Ref. No. : EX/CHE/CHEM/T/212/2017(OLD)

B. CHEM. 2ND YR 1ST. SEM. EXAM.-2017(OLD)

Subject : PHYSICAL CHEMISTRY **Time : Three hours** **Full Marks : 100**

Part - I

Use Separate Answer scripts for each Part

1. (a) State briefly the properties of a typical black-body along with a suitable example. Using the Planck's result of black-body radiation density with frequency between ν and $\nu + d\nu$,

$$u(\nu)d\nu = (8\pi h/c^3).\ [\nu^3/\{\exp(h\nu/kT) - 1\}].\ d\nu,$$

Elaborate on its high and low frequency limiting values and show how the classical prediction of ultraviolet catastrophe is proved to be wrong.

(b) Describe the de-Broglie hypothesis. When a metal with work function 2.33 eV is irradiated with light, the kinetic energy of the ejected electron is 2.84×10^{-19} J. Find the wavelength of the incident radiation.

(2+6)+(3+3)

2. (a) Describe Heisenberg's uncertainity principle with some qualitative justification. Calculate the de-Broglie wavelength of an electron traveling at 2.0% of the speed of light.

(b) Define hermitian operators and show that the eigen values of such operators are real.

(3+3)+(2+4)

3. (a) Evaluate the following commutators,

$[x, p_x]$ and $[p_x^2, x]$ (x & p_x are position and momentum operators in one dimension).

(b) Describe the Beer-Lambert law and state the reasons for which a photochemical system may show deviation from it.

2X3+(2+4)

4. (a) For a free particle in a one-dimensional box of length `a ', the eigen functions are,

$$\Psi_n(x) = (2/a)^{1/2}\ \mathrm{Sin}(n\pi x/a),\ n=1,2,3,\ldots.$$

Evaluate the possible energy values for such a particle and give an estimate of the minimum frequency of radiation that can be absorbed by the particle.

(b) State what is the full form of **LASER**. Evaluate the most probable radial distance associated with the electron in the 1s orbital of a hydrogen atom. The 1s orbital wave function of the hydrogen atom is given as,

$$\Psi_{1s}(r) = (1/\sqrt{\pi}).\ (1/a_0)^{3/2}.\ \exp(-r/a_0).$$ (a_0 is Bohr radius).

6+(1+5)

[Turn over

EX/CHE/CHEM/T/212/2017(OLD)

B. Chemical Engineering Examination, 2017
(2nd Year, 1st Semester)
PHYSICAL CHEMISTRY

Part - II

1 (a) Show the steps followed to transform Weiss indices into Miller indices.

(d) Among SCC, BCC and FCC which one is closest packed? Show its % occupancy.

(c) Calculate the density and atomic radius of elemental silver that crystallizes in a F.C.C lattice with unit cell length of 4.086 Å.

4 + (1 + 4) + 5

2 (a) Calculate the pH of 10^{-8} (N) HCl solution. How would you prepare 10^{-8} (N) HCl solution from a given 10 (N) HCl ?

(b) Calculate the pH of a 0.1 mol dm^{-3} solution of acetic acid whose acid dissociation constant is 1.76×10^{-5} at the experimental temperature.

(c) Predict with logic whether an aqueous solution of sodium acetate will be acidic, neutral or basic.

4 + 3 + 5 + 5

3 (a) Describe a relative method of determination of the coefficient of viscosity of a liquid.

(b) How does the coefficient of viscosity of a liquid vary with an increase in temperature?

5 + 4

4 (c) How and why does the shape (in terms of contact angle) of a drop of water on a horizontal glass surface differ from that of a drop of mercury on the same surface?

(d) Draw and explain the curve obtained for the conductometric titration of $AgNO_3$ with KCl, the latter being added from the burette.

5 + 5