

QP Code : 03294

(2½ Hours)

[Total Marks : 75

- N.B.** (1) All questions are **compulsory**.
 (2) **Figures** to the **right** indicate **full** marks.
 (3) Use of **logarithmic table / non-programmable** calculator is **allowed**.

Physical Constants

$$N = 6.022 \times 10^{23}$$

$$k = 1.38 \times 10^{-23} \text{ JK}^{-1}$$

$$F = 96,500 \text{ coulombs}$$

$$R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$$

$$h = 6.625 \times 10^{-34} \text{ J. s.}$$

$$c = 3.1 \times 10^8 \text{ ms}^{-1}$$

$$\frac{2.303RT}{F} = 0.0592 \text{ at } 298 \text{ K}$$

$$\pi = 3.142$$

1. Attempt any **three** of the following :—

- State any three merits and two drawbacks of collision theory. **5**
- With the help of neat labeled diagram explain the stop flow method used to study the kinetics of fast reactions. State the advantages of this method. **5**
- Explain the low resolution NMR spectrum of methanol and ethanol. **5**
- Discuss the viscosity method of determining molar mass of polymers. **5**
- A polymer sample is composed of chains of three distinct molecular weights 2×10^4 , 3×10^4 and 4×10^4 in the ratio 1 : 2 : 1. Calculate \bar{M}_n and \bar{M}_w **5**
- Explain the following terms with suitable diagrams in NMR spectroscopy : **5**
 - Flipping of a proton
 - Larmor precession.

2. Attempt any **three** of the following :—

- Define an expression for determination of pH using quinhydrone electrode in acidic and alkaline medium. **5**
- Define decomposition potential. Describe the experimental method for determination of decomposition potential. **5**
- State any two objectives of electroplating. **2**
 - The overvoltage of hydrogen on a certain cathode is 0.44V. Calculate the minimum voltage that must be applied to evolve hydrogen on this cathode from a solution of pH = 3.6 **3**
- Describe the principle, construction and working of the silicon solar cell with the help of a neat labeled diagram. **5**
- The emf of the cell **5**

$$\text{Ag} \mid \text{KCl (0.1M)} \mid \text{calomel electrode}$$

is 0.0390V at 298K. Calculate the solubility product and solubility of AgCl in pure water at 298K. (γ of KCl = 0.769)
- Name the cathode and anode used in the lithium ion cell. **2**
 - State any three advantages of hydrogen as a fuel. **3**

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3. Attempt any **three** of the following :—

- (a) Describe the principle, construction and working of GM counter. 5
- (b) (i) Explain secular radioactive equilibrium. 2
- (ii) Calculate the weight of ^{235}U in equilibrium with 1g of ^{231}Th . The half life of ^{235}U is 6.97×10^9 years while that of ^{231}Th is 22.4 hours. 3
- (c) Explain the basic components of a nuclear power reactor. 5
- (d) Discuss the use of radioisotopes as tracers in Friedel-Craft's reaction and ester hydrolysis. 5
- (e) For ^{27}Al (n, γ) reaction Q value is 6.569MeV. If the mass of ^{27}Al and the neutron is 26.990080 amu and 1.0089830 amu respectively. Calculate the mass of the product nucleus. 5
- (f) Explain the thermonuclear reactions on earth. 5

4. Attempt any **three** of the following :—

- (a) Explain any two limitations of classical mechanics. 5
- (b) (i) State and explain Heisenberg's Uncertainty Principle. 2
- (ii) A cricket ball weighing 50g is to be located within $0.2 \times 10^{-10}\text{m}$ What is the uncertainty in its velocity ? 3
- (c) The first order reflection maxima from (100), (110), (111) planes of a given crystal occur at 7.2° , 10.2° and 12.5° respectively. What type of a lattice does the crystal possess ? 5
- (d) Derive Bragg's equation $n\lambda = 2d \sin \theta$. 5
- (e) Explain the following with suitable examples : 5
 - (i) Linear operator
 - (ii) Commutative operator.
- (f) State and explain any two laws of crystallography. 5

