Presidency University, Kolkata

Admission Test for B.Sc. (PHYSICS) Course - 2013

Booklet series- D 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**

Each wrong answer will be awarded 0.5 *negative* marks

1. A particle is moving with velocity $\vec{v} = 5(y\hat{i} - x\hat{j})$. The general equation for its path is:
(a) straight line (b) parabola (c) circle (d) hyperbola

2. If all of space were full of water, except for two air bubbles, how would these bubbles move ?
(a) They would be stationary (b) They would move away from each other (c) They would move towards each other (d) There is not enough information to predict their behaviour

3. A laptop computer is operated with 220 V AC mains and then with the DC battery backup of 12 V. The power consumed by the equipment in the second case is
(a) equal to that in the first case (b) lower than that in the first case (c) higher than that in the first case (d) almost 220/12 times that in the first case

4. Imagine a transportation system in which every capital on the Earth is connected with every other capital through straight tunnels. All trains depart on the hour, *i.e.* at 8:00, 9:00 and so on. When do they arrive at their destinations, if the trains slide through the tunnels under the influence of gravity without any resistance? Consider that Earth is a homogeneous, nonrotating sphere of radius 6400 km and assume g= 10 m s^{-2}.
(a) 84 min (b) 21 min (c) 42 min (d) 24 min

5. In the CERN intersecting Storage Ring, beam of protons of kinetic energy 24 GeV (with a velocity approaching the velocity of light) carries current 30 A in the ring of circumferance of 950 meter. The total energy of the beam when it is ejected from the ring is
(a) 2.28×10^{-6} J (b) 4.67×10^{4} J (c) 5.28×10^{6} J (d) 3.4510^{-7} J.

6. A particle of mass m, moving with a velocity u along a straight line, collides elastically head on with another particle of mass M at rest. If after the collision the mass M moves with a velocity v along the same line, but m stops, then
(a) u = m/(M + m) (b) u = m/M (c) m = M (d) v = mu/(M + m)

7. The volume-temperature graph of a perfect gas is drawn at different pressures such that the slope increases each time. That means the pressure
(a) increases (b) decreases (c) remains constant (d) doubles each time

8. When observed from the earth, the angular diameter of the sun is half a degree. Determine the diameter of the image of the sun formed by a convex lens of focal length $f = 0.5$ m.
(a) 0.5 mm (b) 8.8 mm (c) 2.2 mm (d) 4.4 mm

9. Statement I: Conduction current in n-type semiconductor is greater than that in p-type semiconductor. Statement II: Mobility of electron is greater than that of hole.
(a) both Statements I and II are correct and Statement II is the reason for Statement I
(b) both Statements I and II are correct but statement II is not the reason for Statement I
(c) Statement I is correct and Statement II is incorrect
(d) Statement I is incorrect and Statement II is correct

10. A 300 W electric immersion heater is used to heat a cup of water. The cup has mass of 300 g and its contains 100 g of water at 30°C. How much time is needed to bring the water to the boiling point ? The temperature of the cup is the same as that of the water and no heat is lost to the air. The specific heat of the material of the cup is 664 J kg^{-1} $^oC^{-1}$ and that of water is 4180 J kg^{-1} $^oC^{-1}$.
(a) 14.4×10^{2}s (b) 14.4 min (c) 1.44×10^{2}s (d) 1.444×10^{3}s

11. If ϵ_0 be the permittivity of free space L the length, ΔV and Δt are potential difference and time interval respectively, then the dimensional formula for the quantity $\epsilon_0 L^{-1}\frac{\Delta V}{\Delta t}$ corresponds to:
(a) current density (b) resistivity (c) surface charge density (d) electric field

12. Statement: A guineapig touches a conductor having potential of 200 V and dies. Another guineapig touches a conductor having potential of 220000 V and stays safe.
Comment-I: It is absurd. Comment-II: May be, the current is negligible in the second case
Comment-III: Neither the voltage nor the current the electric power is the fatal entity.
(a) Comment-I is true (b) Comment-II is true (c) Comments II and III are true. (d) Comment-III is true

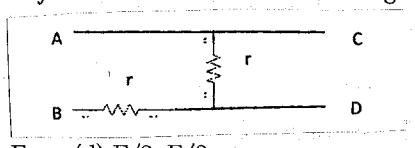
13. A student performed the following experiment. The base of an n-p-n transistor was connected to the positive terminal of a variable voltage source and the emitter was connected to the negative terminal of the voltage source through a miliammeter in series. The current through the circuit was measured varying the voltage. The current-voltage graph looked like that of a forward biased diode.
(a) The result was just a coincidence having no proper theory. (b) The same result would be obtained even on interchanging the polarity of the voltage source (c) It was a bad activity, the transistor would get damaged. (d) It was a regular phenomenon.

