PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 62

Total Marks : 24

Max. Time : 24 min.

Topics : Heat, Current Electricity, Magnetic Effect of Current and Magnetic Force on Charge/current, Rotation, Kinematics, Center of Mass

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.5	(3 marks, 3 min.)	[15, 15]
Comprehension ('–1' negative marking) Q.6 to Q.8	(3 marks, 3 min.)	[9, 9]

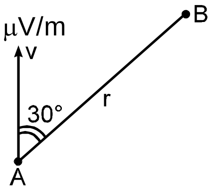
1. A rod of length ℓ and cross section area A has a variable thermal conductivity given by $k = \alpha T$, where α is a positive constant and T is temperature in kelvin. Two ends of the rod are maintained at temperatures T_1 and T_2 ($T_1 > T_2$). Heat current flowing through the rod will be

(A) $\frac{A\alpha(T_1^2 - T_2^2)}{\ell}$ (B) $\frac{A\alpha(T_1^2 + T_2^2)}{\ell}$ (C) $\frac{A\alpha(T_1^2 + T_2^2)}{3\ell}$ (D) $\frac{A\alpha(T_1^2 - T_2^2)}{2\ell}$

2. A potentiometer wire of length 10 m and resistance 10 ohm is connected in series with an ideal cell of E.M.F. 2 V. If a rheostat having range 0 –10 ohm is used in series with the cell then maximum potential gradient of the wire will be :

(A) 2 V/m (B) 0.2 V/m (C) 2 μV/m (D) 0.2 μV/m

3. A charge particle A of charge q = 2 C has velocity v = 100 m/s . When it passes through point A & has velocity in the direction shown . The strength of magnetic field at point B due to this moving charge is (r = 2 m):



(A) 2.5 μ T (B) 5.0 μ T (C) 2.0 μ T (D) none of these

4. Two like parallel forces P and 3 P are 40 cm apart. If the direction of P is reversed, then the point of application of their resultant shifts through a distance of :

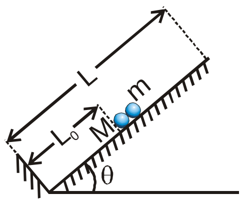
(A) 30 cm (B) 40 cm (C) 50 cm (D) 60 cm

5. The engine of a futuristic nuclear powered car for which power and speed can have fantastic values (say 600 kph) can produce a maximum acceleration of 5 m/s^2 and its brakes can produce a maximum retardation of 10 m/s^2. The minimum time in which a person can reach his workplace, located 1.5 km away from his home using this car is

(A) 5 sec. (B) 10 sec. (C) 15 sec. (D) 30 sec.

COMPREHENSION

Two small balls of same size having masses m and M with a slight separation are released from rest simultaneously on a smooth fixed inclined plane of inclination $\theta = 53°$ and length L. There is a fixed wall at the bottom of the incline such that wall is perpendicular to inclined plane as shown. The collision of both balls takes place only after the collision of mass M with wall is over. Initially M is at a distance L_0 = 9 m from the wall. If M comes to stop just after its collision with m answer the following three questions. (All collisions are perfectly elastic and g = 10 m/s^2 and $\sin 53° = \frac{4}{5}$)



6. Just after collision of both balls, velocity of ball having mass m up the incline is:

(A) 20 m/s (B) 22 m/s (C) 24 m/s (D) 12 m/s

7. The ratio m : M is :

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

8. The minimum value of L (in meter) so that m does not leave the incline.

(A) 12 (B) 24 (C) 36 (D) 48

Answers Key

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

Hints & Solutions

1. Heat current : $i = -kA\frac{dT}{dx}$

$idx = -kA\,dT$

$$i\int_0^{\ell} dx = -A\alpha \int_{T_1}^{T_2} T\,dT$$

$$\Rightarrow \quad i\ell = -A\alpha \frac{(T_2^2 - T_1^2)}{2}$$

$$\Rightarrow \quad i = \frac{A\alpha(T_1^2 - T_2^2)}{2\ell}$$

2. $i = \frac{2}{10+R} \quad \Rightarrow \quad V_{AB} = \frac{2}{10+R} \times 10$

$$\Rightarrow x = \frac{2}{10+R} \times \frac{10}{10} \quad \Rightarrow \quad x_{max} = 0.2 \text{ V/m.}$$

3. $\vec{B} = \frac{\mu_0}{4\pi}\frac{2\vec{v}\times\vec{r}}{r^3}$

$$B = \frac{\mu_0}{4\pi}\frac{qv\sin\theta}{r^2}$$

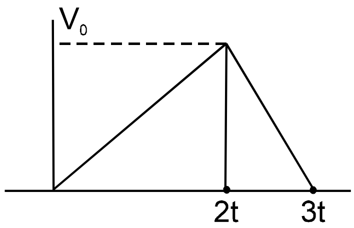
$$= 10^{-7} \times \frac{2 \times 100 \times \sin 30°}{(2)2}$$

$$= 10^{-7} \times \frac{2 \times 100 \times \frac{1}{2}}{2^2}$$

$= 25 \times 10^{-7}$ T

$= 2.5 \times 10^{-6}$ T

$= 2.5\ \mu$T

5. 

$V_0 = 5 \times 2t = 10\ t$

$S = 1500 = \frac{1}{2}V_0.3t = \frac{1}{2}10t.3t$

$\Rightarrow$ t = 10 sec.

$\therefore$ total time = 3t = 30 sec.

6. Just before collision velocity of M and

m = $\sqrt{2gL_0 \sin\theta}$ = 12 m/s

Since collision is elastic, let velocity of m just after collision is v then by relative velocity of separation = relative velocity of approach

v = 12 + 12 = 24 m/s **Ans.**

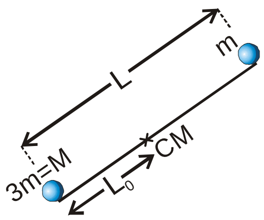
7. By momentum conservation during collision of m and M.

12 M – 12 m = 24 m

m : M = 1 : 3

8. By mechanical energy conservation for m, just after collision

$\frac{1}{2}mv^2 = mgL \sin\theta$



$\Rightarrow$ $L = \frac{v^2}{2g\sin\theta} = \frac{24^2 \times 5}{20 \times 4}$ = 36 meter.

Alternate :

since there is no energy loss, center of mass of m and M rises to the same initial position.

$3mL_0 = m(L - L_0)$

$\Rightarrow$ $4mL_0 = mL$

$\Rightarrow$ $L = 4L_0$ = 36 meter.