

**JADAVPUR UNIVERSITY**

**B.E. POWER ENGINEERING SECOND YEAR FIRST SEMESTER-2023**

**Subject: CHEMISTRY OF ENERGY SCIENCE**

**Time: 3 Hrs**

**Full Marks: 100**

**General instructions: Internal Choices are provided.**

**Answer any 4 Questions:**

- 1a) Mention the names of the electron carriers responsible for the electron transport mechanism in Photosynthesis. [5]
- b) Explain the formation of ATP mentioning the role of the binuclear Mn protein complex in context with Photo system-II. [8]
- c) Give a detailed outline of the structural and functional unit responsible for photosynthesis. [8]
- d) Why mitochondrion is considered as the powerhouse of the cell? [4]

OR,

- e) Explain with the help of schematic diagram the mechanism of cellular respiration of energy transfer in mitochondria considering the anaerobic pathway. [10]
- f) Mention the role of P-700 Chlorophyll involved in the photosynthetic electron transfer. [10]
- g) Mention the wavelengths of light absorbed by chlorophyll-a,b and carotenoids. [5]
- 2a) Mention a few characteristics of a good fuel. What is meant by ranking of coal? Distinguish between HTC and LTC. [4+2+5]
- b) Why is CNG preferred over gasoline or LPG? Mention the composition of LPG and mention its calorific value. What is meant by octane rating of a fuel? [3+3+2]
- c) A sample of coal was analyzed as follows:

Exactly 2.500 g was weighed into a silica crucible. After heating for an hour at 110<sup>o</sup>C, the residue weighed 2.415 g. The crucible was then covered with a vented lid and strongly heated for exactly 7 minutes at 950 ± 20<sup>o</sup>C. The residue weighed 1.528 g. The crucible was then heated without the cover, until a constant weight was obtained. The last residue was found to weigh 0.245 g. Calculate the percentage of moisture, volatile matter, ash and fixed carbon content in the coal sample. [6]

OR,

[ Turn over

d) Calculate the gross and net calorific value of coal having the following composition: C=85%  
H=8% S=1%N=2%Ash=4%; Latent heat of steam=587cal/g [5]

e) Write short notes on the following: (Any 4) [4x5=20]

i. Coal Gas

ii. Refining of petroleum

iii. Producer gas

iv. Significance of ultimate analysis of coal

v. Anti-knocking agents and their function

vi. Tidal energy

3a) What is reverse osmosis? Explain with a diagram. Mention its advantages and disadvantages. [2+4+2]

b) Calculate the amount of lime and soda required for softening 18000L of water which is analyzed as follows:

Temporary hardness = 25 ppm, Permanent hardness=20ppm, Permanent Mg hardness=15 ppm [8]

c) What is meant by alkalinity? Mention its types and how will you determine alkalinity of water? [2+4=6]

d) How can you determine DO by Winkler's method? [3]

OR,

e) Mention the merits and demerits of Lime-Soda process. [5]

f) Calculate the amount of lime and soda needed for softening a water sample which contains the following impurities. Given:  $\text{Ca}^{2+}$ =20 ppm  $\text{SO}_4^{2-}$ =24 ppm,  $\text{Mg}^{2+}$ =18 ppm,  $\text{HCO}_3^-$ =183ppm (atomic masses of Ca=40, Mg=24,  $\text{HCO}_3^-$ =61,  $\text{SO}_4^{2-}$ = 96) [8]

g) Explain the methods of sequestration in conjunction with water treatment. [6]

h) Give equations to explain the sedimentation with addition of coagulants to purify municipal waste water. [6]

4a) What are fuel cells? How does a fuel cell differ from a storage cell? Mention the different types of fuel cell. [3+3+4=10]

b) Write short notes on the following: [4x2=8]

i. Bio fuel

ii. Lead storage Battery

c) What are primary cells? Mention the composition, reactions involved in a dry cell. [2+5=7]

OR,

d) Why photovoltaic cells are replaced by organic solar cells? Mention the working principle of an organic solar cell. What are the two types of organic solar cell available? Mention a few advantages of using such cells in industry. [3+3+2+2=10]

e) Give a diagrammatic representation of Methanol-Oxygen fuel cell. Highlight on the following points: [5+5=10]

i. Composition of the cell

ii. Electrode reactions involved in the cell

iii. EMF generated and applications of the cell

iv. Fate of the product obtained.

f) Write down the reactions taking place in solid oxide fuel cells. What are its applications and advantages over other fuel cells? [2+2+1=5]

**Question 1= CO1 – Describe the chemistry of photosynthesis and energy transfer process in cells. (K2)**

**Question 2= CO2 – Classify fossil fuels, explain their properties and solve the stoichiometric calculations (K2)**

**Question 3= CO3 – Illustrate the water treatment plant of thermal power plants and describe DM water properties (K3)**

**Question 4= CO4—Assess the chemistry of devices like solar cell, battery, fuel cell, super capacitor. (K3)**