Presidency University, Kolkata

Admission test for B.Sc. PHYSICS (Honours) Course-2012

Booklet Series- A | Full Marks -100 | Time – 2 Hours

Attempt all questions. Calculations/Rough works are to be done on the supplied blank sheets. **Answer must be given on the OMR sheet. Mark booklet series on the OMR sheet.**

1. An object is released from rest. The time it takes to fall through a distance h and the speed of the object as it falls through the distance are measured with a pendulum clock. The entire set-up is taken to the moon and the experiment is repeated. Find which one is true: **(A)** the measured times are same **(B)** the actual times in the fall are equal **(C)** actual speeds are equal **(D)** none of the above.

2. A smooth wooden plank of length L is fixed at an inclination θ on the floor of an elevator. The time taken by a particle to reach the bottom by sliding down the inclination is t_0 when the elevator is at rest and it takes the time t when the elevator is moving up with acceleration αg (where the factor $\alpha < 1$). The ratio t^2/t_0^2 will be
(A) 1 **(B)** $(1-\alpha)^{-1}$ **(C)** $1/\alpha$ **(D)** $(1+\alpha)^{-1}$.

3. A thin uniform rod is rotated about an axis through its mid point and perpendicular to its length. The same rod is bent into a circular ring and allowed to rotate about one of its diameter. The ratio of the moment of inertia of the rod to the ring is
(A) $4\pi^2/3$ **(B)** $2\pi^2/3$ **(C)** π^2 **(D)** $\pi^2/3$.

4. The coefficient of static friction between a small coin and the surface of a turntable is 0.3. The turntable rotates at 33.3 revolutions per minute. What is the maximum distance from the centre of the turntable at which the coin will not slide? (Take $g = 9.8\ m/s^2$)
(A) 0.024 m **(B)** 0.242 m **(C)** 0.121 m **(D)** 0.048 m.

5. A particle is constrained to move on a circle of radius 10 m. At one instant, the particle's speed is 10 m/s and is increasing at $10\ m/s^2$. The angle between the particle's velocity and acceleration vectors, at that instant, is **(A)** 0^0 **(B)** 45^0 **(C)** 30^0 **(D)** 60^0.

6. A uniform rod of mass M and length L is positioned vertically above an anchored frictionless pivot point. It is then allowed to fall on the ground. What is the speed of the free end of the rod at the point of striking the ground?
(A) $\sqrt{(g/(3L))}$ **(B)** $\sqrt{(gL)}$ **(C)** $\sqrt{(3gL)}$ **(D)** $12\sqrt{(gL)}$.

7. An assembly of two identical blocks connected by a weightless spring is hung at rest by a weightless inextensible string from the ceiling of a room, with one block connected to the string. If the string breaks suddenly, what is the downward acceleration of the upper block?
(A) g/2 **(B)** g **(C)** $\sqrt{2}g$ **(D)** 2g.

8. An artificial satellite of mass m is moving in a circular orbit of radius R around the earth. A force having impulse I is suddenly applied to the satellite in the direction of its motion. Which one of the following statement is true ? **(A)** The angular momentum of the satellite remains constant **(B)** the change in kinetic energy of the satellite is proportional to I **(C)** the total mechanical energy of the satellite is constant **(D)** the change in angular momentum is proportional to I.

9. A man and a child of masses 2M and M respectively are seated at the back and the front end of a boat of length L and negligible mass at rest in a lake. After the man and child exchange places **(A)** the boat moves forward by L/2 **(B)** the boat remains at rest **(C)** the boat moves forward by L/3 **(D)** the boat moves backward by L/3.

10. A particle executing SHM satisfies the boundary conditions: x(t=0)=5 cm, x(t=T/2)=25 cm and v(t=0)=v(t=T/2)=0 where the time period T=π s. The speed (in cm/sec) at a distance of 9 cm from the origin will be **(A)** 2.56 **(B)** 8.72 **(C)** 16.0 **(D)** 1.39.

11. A violin string 33cm long vibrates at a fundamental frequency of 440 Hz. Where should a finger be pressed on the string against the finger board so that its decreased length causes it to vibrate at five-fourth of its original frequency?
(A) 26.4 cm (B) 13.2 cm (C) 19.8 cm (D) none of these.

