CHC 105

Total No. of Printed Pages:3

B.Sc. (Semester-V)
EXAMINATION NOVEMBER 2022
Chemistry
Physical Chemistry

[Duration : Two Hours] **[Total Marks : 80]**

Instructions:
1. Answers to the **two** sections should be written on **separate** answer books.
2. Figures to the **right** indicate **full** marks.
3. **Use** of non-programmable calculator is **allowed**.
4. **All** questions are **compulsory**, however **internal choice** is available.

Physical Constants: h= 6.625×10^{-34} Joule.sec.
c=3×10^{8} meter/sec.
N=6.023×10^{23} molecules/mole.

$\frac{2.303RT}{F}$ at 25°C = 0.0591
1 a. m. u. = 931.5 MeV
= 1.66×10^{-27} Kg
At. Wts.: C = 12, H= 1, Li = 3, O = 16, N = 14, CI = 35.5

SECTION A 40 Marks

Q.1 Answer **any four** of the following questions: **4x4=16**

i. Describe the construction and working of Semiconductor counter.
ii. Elucidate the periodicity of nuclear properties based on the shell model.
iii. Define over potential. State and explain the factors affecting over potential.
iv. Discuss the classification of fixed-site and mobile-site membranes of ion selective electrodes with suitable examples.
v. With a neat labelled diagram, describe the Hydrogen-Oxygen fuel cell.
vi. State the applications of electrochemical sensors.

Q.2 A. i) The radio-element actinium (atomic weight 227 and atomic number 89 undergoes a series of disintegrations leading to the formation of lead with atomic weight 207 and atomic number 82. How many α and β-emissions are involved? **2**

ii) Discuss the composition of the nucleus based on proton-neutron hypothesis. **4**

OR

A. iii) 1 gram of radioelement disintegrates to 0.125 gram in 150 hours. Calculate its decay constant. **2**

iv) Using liquid drop model, explain the phenomenon of nuclear fission. **4**

B. i) State the characteristics of nuclear forces. 3
ii) Explain briefly hydrogen and oxygen over voltage. 3

Q.3 A. i) Describe Fluoride ion selective electrode. 4
ii) Write the half-cell reactions of molten carbonate fuel cell. 2

OR

iii) With a neat labelled diagram, describe the glass electrode. 4
iv) State two applications of ion selective electrodes. 2

B. i) Calculate the 'Q' value and threshold energy of the following nuclear reaction 4

$Li^7 + H^1 \rightarrow 2^4_2He$

Given the masses of Li^7, H^1 and He^4 are 7.018, 1.008 and 4.004 a.m.u. respectively.

ii) Give two applications of decomposition potential. 2

SECTION B

40 Marks

Q.4 **Answer any four of the following: -** **4x4=16**

i) If $\hat{C} = \frac{d^2}{dx^2}$ and $\hat{D} = x^2 \times$, check if these operators commute with each other.

ii) What are eigen functions and eigen values? Is the time-independent Schrodinger Equation an example of eigen function? Justify your answer.

iii) Why normalization of the wave function is important in quantum mechanics? Find the normalization constant for $\Psi(x) = \sin(\frac{n\pi x}{L})$ for x between 0 and L.

iv) What are linear operators? Write 1 example of linear operator and 1 example of non-linear operator.

v) What is the basic requirement for any molecule to be IR active? Which of the following molecules will be IR active and justify your answer: HF and H_2 molecule.

vi) Explain the isotope effect in microwave spectroscopy.

Q.5 A. i) What are the boundary conditions for particle in one-dimensional box? Check if the wave function defined as $\Psi(x) = (x - a)(x + a)$ satisfy the boundary condition for $0 < x < a$. 4

ii) The wave function for particle in one-dimensional box ($0<x<L$) is: 2

$\Psi(x) = A\cos(kx) + B\sin(kx)$

What are the values of A, B, k and $\int_0^L |\psi(x)|^2 dx$?

OR

iii) Define 'average value' of operator $\hat{A}$ in quantum mechanics. For particle in one-dimensional box find the value of $< E >$ if $\Psi(x) = \sqrt{\frac{2}{a}}\sin(\frac{n\pi x}{a})$. 4

iv) Plot graphs of $\psi_n(x)$ and $|\psi_n(x)|^2$ for n=2. 2

B. i) Give 4 points of differences between harmonic and anharmonic oscillator. 4

ii) The intensity of lines in the microwave spectra of diatomic molecules depend upon which factors? 2

Q.6 A. i) Rotational constant for $^{13}C^{16}O$ is 1.915 cm^{-1}. Calculate bond length if masses of carbon and oxygen isotopes are 2.1×10^{-26} and 2.6×10^{-26} kg respectively. 4

ii) Write two points of differences between P and R branch lines in the rotational-vibrational spectrum of diatomic molecule. 2

OR

iii) You are given 2 molecules: CO and HF. Will these molecules be microwave active and why? In which case will the spectrum be 'pure' microwave spectrum? Justify your answers. 4

iv) Give 2 points of difference between Raman Spectroscopy and IR spectroscopy 2

B. i) Explain the term degeneracy taking the case of particle in three-dimensional cubical box. 4

ii) When do you say the wave functions are orthogonal to each other? 2