SATISH SCIENCE ACADEMY

DHANORI PUNE-411015

PHYSICS

JEE main - Physics

Time Allowed: 1 hour **Maximum Marks: 100**

General Instructions:

- All questions are compulsory.
- There are 25 questions where the first 20 questions are MCQs and the next 5 are numerical.
- You will get 4 marks for each correct response and 1 mark will be deducted for an incorrect answer.

PHYSICS (Section-A)

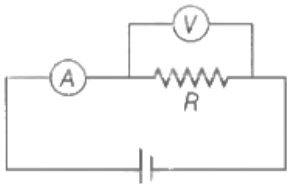
Attempt any 20 questions

1. The dimensions of $\frac{B^2}{2\mu_0}$, where B is magnetic field and μ_0 is the magnetic permeability of vacuum, is: **[4]**

   a) ML^2T^{-1} b) $ML^{-1}T^{-2}$

   c) MLT^{-2} d) ML^2T^{-2}

2. The actual value of resistance R , shown in the figure is 30 Ω. This is measured in an experiment as shown using the V standard formula $R = \frac{V}{I}$, where V and I are the readings of the voltmeter and ammeter, respectively. If the measured value of R is 5% less, then the internal resistance of the voltmeter is **[4]**



   a) 350 Ω b) 570 Ω

   c) 35 Ω d) 600 Ω

3. A helicopter is flying horizontally with a speed **v** at an altitude **h** has to drop a food packet for a man on the ground. What is the distance of helicopter from the man when the food packet is dropped? **[4]**

   a) $\sqrt{\frac{2ghv^2+1}{h^2}}$ b) $\sqrt{2ghv^2+h^2}$

   c) $\sqrt{\frac{2v^2h}{g}+h^2}$ d) $\sqrt{\frac{2gh}{v^2}}+h^2$

4. A block of mass 5 kg is placed at rest on a table of rough surface. Now, if a force of 30 N is applied in the direction parallel to surface of the table, the block slides through a distance of 50 m in an interval of time 10 s. Coefficient of kinetic friction is (given, g = 10 ms^{-2}) **[4]**

   a) 0.75 b) 0.60

   c) 0.50 d) 0.25

5. Two particles of the same mass m are moving in circular - orbits because of force, given by $F(r) = \frac{-16}{r} - r^3$. The first particle is at a distance r = 1, and the second, at r = 4. The best estimate for the ratio of kinetic energies **[4]**

of the first and the second particle is closest to

a) 3×10^{-3} b) 10^{-1}

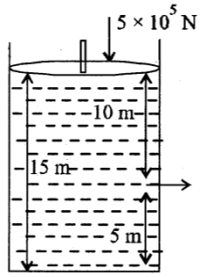
c) 6×10^{-2} d) 6×10^{2}

6. From a solid sphere o f mass M and radius R, a cube of maximum possible volume is cut. Moment of inertia of cube about an axis passing through its centre and perpendicular to one of its faces is **[4]**

a) $\frac{4MR^2}{9\sqrt{3}\pi}$ b) $\frac{MR^2}{16\sqrt{2}\pi}$

c) $\frac{MR^2}{32\sqrt{2}\pi}$ d) $\frac{4MR^2}{3\sqrt{3}\pi}$

7. Consider a cylindrical tank of radius 1 m is filled with water. The top surface of water is at 15 m from the bottom of the cylinder. There is a hole on the wall of cylinder at a height of 5 m from the bottom. A force of 5×10^5 N is applied on the top surface of water using a piston. The speed of efflux from the hole will be: (given atmospheric pressure $P_A = 1.01 \times 10^3$ Pa, density of water ρ_w = 1000 kg/m^3 and gravitational acceleration g = 10m/s^2) **[4]**



a) 10.8 m/s b) 11.6 m/s

c) 17.8 m/s d) 14.4 m/s

8. Three rods of Copper, Brass and Steel are welded together to form a Y-shaped structure. Area of cross-section of each rod = 4 cm^2. End of copper rod is maintained at 100^{o}C whereas ends of brass and steel are kept at 0^{o}C. Lengths of the copper, brass and steel rods are 46, 13 and 12 cms respectively. The rods are thermally insulated from surroundings except at ends. Thermal conductivities of copper, brass and steel are 0.92, 0.26 and 0.12 CGS units respectively. Rate of heat flow through copper rod is: **[4]**

a) 2.4 cal/s b) 1.2 cal/s

c) 6.0 cal/s d) 4.8 cal/s

9. A Carnot engine take 5000 kcal of heat from a reservoir at 727°C and gives heat to a sink at 127°C. The work done by the engine is: **[4]**

a) Zero b) 12.6×10^6 J

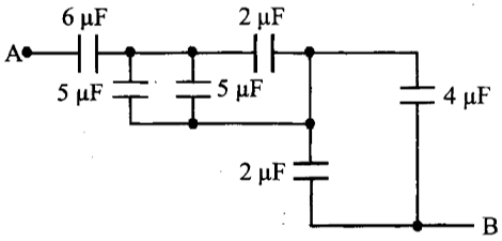
c) 3×10^6 J d) 8.4×10^6 J

10. A simple pendulum of length 1 m is oscillating with an angular frequency 10 rad/s. The support of the pendulum starts oscillating up and down with a small angular frequency of 1 rad/s and an amplitude of 10^{-2} m. The relative change in the angular frequency of the pendulum is best given by **[4]**

a) 10^{-5} rad/s b) 1 rad/s

c) 10^{-3} rad/s d) 10^{-1} rad/s

11. The equivalent capacitance between A and B in the circuit given below is: **[4]**



a) 4.9 μF

b) 5.4 μF

c) 3.6 μF

d) 2.4 μF

12. An electron with energy 0.1 keV moves at right angle to the earth's magnetic field of 1×10^{-4} Wbm^{-2}. The frequency of revolution of the electron will be (Take mass of electron = 9.0×10^{-31} kg) **[4]**

