-Library 09/04/15 B.Sc (VI)
* Physical Chem

Q.P. Code : 14564

(2½ Hours) [Total Marks : 75

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

Physical Constants.

$N = 6.022 \times 10^{23}$
$k = 1.38 \times 10^{-23}$ J / K
$F = 96{,}500$ C
$R = 8.314$ J / mol / K
$h = 6.626 \times 10^{-34}$ J.s
$c = 3.0 \times 10^{8}$ m / s $\pi = 3.142$
$\frac{2.303\,RT}{F} = 0.0592$ at 298 K
Mass of electron $= 9.109 \times 10^{-31}$ kg
1 amu = 931 MeV $= 1.66 \times 10^{-27}$ kg

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

(a) Explain the term force constant as applicable to vibrational spectra. A solution of CO in an inert solvent shows IR absorption radiation at 2.14×10^{5} m^{-1}. Calculate the force constant of the C-O bond, if the reduced mass of CO is 1.14×10^{-26} kg. 5

(b) Show that the frequency separation of successive lines in rotational spectrum of a diatomic molecule is given by 2B, where B is rotational constant. 5

(c) A diatomic molecule was exposed to radiation of frequency 2.22×10^{6} m^{-1}. If the frequency difference between the first stoke's line and first Anti-stoke's line is 7.22×10^{4} m^{-1}. Calculate - 5
(i) Raman shift (ii) Frequencies of both lines.

(d) Explain the use of dipole moment measurement in differentiating between 5
(i) cis and trans isomers
(ii) linear and non-linear molecules
by giving suitable examples.

(e) Explain the different types of stretching and bending modes of vibration in a molecule citing example of H_2O molecule. 5

(f) Show that the frequencies of fundamental band, first overtone and second overtone bands are in the ratio 1 : 2 : 3 in the vibrational-rotational spectrum of an anharmonic oscillator. 5

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

(a) State whether the following functions are eigen functions of the operator $\frac{d^2}{dx^2}$ and find its eigen value. (i) sin 3x (ii) $5x^3$ 5

(b) In the electrolysis of 2 N H_2SO_4 using Nickel electrodes, the hydrogen overvoltage was 0.36 V for a given current density. What will be the hydrogen overvoltage for the same cathode if the current density is increased 5 times of the present value (Given b = 0.12 at 298 K). 5

(c) State and explain any three postulates of quantum mechanics. 5

(d) Describe the limitation of classical mechanics in explaining the 5
(i) Photoelectric effect (ii) Compton effect

(e) State Schrodinger's time independent wave equation and explain the terms involved in it. Give any two characteristics of wave function. 5

(f) Explain the experimental determination of overvoltage. 5

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

(a) Explain following terms with respect to NMR 5
(i) Chemical shift (ii) spin-lattice relaxation.

(b) Explain Lindemann's theory of reaction rates for unimolecular reactions. 5

(c) Explain the construction and working of solar cell. 5

(d) What are shielded and deshielded protons ? Explain the low resolution spectrum of ethyl alcohol. 5

(e) Explain the classification of chemical reactions based on rate of reaction, giving examples. 5

(f) What are secondary cells ? With respect to lithium ion cell, explain the anode, cathode and eletrolytes used, in the cell. 5

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

(a) Explain the construction and working of G. M. Counter. 5

(b) The half life period of ^{226}Ra is 1600 years. 5
Calculate - (i) decay constant
(ii) weight of one millicurie of ^{226}Ra.

(c) Explain the construction and overall working of nuclear power reactor. (diagram necessary) 5

(d) Distinguish between Chemical and Radioactive equilibrium. 5

(e) Explain how radioactive isotopes are useful as tracers in determination of reaction mechanism, giving examples. 5

(f) Calculate Q-value and threshold energy for the following nuclear reaction. 5

$^{14}_{7}N + {}^{4}_{2}He \longrightarrow {}^{17}_{8}O + {}^{1}_{1}H$

Given : Isotopic masses in a.m.u.

