1st Yr.– 1st Semester

102(S)

December 2014

BASIC PHYSICS

Time Allowed: 3 Hours *Full Marks: 70*

Answer to Question No.1 is compulsory and to be answered first.
This answer is to be made in separate loose script(s) provided for the purpose.
Maximum time allowed is 45 minutes, after which the loose answer scripts will be collected and fresh answer scripts for answering the remaining part of the question will be provided.
On early submission of answer scripts of Question No.1, a student will get the remaining script earlier.

Answer questions from Group-A & B, as directed.

1. Pick up the correct answer from the given alternatives. 20x1

i) Which of the following physical quantities is a non-dimensional variable? (a) Power (b) Torque (c) Strain (d) Surface tension.

ii) If m be the mass and k be the force per unit length, then the dimensional formula of m/k is – (a) $[M^{-1} L^{-1} T^{2}]$ (b) $[L T^{-2}]$ (c) $[L^{-1} T^{2}]$ (d) $[T^{2}]$.

iii) The longitudinal strain of a wire is 0.5×10^{-3} and its Poisson's ratio is 0.2. The value of the lateral strain of the wire is (a) 10^{-5} (b) 10^{-4} (c) 10^{-3} (d) 10^{-2}.

iv) Compressibility of a substance is the reciprocal of its (a) bulk modulus (b) rigidity modulus (c) Young's modulus (d) none of these.

v) The height of a liquid in a capillary tube of radius r, dipped into it, is h. The height of the liquid in another capillary tube of same material but of radius $r/2$ is (a) $h/2$ (b) h (c) $2h$ (d) $4h$.

vi) Bernoulli's theorem in fluid dynamics is another form of law of conservation of (a) mass (b) momentum (c) energy (d) none of these.

vii) The apparent weight of a body floating in a liquid is equal to (a) the weight of the immersed part of the body (b) the weight of the un-immersed part of the body (c) the weight of the liquid displaced (d) zero.

viii) The principle of multiplication of force is based on (a) Pascal's law (b) Archimedes' principle (c) both Pascal's law and Archimedes' principle (d) Stoke's law.

ix) If β and γ are the coefficients of superficial expansion and cubical expansion respectively, then (a) $\gamma=(3/2)\beta$ (b) $\gamma=(2/3)\beta$ (c) $\gamma=2\beta$ (d) $\gamma=3\beta$.

x) Which of the following statements is true? (a) In adiabatic process temperature is constant (b) In isochoric process pressure is constant (c) In isothermal process volume is constant (d) None of these.

xi) The ratio of specific heat at constant pressure and specific heat at constant volume of a mono-atomic gas is (a) 1.67 (b) 1.40 (c) 1.33 (d) 1.11.

xii) In streamline flow of water through a horizontal tube of varying cross-section, the velocity of water at a point is 5.0 cm/s where the cross-sectional area is 3 mm^2. What is the velocity of water at another point where the cross-sectional area is 2 mm^2? (a) 1.2 cm/s (b) 3.33 cm/s (c) 5.0 cm/s (d) 7.5 cm/s.

xiii) If the distance between a point source of light and a screen be increased by 10%, the illumination on the screen (a) increases by 20% (b) decreases by20% (c) increases by 10% (d) decreases by 10%.

xiv) A ray of light passes from vacuum into a medium of refractive index μ, the angle of incidence being twice the angle of refraction. The angle of incidence is (a) $\cos^{-1}(\mu/2)$ (b) $2\sin^{-1}(\mu/2)$ (c) $\sin^{-1}(\mu/2)$ (d) $2\cos^{-1}(\mu/2)$.

xv) The equivalent focal length in Cartesian sign convention of a combination of two thin lenses of powers +6 D and -2 D in contact is (a) + 25.0 m (b) + 25.0 cm (c) – 25.0 m (d) – 25.0 cm.

xvi) The refractive index of diamond is 2.0. The value of critical angle for diamond in air is (a) 15^0 (b) 30^0 (c) 45^0 (d) 60^0.

xvii) If the path difference between two waves be λ/2 (where λ is the wavelength), the corresponding phase difference in radian is (a) 4π (b) 3π (c) 2π (d) π.

xviii) If two waves of amplitudes 6 and 5 units interfere constructively, the resultant amplitude is (a) 1 unit (b) 11 unit (c) 30 unit (d) 1.2 unit.

xix) In photoelectric effect, the kinetic energy of photoelectrons (a) increases with intensity of incident radiation (b) decreases with the increase in intensity of incident radiation (c) increases with frequency of incident radiation (d) decreases with the increase in frequency of incident radiation.

xx) In solar photovoltaic cell, (a) mechanical energy is converted to light energy (b) light energy is converted to mechanical energy (c) electric energy is converted to light energy (d) light energy is converted to electric energy.

