REV-01
MSC/35/40

2025/05

SET A

M.Sc. CHEMISTRY
FOURTH SEMESTER
ADVANCED INORGANIC CHEMISTRY
MSC - 402B

[USE OMR FOR OBJECTIVE PART]

Duration: 3 hrs. **Full Marks: 70**

Objective

Time: 30 min. **Marks: 20**

Choose the correct answer from the following: ***1×20=20***

1. What is the primary limitation of AB_5-type hydrides as hydrogen storage materials?
   a. Low storage capacity
   b. Limited reversibility
   c. High desorption temperature
   d. Poor thermal conductivity

2. What is the reason for the white color of Titanium dioxide (TiO_2)?
   a. Presence of electronic transitions in the visible region
   b. Large energy gap between valence and conduction bands
   c. Absorption of specific wavelengths of light
   d. Presence of impurities

3. What is the primary mechanism of hydrogen storage in graphene and carbon nanotube through weak van der Waals forces?
   a. Chemisorption
   b. Physisorption
   c. Absorption
   d. Desorption

4. What is the suitable bandgap energy range for a photocatalyst to absorb visible or UV light for water splitting?
   a. 0.5–1.5 eV
   b. 1.6–3.0 eV
   c. 3.5–5.0 eV
   d. 5.5–7.0 eV

5. Which of the following fullerides is known to exhibit superconductivity below ~20 K?
   a. Na_3C_{60}
   b. K_3C_{60}
   c. Rb_2C_{60}
   d. Cs_4C_{60}

6. Wilkinson's catalyst is represented as
   a. $[RhCl_4]$
   b. $[RhCl_4]$
   c. $[Rh(PPh_3)_4]$
   d. $[Rh(PPh_3)_4]$

7. In Fischer-Tropsch process, cobalt catalysts have
   a. A higher conversion rate and a long life.
   b. A lower conversion rate and a long life
   c. Lower conversion rate and a shorter life
   d. Low cost

8. In Steam Reforming
   a. Carbon monoxide is treated with hydrogen
   b. A lower conversion rate and a long life
   c. Natural Gas is mixed with oxygen
   d. Low cost

9. Ziegler-Natta catalyst consists of
   a. $TiCl_4$
   b. $Al(C_2H_5)_3$
   c. $TiCl_4$ in hydrocarbon solvent in presence of $Al(C_2H_5)_3$
   d. $Al(Cl)_3$

10. In Sharpless epoxidation
   a. Allyl alcohol or a derivative is oxidized with tertiary hydro peroxide in presence of a Chiral ligand
   b. Alcohol in presence of Zeigler-Natta catalyst
   c. Propyl alcohol is treated with Rhodium- alloy
   d. Butyl alcohol is treated with $TiCl_3$

11. For the photochemical reaction, $[Co(NH_3)_5(NCS)]^+ \rightarrow [Co(NH_3)_5(SCN)]^+$, which type of electron transition occurs?
   a. LMCT
   b. MLCT
   c. d-d
   d. No transition occurs

12. Charge transfer transition mainly gives rise to
   a. Photorecimization reaction
   b. Photoisomerization reaction
   c. Photoredox reaction
   d. None of the above

13. For the reaction, $[Co(NH_3)_6]^{3+} + H_2O \rightarrow [Co(NH_3)_5(H_2O)]^{3+} + NH_3$ electron occupies which molecular orbital of $[Co(NH_3)_6]^{3+}$ complex after photoexcitation of
   a. e_g
   b. e_g^*
   c. T_{2g}
   d. T_{2g}^*

14. Which of the following is true about prompt photochemical reaction?
   a. It takes long time to complete
   b. It initiates isomerisation reaction
   c. It initiates substitution reaction
   d. It initiates dissociation reaction

15. $[Cr(H_2O)_6]^{3+} + NCS \rightarrow [Cr(H_2O)_5(NCS)]^{2+} + H_2O$ this is an example of
   a. Photoanation reaction
   b. Photoredox reaction
   c. Photoisomerization reaction
   d. None of the above

16. Cu deficiency in human body leads to
   a. Menkes disease
   b. Wilson's disease
   c. Parkinson disease
   d. Vitiligo

17. Silicates and corals are
   a. Fossils
   b. Seaweed
   c. Polymers
   d. Biominerals

18. How many ATP molecules are needed to fix one molecule of nitrogen?
   a. 12
   b. 20
   c. 6
   d. 16

19. ---------- is a denitrifying bacteria.
   a. *Bacillus* b. *E. Coli*
   c. Fungi d. Agar-agar

20. The hydrogenase enzymes has turn over frequencies
   a. >10,000 cycles/s b. =10,000 cycles/s
   c. <10,000 cycles/s d. 20,000 cycles

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Descriptive

Time : 2 hrs. 30 mins. **Marks : 50**

[Answer question no.1 & any four (4) from the rest]

1. a. Discuss the properties and applications of complex hydrides (LiBH4 and NaBH4) as hydrogen storage materials. **3+2+3+2 =10**

   b. Give a brief account of the activation of small molecules by Coordination.

   c. Classify photochemical reactions for metal complexes.

   d. What is role of metallothionein in Zn metabolism.

2. Answer the following questions: **2+3+3+2 =10**
   a. Compare and contrast the properties of AB_2-type hydrides and BCC hydrides.

   b. What are the advantages and challenges of metal hydrides as hydrogen storage materials?

   c. What are white pigments? Give two examples with explanation.

   d. What is the difference in composition between "Egyptian Blue" and "Chinese Blue"? Explain, what electronic transitions are responsible for the blue color of "Egyptian Blue" and "Chinese Blue"?

3. a. Give the general mechanism of cobalt carbonyl catalysed hydro formylation reaction as proposed by Heek and Breslow. **5+5=10**

   b. Give an account of the rhodiumbased Monsanto Process for highly selective generation of ethanoic acid.

4. a. Discuss the characteristics of Wilkinson's Catalyst for generation ofalkene. 2+3+3+2 =10

b. How hydrogen and carbon monoxide can be converted to hydrocarbon and water by reaction over iron or cobalt catalysts by Fisher-Tropsch process?

c. Give a short account of the asymmetric oxidation where appropriate. chiral ligands can be used in conjunction with d-metal catalyst to introduce chirality.

d. Mention the electronic transitions that are responsible for photochemical reactions in metal complexes.

5. a. Discuss different types of photorearrangement reactions in detail with examples. 5+3+2 =10

b. Discuss Adamson's rule for photo substitution reactions with examples.

c. Discuss the laws involved in photochemical reactions.

6. a. Discuss the role of ligand field theory in explaining the electronic transitions and color properties of "Cobalt Aluminate" ($CoAl_2O_4$). 2+2+3+3 =10

b. What is the difference between intrinsic and extrinsic semiconductors? Write two applications of semiconductors.

c. Describe the mechanism of TiO_2 photocatalysis for water splitting.

d. Give three reasons why nitrogen fixers are unique.

7. a. Explain why d-d transition in metal complexes gives rise to photosubstitution and photoisomerization reactions with the help of MO diagram of the complex. 5+5=10

b. Explain the function of [Fe-Fe] hydrogenase in the hydrogen cycle

8. a. How does Iron Regulatory Protein (IRP) regulate if the Fe levels in the cellular level are high? 3+3+4 =10

b. What are the control mechanisms involved in the formation of biominerals?

c. Write the different types of proteins that regulate the Cu level in organisms. Briefly explain each of them.

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