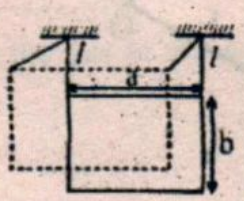
PHYSICS: **Max.Marks : 70**

SECTION I

Single Correct Answer Type

This section contains **10 multiple choice questions**. Each question has four choices A), B), C) and D) out of which **ONLY ONE is correct.**

1. A square plate is hanged vertically with help of two identical strings of length l as shown in the figure. It is displaced in its plane, and released from rest. It performs SHM. Its angular frequency of small oscillations will be.



A) $\sqrt{\frac{g}{l}}$ B) $\sqrt{\frac{g}{l+b}}$

C) $\sqrt{\frac{g}{l+\frac{b}{2}}}$ D) $\sqrt{\frac{2g}{l+\frac{b}{2}}}$

2. A long and thin metallic tube of radius $\frac{2}{\sqrt{\pi}}$ cm carries a current of 4000 amp along its length. Calculate the magnetic pressure (in KPA) on the tube that tries to compress it.

A) 1 B) 2

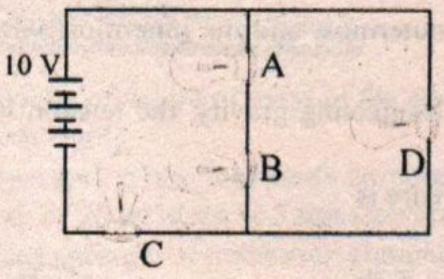
(C) 3 D) 4

3. A copper sphere is suspended in a evacuated chamber maintained at 300 K. The sphere is maintained at constant temperature of 900 K by heating electrically. A total of 300 W electric power is needed to do this. When half of the surface of copper sphere is completely blackened to make this portion completely absorptive, 600 W is needed to maintain the same temperature of sphere. The emissivity of copper is

A) $\frac{1}{4}$ B) $\frac{1}{3}$

C) $\frac{1}{2}$ D) $\frac{1}{5}$

4. In the circuit diagram, all the bulbs are identical. Which bulb will be the brightest?



A) A B) B

C) C D) D

5. A fixed thin spherical shell of radius R, has a uniform charge density σ_c and uniform mass density σ_s. A very small piece of the shell is cut and held in position by applying an external force. When the external force is removed this piece has an initial acceleration ___.

A) $\frac{\varepsilon_0\sigma_s}{2\sigma_c}$

B) $\frac{2\varepsilon_0\sigma_s^2}{\sigma_c^2}$

C) $\frac{\sigma_s^2\sigma_c}{\varepsilon_0}$

D) $\frac{\sigma_c^2}{2\varepsilon_0\sigma_s}$

6. Which of the following is the most sensitive instrument ?

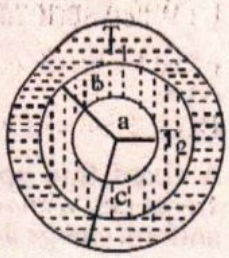
A) A scale whose least count is 0.1cm

B) A vernier calipers in which 10 vernier divisions coincide with 9 main scale divisions whose main scale is millimeter scale

C) A screw gauge in which 50 circular scale divisions equal to 1 main scale divisions (1 msd=1mm)

D) A screw gauge in which 100 circular scale divisions equal to 1 main scale divisions (1msd=1mm)

7. Two different liquid films of surface tensions T_1 and T_2 are held between three concentric wires of radii a, b and c as shown in the figure. The outermost and the innermost wires are fixed. Neglecting gravity, the tension in the middle wire is



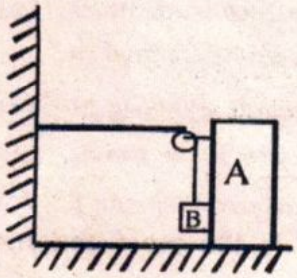
A) $(T_1 - T_2)b$

B) $(T_1c - T_2b)\left(\frac{a}{b+c}\right)$

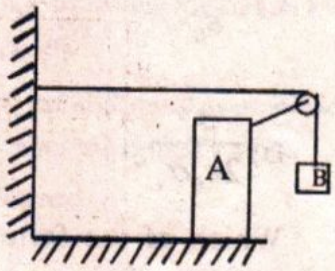
C) $2(T_1 - T_2)b$

D) $(T_1c - T_2B)$

8. A 20 kg block B is suspended from a cord attached to a 40 kg cart A. Find the ratio of the acceleration of block B in case (i) to the acceleration of block B in case (ii) shown in figure immediately after the system is released from rest. (neglect friction).