14. A hemispherical bowl of radius R is set rotating about its axis of symmetry which is kept vertical. A small metallic ball kept within the bowl rotates with it without slipping. If the surface of the bowl is frictionless and the angle made by the radius through the ball with the vertical is θ, the minimum angular speed at which the bowl is rotating is
(a) $\sqrt{\frac{2g}{R\sin\theta}}$ (b) $\sqrt{\frac{2g}{R\cos\theta}}$ (c) $\sqrt{\frac{g}{R\cos\theta}}$ (d) $\sqrt{\frac{g}{R\sin\theta}}$

15. You stand beneath an electric 400 kV high tension AC power line with an ordinary magnetic compass in your hand. The power line runs in the north-south direction. In which direction does the red - painted part of the compass needle point?
(a) perpendicular to the wire (b) in the north direction (c) at 60° to the north (d) at 45° to the north

16. A radioactive nucleus can decay by two different processes. The half life for the first process is T_1 and that for second process is T_2. The effective half life of the nucleus is
(a) $(T_1+T_2)/2$ (b) $\sqrt{T_1T_2}$ (c) $T_1T_2/(T_1+T_2)$ (d) T_1+T_2

17. If a battery of e.m.f. E is connected accross AB and a voltmeter is connected accross CD of the adjacent figure. The voltmeter reading is —— . If the battery and the voltmeter are interchanged, the reading of the voltmeter is —— .



(a) E/2, E (b) E, E/2 (c) E, E (d) E/2, E/2

18. When ice melts at 0° C, the internal energy of ice-water system —— and —— work is done on it.
(a) remains constant, negative (b) remains constant, positive (c) remains constant, no (d) increases, positive

19. An AC supply $V = 200\sin(100t)$ is applied to a resistive heater having coil resistance 10 ohm. What should be the minimum power rating of the coil?
(a) 1000 W (b) 2000 W (c) 200 W (d) 100 W

20. A small amount of water of mass 50 g in a container at temperature 273 K is placed inside a vacuum chamber which is evacuated rapidly. If the latent heat of fusion (ice/water) = 80 cal g^{-1} and the latent heat of vapourization (water/vapour) = 600 cal g^{-1}, amount of water initially freezes and becomes ice equals to :
(a) 50 g (b) 8 g (c) 44 g (d) 6 g

21. A flood relief helicopter flying with horizontal velocity u drop a food packet from height h. A refugee starts running with a constant velocity v towards it from a certain distance and catches the packet just before touching the ground. The distance traversed by the refugee is
(a) $v\sqrt{\frac{2u}{g}}$ (b) $v\sqrt{\frac{2h}{g}}$ (c) $u\sqrt{\frac{2v}{g}}$ (d) $h\sqrt{\frac{2v}{g}}$

22. A horse of mass 200 kg is running up the slope of a hill with a velocity of 10 km per hour making an angle of 30° with the horizontal plane. What is the horse power exerted by the horse ?
(a) 2722 (b) 3.649 (c) one (d) zero

23. The moment of inertia of a body does not depend on
(a) its axis of rotation (b) the distribution of mass in the body (c) its angular velocity (d) its total mass

24. In the case of mechanical resonance of amplitude the relation between the intrinsic frequency (ω_0) of resonator and that of driving force (ω_f) is
(a) $\omega_f = \omega_0$ (b) $\omega_f < \omega_0$ (c) $\omega_f > \omega_0$ (d) $\omega_f \geq \omega_0$

25. Five moles of oxygen having rms speed of molecules 500 m s^{-1} and 25 moles of helium having rms speed of 1 km s^{-1} are introduced in a thermally insulating container. After attaining thermal equilibrium the ratio of the rms speed of the oxygen molecules to that of helium is
(a) 1:1 (b) 1:4 (c) 1:8 (d) $1:2\sqrt{2}$

26. Consider the finite mass of the nucleus of the hydrogen atom instead of infinite mass. Which of the following quantities of the electron in the first Bohr orbit will not be affected ?
(a)radius (b) velocity (c) ionisation energy (d) kinetic energy

27. A frictionless circular table is rotating with angular velocity ω. A large fixed positive charge is placed at the centre of the table and a neagtively charged small disc is placed on it at a certain distance from the centre. If the mass of the disc doubles and charge becomes eight times, then to avoid slipping of the disc ω has to be :
(a) half (b)twice (c) $\sqrt{2}$ times (d) 4 times

28. A conducting circular loop of finite mass and resistance is falling from a great height in a magnetic field with a component $B_Z = B_0(1 + \alpha z)$, where α is a constant. The loop diameter is always parallel to the horizontal.
(a) The e.m.f. in the loop does not depend on the velocity of the loop (b) No e.m.f is induced in the loop (c) The loop will attain constant velocity after a long time (d)The loop will not move.

