Birla Institute of Technology & Science, Pilani, Rajasthan 333 031

Second Semester, 2022-2023

Course Number: CHEM F343 **Course Title: Inorganic Chemistry III** **Marks: 40**

Max Time: 75 min **Comprehensive Test (Closed Book)** **Date: May 17, 2023**

Part A

- **Answer all the questions**
- **Two different type of question are given**
- **1 mark will be deducted for two wrong answers (for only question number I (Q1 o Q15))**
- **Answers written within the box will be considered only**

[Useful values: h = 6.62 x 10^{-34}J-s; c = 3 x 10^{10}cm/s; 1 eV = 1.6 x 10^{-19}J; Bohr magneton of electron = 9.24 x 10^{-24}Am^2; electronic charge = 1.602 x 10^{-19}coulomb]

Name: **ID:**

Right answer ☐ **Wrong answer** ☐ **Obtained marks** ☐

I. Choose one correct answer from the given four options. Each question carries one mark. 15 x 1 = 15M

Q1. Which of the following metalloenzyme and metal cofactor is incorrectly matched?

(A) Methionine sythetase: Co; (B) Carbon monoxide dehydrogenase: Ni;
(C) Nitrogenase: Mo; (D) Purple acid phosphatase: Zn ☐

Q2. Nature has chosen Zn(II) ion at the active site of many hydrolytic enzymes because

(A) Zn(II) is a poor Lewis acid; (B) Zn(II) does not have chemically accessible redox state
(C) Zn(II) has high ligand field stabilization energy;
(D) Zn(II) forms weak complexes with oxygen donor ligands ☐

Q3. Find out the correct metal ion present and its' binding status in ribozyme.

(A) As a metal ion, Mg(II) ion present and it binds to the peptide through H-bonding
(B) As a metal ion, Mg(II) ion present and it binds to the RNA strand through H-bonding
(C) As a metal ion, Zn(II) ion present and it binds to the peptide through H-bonding
(D) As a metal ion, Zn(II) ion present and it binds to the RNA strand through H-bonding ☐

Q4. Telomere has

(A) G-quadruplex structure and can be appropriately stabilized by K^+ ion
(B) G-quadruplex structure and can be appropriately stabilized by Na^+ ion
(C) A-quadruplex structure and can be appropriately stabilized by K^+ ion
(D) A-quadruplex structure and can be appropriately stabilized by Na^+ ion ☐

Q5. Hydroxy apatite is a

(A) Mg(II) salt and possesses a hexagonal structure; (B) Mg(II) salt and possesses a pentagonal structure
(C) Ca(II) salt and possesses a hexagonal structure; (D) Ca(II) salt and possesses a pentagonal structure ☐

Name: **ID:**

Q6. Phospholipase A2 enzyme binds to

(A) the negatively charged substrate and contains Ca(II) ion that stabilizes the excess negative charge
(B) the positively charged substrate and contains Ca(II) ion that stabilizes the excess negative charge
(C) the negatively charged substrate and contains Mg(II) ion that stabilizes the excess negative charge
(D) the positively charged substrate and contains Mg(II) ion that stabilizes the excess negative charge

Q7. The reduced form of 4-iron ferredoxin is as follows:

(A) 4Fe(II); (B) 3Fe(II); 1Fe(III); (C) 2Fe(II); 2Fe(III); (D) 1Fe(II); 3Fe(III)

Q8. The blue type 1 copper protein

(A) has a distorted tetrahedral geometry and the blue coloration arises because of LMCT transition
(B) has a distorted tetrahedral geometry and blue coloration arises because of MLCT transition
(C) has a distorted square pyramidal geometry and blue coloration arises because of LMCT transition
(D) has a square pyramidal geometry and blue coloration arises because of MLCT transition

Q9. In the ETC process of respiration,

(A) The electron donor is $FADH_2$ is the electron donor and H^+ is the electron acceptor
(B) The electron donor is $FADH_2$ is the electron donor and O_2 is the electron acceptor
(C) The electron donor is NADH is the electron donor and H^+ is the electron acceptor
(D) The electron donor is NADH is the electron donor and O_2 is the electron acceptor

Q10. The products obtained in the glycolysis process is as follows:

(A) Net 2ATP, 2NADH and 1pyruvate; (B) Net 4ATP, $2NAD^+$ and 1pyruvate
(C) Net 4ATP, $2NAD^+$ and 2pyruvate; (D) Net 2ATP, 2NADH and 2pyruvate

Q11. Choose the correct option

(A) Oxygen molecule provide the energy to pump proton from cytosolic side to the matrix of mitochondria
(B) Oxygen molecule provide the energy to pump proton from the matrix of mitochondria to cytosolic side
(C) Electron transport provide the energy to pump proton from the matrix of mitochondria to cytosolic side
(D) Electron transport provide the energy to pump proton from cytosolic side to the matrix of mitochondria

