QP Code : 77149

(1)

(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:

$N = 6.022 \times 10^{+23}$
$k = 1.38 \times 10^{-23} \, JK^{-1}$
$F = 96500$ coulombs
$R = 8.314 \, Jmol^{-1}K^{-1}$
$h = 6.624 \times 10^{-34} \, J.s$
$c = 3.0 \times 10^{8} \, ms^{-1}$
$\pi = 3.142$
$\dfrac{2.303 \, RT}{F} = 0.05916$ at 298K.
1 amu = 931 MeV.
Mass of electron = 9.109×10^{-31} kg

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

(A) Explain the term dipole moment and discuss the structure of   5
   (a) BF_3 and NH_3 molecules
   (b)   Cis and trans isomers
on the basis of their dipole moment.

(B) Describe the effect of presence of isotopes on the rotational spectra leading to   5
the deformed spectra.

(C) What is zero point energy?   5

Calculate zero point energy, if the vibrational frequency of a molecule is $3 \times 10^{5} \, m^{-1}$.

(D) For an anharmonic oscillator show that the frequencies of fundamental band, first   5
overtone and second overtone are in the ratio 1:2:3.

(E) Explain the terms:-   5
   (i)   Stoke's lines
   (ii)   Anti-stokes lines
   (iii)   rule of mutual exclusion

(F) Define force constant and state it's significance. Calculate force constant, if   5

vibrational frequency of a diatomic molecule is $1.0 \times 10^{14} \, s^{-1}$ and reduced mass

is 1.2×10^{-27} kg.

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2. Attempt any three of the following:-
    (A) Explain the concept of wave particle duality. Derive de-Broglie equation for matter 5
        waves. 5
    (B) State postulates of quantum mechanics. 5
    (C) State schrondiger's time independent wave equation and explain the terms involved. 5
    (D) Describe the phenomenon of (a) Black body radiation (b) Compton effect. Why
        they can not be explained by classical mechanics? 5
    (E) Define decomposition potential and describe its experimental determination. 5
    (F) Define overvoltage.
        In the electrolysis of H_2SO_4, the overvoltage on Ni cathode is 0.35V. If the current
        density is increased by eight times, what is the new value of overvoltage?
        (b= 0.12V at 298K)

3. Attempt any three of the following:-
    (A) What are solar cells? Describe the construction and working of silicon solar cell. 5
    (B) State any five advantages of hydrogen as universal energy medium. 5
    (C) Explain 'methanol has 2 peaks in NMR', while ethanol has 3 peaks'. 5
    (D) What is meant by relaxation in NMR? Explain spin-spin and spin-lattice relaxation 5
        processes.
    (E) State important assumptions, merits and drawbacks of collision theory. 5
    (F) Discuss the Lindemann's theory for unimolecular reactions. 5

4. Attempt any three of the following:-
    (A) Describe principle and working of G.M. counter, with the help of labelled diagram. 5
    (B) Calculate one millicurie mass of ^{235}U, if its half life is 7.2×10^8 years. 5
    (C) Write an informative note on radioactive equilibrium. Distinguish between 5
        radioactive and chemical equilibrium.
    (D) Define threshold energy. Calculate Q value and E_{Th} for following reaction. 5
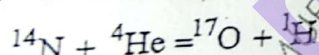
    $^{14}N + {}^4He = {}^{17}O + {}^1H$
    $m_N = 14.00$ amu, $m_{He} = 4.0034$ amu
    $m_O = 17.0021$ amu, $m_H = 1.0072$ amu

    (E) With the help of schematic diagram, describe working of different components 5
        of nuclear power reactor.
    (F) How are radioisotopes used as tracers in chemical analysis? Explain their use in 5
        the determination of mechanism of following reactions.
        (a)   Hydrolysis of esters   (b)   photosynthesis

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JD-Con. 3885-16.

