M.Sc.Examination, 2018

Semester-III
Chemistry(Elective)
Course: CH-915
Optional (Physical Chemistry)

Time: Three Hours **Full Marks: 40**

Questions are of value as indicated in the margin.
Answer ***any four*** questions.

1. a) What is the law of superposition of forces? Give an example in favor of this law. 2.5
   b) Why third or higher derivatives with respect to position are not important in mechanics? 2.5
   c) Derive the wave equation for a mechanical wave. Check that whether f(z, t)=g(z-vt) is a solution of this equation or not. 2.5+2.5

2. a) What is the work energy theorem in one dimension? Is it an independent law of nature? Comment on the statement. 2+1
   b) Using the work energy theorem define the potential energy. What potential energy tells about force? 1.5+1.5
   c) Sketch the total energy, potential energy and kinetic energy in a single diagram which may describe both bounded and non bounded motions of a system. Based on this diagram could you account for the very low rate of the following thermodynamically feasible reaction, $H+H=H_2$? 2.5+1.5

3. Comment on the following statements:
   a) One can not write the Schrödinger equation for a dissipative mechanical system.
   b) If the chemical bonds are harmonic in nature then life can not exists as well as our universe can not be so versatile.
   c) The numerical value of h, when expressed in 'macroscopic units' such as SI unit, is very small. We therefore expect that if, for a physical system, every variable having the dimension of action is very large when measured in unit of h, then quantum effects will be negligible and law of classical physics will be sufficiently accurate. 2.5+2.5+5

4. a) What is the definition of a standing wave? Could you justify the definition mathematically using the superposition principle? 1.5+1.5
   b) The standing wave is a solution of the wave equation. Comment on the statement. 2
   c) What comment can you draw by comparing the form of the standing wave with the stationary solution of the Schrödinger's equation for a bound system? Based on your answer do you have any opinion about the quantization of energy? 1.5+1.5
   d) Derive the relation between the velocity in the Cartesian coordinate and the velocity in the generalized coordinate. 2

5. a) Present the characteristic features of the photoelectric effect. Could you account for the effect based on the classical physics? 1.5+2.5
   b) How Einstein realized the energy of a photon may be $h\nu$? 1.5
   c) The outcome of the double slit experiment with electron implies that the particle can self interfere. Comment on the statement. 2
   d) What is the superposition principle in quantum mechanics? Is there any application of the principle in chemistry? 1+1.5

P.T.O.

6. a) Define the flux in quantum mechanics based on the statistical interpretation of the wavefunction. It implies that the definition of the expectation value (<A>) of an operator $\left(\hat{A}\right)$ would be $\langle A\rangle = \frac{\langle \varphi | A | \varphi \rangle}{\langle \varphi | \varphi \rangle}$. Comment on the statement. 3+2

   b) What is a linearly polarized wave? Why do you call it with such a name? 1+1

   c) Mathematically prove that the superposition of two linearly polarized fields may produce linearly or circularly or elliptically polarized electric field. 3

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