QP Code : 03298

(2½ Hours) **[Total Marks : 75**

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

Physical Constants

$N = 6.022 \times 10^{23}$
$F = 96500$ C
$R = 8.314$ J K^{-1} mol^{-1}
$h = 6.626 \times 10^{-34}$ J s
$C = 3 \times 10^{8}$ m s^{-1}
$m_e = 9.100 \times 10^{-31}$ kg
C = 12
0 = 16
1 amu = 931 MeV
1 amu = 1.66×10^{-27} kg
$\pi = 3.142$

1. Attempt any **three** of the following :—
   (A) Define dipole moment. Explain the structure of BF_3 and NH_3 on basis of dipole moment. **5**
   (B) What is meant by Raman effect ? What are stokes and anti stokes lines ? How do they differ from Rayleigh line. **5**
   (C) Show that the frequency of fundamental, first and second overtone bands are in the ratio 1 : 2 : 3 for anharmonic oscillator. **5**
   (D) Obtain a relationship between moment of inertia and bond length of a diatomic molecule undergoing rotational motion. **5**
   (E) Calculate the bond length of carbon monoxide molecule, if the rotational constant of the molecule is 1.90×10^{2} m^{-1}. **5**
   (F) What is meant by zero point energy ? Calculate the zero point energy of a molecule whose vibrational frequency is 2×10^{5} m^{-1}. **5**

2. Attempt any **three** of the following :—
   (A) Explain : (i) Wave Particle duality **5**
   (ii) Heisenberg's Uncertainity Principle.
   (B) State Schrodinger wave equation for a particle in three dimensional motion. Identify the terms involved. Give the properties of wave function. **5**
   (C) Explain the term commutative operators. Find whether the two operators $\hat{A}$ and $\hat{B}$ commute or not, if $\hat{A} = 2x^2$ and $\hat{B} = \frac{d}{dx}$. **5**
   (D) What is meant by eigen function and eigen value ? Find eigen function and eigen value for sin 4x when it is operated by $\frac{d^2}{dx^2}$. **5**
   (E) What is meant by electroplating ? Explain the process and theory behind it. **5**
   (F) Explain the Tafel's theory of hydrogen overvoltage. **5**

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3. Attempt any **three** of the following :—
   (A) Describe the construction and working of hydrogen oxygen fuel cell. **5**
   (B) Answer the following :—
      (i) Give the merits of fuel cell. **2**
      (ii) Explain why hydrogen is called the fuel of the future. **3**
   (C) Explain why ethanol gives three peaks in NMR spectra. **5**
   (D) Name the internal standard used for production of NMR spectra. Why is it used ? What are the peak positions of the internal standard ? **5**
   (E) What are fast reactions ? Describe the stop flow method to study the kinetics of stop flow method. **5**
   (F) State the important assumptions of collision theory. Give merits and limitations of this theory. **5**

4. Attempt any **three** of the following :—
   (A) Explain the term radioactive equilibrium. How does it differ from chemical equilibrium ? **5**
   (B) Describe the construction and working of Gieger Muller counter. **5**
   (C) What is meant by tracers ? Explain how they are used to study mechanism of hydrolysis of esters. **5**
   (D) Name the basic components of a nuclear reactor and explain them. **5**
   (E) Calculate the Q-Value and threshold energy of the nuclear reaction. **5**

   $^{27}_{13}Al + {}^{4}_{2}He \rightarrow {}^{30}_{14}Si + {}^{1}_{1}H$

   ^{27}Al = 26.982 amu, ^{4}He = 4.0030 amu

   ^{30}Si = 29.9847 amu, ^{1}H = 1.0078 amu

   (F) ^{90}Sr decays to ^{90}X by β–emission. What will be the weight of ^{90}X in equilibrium with 1g of ^{90}Sr. The half life of ^{90}Sr is 28 years and that of ^{90}X = 63 hour. **5**

5. (A) Choose the correct answer :— **4**
   (a) The dipole moment of p-dichlorobenzene is _____ .
      (i) Unity
      (ii) Zero
      (iii) greater than one
   (b) Which of the following molecule is microwave active ?
      (i) H_2
      (ii) O_2
      (iii) HCl
   (c) Number of vibrational modes in H_2O are
      (i) 3
      (ii) 4
      (iii) 9
   (d) _____ can be classified as out of plane vibrations.
      (i) Rocking
      (ii) Scissoring
      (iii) Wagging.

OR

(A) State **True** or **False** of the following :— **4**

(p) The rotational lines on the higher frequency side constitute R-branch lines of vibrational rotational spectra.

(q) The heavier isotopic molecule has smaller value of the rotational constant B as compared to lighter isolopic molecule.

(r) Dipole moment is scalar quantity.

(s) According to Rule of Mutual exclusion, IR active molecule are Raman active too.

5. (B) Choose the correct answer :— **4**

(a) $\hat{A}.C\,f(x) = C.\hat{A}\,f(x)$, where C is a constant is _____ operator.

(i) Linear

(ii) Sound

(iii) Stationary

(b) The waves associated with motion of electron are _____ waves.

(i) Progressive

(ii) Sound

(iii) stationary

(c) When the operator d/dx operators on wave function $\psi = 8e^{4x}$, the eigen value is

(i) 8

(ii) 4

(iii) 4x

(d) The overvoltage is given by the relation _____ , where E_d is decomposition potential and E_r is reversible potential.

(i) $\eta = E_d + E_r$

(ii) $\eta = E_d - E_r$

(iii) $\eta = E_d \times E_r$

OR

(B) State **True** or **False** of the following :— **4**

(p) The classical mechanics could not explain the phenomenon of black body radiation.

(q) Operators exist in classical mechanics.

(r) Decomposition potential depends on the temperature at which electrolysis is carried out.

(s) Simultaneous deposition of two metals from the same solution is possible if their deposition potentials are same.

5. (C) Choose the correct answer :— **4**

(a) The reversible potential of lithum ion cell is _____ .

(i) greater than 3.0V

(ii) less than 3.0V

(iii) 2.0V

(b) In fuel cells, the electrode reactions are _____ .

(i) reversible
(ii) irreversible
(iii) at equilibrium

(c) The spin of $^{13}_{6}C$ is _____ .

(i) half integral
(ii) integral
(iii) zero

(d) The energy of the activated complex formed as an intermediate in a chemical reaction has energy _____ products.

(i) greater than
(ii) less than
(iii) equal to

OR

(C) State **True** or **False** of the following :— **4**

(p) According to activated complex theory, the rate of reaction is given by rate of decomposition of activated complex into the products.

(q) Fuel cells are galvanic cells.

(r) The most widely used solvent in NMR spectra is $CDCl_3$.

(s) The relaxation process is the one in which proton in lower energy state goes to a higher energy state.

5. (D) Choose the correct answer :— **3**

(a) One Curie is _____ disintegrations per second.

(i) 3.7×10^{10}
(ii) 3.7×10^{7}
(iii) 10^{6}

(b) The best projectile that can be used in nuclear transmutation reactions is _____ .

(i) proton
(ii) neutron
(iii) deutron

(c) K-electron capture is characteristic of _____ .

(i) natural radioactivity
(ii) artificial radioactivity
(iii) nuclear transmutation.

OR

(D) State **True** or **False** of the following :— **3**

(p) Fission of ^{235}U is brought about by fast neutrons.

(q) ^{232}Th is fertile material.

(r) During exoergic nuclear reaction, energy is evolved.