PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 80

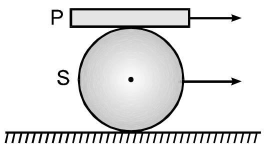
Total Marks : 26

Max. Time : 26 min.

Topics : Rotation, Simple Harmonic Motion, Electromagnet Induction, Alternating Current

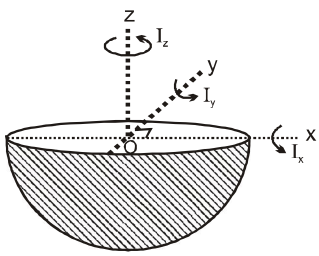
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.3	(3 marks, 3 min.)	[9, 9]
Multiple choice objective ('–1' negative marking) Q.4 to Q.5	(4 marks, 4 min.)	[8, 8]
Comprehension ('–1' negative marking) Q.6 to Q.8	(3 marks, 3 min.)	[9, 9]

1. A plank P is placed on a solid cylinder S, which rolls on a horizontal surface. The two are of equal mass. There is no slipping at any of the surfaces in contact. The ratio of the kinetic energy of P to the kinetic energy of S is:



(A) 1: 1 (B) 2: 1 (C) 8: 3 (D) 1: 4

2. There is a uniform solid hemisphere. On its upper plane x and y axis are drawn which are mutually perpendicular as shown. Z–axis is perpendicular to the upper plane and passing through the centre O. If moment of inertia of the hemisphere about x, y and z-axis are I_x, I_y and I_z respectively then :



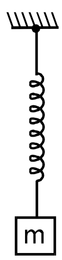
(A) $I_z = I_x + I_y$

(B) $I_z = I_x - I_y$

(C) $I_z = \frac{I_x + I_y}{2}$

(D) $I_z = \frac{I_x - I_y}{2}$

3. A block of mass 'm' is suspended from a spring and executes vertical SHM of time period T as shown in figure. The amplitude of the SHM is A and spring is never in compressed state during the oscillation. The magnitude of minimum force exerted by spring on the block is



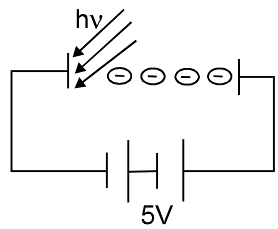
(A) $mg - \frac{4\pi^2}{T^2} mA$

(B) $mg + \frac{4\pi^2}{T^2} mA$

(C) $mg - \frac{\pi^2}{T^2} mA$

(D) $mg + \frac{\pi^2}{T^2} mA$

4. Photons of energy 5 eV are incident on cathode. Electrons reaching the anode have kinetic energies varying from 6eV to 8eV.

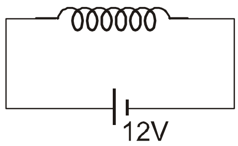


(A) Work function of the metal is 2 eV
(B) Work function of the metal is 3 eV
(C) Current in the circuit is equal to saturation value.
(D) Current in the circuit is less than saturation value.

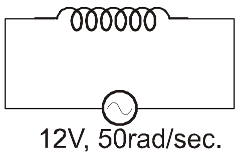
5. An ideal inductor, (having initial current zero) a resistor and an ideal battery are connected in series at time t = 0. At any time t, the battery supplies energy at the rate P_B, the resistor dissipates energy at the rate P_R and the inductor stores energy at the rate P_L.
(A) $P_B = P_R + P_L$ for all times t.
(B) $P_R < P_L$ for all times t.
(C) $P_R < P_L$ only near the starting of the circuit.
(D) $P_R > P_L$ only near the starting of the circuit.