12. The displacement in a stationary wave is given by $z = A \sin(\pi x/a) \cos(2\pi y/b) \exp(i\omega t)$, where A, a, b and ω are constants. Then the intensity is (A) maximum at $x = a/2$, $y = b/4$ (B) minimum at $x = 3a/2$, $y = b/4$ (C) minimum at $x = 3a/2$, $y = b$ (D) maximum at $x = a/4$, $y = b/2$.

13. The tuning of a radio receiver set to a particular station is based on
(A) resonance (B) forced vibration (C) anti-resonance (D) interference.

14. Consider a gas inside a cylindrical container, at one end of which is a tightly fitted movable piston. There is a source of ultrasonic sound waves embedded at the fixed end of the container and a sonic detector is attached to the inner wall of the piston. Let t_1 be the time taken by the sound wave to traverse the container when its length is l_1. If t_2 is the corresponding time when the piston is rapidly moved out and the gas adiabatically expands to a length l_2, then the ratio (t_1 / t_2) is given by ($\gamma = C_p/C_v$)
(A) l_2 / l_1, (B) $(l_1 / l_2)^{(\gamma-1)}$, (C) $\sqrt{(l_1 / l_2)}$, (D) $(l_1 / l_2)^{(\gamma+1)/2}$.

15. The angular deflection θ, of a beam of photon (travelling with velocity c) passing by a point mass m, at a distance of closest approach b is given by (G = universal gravitational constant) (A) $Gm/(bc^2)$ (B) Gm^2b/c^2 (C) $Gm^2/(b^2c)$ (D) $Gm\,c/b^2$.

16. Two identical points of mass M are separated by a distance 2a. Another smaller mass m is located in a plane normal to line joining the masses M and midway between them. The locus of points in the plane for which the gravitational force on m is maximum is (A) a straight line (B) a circle with radius $a\sqrt{2}$ (C) an ellipse (D) a circle with radius $a/\sqrt{2}$.

17. A spherical body is projected horizontally in an infinite viscous medium under the action of gravity. Choose the correct statement: (A) the particle follows a parabolic path (B) finally the particle falls vertically with a steady velocity (C) finally the vertical component of its velocity reaches a steady value whereas its horizontal component does not change with time (D) depending upon the value of coefficient of viscosity the body may move in upward direction.

18. The percentage error in calculating the atmospheric pressure equal to 760 mm of Hg (density = 13600 kg/m^3) according to the height of Hg column (internal diameter of barometric tube is 5 mm, surface tension of Hg = 0.5 N/m, g = 10 m/s^2) is
(A) 0.6 (B) 0.4 (C) 0.2 (D) 0.8.

19. The inverse square law of intensity is valid for light from a
(A) plane source (B) spherical source (C) line source (D) cylindrical source.

20. A thin equiconvex lens of focal length f (in air), refractive index μ and thickness t is placed in air. How much thick will it appear to an observer whose line of sight is along the principal axis? (A) $\mu t^2/f$ (B) $t^2/(\mu f)$ (C) t/μ (D) $\mu\sqrt{(tf)}$.

21. For a given monochromatic light, refractive index (R.I.) of a material of thickness t varies as $n(x) = n_0(1-x/(2t))$. If we define an equivalent medium having constant R.I. n_e, with same transit time, then n_e is equal to (A) $3n_0/4$ (B) $4n_0/3$ (C) $n_0/2$ (D) $2n_0$.

22. A plano-convex lens fits exactly into a plano-concave lens so that their plane surfaces are parallel to each other. If the lenses are made of different material of refractive index μ_1 and μ_2, R be the radius of curvature of the curved surface of lenses, then focal length of the combination is (A) $R/(\mu_1-\mu_2)$ (B) $2R/(\mu_1-\mu_2)$ (C) $R/(2(\mu_1-\mu_2))$ (D) $R/(2-\mu_1-\mu_2)$.

23. Consider two identical iron spheres one of which lies on a thermally insulating plate, whilst the second one hangs from an insulating thread. If equal amounts of heat are given to the two spheres, whose shapes remain unchanged, then (A) first sphere will have higher temperature (B) it is difficult to make any conclusion (C) both the spheres will have same temperature (D) second sphere will have higher temperature.

