PRESIDENCY COLLEGE, KOLKATA

Admission Test for PHYSICS (Honours) Course, 2007

Full Marks : 100 Time : 2 hours

The question paper in full must be returned with the answer script.

Use if you need: $h = 6.6 \times 10^{-27}$ erg-sec, $1eV = 1.6 \times 10^{-12}$ erg, 1 fermi $= 10^{-13}$ cm. Mass of an electron $= 9.1 \times 10^{-31}$ kg, Charge of an electron $= 1.6 \times 10^{-19}$ C, $g = 9.8$ m/s^2

Answer All Questions

Group A

(Each question carries 3 marks)

Give tick (√) mark(s) (on the question paper) to the correct/ best answer(s) to each question. (More than one answer may be correct.) Calculation, if necessary, can be done on the answer script supplied. Scientific calculators may be used.

1. Two identical bar magnets, each with magnetic moment M are placed perpendicular to each other with North pole of one touching with the south pole of the other. The magnetic moment of the combination is
(a) 2M (b) M (c) √2 M (d) M/√2

2. Capacitors $C_1 = 2$ μF and $C_2 = 8$ μF are connected in series with a 100V source. Then the
(a) p. d. across each of C_1 and C_2 is 50V (b) p. d. across C_1 is 20 V and C_2 is 80V (c) p. d. across C_1 is 80 V and C_2 is 20V (d) the energy stored in the system is 8×10^{-3} J.

3. A spherical drop of water of diameter 1 mm is broken into 10^6 spherical droplets of equal size. Surface tension of water is 74 dyne/cm. The work done is approximately
(a) 230 erg (b) 330 erg (c) 600 erg (d) 740 erg

4. The diodes in Fig.1 are ideal. The current through the battery is
(a) 0 A (b) 50 mA (c) 500 mA (d) 200 mA

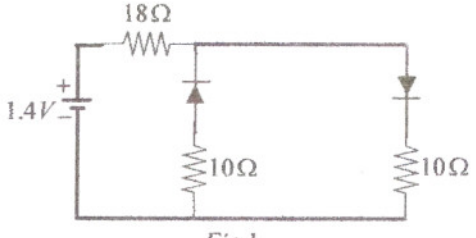

Fig.1

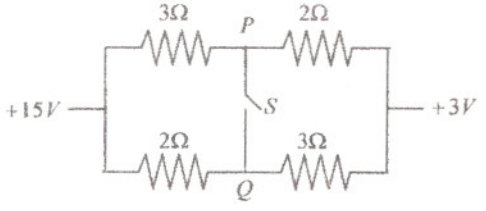

Fig.2

5. The current through the switch S (Fig.2), when it is closed is
(a) 1A, from Q to P (b) 1A, from P to Q (c) 2A, from Q to P (d) 2A, from P to Q.

6. The angle between the vectors $2\hat{i} + \hat{j}$ and $2\hat{i} - \hat{j}$ is
(a) 45^0 (b) 60^0 (c) $\cos^{-1}\frac{3}{5}$ (d) $\cos^{-1}\frac{2}{5}$

7. A body is found to accelerate w. r. t. a particular reference frame. Whether the acceleration is due to some physical force or due to acceleration of the reference frame w. r. t. some inertial frame can be ascertained by using Newton's
(a) 1st law of motion (b) 2nd law of motion
(c) 3rd law of motion (d) 1st and 2nd laws of motion.

8. A planet of mass M moves around the Sun in an elliptic orbit so that its minimum and maximum distances from the Sun are r and R respectively. The time period of revolution of the planet around the Sun is proportional to
(a) $[(r + R)/M]^{1/2}$ (b) $[(r - R)M]^{3/2}$ (c) $(r - R)^{-1/2}$ (d) $(r + R)^{3/2}$

9. Good absorbers of heat are
(a) highly polished objects (b) good emitters of radiation
(c) non-emitters of radiation (d) white- coloured bodies

10. The internal energy of 1 gm-mole of an ideal gas depends on
(a) pressure alone (b) volume alone
(c) temperature alone (d) pressure as well as temperature

11. A small mass 'm' rests at the edge of a horizontal disc of radius 'r'. The coefficient of static friction between the mass and the disc is μ. The disc is rotated with an angular velocity about its axis such that the mass leaves the disc and falls on the floor. The height of the disc from the floor is 'h'. The horizontal distance that the mass travels from the point it leaves the disc is
(a) $\sqrt{(\mu rh)}$ (b) $2\sqrt{(\mu rh)}$ (c) $\sqrt{(2\mu rh)}$ (d) none of these

12. A body placed on a vertical spring resting on a table compresses it by 2 cm. If the body is slightly depressed vertically and then released, it undergoes S.H.M (neglecting damping). The period is approximately
(a) 2.8 sec (b) 1.0 sec (c) 1.4 sec (d) 0.28 sec.

13. The refractive indices of a rarer and a denser medium having a common interface are μ_1 and μ_2 respectively. The depth of an object placed in the rarer medium is 'd' below the interface. Its depth to an observer in the denser medium is
(a) $d[\mu_1/(\mu_2-\mu_1)]$ (b) $(\mu_1/\mu_2)d$ (c) $(\mu_2/\mu_1)\,d$ (d) $d\,(\mu_2-\mu_1)/\mu_1$.