29. The ratio of the speed of sound propagation through a monoatomic gas at a certain temperature to the root mean square speed of the gas molecules at the same temperature is
(a) 1:3 (b)$\sqrt{3}:1$ (c) $\sqrt{5}:3$ (d) $1:\sqrt{2}$

30. A silicon diode is connected in series with a 10 Ω resistor. This series combination is joined across a 3 V battery so that the positive terminal of the battery is connected to the p-side and the negative terminal is connected towards the n-side of the diode. The voltage across the diode is approximately:
(a) 0.6 V (b) 0.3 V (c) 3 V (d) 1.5 V

31. In photoelectric effect, the slope of the graph of the frequency of incident light versus the stopping potential for a given metallic surface is
(a) e/h (b) h/ce (c) he/c (d) ch/e

32. The image size of a distant object, as formed by a convex lens of focal length 20 cm is 1.5 cm. When a concave lens is placed between the convex lens and the image at a distance of 15 cm from the convex lens, the size of the image is 1.8 cm. The focal length of the concave lens is
(a) 15 cm (b) 20 cm (c) 30 cm (d) 6 cm

33. The mutual inductance of two concentric ring is minimum when the angle between them is
(a) 90° (b) 30° (c) 60° (d) 0°

34. Kirchoff's current law at any junction comes from the
(a) conservation of both energy and momentum (b) conservation of energy (c) conservation of momentum of electron (d) conservation of electrical charge

35. If a particle of mass m is raised from the surface of the earth to a height equal to the radius of the earth then the gain in potential energy of the particle is
(a) mgR (b) $mgR/2$ (c) $2mgR$ (d) 0

36. The decay constant of each of two radioactive nuclei is λ. One nucleus decays within a time interval of 1 sec. The probability of decay of the other nucleus in the same time interval is
(a) 0 (b) 1 (c) λ (d) $\lambda/2$

37. Consider a simple pendulum of length L and a pendulum consisting of a uniform rod of same length pivoted at one end. The time period of the pivoted rod is approximately:
(a) 66% of that of simple pendulum (b) 82% of that of simple pendulum (c) same as that of simple pendulum (d) 22% of that of simple pendulum

38. At 100 ms after detonation of a uranium fission bomb, the 'ball of fire' due to adiabetic expansion forms a sphere of gas with radius 50 m and temperature 300000 K. What will be the rough estimate of the radius corresponding to temperature 3000 K ?
(a) 5000 m (b) 500 m (c) 50000 m (d) 500000 m

39. An iron nail gets attracted towards a bar magnet. does the nail acquire kinetic energy ? Four answers are given below. (i) No, creation of energy is against the law of thermodynamics. (ii) Yes, it is at the cost of the energy stored in the magnetic field. (iii) No, the nail does not undergo any linear motion. It only changes the orientation. (iv) Yes, the end of the nail nearer to the pole of the magnet becomes an opposite pole by induction.
(a) both (ii) and (iv) are true (b) only (ii) is true (c) only (iv) is true (d) only (i) is true

40. A steel ball of mass 100 g falls from the height of 1 m on the horizontal surface of a massive slab. if every impact decreases the velocity of the ball by factor of 0.8, the cummulative momentum that the ball imparts to the slab after

numerous bounces is:
(a) 402 kg-m.s^{-1} (b) 4.02 kg-m.s^{-1} (c) 44.7 kg-m.s^{-1} (d) 0.447 kg-m.s^{-1}

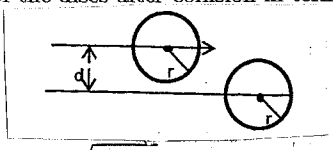
41. Two small satellites move in circular orbits around the earth, at distance r and $r + \Delta r$ from the center of the earth. Their orbital velocities are ω and $\omega + \Delta\omega$ respectively. If $\Delta r << r$ and $\Delta\omega << \omega$ then, $\Delta(\omega^2)/\omega^2$ is equal to:
(a) $-4(\Delta r)/(3r)$ (b) $4(\Delta r)/(3r)$ (c) $-3(\Delta r)/(r)$ (d) $3(\Delta r)/(4r)$

