(d) Derive the expressions for work done in an isothermal and adiabatic expansion of a gas. 20

(e) A gas at atmospheric pressure and temperature of 27ºC is compressed to half of its volume suddenly. Calculate the resulting pressure and temperature. The value of γ is 1.5. 10

5. (a) Define simple harmonic motion. Establish the equation of motion of a simple harmonic motion (SHM) and explain its characteristics. 25

(b) The displacement of a particle describing SHM is
$x = 0.5 \cos(10\pi t + \pi/3)$m.
Calculate (i) amplitude (ii) frequency (iii) phase and (iv) displacement after 2 seconds. 25

OR

(c) Distinguish between Fresnel and Fraunhofer diffractions. Describe the construction of plane transmission diffraction grating. 20

(d) Explain Rayleigh's criterion for the resolution. Obtain an expression for the resolving power of a plane transmission grating under normal incidence. 30

6. (a) Explain how plane polarized light is produced and detected. 15

(b) Distinguish between spontaneous and stimulated emissions. Explain construction and working of Ruby laser. 20

(c) The values of μ_E and μ_O for quartz are 1.5508 and 1.5418 respectively. Calculate the phase retardation for $\lambda = 5000$ Å when the plate thickness is 0.032 mm. The μ_E and μ_O are refractive indices for extra ordinary and ordinary rays, respectively. 15

OR

(d) Discuss the basic theory of Holography. 15

(e) What are the conditions for sustained interference of light waves ? 15

(f) Write the applications of Holography. 20

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> **Physics–I**
>
> **(18)**

Time : Three Hours   Maximum Marks : 300

INSTRUCTIONS

(i) Answers must be written in English.

(ii) The number of marks carried by each question is indicated at the end of the question.

(iii) The answer to each question or part thereof should begin on a fresh page.

(iv) Your answers should be precise and coherent.

(v) The part/parts of the same question must be answered together and should not be interposed between answers to other questions.

(vi) Candidates should attempt **all** questions.

(vii) If you encounter any typographical error, please read it as it appears in the text book.

(viii) Candidates are in their own interest advised to go through the General Instructions on the back side of the title page of the Answer Script for strict adherence.

(ix) No continuation sheets shall be provided to any candidate under any circumstances.

(x) Candidates shall put a cross (X) on blank pages of Answer Script.

(xi) No blank page be left in between answer to various questions.

1. (a) Draw the expression of Newton's Second Law for a system of variable mass. 15

   (b) Obtain an expression for the force on a rocket moving under the influence of gravitational field. 25

   (c) A balloon has a mass of 0.01 kg in air. The air escapes from the balloon at a uniform rate with a velocity of 0.05 m/s and the balloon shrinks completely in 2.5 s. What is the average force acting on the balloon ? 10

   OR

   (d) Explain the principle and working of gyroscope. 20

   (e) How will you distinguish between a hard boiled egg and a raw egg by spinning each on a table top ? 20

   (f) Calculate the torque of a fly wheel of mass 500 kg and diameter 1 m, when its angular frequency changes from 0 to 18 revolutions/minute in five seconds. 10

2. (a) State Kepler's Second Law. Show that it is a consequence of the law of Conservation of angular momentum. 25

   (b) Derive expressions for orbital velocity and time period of a satellite moving around the earth in an orbit. 15

   (c) Find the altitude of geostationary satellite. The radius of earth is 6400 km. 10

   OR

   (d) State and prove the Bernoulli's Theorem. 20

   (e) Show that the velocity of a particle having zero rest mass is equal to the velocity of light. 15

   (f) What should be the maximum average velocity of water in a tube of diameter 2 cm, so that the water flow is streamline ? The viscosity of water is 10^{-3} N.s/m^2. 15

3. (a) State the postulates of the Kinetic Theory of gases. 15

   (b) Explain the transport phenomenon in gases. Derive an expression for the mean free path of a molecule in a gas based on the Kinetic Theory of gases. 20

   (c) Calculate the temperature at r.m.s. velocity of a gas molecule which is same as that of a molecule of another gas at 27ºC. Molecular weights of the first and the second gases are 64 and 32 g, respectively. 15

   OR

   (d) Explain the meaning of thermo-magnetic effect. Briefly describe this effect for the production of very low temperatures. 20

   (e) Define the Solar constant. How do you determine the temperature of the sun using Stefan's Law ? 15

   (f) The average human body may be considered to have a surface area of 1.25 cm^2 and surface temperature of 32ºC. Calculate the rate of energy loss by the human body, if its emissivity is 1. Stefan's constant = 5.67×10^{-8} W.m^{-2} K^4. 15

4. (a) Obtain an expression for the specific heat capacity of solids on the basis of Debye's Theory. 25

   (b) Show that the slope of adiabatic curve between Pressure and Volume is steeper than the similar curve for isothermal process. Also draw these curves in the cases of expansion and compression of a gas. 25

   OR

   (c) What is entropy ? Show that the entropy of a perfect gas remains constant in reversible process but increases in an irreversible process. 20