

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. Choose the correct answer from the given alternatives: 20x1
- i) The diameter of a rod is measured by a screw gauge whose least count is 0.01 mm. If the measured diameter be 2.35 mm, the maximum percentage error in the measurement is – (a) 1.0 % (b) 23.5 % (c) 0.004 % (d) 0.43 %.
 - ii) Which physical quantity has the dimensional formula of $ML^{-1}T^{-2}$? – (a) Surface tension (b) Coefficient of viscosity (c) Young's modulus (d) None of these.
 - iii) Poisson's ratio is the ratio of – (a) lateral strain to longitudinal strain (b) longitudinal strain to lateral strain (c) shearing stress to shearing strain (d) shearing strain to shearing stress.
 - iv) If the length of a wire be increased by x by stretching it within elastic limit, the internal force developed is proportional to – (a) x^{-2} (b) x^2 (c) x^{-1} (d) x .
 - v) The SI unit of surface tension in terms of unit of energy is – (a) J m (b) $J m^{-1}$ (c) $J m^2$ (d) $J m^3$.
 - vi) Hydraulic lift is the practical application of – (a) Archimedes' principle (b) Pascal's law (c) Stoke's law (d) Bernoulli's theorem.
 - vii) The apparent loss in weight of a body immersed partly in a liquid is equal to – (a) the weight of the displaced liquid (b) weight of the body (c) weight of the immersed portion of the body (d) weight of the un-immersed portion of the body.
 - viii) For the streamline flow of an incompressible and non-viscous fluid through a tube of varying cross-section, if A be the cross section of the tube at any point and V be the fluid velocity at that cross section then the Equation of Continuity is expressed as – (a) $AV^{-1} = \text{constant}$ (b) $AV = \text{constant}$ (c) $AV^{-2} = \text{constant}$ (d) $AV^2 = \text{constant}$.
 - ix) The relation between the coefficient of linear expansion (α) and the coefficient of volume expansion (γ) of a substance is – (a) $\gamma = \alpha/3$ (b) $\gamma = \alpha/2$ (c) $\gamma = 2\alpha$ (d) $\gamma = 3\alpha$.
 - x) The SI unit of thermal conductivity is – (a) WmK (b) $Wm^{-1}K$ (c) $Wm^{-1}K^{-1}$ (d) $W m K^{-1}$.
 - xi) The relation between pressure (P) and volume (V) of a gas in isothermal process is (where $\gamma = C_p/C_v$) – (a) $P V = \text{constant}$ (b) $P V^{\gamma-1} = \text{constant}$ (c) $P V^{\gamma} = \text{constant}$ (d) $P V^{\gamma+1} = \text{constant}$.
 - xii) In adiabatic expansion of a gas which of the following physical quantities remain constant? – (a) Pressure (b) Volume (c) Temperature (d) None of these.

- xiii) The illuminance at a point on a surface at a distance 2 m from a point source of light is 10 lux. The luminous intensity of the source is – (a) 20 cd (b) 40 cd (c) 5 cd (d) 2.5 cd.
- xiv) For which colour of light the absolute refractive index of a medium is minimum? – (a) Green (b) Yellow (c) Violet (d) Red.
- xv) Which of the following does not change when a ray of light passes from one medium to another? – (a) Intensity (b) Frequency (c) Wavelength (c) Speed.
- xvi) The focal length of a convex lens of refractive index 1.5 is 15 cm. If the lens be immersed in water of refractive index $\frac{4}{3}$, its focal length will be – (a) 60 cm (b) 20 cm (c) 11.25 cm (d) 16.88 cm.
- xvii) If the refractive index of the material of a convex lens be equal to the refractive index of its surrounding medium, it acts – (a) as a converging lens (b) as a diverging lens (c) as a plane mirror (d) not as a lens.
- xviii) The shape of wave-front emitted by a straight long line source of light is – (a) circular (b) spherical (c) cylindrical (d) plane.
- xix) The rate of emission of photoelectrons from the surface of a metal depends on – (a) the wavelength of the incident radiation (b) the frequency of the incident radiation (c) the intensity of the incident radiation (d) none of these.
- xx) If the magnitude of stopping potential be 0.85 volt, the maximum kinetic energy of photoelectrons is – (a) 0.85 J (b) 0.85 eV (c) 1.36 J (d) 1.36 eV.

