BACHELOR OF CHEMICAL ENGINEERING EXAMINATION 2018

1st YEAR, 1st SEMESTER

Subject: PHYSICS 1B   Time: Three Hours   Full Marks: 100

Answer any **five** questions.

1. (a) Explain with example what do you mean by gradient, divergence and curl? What is the physical significance of gradient of a scalar field?

(b) What do you mean by conservative force field? Show whether $\vec{F} = (y^2 \cos x + z^3)\,\hat{\imath} + (2y \sin x - 4)\,\hat{\jmath} + (3xz^2 + 2)\,\hat{k}$ is a conservative force or not. If so find the corresponding scalar potential.

(c) Prove that $\vec{\nabla} \cdot \left(\dfrac{\vec{r}}{r^3} \right) = 0$

[(6+4)+6+4]

2. (a) Discuss the different theories of light which evolved with time?

(b) What do you mean by coherence? Briefly explain the temporal and spatial coherence.

(c) What is Brewster's law of Polarization? A glass plate (μ=1.5) is used as a polarizer. Obtain the polarizing angle of incidence. What is the angle of refraction when the reflected light is plane polarized?

[6+(2+4)+(4+4)]

3. (a) Explain the interference in thin films due to reflected light?

(b) Are the Newton's rings of equal width? Why? In a Newton's ring experiment the diameter of the 15th ring was 0.590 cm and that of the 5th ring was 0.336 cm. If the radius of the Plano-convex lens is 100 cm, calculate the wavelength of the light used.

(c) Find out an expression for the displacement of the fringes after introducing a thin transparent sheet of thickness t and refractive index μ in one of the interfering beam's path of Young's double slit experiment.

[7+(3+4)+6]

4. (a) What do you mean by diffraction? What are their types? Explain.

(b) Discuss using a schematic, the Fraunhoffer diffraction phenomenon due to a single slit. Plot the intensity profile as a function of angle of diffraction.

(c) What do you mean by a diffraction grating? Discuss the intensity profile of a plane transmission grating. A parallel beam of light of wavelength 5460 Å is incident at an angle of 30° on a plane transmission grating which has 6000 lines/cm. Find the highest order spectrum that can be observed.

[(2+2)+(7+2)+(1+2+4)]

5. (a) What do you understand by microscopic and macroscopic description of system?

(b) How do you interpret the temperature from the Zeroth law of thermodynamics?

(c) State and explain first law of thermodynamics? Considering the first law of thermodynamics for the change of state of a closed system explain the internal energy of the system?

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(d) A certain mass of gas at NTP is expanded to three times its volume under adiabatic conditions. Calculate the resulting temperature and pressure. Assume the γ for the gas is 1.4.

$$2+5+(2+7)+4=20$$

6. (a) How do you explain reversible and irreversible thermodynamical process? Give examples.
(b) State and explain Clausius statement of second law of thermodynamics.
(c) Describe the Carnot cycle and hence deduce the expression for the efficiency of an ideal reversible heat engine.
(d) A Carnot engine whose temperature of the source is 400 K takes 200 calories of heat at this temperature and rejects 150 calories of heat to the sink. What is the temperature of the sink? Also calculate the efficiency of the engine.

$$3+2+(4+5)+(4+2)=20$$

7. (a) What is de Broglie's concept of Matter waves? Starting from the assumption of wave mechanics derive an expression for the wavelength of de Broglie's mater wave.
(b) What do you mean by group velocity and wave velocity of de Broglie waves?
(c) Explain the physical significance of wave function. Write down the expression for 1-D time-independent Schrodinger equation for a particle confined within a box having Infinite Square well potential and explain the term eigen values and eigen functions.
(d) A microscope, using photons, is employed to locate an electron in an atom to within a distance of 0.2 Å. What is the uncertainty in the momentum of the electron located in this way?
(e)

$$(2+7)+2+(2+4)+3=20$$

8. (a) State and prove Bernoulli's theorem.
(b) A horizontal tube has different areas of cross-section at two points P_1 and P_2. The diameter at P_1 is 0.04 m and the diameter at P_2 is 0.02 m. Two manometer limbs are fixed at P and Q. When a liquid of density 800 kg/m³ flows through, the difference in pressure between the manometer limbs is 0.08 m of the liquid column. Calculate the rate of flow of the liquid through the tube.
(c) What is meant by viscosity of liquid? Deduce the expression of the coefficient of viscosity using Poiseuilles method.

$$4+6+(1+9)=20$$

9. a) Deduce the differential equation of a particle executing simple harmonic motion.
(b) What is Forced vibration? Solve the equation of motion of particle under the action of a periodic external force   and also obtain the condition of resonance.
(c) A block of $m=4\,\text{kg}$ mass is attached to a spring, and undergoes simple harmonic motion with a   period of $T=0.35\,\text{s}$. The total energy of the system is $E=2.5\,\text{J}$. What is the force constant of the spring? What is the amplitude of the motion?

$$5+(1+11)+3=20$$