COMPREHENSION

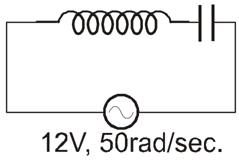
A steady current 4 A flows in an inductor coil when connected to a 12 V dc source as shown in figure 1. If the same coil is connected to an ac source of 12 V, 50 rad/s, a current of 2.4 A flows in the circuit as shown in figure 2. Now after these observations, a capacitor of capacitance $\frac{1}{50}$F is connected in series with the coil and with the same AC source as shown in figure 3 :



(Figure 1)



(Figure 2)



(Figure 3)

6. The inductance of the coil is nearly equal to
(A) 0.01 H (B) 0.02 H (C) 0.04 H (D) 0.08 H

7. The resistance of the coil is :
(A) 1 Ω (B) 2 Ω (C) 3 Ω (D) 4 Ω

8. The average power supplied to the circuit after connecting capacitance in series is approximately equal to:
(A) 24 W (B) 72 W (C) 144 W (D) None of these

Answers Key

1. (C) **2.** (C) **3.** (A) **4.** (A) (D)
5. (A) (C) **6.** (D) **7.** (C)

Hints & Solutions

1. Let velocity of c.m. of sphere be v. The velocity of the plank = 2v.

Kinetic energy of plank = $\frac{1}{2} \times m \times (2v)^2 = 2mv^2$

Kinetic energy of cylinder = $\frac{1}{2} mv^2$

$+ \ \frac{1}{2} + \left(\frac{1}{2} mR^2 \omega^2\right)$

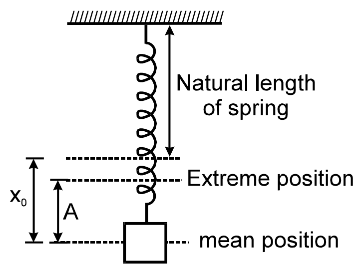
$= \ \frac{1}{2} mv^2 \left(1 + \frac{1}{2}\right)$

$= \ \frac{3}{2} . \frac{1}{2} mv^2$

$\therefore \quad \frac{\text{K.E. of plank}}{\text{K.E. of sphere}} = \frac{2mv^2}{\frac{3}{4} mv^2} = \frac{8}{3}$.

2. $I_x = I_y = I_z = \frac{2}{5} mR^2$

3. The spring is never compressed. Hence spring shall exert least force on the block when the block is at topmost position.



$$F_{least} = kx_0 - kA = mg - m\omega^2 A = mg - 4\frac{\pi^2}{T^2}mA$$

4. $KE_{max} = (5 - \phi)$ eV

when these electrons are accelerated through 5V, they will reach the anode with maximum energy $= (5 - \phi + 5)$eV

$\therefore\ 10 - \phi = 8$

ϕ = 2eV Ans.

Current is less than saturation current because if slowest electron also reached the plate it would have 5eV energy at the anode, but there it is given that the minimum energy is 6eV.

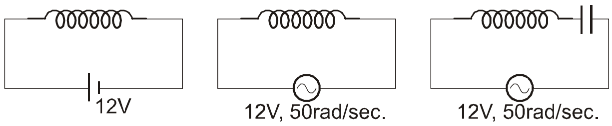
5. By principal of energy conservation.

$P_B = P_R + P_L$

Near the starting of the circuit

$P_R = i^2 R$ and $P_L = L\, i\, \frac{di}{dt}$.

As $\frac{di}{dt}$ has greater value at the starting of the circuit, $P_L > P_R$



(Figure 1) (Figure 2) (Figure 3)

Sol. 1 to 3. : When connected with the DC source

$$R = \frac{12}{4} = 3\ \Omega$$

When connected to ac source $I = \frac{V}{Z}$

$$\therefore\ 2.4 = \frac{12}{\sqrt{3^2 + \omega^2 L^2}} \quad \Rightarrow \quad L = 0.08\ H$$

Using $P = I_{rms} V_{rms} \cos\phi$

$$= \frac{V_{rms}^2}{Z}\cos\phi$$

$$= \frac{V_{rms}^2\ R}{R^2 + (\omega L - \frac{1}{\omega C})^2} = 24\ W$$