Group-A

Answer any three questions.

2.
 - a) Write down the names of the basic physical quantities and their SI unit.
 - b) State the principle of dimensional homogeneity and illustrate with example.
 - c) The centripetal force (F) acting on a particle executing circular motion depends on the mass (m) of the particle, the radius (r) of the path and the linear speed (v) of the particle. Derive the expression for the centripetal force by dimensional analysis. 3+2+5
3.
 - a) What is meant by elasticity of a substance? Define the terms 'stress' and 'elastic limit'.
 - b) Define the term 'angle of contact' of a liquid in contact with a solid with diagram.
 - c) The lower surface of a metallic cube of side 15 cm is fixed and its upper surface is displaced by 0.03 mm by applying a tangential force of 10^3 kg wt on it. Calculate the shearing stress, shearing strain and the rigidity modulus of the metal. ($g = 9.8 \text{ m s}^{-2}$). (1+1+1)+2+5
4.
 - a) A drop of liquid always tends to acquire spherical shape. Explain.
 - b) Explain with neat diagram the phenomenon of multiplication of force or thrust.
 - c) A body of specific gravity 1.5 is released at the surface of water of a lake. If the depth of the lake be 20 m, find the downward acceleration of the body and the time taken by it to reach the bottom of the lake. Neglect viscous force. ($g = 9.8 \text{ m s}^{-2}$). 2+3+5
5.
 - a) State Bernoulli's theorem in fluid dynamics. Which conservation principle does it stand for?
 - b) Define thermal conductivity of a substance.
 - c) Define coefficient of volume expansion of a substance.
 - d) If the temperature outside a refrigerator be 40°C , how much power must the refrigerator supply in order to maintain a temperature of 0°C inside it? The wall thickness of the refrigerator is 10 cm and its surface area is 12 m^2 . The thermal conductivity of the material of the refrigerator is 0.40 SI unit. (2+1)+2+1+4
6.
 - a) What do you mean by the term 'thermal equilibrium'? What is meant by internal energy of a system?
 - b) State first law of thermodynamics. Write down its mathematical form for isothermal process and for adiabatic process.

- c) Define molar specific heat at constant pressure of a gas. Explain qualitatively why the value of molar specific heat at constant pressure (C_P) of a gas is more than the value of molar specific heat at constant volume (C_V). (1+1)+(2+1+1)+(2+2)

Group-B

Answer any two questions.

7. a) Define luminous intensity of a point source of light. Write down its relation with luminous flux.
b) State inverse square law and Lambert's cosine law of photometry.
c) Two point sources of light of luminous intensities 64 cd and 36 cd are separated by a distance of 3.0 m. Where a screen should be placed in between them for both sides of it to be equally illuminated? (2+1)+(2+2)+3
8. a) What is refraction of light? On what factors does the refractive index of a medium depend?
b) Calculate the value of the critical angle for water and air. Refractive index of water is $4/3$.
c) Define with ray diagram the optical centre of a lens.
d) Mention the principle based on which light signals can be transmitted through optical fibre. Mention two advantages of optical fibre over other cables for signal communication. (1+2)+2+2+(1+2)
9. a) Indicate in ray diagram the kind of lens needed, the position of an object and the position of the image in order to obtain a magnified virtual image of the object.
b) An object is placed at a distance of 35 cm from a convex lens of focal length 20 cm. Determine the position and nature of the image. Also calculate the linear magnification.
c) What is a wave-front? Draw the intensity distribution curve in Young's double slit experiment. On what factors does the fringe width in Young's double slit experiment depend? 2+4+(1+1+2)
10. a) What is photoelectric effect? Define threshold frequency. Draw the curve showing the variation of photoelectric current with intensity of incident radiation.
b) Write down Einstein's photoelectric equation with the meaning of symbols used.
c) Briefly explain the working of solar photovoltaic cell. (1+2+1)+2+4