



Comprehensive Examination, 01 May 2018

Maximum Marks: 100

Duration: 2 hours 30 minutes

OPEN BOOK

NOTE

1. There are TWO pages in the question paper with SIX questions.
2. Start answer each question from a new page, all subsections together
3. Use PEN only for both answering and drawing. NO PENCIL USE

Q1. (a) Indicate the special feature of Siroheme prosthetic center which causes efficiency in the unit by drawing the structure. How does the feature help for its efficiency? [2+2]

(b) Among 3Fe-4S and 4Fe-4S ferredoxins, which one will be suitable for 2 electron reduction process? Justify your answer. [3]

(c) Cu(II)/Cu(I) (Azurin); Heme [Fe(III)/Fe(II)] (Cytochrome c); Heme [Fe(III)/Fe(II)] (Cytochrome P-450). What should be the appropriate sequence of these proteins in a particular metabolic cycle? How do you support the sequence of your choice? [4]

(d) Usually the redox centers hold tetrahedral geometry. Why? According to you, could square planar geometry be equally effective? provide reason for your answer. [2+2]

Q2.(a) How is the oxygen affinity of hemoglobin affected by H^+ and Cl^- ion concentrations? Provide reason to support you answer. [2+2]

(b) Why is the chlorophyll chosen by nature to run photosynthesis? Could haem unit be a choice? Justify. [2+2]

(c) What is the magnetic property of copper in bulk? This typical property is also observed in biological systems. Identify. Which analytical technique can justify this property? [3]

(d) What is the expected electrical conductivity of graphene? How do compare its property with that of diamond in the light of band structure? [1+3]

Q3. (a) Assuming that the conductivity for copper is entirely due to free electrons [with mobility of $3.5 \times 10^{-3} \text{ m}^2/(\text{V}\cdot\text{s})$], compare the density of free electrons in copper with the density of atoms and calculate the drift velocity of the free electrons for an electrical field strength of 0.5 V/m. [Given: $\rho_{\text{Cu}} = 8.93 \text{ g}\cdot\text{cm}^{-3}$ and atomic mass = 63.55 amu] [6]

(b) When Si is doped with B, p-type semiconductor gets generated. Instead of B, is Be a better choice? Justify your answer with the help of band structure. [1+2]

(c) Ge appear opaque to visible light, but it is transparent to the longer wavelength. How does it happen? [3]

(d) Is there any benefit of incorporation of Al into zeolite framework? Explain. [3]

Q4. (a) The magnetization within a bar of some metal alloy is $1.2 \times 10^6 \text{ A/m}$ at an H field of 200 A/m. Compute (i) the magnetic susceptibility (ii) the permeability (iii) the magnetic flux density within this material. (iv) what type of magnetism would you suggest as being displayed by this material and why? [Given $\mu_0 = 1.257 \times 10^{-6} \text{ H/m}$]. [8]



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(b) Calculate the saturation magnetization for Fe_3O_4 , given that each cubic unit cell contains 8 Fe^{2+} , who only contribute in magnetization and unit cell edge length = 0.839 nm. [Hint: Saturation magnetization is directly proportional to the number of Bohr magneton per cubic meter only] [5]

Q5.(a) Zinc selenide has a band gap of 2.58 eV. Over what range of wavelengths of visible light is it transparent? [3]

(b) Certain MOF $\text{WS}_4\text{Cu}_4^{2+}$, shows red colour with H_2O and green colour with $\text{C}_2\text{H}_5\text{OH}$ within it. How is the experimental data justified? [2+2]

(c) Nanomaterials have huge applications in catalysis. Why? Artificial photosynthesis when catalysed by nanomaterial, which property of nanomaterials is/are actually explored? [2+2]

(d) What is embedded mechanism of the release of active molecules from a carrier grafted with Coumarin in presence of light? What is expected result when release of active molecule is carried out in presence of heat? [3+1]

Q6.(a) Mention roles of surfactants for the synthesis of mesoporous materials? What property of surfactant makes it so important in this regards? Justify whether inverse micellization is more effective over normal micellization. [3+2+2]

(b) What is hydrothermal technique widely used in material chemistry? Typically which are the materials are synthesized by technique? [2+2]

(c) What is the typical property of semiconductor so that it could used as solar cell? Explain. [3]

(d) Among silicon and silver, who will be better choice to be used as solar cell and why? [3]

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