42. A solid glass cube (r.i. 1.5) is immersed in water (r.i. 1.33) with one of its face placed horizontally. At what maximum angle (in degree) must the ray incident on any vertical side of the cube so that total internal reflection occurs at the top surface of the cube ?
(a) 45 (b) 90 (c) 31.4 (d) 30.2

43. Two protons are fired at each other with the same kinetic energy of 0.360 MeV. Assume a proton is a spherical object of radius r. If the protons are brought to rest by their mutual Coulomb repulsion when they are just touching each other, the value of r in the unit of fm (1 fm = 10^{-15} m) is
(a) 1.0 (b) 0.5 (c) 2.0 (d) 0.25

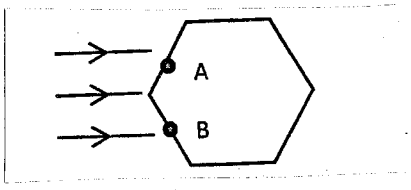
44. If energy (E), velocity (V), time (T) were chosen as the fundamental units, the dimensional formula for coefficient of viscosity would be
(a)EV^2T^{-2} (b) E $V^{-1}T^{-2}$ (c) $E^2V^{-1}T^{-2}$ (d) $EV^{-3}T^{-2}$

45. Disc-1 of radius r moving on perfectly smooth surface at a speed v undergoes an elastic collision with an identical stationary disc-2. The speed of each of the discs after collision in terms of the parameter $d < 2r$ (see figure)



(a) $v_1 = \frac{vd}{2r}$, $v_2 = v\sqrt{1 - \frac{d^2}{4r^2}}$ (b) $v_1 = v\sqrt{1 - \frac{d^2}{r^2}}$, $v_2 = \frac{vd}{r}$ (c) $v_1 = \frac{vd}{3r}$, $v_2 = \frac{vd}{4r}$ (d) $v_1 = \frac{vd}{r}$, $v_2 = v\sqrt{1 - \frac{d^2}{4r^2}}$

46. A parallel beam of monochromatic light strikes a transparent crystal having the cross section of a regular hexagon. The beam is parallel to the top and bottom faces of the hexagon, and points A and B in the attached diagram are the midpoints of the corresponding edges. After the refraction, two separate parallel beams of light emerge from the crystal. What is the minimum index of refraction of the material that allows such an effect?



(a) 1.5 (b) $\sqrt{15}/2$ (c) $\sqrt{13}/2$ (d) 1.75

47. If low energy electron of mass m and energy E has the same De-Broglie wavelength as the wavelength of photon of energy E' then
(a) $E = E'$ (b) $E' = c\sqrt{2mE}$ (c) $E'^2 = \frac{h^4c^2}{2mE}$ (d) $E' = \frac{h^2c^2}{2mE}$

48. A hemispherical surface of radius R is located in front of a thin, infinite, non-conducting sheet with a uniform charge density σ. The sheet is perpendicular to the axis of the hemisphere. The magnitude of the electric flux through the hemisphere is
(a) $\pi r^2\sigma/\epsilon_0$ (b) $\pi r^2\sigma/2\epsilon_0$ (c) $2\pi r^2\sigma/\epsilon_0$ (d) 0

49. Three point charges each of mass m, charge q are placed on the vertices of an equilateral triangle of side a. They rotate with an angular velocity ω about an axis perpendicular to the plane of the triangle and passing through the cetroid. The expression for ω^2 is
(a) $\frac{3q^2}{4\pi\epsilon_0 ma^3}$ (b) $\frac{2q^2m}{4\pi\epsilon_0 a^2}$ (c) $\frac{q^2}{4\pi\epsilon_0 ma^2}$ (d) $\frac{\sqrt{3}q^2}{8\pi\epsilon_0 ma^3}$

50. A parallel plate capacitor has an air gap of distance D between the plates. A dielectric slab of thickness d ($d < D$) is inserted within this air gap. In another case, a metallic slab of the same thickness d is inserted there.
(a) In the second case, the capacitance increases and in the first case it decreases (b) In both cases, the capacitance increases because of the same reason (c) In the first case, the capacitance increases and in the second case it decreases (d) In both cases, the capacitance increases but the reason is different