

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:

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

OR

1. e) Explain with the help of schematic diagram the mechanism of cellular respiration showing energy transfer in mitochondria considering the glycolysis pathway.
- f) Mention the role of P-700 Chlorophyll involved in the photosynthetic electron transfer.
- g) Name the different chlorophylls which are included in photosynthetic systems.

[10+10+5]

2. a) Mention a few characteristics of a good fuel. What is meant by ranking of coal? Distinguish between GCV and NCV. (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 number and cetane number? (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°C,

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the residue weighed 2.415 g. The crucible was then covered with a vented lid and strongly heated for exactly 7 minutes at $950 \pm 20^\circ\text{C}$. 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

2. 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) (4*5=20)

- i. Aviation fuel
- ii. Refining of petroleum
- iii. Producer gas
- iv. Significance of proximate analysis of coal
- v. Anti-knocking agents and their function
- vi. OTCE

3. a) Mention a few advantages of hot lime soda process. How can one remove scales from boilers? (5+3=8)
- b) A water works has to supply $1 \text{ m}^3/\text{s}$ of water. Raw water contains: $\text{Mg}(\text{HCO}_3)_2=219$ ppm, $\text{Mg}^{2+}=36$ ppm, $\text{HCO}_3^-=18.3$ ppm, $\text{H}^+=1.5$ ppm. Calculate the cost of treating water per day, if lime (90% pure) and soda (95% pure) cost Rs 500 per ton and Rs 7000 per ton respectively. Given: Molecular weight of $\text{Mg}(\text{HCO}_3)_2$ is 146, atomic mass of Mg is 24, HCO_3^- is 61 and H+ is 1 (8)
- c) What is meant by sequestration? How can you remove boiler scales by Calgon conditioning process? (2+4=6)
- d) How can you prevent caustic embrittlement? (3)

OR

3. e) Distinguish between scale and sludge (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 HCO_3^- =183ppm (atomic masses of Ca=40, Mg=24, HCO_3^- =61, SO_4^{2-} = 96) (8)

- g) Explain the terms Priming and Foaming in conjunction with boiler corrosion. (6)
- h) Give equations to explain the formation of acids by dissolved salts and carbon dioxide in boiler corrosion. (6)
4. a) 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: (4*2=8)
- i. Aviation fuel ii. Ni-Cad Battery
- c) What are secondary cells? Mention the composition, reactions involved in a lead acid battery. (2+5=7)

OR

4. 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 Hydrogen-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 an alkaline battery. What are its advantages over a dry cell? Mention its EMF and uses. (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)