4) How radio carbon is used to study the mechanism of photosynthesis?
- 5) Explain the exchange of ligands in metal complexes with free labelled ligands in solution.
- 6) Explain associative and dissociative mechanisms of nucleophilic substitution reactions of complexes with examples.
- 7) Write the mechanism of isomerization taking place during the substitution reaction of octahedral complexes.
- 8) Explain ligand chirality with an example.
- 9) Define racemisation of complexes with an example.

- Q.3.[A] Explain the nuclear reaction which takes place in hydrogen bombs. [4]  
[B] What is Nuclear Binding Energy? Explain with suitable example. Also, calculate the same for  ${}^7\text{Li}$ . [4]

Or

- Q.3. Explain the Group Displacement Law in detail. [8]

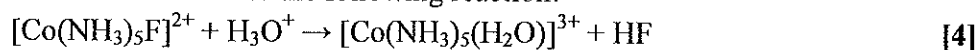
- Q.4.[A] Write a detailed note on Ortho and Para Hydrogen. [4]  
[B] Describe the thermal diffusion method for the separation of stable isotopes. [4]

Or

- [A] Explain the separation of unstable isotopes. [4]  
[B] Describe corrosion and passivity. [4]

- Q.5.[A] Discuss the trans effect in ligand substitution reactions of square-planar complexes giving suitable examples. [4]

- [B] Describe the mechanism of the following reaction:



Or

- [A] Discuss the leaving group effect on substitution reactions of octahedral complexes giving examples. [4]

- [B] Describe the mechanism of the following reaction:



- Q.6.[A] Describe the mechanism of racemisation of the complex  $\text{M}(\text{L-L})_3$ . [4]

- [B] Discuss the differences between inner-sphere and outer-sphere mechanisms for redox reactions. [4]

Or

- [A] Describe the mechanism of the reduction of  $[\text{CoCl}(\text{NH}_3)_5]^{2+}$  by  $\text{Cr}^{2+}(\text{aq})$ . [4]

- [B] Discuss the intramolecular mechanisms of racemisation. [4]

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