14. The magnetic flux ϕ through a stationary conducting wire loop with resistance R varies during the time interval τ as $\phi = A(\tau - t)t$, where A is a constant and t = time. The amount of heat generated in the loop during that time interval (neglecting self inductance) is
(a) $A^2\tau^3/R$ (b) $(A^2\tau^3)/4R$ (c) $4\log_e(A^2\tau^3/R)$ (d) $(A^2\tau^3)/(3R)$

15. An electron and a proton are accelerated through the same potential difference. If their De Broglie wave lengths are λ_e and λ_p respectively, then
(a) $\lambda_e > \lambda_p$ (b) $\lambda_e < \lambda_p$ (c) $\lambda_e = \lambda_p \neq 0$ (d) $\lambda_e = \lambda_p = 0$

16. An open pipe is suddenly closed at one end with the result that the frequency of the third harmonic of the closed pipe is found to be higher by 100 Hz than the fundamental frequency of the open pipe. The fundamental frequency of the open pipe is
(a) 200 Hz (b) 300 Hz (c) 480 Hz (d) none of these

17. The distance of closest approach between a 5.3 MeV α-particle and a $_{29}Cu^{63}$ nucleus is nearly

(a) 160 fermi (b) 16 fermi (c) 1.6 fermi (d) 0.16 fermi

18. A double slit produces interference pattern with monochromatic light. If the entire system is immersed in water the

(a) fringe width decreases as wavelength decreases (b) fringe width decreases as wavelength increases (c) fringe width remains unchanged (d) fringe width increases

19. In an n-p-n transistor in CE configuration a tungsten filament lamp is connected between the collector and the positive terminal of the battery. An ideal dc voltmeter is connected across the lamp. It will be observed that

(a) on increasing the base current, the bulb glows more and the voltmeter reading increases (b) on increasing the base current, the bulb glows less but the voltmeter reading increases (c) on decreasing the base current, the bulb glows less and the voltmeter reading decreases (d) on decreasing the base current, the bulb glows more and the voltmeter reading decreases.

20. A soap bubble filled with helium floats in air. The mass of the helium is

(a) equal to the mass of displaced air

(b) less than the mass of the wall of the bubble

(c) less than mass of the air displaced by the bubble

(d) greater than the mass of air displaced by the bubble.

Group B

(Each question carries 5 marks)

21. A uniform thin rod of mass 'M' and length 'L' is placed along the z-axis with its lower end at z = 0. Find the gravitational force on a mass 'm' placed on the z-axis at a distance 'd' from the origin (d>>L). If a point mass M is placed at a point $z = z_0$, such that the force on 'm' remains the same, find z_0.

22. The time period of radial oscillation of a spherical star is assumed to depend on its mean radius 'r', its mean density 'ρ' and the universal gravitational constant 'G'. Find the time period of oscillation from dimensional analysis.

23. Three identical metallic spheres of radius 'a', carrying equal charge of 'q', are placed at the corners of an equilateral triangle with sides d >> a. One of the spheres is grounded for some time and then the grounding is removed. The same procedure is followed for the other two spheres in turn. Determine the final charges of the spheres.

24. One mole of an ideal monatomic gas undergoes a cyclic process ABC as in Fig 3

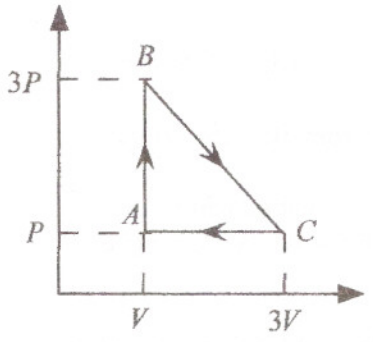

Fig 3

Calculate (a) the total work done by the gas over the full cycle.
(b) total heat transferred in the full cycle
(c) heat absorbed along the path AB and BC.

25. A thin equi-convex lens is placed on a plane mirror, with its axis normal to the mirror. A point object is placed on the axis of the convex lens at a distance of 10 cm from the lens. The image produced by the lens mirror combination coincides with the object. If a few drops of a liquid is placed on the mirror and the lens is placed on the liquid the image produced again coincides with the object if it is moved away along the axis of the lens by 5 cm. Find the refractive index of the liquid, if that of the material of the lens is 1.5.

26. The stopping potential for photoelectric emission in case of Sodium is 1.85 V for $\lambda = 300$ nm, and 0.82 V for $\lambda = 400$ nm. Find out the Planck's constant h, work function W and cut-off wavelength for Sodium.

27. A wire is sharply bent at the middle to form a V-shaped frame, the angle between the two parts of the wire being an acute angle θ. It is held symmetrically in the vertical plane in a uniform, horizontal magnetic field, B, which is normal to the plane of the frame. A piece of horizontal wire, of resistance, R, slides up the frame, starting from the apex, with a uniform speed 'v'. Show that the induced current at time, t, in the circuit is $\frac{2Bv^2t}{R}\tan\frac{\theta}{2}$. Draw a diagram to show the directions of B, v and the induced current.

28. Construct the truth tables of the circuits given in Fig.4. Y_1 and Y_2 are the outputs, A and B are the inputs. Are the outputs identical ?

(a) (b)

Fig. 4