Group-A

Answer any three questions.

2. a) Write down the names of the basic physical quantities and their units in SI system.
   b) The expression for the terminal velocity of a spherical body of radius r moving through a liquid of coefficient of viscosity η is given by $v_t = 2r(\rho-\sigma)g / 9\eta$, where ρ and σ are the densities of the body and the liquid respectively. On the basis of dimensions, check whether the given expression is correct or not.
   c) The viscous force (F) on a spherical body moving through a liquid depends upon the velocity (v) of the body, the radius (r) of the body and the coefficient of viscosity (η) of the liquid. Derive the expression for the viscous force by dimensional method. 3+2+5

3. a) State Hooke's law. On what factors does the modulus of elasticity of a substance depend?
   b) Is Poisson's ratio an elastic modulus? Expalin. Write down the relation between Young's modulus, modulus of rigidity and Poisson's ratio.
   c) When a load of mass 20 kg is hanged at the lower end of a wire whose upper end is fixed to a rigid support, the increase in length of the wire is 1.0 mm. If the length and diameter of the wire are 1.5 m and 2.0 mm respectively, calculate the Young's modulus of the material of the wire. If the Poisson's ratio of the wire be 0.3, calculate the decrease in its diameter. (1+2)+(1+1)+5

4. a) Define angle of contact for a liquid in contact with a solid.
   b) Calculate the fall of mercury inside a capillary tube of radius 0.3 mm when it is dipped vertically into mercury. Surface tension of 0.46 N/m, angle of contact is 135^0 and density of mercury is 13.6 g/cc.
   c) With a neat diagram, explain the phenomenon of multiplication of force. 2+4+4

5. a) Write down the conditions of equilibrium of a floating body.
   b) Write down Newton's formula for the viscous force. Define the term "coefficient of viscosity" and write down its SI unit.
   c) State Archimedes' principle. Does it hold good in artificial satellite?
   d) Write down three differences between conduction and convection. 2+3+2+3

6. a) Define thermal conductivity of a substance. Obtain its SI unit.
   b) State Zeroth law of thermodynamics. What do you mean by internal energy of a system?
   c) Write down two important differences between isothermal process and adiabatic process.
   d) The densities of a solid at 20^0C and 300^0C are 2135 kg/m^3 and 2120 kg/m^3 respectively. Calculate the value of the coefficient of linear expansion of the solid .(1+2)+2+2+3

Group-B

Answer any two questions.

7. a) Define illuminance at a point on a surface. Write down its SI unit. State the principle of photometry.
   b) Write down the conditions for total internal reflection of light. On what factors does the critical angle for a pair of media depend?
   c) If the angle of incidence and angle of refraction of a ray of light while passing from medium-*a* to medium-*b* are 45^0 and 30^0 respectively and the speed of light in medium-*a* be 2.0 X 10^8 m/s, find the speed of light in medium-*b*. 3+(2+2)+3

8. a) Define first principal focus of a convex lens. Give the ray diagram.
   b) With neat ray diagram explain the magnifying action of a convex lens.
   c) Indicate in ray diagram the kind of lens needed, the position of the object and the position of the image in order to obtain a diminished virtual image.
   d) An object is placed at a distance of 30 cm from a lens. A real image is formed at a distance of 60 cm from the lens. Find the focal length of the lens. What kind of lens is it? Find also the power of the lens. 2+2+2+4

9. a) State Huygen's principle on propagation of wave-front.
   b) Write down the conditions for stationary interference pattern.
   c) Derive the expression for the fringe-width in Young's double slit experiment. 2+3+5

10. a) Define the term "stopping potential" related to photo-electric effect. How is it related to maximum kinetic energy of photo-electrons?
    b) Write down Einstein's photo-electric equation with the meaning of symbols used. Using this equation express stopping potential in terms of frequency of incident radiation. Draw the curve showing the variation of stopping potential with frequency. Explain how the values of Planck's constant and work function can be determined from the graph. (2+1)+(2+1+1+3)
