Ref. No.: EX/CHE/PH/T/1B/116/2017

BACHELOR OF ENGINEERING EXAMINATION, 2017

(1st Year, 1st Semester)

PHYSICS

Time: 3 hours Full Marks: 100

Answer ***any five*** questions (5 x 20 = 100)

1. (a) What is wave particle duality? What do you mean by de Broglie wave length? Write the expression of de Broglie wavelength for a photon. Compare the wavelengths of a photon and an electron having same energy as 10 eV.

   (b) Explain Heisenberg Uncertainty Principle with the expression of position-momentum relation.

   (c) An electron is confined in a box of length10^{-9} m calculate the minimum uncertainty in the measurement of its velocity.

   (d) Write down Schrodinger time dependent equation for free particle and when the particle is acted upon by a force field derivable from a potential V(x). Write the wave function of one dimensional infinite potential well.

   [8+4+4+4=20]

2. (a) What is unit vector? Write its expression. Find a unit vector parallel to the resultant of vectors $\mathbf{r_1} \times \mathbf{r_2}$ where, $\mathbf{r1} = 2i + 5j - 5k$ and $\mathbf{r_2} = i + 2j + 3k$

   (b) What is scalar and vector field? Explain with example. Determine the value of a so that $\mathbf{A} = 2i + aj + k$ and $\mathbf{B} = 4i - 2j - 2k$ are perpendicular. If $\mathbf{A} \times \mathbf{B} = 0$ and if **A** and **B** are not zero show that **A** is parallel to **B**.

   (c) Write and explain Gauss's divergence law (No proof).

   [8+8+4=20]

3. (a) Obtain the expressions of kinetic and potential energies of a particle executing simple harmonic motion. Establish the equation of motion of a simple harmonic oscillator from energy consideration. [Cont.]

(b) A quantity of gas is enclosed in a cylinder, fitted with a heavy piston. The axis of the cylinder is vertical. The piston is thrust downward to compress the gas and let go. Show the ensuing motion of the cylinder is simple harmonic. What is its time period?

(c) A particle oscillating simple harmonically has the displacements x_1 and x_2 when the velocities are v_1 and v_2 respectively. Calculate the amplitude and time period.

[6 + 7 +7 =20]

4. (a) What is a wave group? Discuss how a monochromatic wave train of finite length leads to the concept of wave group. Does the shape of a wave group change in a dispersive medium?

(b) Define phase velocity and group velocity. Establish a relation between them in a dispersive medium. Is group velocity less than or greater than phase velocity? Comment under what condition they will be equal. **[10 + 10 =20]**

5. (a) Define coefficient of viscosity of a liquid. What is its dimension?

(b) Distinguish between stream line and turbulent motion.

(c) Deduce Poiseuille's equation for the flow of liquid through a narrow horizontal tube.

(d) Water flows through a horizontal tube of length 20 cm and internal radius 0.081 cm under a constant head of the liquid 20 cm high. In 12 minutes 864 cc of liquid issues from the tube. Calculate the coefficient of viscosity for water. The density of water is 1 g/cc and g= 981 cm/sec^2.

[3 + 3+ 8 +6 =20]

6. (a) Explain Bernoulli's theorem. Water flows along a horizontal tube of which the cross section is not constant. Calculate the change in pressure when the velocity of flow changes from 10 cm/sec to 20 cm/sec.

[Cont.]

(b) Obtain the expressions for the growth and decay of current in series LR circuit when connected with a dc supply of V volt. Hence define the term "time constant" of the circuit.

(c) A coil of inductance 15 H and resistance 20 Ω is connected to a steady voltage of 100 volt at time t= 0. Find the value of current at t = 0.1 sec. What is the time taken for the current to reach one half of its steady value?

[7+ 8+ 5 =20]

7. (a) Monochromatic light falls on thin film. Find the necessary condition for interference fringes when viewed in the reflected light.

(b) Show that the diameters of bright rings in Newton's experiment of reflected light are proportional to square of odd natural numbers.

(c) In Newton's ring experiment the diameters of the 5^{th} and 15^{th} bright rings are 2.3 and 4.1 mm, respectively. If the wavelength of light used is 589 nm, find the radius of curvature of the convex lens.

[8 + 7 + 5]

8. (a) State the first law of thermodynamics in differential form. Applying the first law, find the relation between the specific heats at constant pressure and constant volume of an ideal gas.

(b) Calculate the work done of an ideal gas when it undergoes an isothermal expansion and an adiabatic expansion.

[10 + 10]

9. (a) Describe Carnot engine and find its thermal efficiency.

(b) What is more effective way to increase the efficiency of a Carnot engine: increasing the source temperature or decreasing the sink temperature? Give reason for your explanation.

(c) The temperatures of the source and sink for a Carnot engine are 400 and 30 °C respectively. Calculate the percentile change in the efficiency if the source temperature is reduced to 300 °C.

[10 + 5 + 5]