Birla Institute of Technology & Science, Pilani, Rajasthan 333 031
Second Semester, 2021-2022

Course Number: CHEM F343 **Course Title: Inorganic Chemistry III** **Marks: 40**
Max Time: 90 min **Comprehensive Test (Closed Book)** **Date: May 14, 2022**

Instructions

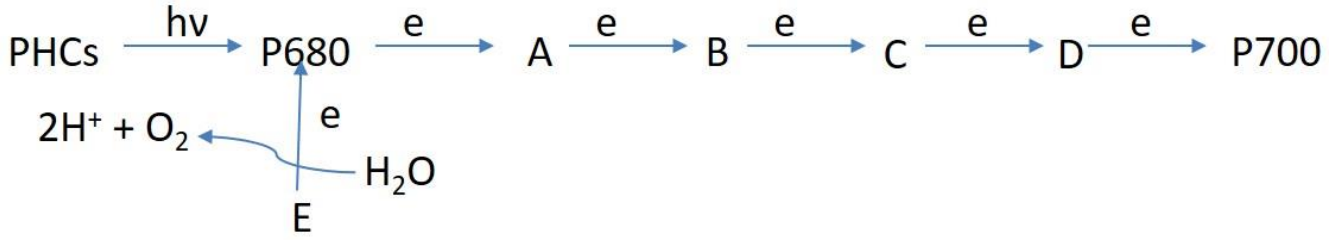
- Answer all the questions
- Answers to be pointed
- All the part answers in a question to be written altogether

[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}]

Q.1 The following complex K[Ru(Hedta)Cl] (H_4edta = ethylenediaminetetraacetic acid) are used for cardiovascular diseases scavenger.
(a) Draw the chemical structure of the complex.
(b) Draw the structure of the resulting complex after scavenging. What is the driving force for the formation of this complex.

1.5 + (1.5 + 1) = 4M

Q.2(a) (i) Show that Fe_3O_4 is an inverse spinel.
(ii) State the specific role of the metal ions in that oxide which help to orient the cells in an external magnetic field in magnetotactic bacterial.
(b) In the photosynthesis process, electron moves through the following electron transport chain:



(i) Write down the name of the species A, B, C and D. (ii) Write down the molecular formula of E. (iii) What is the full form of PHCs?
(c) Ruthenium(II) forms well known donor (D)-acceptor (A) complexes. The common framework is shown below.

(i) Which part(s) of these framework is responsible for photoexcitation, water splitting and hydrogen formation. (ii) Show the appropriate chemical reactions of water splitting and hydrogen formation

(2.5 + 2.5) + 3 + 0.5 x 3 + 1.5 = 11M

Q.3 (a) Draw the chemical structure of 2,3-diphosphoglycerate. Why does the species show an allosteric inhibitor? Justify it.

(b) Draw the chemical structure of Hemerythrin in both deoxygenated and oxygenated forms (indicate the oxidation states of Fe in both cases; mention the form of oxygen in bound state)

3 + 5 = 8M

Q4. (a) (i) A superconducting tin has a critical temperature of 3.7 K at zero magnetic field and a critical field of 0.0306 Tesla at 0 K. Find the critical field at 2 K.

(ii) Determine the magnetic susceptibility and the magnetic permeability of a superconductor.

(b) Find the resistance of an intrinsic Ge rod 1 mm long, 1 mm wide and 1 mm thick at 300 K. The intrinsic carrier density 2.5×10^{19} m^{-3} is at 300 K.

(c) We find that 20% of the original intensity of a beam of photons is transmitted from air through a 1-cm thick-material having a dielectric constant of 2.3 and back into air. Determine the fraction of the beam that is (i) reflected at the front surface, (ii) absorbed in the material, and (iii) reflected at the back surface, (iv) Determine the linear absorption coefficient of the photons in the material ($n_{material} = 1.5166$).