a) 2.8×10^6 Hz

b) 1.8×10^6 Hz

c) 1.6×10^5 Hz

d) 5.6×10^5 Hz

13. A bar magnet is demagnetized by inserting it inside a solenoid of length 0.2 m, 100 turns, and carrying a current of 5.2 A. The coercivity of the bar magnet is: **[4]**

a) 1200 A/m

b) 285 A/m

c) 2600 A/m

d) 520 A/m

14. A long solenoid of radius R carries a time (t) - dependent current $I(t) = I_0t(1 - t)$. A ring of radius 2R is placed coaxially near its middle. During the time interval $0 \leq t \leq 1$, the induced current (I_R) and the induced EMF(V_R) in the ring change as: **[4]**

a) At t = 0.25 direction of I_R reverses and V_R is maximum

b) At t = 0.5 direction of I_R reverses and V_R is zero

c) Direction of I_R remains unchanged and V_R is zero at t = 0.25

d) Direction of I_R remains unchanged and V_R is maximum at t = 0.5

15. The minimum and maximum distances of a planet revolving around the Sun are x_1 and x_2. If the minimum speed of the planet on its trajectory is v_0 then its maximum speed will be: **[4]**

a) $\frac{v_0 x_1^2}{x_2^2}$

b) $\frac{v_0 x_1}{x_2}$

c) $\frac{v_0 x_2^2}{x_1^2}$

d) $\frac{v_0 x_2}{x_1}$

16. A radar sends an electromagnetic signal of electric field (E_0) = 2.25 V/m and magnetic field (B_0) = 1.5×10^{-8} T which strikes a target on line of sight at a distance of 3 km in a medium. After that, a pail of signal (echo) reflects back towards the radar with same velocity and by same path. If the signal was transmitted at time t_0 from radar then after how much time echo will reach to the radar? **[4]**

a) 8.0×10^{-5} s

b) 4.0×10^{-5} s

c) 2.0×10^{-5} s

d) 1.0×10^{-5} s

17. The stopping potential in the context of the photoelectric effect depends on the following property of incident electromagnetic radiation: **[4]**

a) Intensity

b) Frequency

c) Phase d) Amplitude

18. A hydrogen atom makes a transition from n = 2 to n = 1 and emits a photon. This photon strikes a doubly ionized lithium atom (z = 3) in an excited state and completely removes the orbiting electron. The least quantum number for the excited state of the ion for the process is: **[4]**

a) 5 b) 3

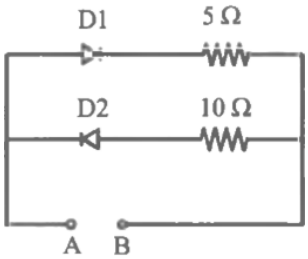
c) 2 d) 4

19. In a reactor, 2 kg of $_{92}U^{235}$ fuel is fully used up in 30 days. The energy released per fission is 200 MeV. Given that the Avogadro number, N = 6.023×10^{26} per kilo mole and 1 eV = 1.6×10^{-19} J. The power output of the reactor is close to: **[4]**

a) 54 MW b) 60 MW

c) 35 MW d) 125 MW

20. A 2V battery is connected across AB as shown in the figure. The value of the current supplied by the battery when in one case battery's positive terminal is connected to A and in another case when the positive terminal of the battery is connected to B will respectively be: **[4]**



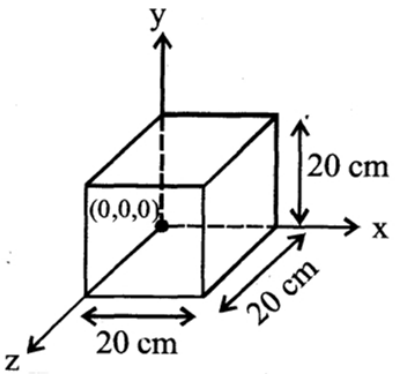
a) 0.4 A and 0.2 A b) 0.2 A and 0.1 A

c) 0.2 A and 0.4 A d) 0.1 A and 0.2 A

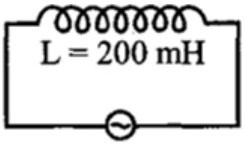
PHYSICS (Section-B)

Attempt any 5 questions

21. Expression for an electric field is given by $\vec{E} = 4000x^2\,\hat{i}\,\frac{V}{m}$. The electric flux through the cube of side 20 cm when placed in electric field (as shown in the figure) is _____ V cm. **[4]**



22. As shown in the figure an inductor of inductance 200 mH is connected to an AC source of emf 220 V and frequency 50 Hz. The instantaneous voltage of the source is 0 V when the peak value of current is $\frac{\sqrt{a}}{\pi}$A. The value of a is _____. **[4]**



23. A fish rising vertically upward with a uniform velocity of 8 ms^{-1}, observes that a bird is diving vertically **[4]**

downward towards the fish with the velocity of 12 ms^{-1}. If the refractive index of water is $\frac{4}{3}$ then the actual velocity of the diving bird to pick the fish, will be _____ ms^{-1}.

24. A tunning fork of frequency 340 Hz resonates in the fundamental mode with an air column of length 125 cm in a cylindrical tube closed at one end. When water is slowly poured in it, the minimum height of water required for observing resonance once again is _____ cm. (Velocity of sound in air is 340 ms^{-1}) **[4]**

25. A uniform metallic wire is elongated by 0.04 m when subjected to a linear force F. The elongation, if its length and diameter is doubled and subjected to the same force will be _____ cm. **[4]**