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)

1. A student measured the length of a rod and wrote it as 4.40 cm. Which of the following instrument did he use to measure it? **[4]**

    a) A screw guage having 50 divisions in the circular scale and pitch as 1 mm.

    b) A screw gauge having 100 divisions in the circular scale and pitch as 1 mm.

    c) A vernier calliper where the 10 divisions in vernier scale match with 9 division in the main scale and main scale have 10 divisions in 1 cm.

    d) A meter scale

2. A car starts from rest, attains a velocity of 36 km/h with an acceleration of 0.2 m/s^2, travels 9 km with this uniform velocity and then comes to halt with a uniform deceleration of 0.1 m/s^2. The total time of travel of the car is **[4]**

    a) 950 s

    b) 1,000 s

    c) 900 s

    d) 1,050 s

3. A stone projected with a velocity at an angle θ with the horizontal reaches maximum height H_1. When it is projected with the velocity at an angle $\left(\frac{\pi}{2} - \theta\right)$ with the horizontal, it reaches a maximum height H_2. The relation between the horizontal range R of the projectile H_1 and H_2 is: **[4]**

    a) $R = \frac{H_1^2}{H_2}$

    b) $R = 4(H_1 - H_2)$

    c) $R = 4\sqrt{H_1 H_2}$

    d) $R = 4(H_1 + H_2)$

4. A bullet of mass 25 g moving with a velocity of 200 m/s is stopped within 5 cm of the target. The average resistance offered by the target is: **[4]**

    a) 10 kN

    b) 30 kN

    c) 20 kN

    d) 40 kN

5. A body of mass m= 10^{-2} kg is moving in a medium and experiences a frictional force F = - kv^2. Its initial speed **[4]**

is $v_0 = 10$ ms^{-1}. If, after 10 s, its energy is $\frac{1}{8}mv_0^2$, the value of k will be

    a) 10^{-3} kgs^{-1} b) 10^{-3} kgm^{-1}

    c) 10^{-4} kgm^{-1} d) 10^{-1} kgm^{-1}s^{-1}

6. A body of mass 2 kg makes an elastic collision with a second body at rest and continues to move in the original **[4]** direction but with one-fourth of its original speed. What is the mass of the second body?

    a) 1.2 kg   b) 1.8 kg

    c) 1.5 kg   d) 1.0 kg

7. A volume V of a viscous liquid flows per unit time due to a pressure head ΔP along a pipe of diameter d and **[4]** length l. Instead of this pipe, a set of four pipes each of diameter $\frac{d}{2}$ and length 2l is connected to the same pressure head ΔP. Now the volume of liquid flowing per unit time is:

    a) $\frac{V}{16}$ b) $\frac{V}{4}$

    c) V   d) $\frac{V}{8}$

8. A piece of iron is heated in a flame. It first becomes dull red then becomes reddish yellow and finally turns to **[4]** white hot. The correct explanation for the above observation is possible by using:

    a) Newton's Law of cooling   b) Stefan's Law

    c) Kirchhoff's Law   d) Wien's displacement Law

9. In a cyclic process, the amount of heat given to a system is equal to: **[4]**

    a) net change in volume   b) net decrease in internal energy

    c) net work done by the system   d) net increases in internal energy

10. On a smooth inclined plane, a body of mass M is attached between two springs. The other ends of the springs are **[4]** fixed to firm supports. If each spring has force constant k, the period of oscillation of the body is: (assuming the springs as massless)
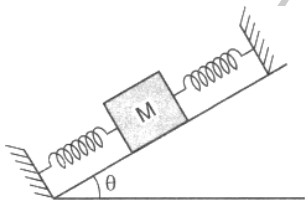
    a) $2\pi(2M/k)^{1/2}$ b) $2\pi\left(Mg\sin\theta/2k\right)$

    c) $2\pi(2Mg/k)^{1/2}$ d) $2\pi(M/2k)^{1/2}$

11. A parallel plate air capacitor has a capacitance C. When it is half filled with a dielectric of dielectric constant 5, **[4]** the percentage increase in the capacitance will be:

    a) 200%   b) 400%

    c) 66.6%   d) 33.3%

12. A ring of radius R, made of an insulating material carries a charge Q uniformly distributed on it. If the ring **[4]** rotates about the axis passing through its centre and normal to plane of the ring with constant angular speed ω, then the magnitude of the magnetic moment of the ring is:

    a) $Q\omega^2 R$ b) $Q\omega R^2$

c) $\frac{1}{2}Q\omega^2 R$ d) $\frac{1}{2}Q\omega R^2$

13. An iron rod of 0.2 cm^2 cross-sectional area is subjected to a magnetizing field of 1200 Am^{-1}. If the susceptibility of iron is 599, the magnetic flux produced is : **[4]**

     a) 1.81×10^{-5} weber   b) 5.34×10^{-5} weber

     c) 2.34×10^{-5} weber   d) 0.904×10^{-5} weber

14. A small circular loop of wire of radius a is located at the centre of a much larger circular wire loop of radius b. The two loops are in the same plane. The outer loop of radius b carries an alternating current $I = I_0 \cos (\omega t)$. The emf induced in the smaller inner loop is nearly: **[4]**

     a) $\frac{\pi\mu_0 I_o}{2} \cdot \frac{a^2}{b}\omega \cos(\omega t)$ b) $\frac{\pi\mu_0 I_0 b^2}{a}\omega \cos(\omega t)$

     c) $\pi\mu_0 I_0 \frac{a^2}{b}\omega \sin(\omega t)$ d) $\frac{\pi\mu_0 I_o}{2} \cdot \frac{a^2}{b}\omega \sin(\omega t)$