Q12. The respiration process in *Desulfovibrio Vulgaris* bacteria,

(A) the electron is transported by cytochrome C3 and it is used to reduce SO_4^{2-} to SO_3^{2-}
(B) the electron is transported by cytochrome C3 and it is used to reduce SO_4^{2-} to S^{2-}
(C) the electron is transported by ATP dehydrogenase and it is used to reduce SO_4^{2-} to S^{2-}
(D) the electron is transported by ATP dehydrogenase and it is used to reduce SO_4^{2-} to SO_3^{2-}

Q13. In photosynthesis, the source of electrons is

(A) NADPH and it is transferred to PS-I; (B) NADPH and it is transferred to PS-II;
(C) H_2O and it is transferred to PS-I; (D) H_2O and it is transferred to PS-II

P.T.O.

Name: **ID:**

Q14. In photosynthesis,
(A) PSI absorbs at 680nm and the site for oxygen evolution;
(B) PSII absorbs at 680nm and the site for oxygen evolution;
(C) PSI absorbs at 700nm and the site for oxygen evolution;
(D) PSII absorbs at 700nm and the site for oxygen evolution; ☐

Q15. The complex responsible in water splitting in photosynthesis consisting of
(A) five equivalents of Mn(II) connected by oxo-bonds and four equivalents of water molecules
(B) five equivalents of Mn(II) connected by oxo-bonds and two equivalents of water molecules
(C) four equivalents of Mn(II), one equivalent of Ca(II) and two equivalents of water molecules
(D) four equivalents of Mn(II), one equivalent of Ca(II) and four equivalents of water molecules ☐

II. Write the correct answer inside the box provided (if a question has multiple answer, then equal weightage will be given to each answer): 25 x 1 = 25M

Q1. The concentration of Ca(II) is low in intracellular medium and the skeletal matter is primarily formed by Ca(II) salts. What is the reason? ☐

Q2. The movement of charged species across a biological membrane is dependent on ☐

Q3. The use of pre-existing ion gradients and membrane potentials to transport other solute molecules is termed as ☐

Q4. The distinct permeabilities of each ionic species results in the generation of diffusion potential that are named as ☐

Q5. The metal ions have high affinity for heteroatoms of the bases and hence it disrupts base pairing and stacking, so helixes gets destabilize. Which type of metal ions has these properties? ☐

Q6. The kinetics of self-assembled monolayer (SAM) formation involved two steps. The _____ angle is used to monitor the steps in SAM formation. ☐

Q7. The *cis*-platin is used for the treatment of cancer. The N7 of the base of _____preferably binds strongly to Pt(II) of *cis*-platin. ☐

Q8. $[Tc(CNR)_6]^+$ is used for imaging the heart. This complex is inert owing in part to their _____electronic configuration of the metal center. ☐

Q9. In MRI, the Gd(III) complexes are used as contrast agent because it has _____ and _____. ☐ ☐

Q10. Iron bearing siderophore complexes exhibit higher _____ character than ionophores and hence requires the assistance of membrane protein for translocation. ☐

Q11. The structure of the Na-K ATPase is composed of three sites. Site one and two overlap within both the _____states and the site three is exclusively in the _____ state. ☐ ☐

P.T.O.

Name: **ID:**

Q12. Iron cannot be transported around the body's circulation system as free iron, since it would be susceptible to _____ or _____.

Q13. Myoglobin and hemoglobins may bind _____and _____ oxygen molecules, respectively.

Q14. After oxygen ligation to heme iron, there is 15° reorientation of one αβ dimer relative to the other αβ dimer and 0.8 Å translation of $\alpha_2\beta_2$ relative to $\alpha_1\beta_1$. Which fact triggers this movement?

Q15. Diphosphoglycerate stabilizes the T-state of Hb. What is the reason?

Q16. The light ray falls on the front surface of a block with intensity I_0. The following phenomena are observed to occur: reflection, absorption and transmission. The intensity of the ray gets reflected from the back surface of the block is (if thickness of the block = x, absorption coefficient of block = α and reflectivity = R)

Q17. Ge is opaque to visible light. Why?

Q18. Write the full form of EDX and it is an accessory of which equipment?

Q19. According to the _____ theory, superconductivity occurs as a result of the formation of pairs of electrons known as _____.

Q20. The conductivity of the extrinsic semiconductor depends primarily on the ____and in a certain temperature range, is _____ of temperature.

Q21. The group of dielectric materials called _____ which primarily exhibit spontaneous polarization.