As a result of temperature rise of 32^0C, a bar with a crack at its centre buckles upward (see below). If the fixed distance L_0 is 3.77 m and the coefficient of linear expansion of bar is 25×10^{-6} per ^{0}C, the rise x of the centre will be
(A) 6.72 cm (B) 5.45 cm (C) 7.54 cm (D) none of these..

25. After detonation of a Uranium fission bomb, there forms a "ball of fire" made of a sphere of gas with radius of about 50 ft and a temperature 3×10^5 K. Making very rough assumption and considering the process as adiabatic with $C_p/C_v = 5/3$, find at what radius its temperature will be 3×10^3 K:
(A) 5000 ft (B) 500 ft (C) 2000 ft (D) none of these.

26. An ideal monoatomic gas expands quasi-statically to twice its volume. The absolute magnitudes of the corresponding isothermal and adiabatic work done are W_i and W_a respectively. Which of the following is true?
(A) $2W_i = W_a$ (B) $W_i < W_a$ (C) $W_i > W_a$ (D) $W_i = 2W_a$.

27. A thermally insulated vertical cylinder of cross section d contains an ideal gas (C_p/C_v = 7/5) under a piston of mass M kg. A heater supplying heat to the gas at a constant rate P Joules/sec is switched on at t=0. If atmospheric pressure is P_0 N/m^2, then velocity of the piston is (A) $3P/[3P_0A + 2Mg)]$ (B) $3P/(5P_0A)$ (C) $2P/[5(Mg+P_0A)]$ (D) none of these.

28. A Carnot engine whose low temperature reservoir is at 17 ^{0}C has an efficiency of 40 per cent. By how much should the temperature of the high temperature reservoir be increased to increase the efficiency to 50 percent?
(A) 40 K (B) 96.67 K (C) 72K (D) 30 K.

29. A gas at a temperature of 300 K has pressure 4×10^{-10} N/m^2. Taking Boltzmann's constant = 1.38×10^{-23} Joules/K, the number of molecules per cm^3 is of the order of
(A) 10^2 (B) 10^8 (C) 10^6 (D) 10^5.

30. Three closed containers A, B, C contain gases at the same temperature T. A contains only oxygen, B contains only nitrogen and C a mixture of equal quantities of oxygen and nitrogen. If the average speed of oxygen molecules in container A is v_1 and that of the nitrogen molecules in container B is v_2, then the average speed of the oxygen molecules in container C is (A) $(v_1 + v_2)/2$ (B) $2v_1/(v_1 + v_2)$ (C) $\sqrt{(v_1v_2)}$ (D) v_1.

31. Force between the charges q_1 and q_2 is F. The new force between q_1 and q_2 when another charge q_3 is inserted between them is (A) F (B) q_3F/q_1 (C) $q_3F/(q_2+q_1)$ (D) none of these.

32. A dielectric liquid is taken in a capillary tube connected to a distant wider tube. The capillary tube is placed in a strong electric field parallel to its length between the plates of a capacitor. The level of the liquid in the capillary tube (A) will oscillate constantly (B) will fall (C) will neither fall nor rise (D) will rise.

33. The potential at the centre of a cube of length "a" due to the presence of identical charges q at each of its corners will be (A) 0 (B) $4q/(2^{1/2}\pi\varepsilon_0 a)$ (C) $3^{1/2}q/(\pi\varepsilon_0 a)$ (D) $4q/(3^{1/2}\pi\varepsilon_0 a)$.

34. The following statements are based on the observation: "total electric flux through a given closed surface is zero". *(i)* There may be equal and opposite charges placed separately inside the surface. *(ii)* Total charges outside the close surface should be zero. *(iii)* Closed surface must identify as an equipotential surface. *(iv)* At every point on the closed surface electric field will be zero. Find the correct option: (A) *only* (i) and (ii) are correct statements (B) *only* the statement *(i)* is correct (C) *all four* statements are correct (D) *only* (i) and (iii) are correct statements.

35. A positive charge Q is located at a distance L above an infinite grounded conducting plane. What is the total charge induced on the plane? (A) 0 (B) - Q (C) Q (D) 2Q.

36. Electrical potential 'V' in space as a function of co-ordinates is given by V(x,y,z) = 1/x + 1/y + 1/z. Then the electric field intensity at (1,1,1) is
(A) (i+j+k) (B) 0 (C) -(i+j+k) (D) (i+j+k)/3.

