



# UNIVERSITY OF THE PUNJAB

B.A. / B.Sc. Part - I Annual Exam - 2019

Subject: Physics-I

Paper: A (Physics-I)

Roll No. ....

Time: 3 Hrs. Marks: 75

**NOTE:** Attempt FIVE questions, selecting not more than TWO questions from each section.

## Section I

- Q-1 (a) Define gradient of a scalar field and show that  $\text{grad } S = \nabla S$  8  
(b) Prove that  $\text{grad } r = \hat{r}/r$  5  
(c) What is physical interpretation of scalar triple product. 2
- Q.2 (a) What is a rotor? Find a relation for tangential velocity to prevent slipping. 8  
(b) Consider a rotor of radius 2m. It is given that coefficient of friction between material of clothing and rotor wall is 0.40. Find speed of object and time period of rotor. 5  
(c) Why roads are banked in hill stations? 2
- Q.3 (a) Define center of mass. Find relation for center of mass of uniform solid cylinder. 8  
(b) Show that the ratio of distances of two particles from their center of mass is inverse ratio of their masses. 5  
(c) Does the center of mass of a solid object necessarily lie within the object? If not, give example. 2
- Q.4 (a) Discuss the consequences of Lorentz transformation for the relativity of length and relativity of time. 8  
(b) A spaceship of rest length 130 m drifts past a timing station at a speed of  $0.74c$ . What is the length of spaceship as measured by the timing station? 5  
(c) Some distant galaxies are moving away from us at speeds greater than  $0.5c$ . What is speed of light received on earth from these galaxies? 2

## Section II

- Q. 5 (a) What is torsional oscillator? Derive a relation for its time period. 8  
(b) Consider a block-spring system in which spring constant of spring is  $221 \text{ N/m}$  and mass of block is  $2.43 \text{ kg}$ . The block is stretched in the x-direction a distance of  $11.6 \text{ cm}$  from equilibrium and released. What is total energy in the system? 5  
(c) Could we ever construct a true simple pendulum? Explain. 2
- Q.6 (a) Describe Young's double slit experiment. Find expression for fringe spacing for dark and bright fringes. 8  
(b) A double slit experiment is performed with blue green light of wavelength  $512 \text{ nm}$ . The slits are  $1.2 \text{ mm}$  apart and screen is  $5.4 \text{ m}$  from slits. How far apart are the bright fringes as seen on screen? 5  
(c) Can interference fringes be produced by two separate lighted candles or electric bulb? Explain. 2

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Q.7 (a) Discuss diffraction at single slit in detail. Find a general formula for minima. 8

(b) Slit of width  $d$  is illuminated by white light. For what value of  $d$  does the first minimum for light of 650 nm fall at  $\theta = 15^\circ$ ? 5

(c) Name various applications of polarization. 2

### Section III

Q.8 (a) What is adiabatic process. Find a relation for work done in adiabatic process. 8

(b) A sample of gas consisting of 0.11 moles is compressed from a volume of  $4 \text{ m}^3$  to  $1 \text{ m}^3$ , while its pressure increases from  $10 \text{ N/m}^2$  to  $40 \text{ N/m}^2$ . Calculate work done during isothermal process in compressing the gas. 5

(c) How Brownian motion can be increased in a gas? 2

Q.9 (a) What is meant by internal energy of an ideal gas? Derive an expression for Maxwell Boltzmann energy distribution. 8

(b) Calculate root mean square speed of ammonia molecules at  $56^\circ\text{C}$ . Given that an atom of nitrogen has a mass  $2.33 \times 10^{-26} \text{ kg}$  and that of a hydrogen atom has  $1.67 \times 10^{-27} \text{ kg}$ . 5

(c) The average speed of air molecules in a room is of the order of speed of sound. What is their average velocity? 2

Q.10 (a) What is entropy? Derive a relation for the change in entropy during a reversible process. 8

(b) The turbine in a steam power plant takes steam from a boiler at  $520^\circ\text{C}$  and exhausts it into a condenser at  $100^\circ\text{C}$ . Find its efficiency. 5

(c) Is it true that heat energy of the universe is steadily growing less available? If so, why? 2



NOTE: Attempt FIVE questions, selecting not more than TWO questions from each section.

Section – I

- Q1. (a) State and prove Stoke's theorem. (7)
- (b) If  $\vec{A} = xz^3\hat{i} - 2x^2yz\hat{j} + 2yz^4\hat{k}$  Find  $\nabla \cdot \vec{A}$  at point (1,-1,1) (5)
- (c) What is physical significance of gradient of a scalar function? (3)
- Q2. (a) Write down the expression for rotational kinetic energy of disc, hoop and sphere. (6)
- (b) Drive expression for the velocity of disc and hoop at the bottom of an incline plane when rolls down without slipping. (5)
- (c) Calculate the rotational inertia of a meter stick of mass 0.60 Kg about an axis perpendicular to the stick and located at 20 cm mark. (4)
- Q3. (a) State basic postulates of Einstein Special Theory of Relativity. Drive expression for the relativistic momentum of a particle moving with relativistic velocity. (10)
- (b) What is the momentum of an electron moving with velocity of  $v = 0.99 c$ ? (5)
- Q4. (a) What is escape velocity? Drive an expression for it using the method of calculus. Show that escape velocity is independent of mass of the body. (7)
- (b) What are artificial satellites? Give some of their important applications. (3)
- (c) An artificial satellite revolves around the earth in a circular orbit of radius  $r$ . find its period and velocity. (5)

Section –II

- Q5. (a) What is meant by Diffraction of light? Drive the conditions for maxima and minima of diffraction due to a single slit. (8)
- (b) What are coherent sources of light? (3)

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- (c) If the distance between the first and the tenth minimum of a double slit pattern is 18 mm and the slits are separated by 0.15 mm with screen 50 cm from slits. What is the wavelength of the light used? (4)
- Q6. (a) What is a Fresnel Bi-prism? Explain in detail how the bi prism is used for determination of unknown wavelength of light? (10)
- (b) Describe different states of polarization. (5)
- Q7. (a) What is Doppler Effect? Calculate the apparent change in frequency of the sound heard by the listener in the following cases (10)
- (i) when listener moves away from the stationary source of sound
- (ii) When source of sound moves towards the listener at rest
- (b) State and explain the principle of superposition of waves. (5)

### Section – III

- Q8. (a) State First Law of Thermodynamics and apply it to explain (8)
- (i) Isothermal process (ii) Adiabatic Process
- (b) Real gases always cool when making a free expansion where as an ideal gas does not. Explain. (2)
- (c) A sample of  $n$  moles of an ideal gas under goes an isothermal expansion. Find the heat flow into the gas in terms of the initial and final volumes and temperatures. (5)
- Q9. (a) What is meant by Conduction of heat? On what factors does the conduction of heat through an isolated rod depend? Drive expression for the rate of conduction of heat through the rod. (8)
- (b) Give a brief description of thermal resistance of materials. (3)
- (c) At what temperature would the average translational K.E of gas molecules be equal to  $1.632 \times 10^{-18} J$  (Given that Boltzmann's constant  $K = 1.38 \times 10^{-23} J / K$ ) (4)
- Q10. (a) State and prove Law of equi-partition of energy. (9)
- (b) Give a detailed description of Thermodynamic Scale of Temperature. (6)