case (i)



case (ii)

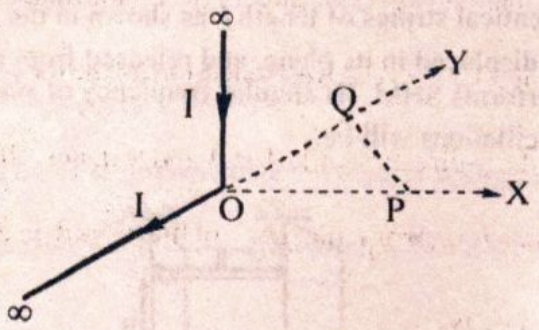
A) $\frac{\sqrt{2}}{3}$

B) $3\sqrt{2}$

C) $3/2$

D) $3/2\sqrt{2}$

9. Figures shows combination of two semi infinite long wires kept on Z and Y-axis. It carries constant current I as shown in figure. Calculate $\int_Q^P \vec{B}\cdot\vec{dl}$ on line QP. Co-ordinate of point P and Q are (a, 0, 0) and (0, a, 0) respectively.



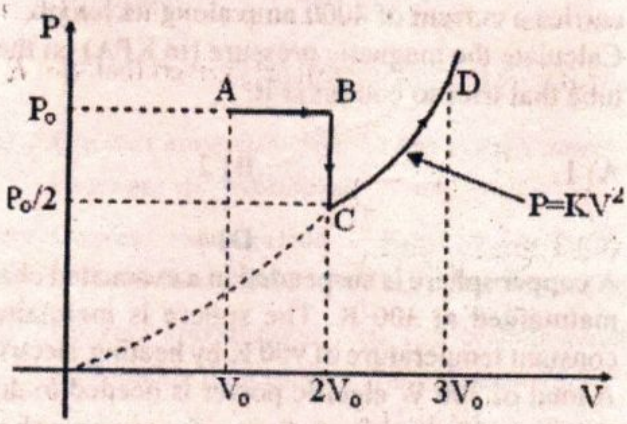
A) $\mu_0 I$

B) $\frac{\mu_0 I}{2}$

C) $\frac{\mu_0 I}{4}$

D) $\frac{\mu_0 I}{8}$

10. A process ABCD has been performed on an ideal gas as shown in figure. The process CD is defined by $P = KV^2$ where K is a positive constant. If the temperature at A is T_0 then the temperature at D will be



A) $\frac{8}{27}T_0$

B) $\frac{27}{8}T_0$

C) $\frac{9}{8}T_0$

D) $\frac{8}{9}T_0$

SECTION II

Multiple Correct Answer(s) Type

This section contains **5 multiple choice questions**. Each question has four choices A), B), C) and D) out of which **ONE or MORE are correct.**

11. A beam of photons of all wavelengths of ultraviolet region passes through hydrogen gas sample at room temperature, in the x-direction. Assume that all photons emitted due to electron transition inside the gas emerge in the y-direction only. Let A and B denote the photons emerging from the gas in the x and y directions respectively.

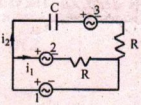
A) Some of the incident wavelengths will be absent in A

B) Only those wavelengths will be present in B which are absent in A

C) B will contain some visible light

D) B will contain some infrared light

12 Figure shows an ac circuit which has three identical sources 1, 2 and 3. Voltage across these all varies with time as $V = V_0 \sin \omega t$. Given that $\omega CR = 1$.



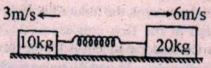
A) $i_1 = \dfrac{2V_0 \sin \omega t}{R}$

B) $i_2 = \dfrac{\sqrt{2}V_0 \sin(\omega t + \pi/4)}{R}$

C) Average power across source 2 is $= \dfrac{V_0^2}{2R}$

D) Average power across source 1 is zero.

