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**HPAS (Main)—2012**

**PHYSICS**

**Paper I**

*Time : 3 Hours*

*Maximum Marks : 150*

*Note :— Question No. 1 is compulsory. Attempt any four questions from the rest. All questions carry equal marks.*

1. Answer the following :

(a) A bomb of mass 100 kg falling freely under gravity from rest explodes and splits into two parts of masses 80 and 20 kgs. If the first part flies off with velocity  $(a\hat{i} + b\hat{j} + c\hat{k})$  m/sec, deduce the magnitude and direction of the velocity of other part. 6

(b) When we stretch a wire, we have to perform work, why ? What happens to the energy given to the wire in this process ? 6

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- (c) "It is possible to perform Newton's ring experiment with a narrow slit". Is this statement true ? Give reason for your answer. 6
- (d) No heat is imparted from outside in adiabatic compression of a gas, but the temperature of gas increases. Explain the reason with the help of equation or the law related to it. 6
- (e) Two Carnot engines are operated in series. First engine absorbs heat  $Q_1$  at the higher temperature  $T_1$  and rejects heat  $Q_2$  at the lower temperature  $T_2$ , doing work  $W_1$ . The other engine absorbs heat  $Q_2$  at temperature  $T_2$  and transfers heat  $Q_3$  at still lower temperature  $T_3$  after doing work  $W_2$ . Calculate the efficiency of the combination. 6
2. (a) Prove that the square of time period of any planet about the sun is proportional to the cube of the semi-major axis of the elliptical path. 10

- (b) What do you mean by rigid body ? Explain the rotational motion of rigid body. 10
- (c) Give the reason of the following :
- (i) Small drops of liquids are spherical in shape.
  - (ii) Particles of camphor exhibit a vigorous movement on the surface of water.
  - (iii) Small drops of mercury are spherical while the large drops are flat. 10
3. (a) What is intermolecular force and equilibrium distance ? Explain the nature of intermolecular force with the help of potential energy-distance curve. 10
- (b) What is the ideal fluid ? Prove that in streamline flow of ideal liquid through any tube, the product of cross-sectional area and velocity of liquid flow is constant. 10

- (c) A disc of mass 1 kg and radius 10 cm is suspended horizontally by a vertical wire of length 60 cm and radius 0.5 mm. If the period of torsional oscillations is 3.9 second, then calculate the modulus of rigidity of the material of the wire. 10
4. (a) What do you understand by coherent sources ? Is it possible to see interference with two independent sodium light sources ? Give reason to your answer. How are two coherent waves obtained ? 10
- (b) With reference to biprism experiment, explain the following : 10
- (i) Why is the width of slit kept small ?
- (ii) Why is the refractive angle of biprism kept small ( $\sim 30^\circ$ ) ?
- (iii) How is it possible to distinguish central fringe ?

- (iv) What do you understand by the lateral shift in fringes ? How is it removed ?
- (v) How are the fringes affected when a thin transparent plate is inserted in the path of one of the interfering wave ? Deduce the necessary formula.
- (c) What do you understand by achromatic fringes ? How will you obtain achromatic fringes using white light source with the help of Lloyd's mirror ? 10
5. (a) Two curved surfaces of radii of curvature  $R_1$  and  $R_2$  are kept in contact. Show that the diameter of  $n$ th dark ring  $D_n$  is expressed as :

$$\frac{1}{R_1} \pm \frac{1}{R_2} = \frac{4n\lambda}{D_n^2} \quad 10$$

- (b) Explain the rectilinear propagation of light by the half period zone method on the basis of principle of wavefront. 10

- (c) Describe and explain the effect of diffraction obtained on :
- (i) axial points,
  - (ii) non-axial points by a narrow circular aperture illuminated by a mono-chromatic point source. 10
6. (a) The dispersive power of a grating in second-order spectrum is just equal to the resolving power of prism in the range of wavelength  $\lambda = 6600 \text{ \AA}$ . The ruled width of grating and the length of base of prism are equal. If the value of  $\mu$  for wavelengths  $6708 \text{ \AA}$ ,  $6438 \text{ \AA}$  are 1.5400 and 1.5412, respectively, calculate the grating element. 10
- (b) State the condition of limit of resolving power of an optical instrument on the basis of Rayleigh's criterion. 10

(c) "Light wave is transverse and not longitudinal".  
Establish this statement by an experiment. 10

7. (a) What do you mean by a thermodynamic system and the thermodynamic coordinates? Explain the meaning of equation of state of a thermodynamic system. 10

(b) What do you understand by the internal energy of a gaseous system? Show that the change in internal energy in between the two thermodynamic states of a system remains constant for each path between the two states. 10

(c) Explain the need of second law of thermodynamics. State its both statements and show their equivalence. Explain the meaning of first and second kinds of perpetual motion in terms of first and second laws of thermodynamics. 10

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8. (a) "It is impossible to attain absolute zero temperature".  
Explain this statement in detail. 10
- (b) Deduce an expression for the mean energy of a Planck's oscillator. Under what conditions, does a Planck's oscillator behave like a classical oscillator ? 10
- (c) The angular frequency of a one-dimensional simple harmonic oscillator is  $5 \times 10^{14}$  rad/sec. Calculate the zero point energy. If the simple harmonic oscillator is an electron, what will be the classical limits of its motion in the state  $n = 0$  ? 10