5. (A) Choose the correct answer :— 4

- (a) Ultracentrifuge method for determination of molecular weight requires _____ quantities of synthetic macromolecules.
 - (i) large
 - (ii) small
 - (iii) both
- (b) _____ is a natural polymer.
 - (i) cellulose
 - (ii) Melamine
 - (iii) Nylon.
- (c) A nucleus containing even number of protons and even number of neutrons will have _____ spin.
 - (i) zero
 - (ii) integral
 - (iii) half integral.
- (d) The rate of the reaction is _____ to the energy of activation.
 - (i) directly proportional
 - (ii) inversely proportional
 - (iii) not proportional.

OR

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(A) State whether **True** or **False** :—

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- (p) Silk is an example of an inorganic polymer.
- (q) According to the activated complex theory of reactions rates, the rate constant of a reactions is given by $K = \frac{RT}{Nh} e^{-\Delta G^\ddagger/RT}$
- (r) The ratio of weight average molecular weight to number average molecular weight is called polydispersity index.
- (s) $^{10}_5\text{B}$ has zero spin.

(B) Match the following :—

4

Column M**Column N**

- | | |
|-------------------------------|--|
| (a) Glass electrode | (i) Bacon |
| (b) ΔS | (ii) $-nFE$ |
| (c) ΔG | (iii) ion selective electrode |
| (d) Hydrogen oxygen fuel cell | (iv) $nF \left(\frac{\partial E}{\partial T} \right)_P$ |
| | (v) $\left(\frac{\partial E}{\partial T} \right)_T$ |
| | (vi) Redox electrode |

OR(B) State whether **True** or **False** :—

4

- (p) Quinhydrone electrode can function satisfactorily in highly acidic solutions.
- (q) $E_G = E^\circ_G + 0.05916 \text{ pH}$
- (r) If the temperature coefficient is positive the emf of the cell decreases with rise in temperature.
- (s) Calomel electrode is used in the experimental determination of overvoltage.

(C) Choose the correct answer :—

4

- (a) In a breeder reactor ^{238}U is converted into _____ .
- (i) $^{238}_{92}\text{Pu}$
- (ii) $^{238}_{93}\text{Pu}$
- (iii) $^{238}_{92}\text{Pu}$
- (b) An ideal phosphor should have _____ scintillation efficiency.
- (i) low
- (ii) high
- (iii) medium
- (c) The change $^{30}_{15}\text{P} \rightarrow ^{30}_{40}\text{Si}$ requires the emission of :
- (i) α particle
- (ii) positron
- (iii) neutron

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- (d) In nuclear transmutation _____ .
- total charge and number of nucleons is conserved.
 - only total charge is conserved.
 - neither total charge nor number of nucleons are conserved.

OR

(C) State whether **True** or **False** :—

4

- ^{235}U is called fissile material.
- Radiative equilibrium is essentially an irreversible equilibrium.
- In artificial radioactivity there are no radioactive series of elements formed.
- $^{14}_7\text{N} + ^4_2\text{He} \rightarrow ^{17}_8\text{O} + ^1_1\text{H}$ is an example of (α , n) type of nuclear transmutation.

(D) Choose the correct answer :—

3

- The wave function _____ .
 - should be finite, single valued and continuous.
 - should be discontinuous.
 - should be infinite and single valued.
- The expression of the de Broglie's equation is :
 - $\lambda = h.p$
 - $\lambda = \frac{h}{p}$
 - $p = h\lambda$
- NaCl molecule has _____ elements of symmetry.
 - 23
 - 22
 - 24

OR

(D) State whether True or False :—

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- $\frac{1}{x}$ is not an eigen function of the operator $\frac{d^2}{dx^2}$
 - A total of four Na^+ ions belongs to a unit cell.
 - X-rays are produced in a Coolidge tube.
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