Q22. In_____, the maximum energy of the valence band occurs at a different value of momentum to the minimum in the conduction band energy.

Q23. Ferromagnetic materials are classified as _____.

Q24. Coercivity of magnetic particles depends upon the _____ of the particles. This is why in magnetic recording media we use _____.

Q25. Soft magnets produced from _____ have a high resistivity and therefore are less likely to heat than metallic ferromagnetic materials.

END

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Second Semester, 2022-2023

Course Number: CHEM F343 Course Title: Inorganic Chemistry III Marks: 55
Time: 105 min Comprehensive Test (Open Book) Date: May 17, 2023
Part B

- Answer all the questions
- All the part answers in a question to be written altogether
- **Your answers must be pointed to the questions; marks will be deducted for additional write-up against any question**

[Useful values: h = 6.62 x 10^{-34}J-s; c = 3 x 10^{10}cm/s; 1 eV = 1.6 x 10^{-19}J; Bohr magneton of electron = 9.24 x 10^{-24}Am^2; electronic charge = 1.602 x 10^{-19}coulomb; mobility of electron, μ_e = 0.39m^{2}V^{-1}s^{-1}; mobility of hole, μ_e = 0.19m^{2}V^{-1}s^{-1}]

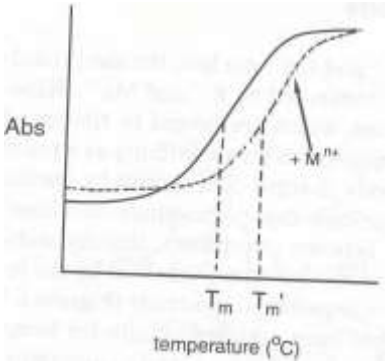
Q1. (a) Determine the wavelength of photons (in cm) produced when electrons excited into the conduction band of indium-doped silicon (i) drop from the conduction band to the acceptor band and (ii) then drop from the acceptor band to the valence band (band gap in intrinsic Si = 1.107 eV; the energy gap of acceptor and valence band in indium doped Si = 0.16 eV)
(b) (i) Prove that the magnetic susceptibility of a superconductor is -1.
(ii) Calculate the maximum magnetization is expected for the case of iron. (FCC structure; unit cell length = 2.866Å)
(c) The observed electronic polarization in nickel is 2 x 10^{-7} C/m^2. Determine the average displacement of the electrons relative to the nucleus of nickel (in meter) (unit cell length = 3.5167Å)
(d) (i) Write the factors responsible to stabilize the T-state of Hb (any three). (ii) How do these factors stabilizes the T-state of Hb? (iii) Show these diagrammatically (any two). [**6** + **6** + **6** + **6 = 24M**]

Q2. (a) State the specific roles of the first prosthetic group present on complex II embedded in the mitochondrial membrane for transporting electron in respiration (show the complete chemical reactions). **(b)** Show the chemical structures of this prosthetic group in oxidized and reduced form. **(c)** Name the complexes responsible to generate the proton motive forces across the mitochondrial membrane. How does it generate? [**6M**]

Q3. (a) State the names of the species responsible for generating/ or absorbing H^+ during transporting of electron across the thylakoid membrane of light reactions in photosynthesis (mention the thylakoid interior side or stroma side where the protons generated or absorbed). **(b)** Write down the corresponding reactions involved in generating / absorbing the protons (including the name of the enzymes / species which is responsible). [**6M**]

Q4. (a) Recently scientists are trying to mimic some part of the photosynthetic system. Which part of the photosynthetic system being attempted to mimic and why? **(b)** What are the components required to mimic this system? **(c)** Give an example of one system which may be considered to accomplish it? [**7M**]

Q5.



In the above figure, the variation of absorbance property of DNA with increasing temperature (bold one) is shown here. In another plot (dotted one), the same variation of absorbance of DNA and alkali metal ion complexes with increasing temperature is shown. Answer the following questions. **(a)** Why does the absorbance of DNA increases with increasing temperature? **(b)** Why does the DNA metal ion complexes show relatively higher melting point as compared to the sole DNA? **(c)** Why does it show the red shifted absorbance with varying the metal ion from low to high concentration (not shown the Figure)? [**6M**]

Q6. (a) An efficient fluorescence based probe will have a high stokes shift to separate the emission from the autofluorescence. Explain the terms Stokes' shift and the autofluorescence (write answer within one line for each case). **(b)** *cis*-Platin is useful in cancer treatment while the *trans*-platin is not useful - explain. **(c)** PDT therapy is an emerging technique to kill the cancerous cells efficiently. (i) What are the things required in this therapy to kill cancerous cells? (ii) Name the generated species responsible to kill the cancerous cells. [**6M**]

END