(A) State **True** or **False**:-
  (a) Homonuclear molecules are microwave active.
  (b) The minimum value of rotational energy is one.
  (c) p-dinitrobenzene has zero dipole moment.
  (d) Rotational constant is also called as Bjerrum's constant.

4

OR

(A) Fill in the blank with appropriate choice.

4

  (p) Rotational constant is_____to moment of inertia.
    (i) directly proportional (ii) equal
    (iii) inversely proportional
  (q) For, Rayleigh scattering,_____.

    (i) $\bar{v}_s < \bar{v}_i$ (ii) $\bar{v}_s = \bar{v}_i$

    (iii) $\bar{v}_s > \bar{v}_i$

  (r) For a molecule to be Raman active, there must be a change in_____on absorption of light.
    (i) frequency (ii) polarizability
    (iii) dipole moment
  (s) For a non-linear molecule, the total number of modes of vibration are given by
    (i) 3n-4 (ii) 3n-5
    (iii) 3n-6

5. (B) Fill in the blank with appropriate choice.

4

  (a) The wave function (Ψ) must be_____valued.
    (i) single (ii) double
    (iii) infinite
  (b) If $\hat{A}\hat{B} \ f(x) = \hat{B}\hat{A} \ f(x)$, then the two operators $\hat{A}$ and $\hat{B}$ are said to be _____operators.
    (i) linear (ii) commutative
    (iii) additive
  (c) _____involves producing a thin coating of metal on given surface by electrodeposition.
    (i) electrolysis (ii) electroplating
    (iii) electrophoresis
  (d) Simultaneous deposition of two metal ions occurs, provided the discharge potential of these two ions is _____.
    (i) different (ii) same
    (iii) high

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(4) OR

(B) State True or False:-
(p) The base metal to be coated is made anode and coating metal is made cathode in electroplating process.
(q) Overvoltage is susceptible to presence of impurities.
(r) Photoelectric effect can be explained on the basis of classical mechanics.
(s) For standing waves, nodes are the points of zero displacement.

5. (C) Fill in the blanks with appropriate choice:-
(a) The spin of proton is_____.
(i) $\frac{1}{2}$　　　(ii) $\frac{3}{2}$　　　(iii) 1

(b) _____method is used to study the ultra-fast reactions.
(i) Short-flow　　(ii) Stop-flow　　(iii) Slow-flow

(c) Batteries are devices which convert _____energy into electrical energy.
(i) solar　　(ii) chemical　　(iii) mechanical

(d) Total number of possible orientations of a nucleus are given by
(i) $I + 1$　　(ii) $2I + \frac{1}{2}$　　(iii) $2I + 1$

OR

(C) Match the following:-
(p) Fast reaction
(q) Slow reaction
(r) Internal standard
(s) Fuel cell

(i) TMS
(ii) Lithium ion cell
(iii) 10^{-7} to 10^{-4} dm3.mol^{-1} s^{-1}
(iv) 10^2 to 10^5 dm^3.mol^{-1}.s^{-1}
(v) Bacon's cell
(vi) 10^{-4} to 10^{-1} dm^3.mol^{-1}.s^{-1}

5. (D) Fill in the blanks with appropriate choice.
(a) Nuclear fission reaction is not self sustainable, if_____
(i) K<1　　(ii) K = 1　　(iii) K>1

(b) Geiger - Nuttal rule is given as
(i) $\log_{10} A = B + \log_{10} R$　　(ii) $\log_{10} \lambda = A + B \log_{10} R$
(iii) $\log_{10} \lambda = A \log_{10} R + B$

(c) Rutherford activity of a radioelement means_____
(i) 1 dps　　(ii) 3.7×10^6 dps
(iii) 10^6 dps

OR

5. (D) State True of False:-
(p) In secular equilibrium, the half life of parent element is far greater than half life of daughter element.
(q) The penetration power of γ rays is very low while ionization power is very high.
(r) ^{238}U is a fertile material while ^{235}U is a fissile material.

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