

Topics : Heat, Simple Harmonic Motion, Current Electricity, Kinematics, Capacitance

Type of Questions

Single choice Objective ('-1' negative marking) Q.1 to Q.2

(3 marks, 3 min.)

[6, 6]

Subjective Questions ('-1' negative marking) Q.3 to Q.4

(4 marks, 5 min.)

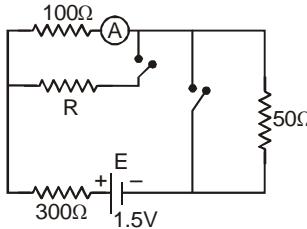
[8, 10]

Comprehension ('-1' negative marking) Q.5 to Q.8

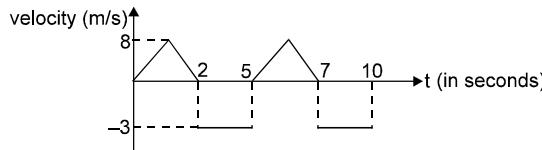
(3 marks, 3 min.)

[12, 12]

1. A wall has two layers A and B each made of different material, both the layers have the same thickness. The thermal conductivity of the material A is twice that of B. Under thermal equilibrium the temperature difference across the wall B is 36°C . The temperature difference across the wall A for the flow of heat through its thickness is
(A) 6°C (B) 12°C (C) 18°C (D) 24°C
2. If the length of a simple pendulum is doubled then the % change in the time period is :
(A) 50 (B) 41.4 (C) 25 (D) 100
3. In the circuit shown, the reading of the ammeter (ideal) is the same with both switches open as with both closed. Find the value of resistance R in ohm.

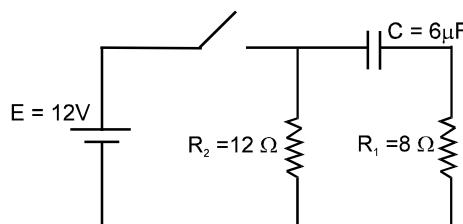


4. A particle moves along X axis. At $t = 0$ it was at $x = -1$. Its velocity varies with time as shown in the figure. Find the number of times the particle passes through the origin in $t = 0$ to $t = 10$ sec.



COMPREHENSION

The circuit contains ideal battery E and other elements arranged as shown. The capacitor is initially uncharged and switch S is closed at $t = 0$. (use $e^2 = 7.4$)



5. Time constant of the circuit is
(A) $48 \mu\text{s}$ (B) $28.8 \mu\text{s}$ (C) $72 \mu\text{s}$ (D) $120 \mu\text{s}$
6. The potential difference across the capacitor in volts, after two time constants, is approximately :
(A) 2 (B) 7.6 (C) 10.4 (D) 12
7. The potential difference across resistor R_1 , after two time constants, is approximately :
(A) 1.6 V (B) 7.6 V (C) 10 V (D) 12 V
8. The potential difference across resistor R_2 , after two time constants, is :
(A) 2V (B) 7.6V (C) 10V (D) 12 V

Answers Key

1. (C) 2. (B) 3. 600 4. 4 times
5. (A) 6. (C) 7. (A) 8. (D)

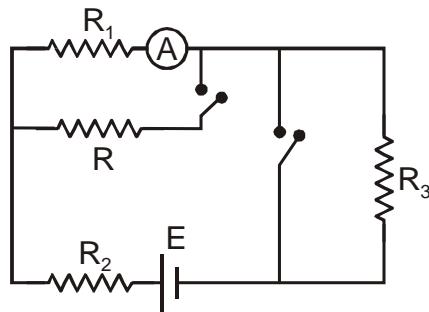
Hints & Solutions

2. $\frac{\Delta T}{T} \times 100 = \frac{1}{2} \frac{\Delta \ell}{\ell} \times 100$ is not valid as $\Delta \ell$ is not small.

$$T_1 = 2\pi\sqrt{\frac{\ell}{g}} \quad T_2 = 2\pi\sqrt{\frac{2\ell}{g}} \quad \% \text{ change} = \frac{T_2 - T_1}{T_1} \times$$

$$100 = (\sqrt{2} - 1) \times 100 = 41.04.$$

3. Switches open :



$$I_A = \frac{E}{R_1 + R_2 + R_3}$$

Switches closed :

There will be no current through R_3 .

Current through E and R_2

$$I' = \frac{E}{R_2 + \frac{RR_1}{R + R_1}}$$

Current through the ammeter

$$I'_A = \frac{RI'}{R + R_1} = \frac{RE}{(R + R_1)R_2 + RR_1}$$

$$= \frac{E}{R_1 + R_2 + \frac{R_2 R_1}{R}}$$

As $I_A = I'_A$

$$R = \frac{R_1 R_2}{R_3} = \frac{100 \times 300}{50} = 600 \Omega$$

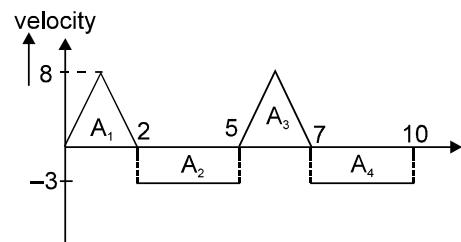
4. 4 times

$$A_1 = A_3 = 8 \text{ (area)}$$

$$A_2 = A_4 = 9$$

Position of the particle at any time t is given by

$$X = X_0 + \int_0^t V dt \quad X_0 = \text{Initial position}$$



$$\int_0^t V dt = \text{Area under the curve}$$

$$\text{Now at } t = 0 \quad X = X_0 = -1$$

$$\text{at } t = 2 \quad X = X_0 + A_1 = -1 + 8 = 7$$

$$\begin{aligned} \text{at } t = 5 \quad X &= X_0 + A_1 - A_2 = -1 + 8 - 9 \\ &= -2 \end{aligned}$$

$$\begin{aligned} t = 7 \quad X &= X_0 + A_1 - A_2 + A_3 = -1 + 8 - 9 + 8 \\ &= 6 \end{aligned}$$

$$\begin{aligned} t = 10 \quad X &= X_0 + A_1 - A_2 + A_3 - A_4 = -1 + 8 - 9 + 8 - 7 = 3 \end{aligned}$$

As during 10 seconds four times the position of the particle changed in sign. Particles passes 4 times the origin

5. Once the switch is closed, the capacitor is charged through resistance R_1 by the battery's e.m.f. Time constant is $R_1 C$.

6. Using $V_c = E (1 - e^{-t/RC})$
 $\Rightarrow V_c = 12 (1 - e^{-2})$
 $= 10.4 \text{ V}$

7. At any moment in the circuit –

$$\begin{aligned} V_c + V_{R_1} &= 12 \text{ V} \\ \Rightarrow V_{R_1} &= 12 \text{ V} - 10.4 \text{ V} \\ &= 1.6 \text{ V} \end{aligned}$$

8. If loop law is applied to the left hand loop in clockwise direction

$$E - V_{R_2} = 0$$

$$V_{R_2} = E = 12 \text{ V}$$