37. A point charge Q is kept inside a conducting shell having net charge zero. Radius of the shell is R and the charge is kept at a distance x from the centre. The potential at the centre of the shell is ($k=1/4\pi\varepsilon_0$)
(A) kQ/x (B) kQ/R (C) - kQ/R + kQ/x (D) not possible to calculate.

38. Equal and opposite currents flow through two co-axial very long and straight metallic cylinders. If the inner cylinder be a solid one, the resultant magnetic field will be zero (A) Everywhere outside the cylinders (B) at some points outside the cylinders (C) at some points within the gap between the cylinders (D) nowhere.

39. An equilateral triangular loop having a resistance R and length of each side L is placed in a magnetic field perpendicular to the area and varying at a rate of 1 Tesla/sec. The induced current in the loop will be

(A) $4R/(\sqrt{3}L^2)$ (B) $4\ L^2/(\sqrt{3}R)$ (C) $\sqrt{3}\ R/(4L^2)$ (D) $)\sqrt{3}\ L^2/(4R)$.

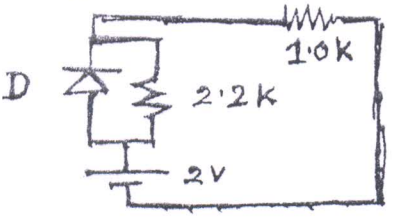
40. One end of a nichrome wire of length 2L and cross sectional area A is attached to an end of another nichrome wire of length L and cross sectional area 2A. If the free end of the longer wire is at an electric potential of 8 volts and the free end of the shorter wire at 1 volt, the potential at the junction of the two wires is most nearly equal to
(A) 3.3 volts (B) 5.7 volts (C) 4.5 volts (D) 2.4 volts.

41. A moving coil galvanometer has a resistance of 10 ohm and it shows full scale deflection for a current of 2 mA. It can be converted to a voltmeter of range 0-10 V by connecting (A) 0.02 ohm in parallel (B) 5000 ohm in parallel (C) 4990 ohm in series (D) both B and C are valid options.

42. A 1.5 V dry cell is labelled 1800 mA-hour. The maximum amount of electrical energy stored in it is (A) 9720 J (B) 6480 J (C) 9720 × 4.2 J (D) 6480 × 4.2 J.

43. **Statement -I**. The emitter and the collector of a p-n-p transistor cannot be interchanged keeping the base common. **Statement -II**. The emitter has doping concentration and the surface area different from that of of the collector. (A) I is *true*. II is also *true*, but it does not justify statement I (B) I is *true*. II is also *true*, and it gives the proper justification of statement I (C) I is *false* but II is *true* (D) Both I and II are *false*.

44. In linear circuit analysis, a p-n junction diode in forward bias is replaced by (A) a constant voltage source (B) a constant current source (C) a switch with a resistance in series (D) a constant voltage source and a series resistance.



45. In the above circuit, consider D as an ideal diode. The magnitude of current through 1 K resistance is
(A) 2 mA (B) 0.625 mA (C) 2.91 mA (D) 0 mA.

46. In a positronium atom (proton replaced by a positron in a hydrogen atom), a transition takes place from the state with n = 3 to a state with n = 1. The energy of the photon emitted is closest to
(A) 6.8 eV (B) 6.0 eV (C) 12.2 eV (D) 13.6 eV.

47. An electron in a hydrogen atom makes a transition from first excited state to ground state. The equivalent current due to the circulating electron
(A) increases 2 times (B) increases 4 times (C) increases 8 times (D) remains same.

48. A nucleus disintegrates into two nuclear parts which have their velocities in the ratio 2:1. Assume nuclear density is independent of mass number. The ratio of their sizes will be
(A) $1 : 3^{1/3}$ (B) $1 : 2^{1/3}$ (C) $3^{1/2} : 1$ (D) $2^{1/3} : 1$.

49. If an α particle and a proton are separately energised by accelerating through a potential difference V, the ratio of the associated de Broglie wavelengths $\lambda_\alpha / \lambda_p$ will be close to
(A) $1/\sqrt{8}$ (B) 1 (C) $\sqrt{2}$ (D) 1/2.

50. The manifestation of band structure in solid is due to (A) Pauli exclusion principle (B) Heisenberg uncertainty principle (C) Bohr correspondence principle (D) Boltzmann law.