15. The resistance of a coil for DC is in Ω. In AC, the resistance: **[4]**

     a) will decrease   b) will increase

     c) will remain same   d) will be zero

16. An X-ray tube operated at 30 kV emits a continuous X-ray of short wavelength limit $\lambda = 0.414 \, \overset{\circ}{A}$. The value of Planck's constant is: **[4]**

     a) 6.62×10^{-34} J-sec   b) 6.7×10^{-34} J-sec

     c) 6.67×10^{-34} J-sec   d) 6.6×10^{-34} J-sec

17. An electron of mass m when accelerated through a potential difference V, has de Broglie wavelength λ. The de Broglie wavelength associated with a proton of mass M accelerated through the same potential difference, will be: **[4]**

     a) $\frac{\lambda M}{m}$ b) $\frac{\lambda m}{M}$

     c) $\lambda\sqrt{\frac{m}{M}}$ d) $\lambda\sqrt{\frac{M}{m}}$

18. The light given out by the glow-worm is due to: **[4]**

     a) fluorescence   b) luminescence

     c) reflection of moonlight   d) bioluminescence

19. M_X and M_Y denote the atomic masses of the parent and the daughter nuclei, respectively in a radioactive decay. The Q value for a β^- decay is Q_1 and that for a β^+ decay is Q_2. If m_e denotes the mass of an electron, then which of the following statements is correct? **[4]**

     a) $Q_1 = (M_X - M_Y)c^2$ and $Q_2 = (M_X - M_Y - 2m_e)c^2$ b) $Q_1 = (M_X - M_Y + 2m_e)c^2$ and $Q_2 = (M_X - M_Y + 2m_e)c^2$

     c) $Q_1 = (M_X - M_Y)c^2$ and $Q_2 = (M_X - M_Y)c^2$ d) $Q_1 = (M_X - M_Y - 2m_e)c^2$ and $Q_2 = (M_X - M_Y + 2m_e)c^2$

20. An AND gate: **[4]**

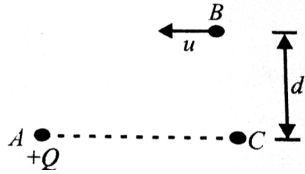   a) is an any or all gate   b) implements logic addition

c) is equivalent to a series switching circuit   d) is equivalent to a parallel switching circuit

PHYSICS (Section-B)

21. A positive charge +Q is fixed at a point A. Another positively charged particle of mass m and charge +q is projected from a point B with velocity u as shown in the +Q figure. Point B is at a large distance from A and at distance d from the line AC. The initial velocity is parallel to the line AC. Point C is at a very large distance from A. If the minimum distance (in metre) of +q from +Q during motion. **[4]**
[Take $Qq = 4\pi\varepsilon_0 mu^2 d$] is $d(1 + \sqrt{x})$, then find the value of x.

22. With what velocity (in km/s) should a body be thrown up so as to reach a height four times the radius of earth from earth's surface? (Radius of earth = 6.4×10^6 m and g = 9.8 m/s^2) **[4]**

    [4]

23.

In the adjoining figure a block of mass m = 10 kg is attached to an end of a massless spring of stiffness k whose other end is fixed. The coefficient of friction between the block and ground is $\mu = 1$. The block is performing SHM of amplitude A = 1 cm and energy of SHM is $\frac{1}{2}KA^2$. The work done by person in one complete cycle of block is _____ J. (Take g = 10m/s^2)

24. A wire shaped as a semi-circle of radius a rotates about an axis OO' with an angular velocity ω in a uniform magnetic field of induction B (shown in figure). The rotation axis is perpendicular to the field direction. The total resistance of the circuit is equal to R. Neglecting the magnetic field of induced current, calculate the mean amount of thermal ower being generated in the loop during one rotation period and express it in the form P$_{mean}$ = B^{m}a^{n}w^p × Constant. Find the value of P. **[4]**
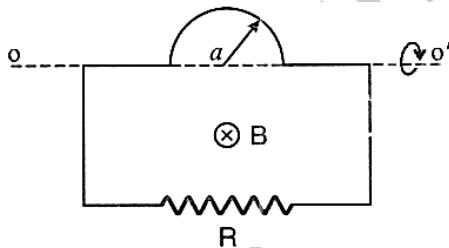
25. An iron tyre is to be fitted onto a wooden wheel 1.0 m in diameter. The diameter of the tyre is 6 mm smaller than that of wheel. The tyre should be heated so that its temperature increases by a minimum of _____ ^{o}C. **[4]**
(Coefficient of volume expansion of iron is 3.6×10^{-5}/^{o}C)