13. As shown in figure, two blocks are connected with a light spring. When spring was at its natural length, velocities are given to them as shown in figure. Choose the correct alternative.



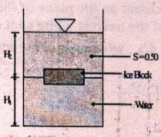
A) Velocity of centre of mass of the system is 3 m/s (towards right)

B) When spring is at maximum compression velocity of 20 kg block is 3 m/s (towards right)

C) When spring is at maximum elongation velocity of 10 kg block is 3m/s (towards left)

D) both blocks will perform SHM with same angular frequency with respect to centre of mass

14. A block of ice (specific gravity $S_{ice} = 0.90$) is floating in a container having two immiscible liquids (one of specific gravity $S_1 = 0.50$ and other is water) as shown in the figure. (H_1, H_2 are heights of water, other liquid columns respectively.) Now the ice block melts completely, then



A) H_2 will decrease

B) H_1 will increase

C) $H_1 + H_2$ will remains unchanged

D) $H_1 + H_2$ decrease

15. Two different coils have self inductances $L_1 = 8$ mH and $L_2 = 2$ mH. The current in one coil is increased at a constant rate. The current in the second coil is also increased at the same constant rate. At a certain instant of time, the power given to the two coils is the same. At that time, the current, the induced voltage and the energy stored in the first coil are i_1, V_1 and W_1 respectively. Corresponding values for the second coil at the same instant are i_2, V_2 and W_2 respectively. Then:

A) $\frac{i_1}{i_2} = \frac{1}{4}$ B) $\frac{i_1}{i_2} = 4$

C) $\frac{W_1}{W_2} = \frac{1}{4}$ D) $\frac{V_1}{V_2} = 4$

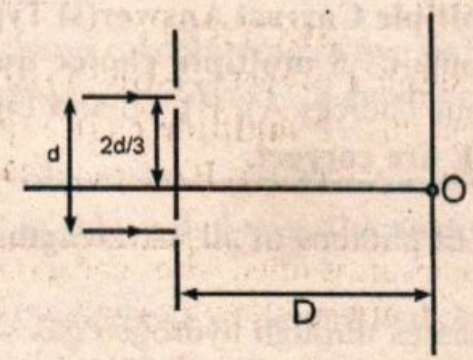
SECTION III

Integer Answer Type

This section contains **5 questions**. The answer to each question is single digit integer, ranging from 0 to 9 (*both inclusive*).

16. Two radioactive sources *A* and *B* initially contain equal number of radioactive atoms. Source *A* has a half-life of 1 hour and source *B* has a half-life of 2 hours. At the end of 2 hours, the ratio of the rate of disintegration of *A* to that of *B* is :

17. In the figure shown if a parallel beam of white light is incident on the plane of the slits then the distance of the nearest white spot on the screen from O is d/x , where x is: [assume d << D, λ << d]



18. A uniform ring of radius R is given a back spin of angular velocity $V_0/2R$ and thrown forward on a horizontal rough surface with velocity of center of mass as V_0 such that plane of ring is perpendicular to horizontal surface. The velocity of center of mass of the ring when it starts pure rolling is $\frac{V_0}{N}$. Find N

19. A double convex lens forms a real image of an object on a screen which is fixed. Now the lens is given a constant velocity v_0 along its axis and away from the screen. For the purpose of forming the image always on the screen, the object is also required to be given an appropriate velocity. Find the velocity of the object(in m/s) at the instant its size is *n* times the size of image. (Take n = 1/2 and $v_0 = 1m/s$)

20. A metallic wire is initially at rest along the curve $y = \frac{\lambda}{\mu}\sin\left(\frac{\pi x}{\lambda}\right), x \in (0, 2\lambda)$. It is moved along the x–y plane parallel to the line $x = y$, with a speed u. There is a uniform magnetic field $2B_0\hat{k}$ in the region. The maximum magnitude of induced emf between any two points on the wire is $\sqrt{\alpha}B_0\lambda u$. The value of α is