6 + 5 + 6 = 17M

END

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Time: 90 min **Comprehensive Test (Open Book)** **Date: May 14, 2022**

- Answer all the questions
- Answers to be pointed
- All the part answers in a question to be written altogether

[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 = 180cm^{2}V^{-1}s^{-1}; Atomic weight of Ni, 58.7; Density of Nickel, 8906 kgm^{-3}; permittivity of free space, ε_0 = 8.854 x 10^{-12} Fm^{-1}]

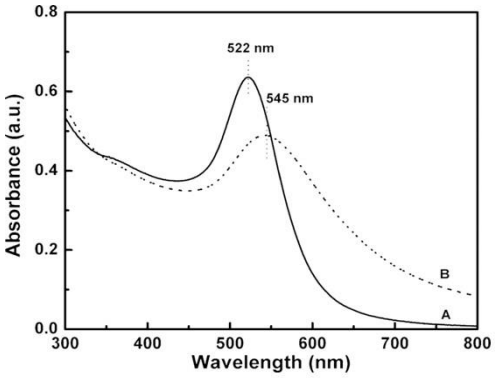
Q1 In the following figure, absorbance spectra, color and the sizes of two gold nanoparticles are shown. Answer the following questions:

(a) The gold nanoparticles (as compared to bulk) absorbs intensely – why? What is the nature of the absorbance band? How does it arise?

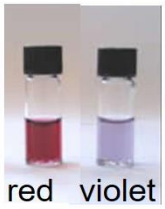
(b) Name the microscopy which shows the image below (in F).

(c) Fill in the Table given below.

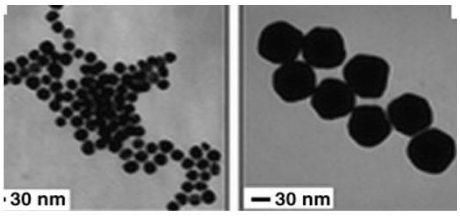
Absorbance (λ_{max}, nm)	Color	Size
522 nm	?	?
545nm	?	?



D



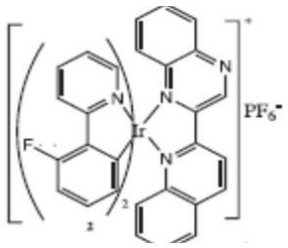
E



F

3 + 1 + 2 = 6M

Q 2(a) This iridium(III) complex has the potentially to penetrate the cell. What is the most important attribute of it which make it possible to penetrate the cell? Justify it.
(b) This compound stains the cytoplasm successfully. State the important characteristics of this complex which turns it a potential staining agent in comparison to a common organic staining agent (any three).



2 + 3 = 5M

Q3 (a) A pancreatic hydrolytic enzyme contains alkaline metal ions as an activator. The presence of lysine residues helps it to bind the negatively charged substrate. (i) Write the name of the enzyme. (ii) Draw the chemical structure of the substrate and the hydrolysed product(s). (iii) What is the name of activator in this enzyme? (iv) Differentiate of activator with the prosthetic group.

(b) In a metabolic process, ubiquinone transfers the electrons to another species (A) which is sequentially transferred to other species (B) and finally it is transferred to an iron containing enzyme (C). The sequence of reactions is given below:

$$\text{Ubiquinone (Q)} + 2H^+ + 2e \longrightarrow QH_2$$

$$QH_2 \longrightarrow A\ (Fe^{3+}/Fe^{2+}) \longrightarrow B\ (Fe^{3+}/Fe^{2+}) \longrightarrow C\ (Fe^{3+}/Fe^{2+})\ \text{Enzyme}$$

Write down the (i) chemical structure of QH_2; (ii) State the names of the species A, B and C?

(4 x 1) + (1 + 1 x 3) = 8M

Q4 (a) (i) Draw the dissociation curve of Mb and Hb with oxygen molecule. (ii) Mb has better storing power of oxygen than Hb – put three points to justify the statement using the drawn dissiciation curve. (iii) What is the shape of the binding curve of Hb with oxygen? Which attribute of Hb is resulted from the shape shown by the curve? (iv) Plot the binding curve of oxygen with Hb present in muscle tissues and the Hb present in lungs. What difference is expected for these two kinds of Hemoglobins?
(b) Check the following Table.

A	B	C
Allosteric activator	?	?
Allosteric inhibitor	?	?

B-column: R state or T state
C-column: Low pH or High pH
Fill in the B and C columns appropriately. Justify your answer.

(1 + 2 + 2 + 2) + 4 = 11M

Q5 (a) The saturation magnetic induction of Nickel is 0.65 Wbm^{-2}. Calculate the magnetic moment of the nickel atom in Bohr magneton.

(b) Calculate the electronic polarization of argon atom. Given relative permittivity = 1.0024 at NTP and number of atoms per unit volume = 2.7×10^{25} atom m^{-3}.

5 x 2 = 10M

END