$^{14}N = 14.0075$ amu $\quad {}^{17}O = 17.0045$ amu

$^{4}He = 4.0038$ amu $\quad {}^{1}H = 1.0081$ amu

5. Attempt any **fifteen** of the following. Choose the correct answer.

(1) Force constant of C – C bond is _____ than C ≡ C bond. 1

(a) more (b) less (c) equal

(2) Rule of mutual exclusion is applicable to _____. 1

(a) CO (b) CO_2 (c) H_2

(3) When molecule obeys selection rule then _____ for rotational spectra. 1

(a) $\Delta J = \pm 1$ (b) $\Delta J = \pm 0$ (c) $\Delta J = \pm 2$

(4) When dipole moment is zero, molecule has same substituents at _____. 1

(a) meta position (b) Ortho position (c) para position

(5) For stoke's lines in Raman spectra _____. 1

(a) $\nu_i = \nu_s$ (b) $\nu_i > \nu_s$ (c) $\nu_i < \nu_s$

(6) Pure rotational spectra is shown by _____. 1

(a) H_2 (b) HCl (c) O_2

(7) The eigen value for sin 2x is _____. 1

(a) + 4 (b) – 4 (c) + 2

(8) Following is the slowest step as per Tafel's theory in hydrogen gas evolution at cathode. 1

(a) Transfer of H^+ to electrode surface.

(b) Neutralization of H^+.

(c) Combination of two atoms of hydrogen to form a molecule.

(9) Tetramethylsilane has _____ equivalent protons. 1

(a) 8 (b) 12 (c) 10

(10) As per uncertainty principle, 1

$\Delta x \times \Delta p \geq$ _____.

(a) $\frac{h}{4\pi}$ (b) $\frac{h}{2\pi}$ (c) $\frac{h}{2\pi c}$

(11) The fundamental equation of de Broglie's theory of wave-particle duality is _____. 1

(a) $\lambda = \frac{hm}{v}$ (b) $\lambda = \frac{h}{mv}$ (c) $\lambda = \frac{h}{mc}$

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(12) If $\hat{A}[f(x)+m(x)] = \hat{A} f(x) + \hat{A} m(x)$, then the operator is _____. 1

(a) linear (b) commutative (c) hamiltonian

(13) In electroplating, the metal to be coated is made _____. 1

(a) anode (b) cathode (c) reference.

(14) Hydrogen is considered as most promising fuel of the future because it is _____. 1

(a) renewable fuel (b) extinct fuel (c) diminishing fuel

(15) In a fuel cell, hydrogen and _____ combine to produce electricity and water. 1

(a) oxygen (b) fuel (c) oxident

(16) For NMR spectra, for shielded proton _____. 1

(a) $H_{eff} > H_{app}$ (b) $H_{eff} = H_{app}$ (c) $H_{eff} < H_{app}$

(17) When a chemical reaction obeys collision theory, probability factor _____. 1

(a) $P = 1$ (b) $P < 1$ (c) $P > 1$

(18) _____ method is used to determine rate of the reaction of ultra-fast reactions. 1

(a) continuous - flow (b) stop - flow (c) non - flow

(19) The penetration power of γ - rays is _____ alpha rays. 1

(a) lower than (b) higher than (c) equal to

(20) Geiger Nuttal rule is given by _____. 1

(a) $\lambda = A \log R + B$ (b) $\log\lambda = A \log R - B$ (c) $\log\lambda = A \log R + B$

(21) One rutherford activity equals _____. 1

(a) 3.7×10^6 dis/s (b) 10^6 dis/s (c) 10^{10} dis/s

(22) Threshold energy is calculated only if nuclear reaction is _____. 1

(a) exoergic (b) endoergic (c) endothermic

(23) Fission reaction is sustainable in a nuclear reactor, if multiplication factor _____. 1

(a) $K > 1$ (b) $K < 1$ (c) $K = 0$

(24) _____ is a fissile material. 1

(a) ^{238}U (b) ^{235}U (c) ^{232}Th