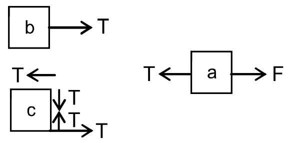
PHYSICS PAPER II SOLUTIONS



1. **BC**

$F - T = 10 \times a$ …(1)

$T = 10 \times a$ …(2)

$F = 20a \Rightarrow a = 1$

$T = 10$ N, $a_a = a_b = 1$, $a_c = 0$

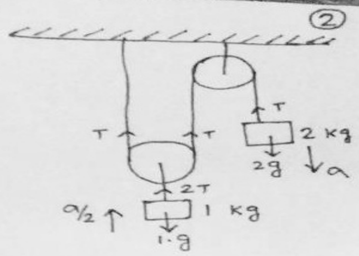
Q.2 (A) work done on 2 kg block by gravity is 6 J

(B) work done on 2 kg block by string is –2 J

(C) work done on 1 kg block by gravity is –1.5 J

(D) work done on 1 kg block by string is 2 J

Force equation for both the blocks can be written as



$2g - T = 2a$ — (i)

$2T - g = \frac{a}{2}$ — (ii)

$2g - T = 2a \;] \times 2$

$2T - g = \frac{a}{2}$

$4g - g = \frac{9a}{2}$

$3g = \frac{9a}{2}$

$a = \frac{2g}{3}$

$T = 2(g - a)$

$T = 2\left(g - \frac{2g}{3}\right)$

$T = \frac{2g}{3}$

Displacement of 2 kg block in 0.3 s

$x_1 = \frac{1}{2}at^2 = \frac{1}{2} \times \frac{2g}{3} \times \frac{9}{100} = \frac{3}{10}$ m ↓

$x_2 = \frac{3}{20}$ m ↑ (Displacement of 1 kg block)

on 2 kg block

$W_{Mg} = 2g \times \frac{3}{10} = 6$ J

$W_T = -T \times \frac{3}{10} = -\frac{2g}{3} \times \frac{3}{10} = -2$ J

on 1 kg block

$W_{Mg} = -g \times \frac{3}{20} = -1.5$ J

$W_T = 2T \times \frac{3}{20} = 2 \times \frac{2g}{3} \times \frac{3}{20} = 2$ J

(a), (b), (c), (d) is correct.

Q.3 (B) Work done by $\vec{F}_2$ is 180 J

(C) Work done by $\vec{F}_3$ is 45 π

(D) $\vec{F}_1$ is conservative in nature

3 → Work done by F_2 (3)

$$W_{F_2} = \int_0^6 F_2\,dx = 30 \times 6 = 180\,N$$

Work done by F_3

$$\vec{F_3} = F_1 \sin\theta\,\hat{i} + F_1 \cos\theta\,\hat{j}$$

$$\vec{dr} = dr \sin\theta\,\hat{i} + dr\cos\theta\,\hat{j}$$

$$dw = \vec{F_3}\cdot\vec{dr}$$

$$dw = F_3\,dr\,(\sin^2\theta + \cos^2\theta)$$

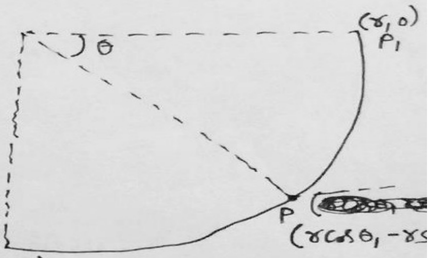
$$dw = F_3\,dr$$

$$W = F_3\int dr = F_3 \cdot \frac{\pi r}{2}$$

$$W_{F_3} = 15 \times \frac{\pi \times 6}{2} = 45\pi\,J.$$

Work done by F_1

Direction of $\vec{F_1}$ is along $\vec{PP_1}$



$$\vec{PP_1} = (r - r\cos\theta)\,\hat{i} + r\sin\theta(+\hat{j})$$

unit vector along F_1 is

$$\hat{u} = \frac{(r - r\cos\theta)\hat{i} + r\sin\theta(+\hat{j})}{\sqrt{(r - r\cos\theta)^2 + r^2\sin^2\theta}}$$

$$\hat{u} = \frac{2r\sin^2\frac{\theta}{2}\,\hat{i} + 2r\sin\frac{\theta}{2}\cos\frac{\theta}{2}\,(+\hat{j})}{\sqrt{2r^2(1-\cos\theta)}}$$

$$\hat{u} = \frac{2r\sin\frac{\theta}{2}\left(\sin\frac{\theta}{2}\,\hat{i} + \cos\frac{\theta}{2}\,(+\hat{j})\right)}{2r\sin\frac{\theta}{2}}$$

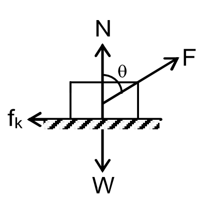
$$\hat{u} = \sin\frac{\theta}{2}\,\hat{i} + \cos\frac{\theta}{2}\,(+\hat{j})$$

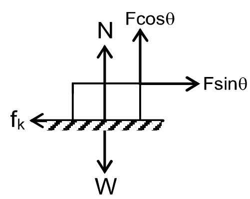
4. **BC**

4. N = W – Fcosθ N < W

F sinθ = f_k θ < 90°, sinθ < 1

F > f_k





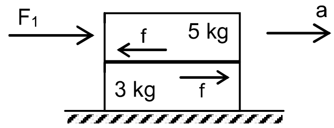
5. **ABCD**

Incline may accelerate in any direction.

Q.6.(a) is independent of shape of trajectory
(c) depends upon both the components of displacement

Q.7. (B) $F_1(max) > F_2(max)$
(D) $F_1(max) : F_2(max) = 5 : 3$

In first case:

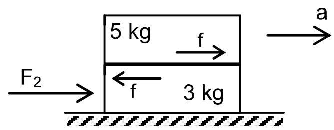


$a = \frac{F_1}{8}$

For motion of 3 kg

$f = \mu(5)(g) = (3)\left(\frac{F_1}{8}\right)$ …(1)

In second case:



$A = \frac{F_2}{8}$

For motion of 5 kg

$f = \mu(5)(g) = (5)\left(\frac{F_2}{8}\right)$ …(2)

From (1) and (2)

$3F_1 = 5F_2$

(B) and (D)

Q.8. (B) x = 2mg/k
(C) The ball will have no acceleration at the position where it has descended through x/2.
(D) The ball will have an upward acceleration equal to g at its lowermost position

Paragraph 1

Q.9. (A) zero

$W = ma \times 0 = 0$

Q.10. B) $\frac{1}{2}ma^2t_0^2$

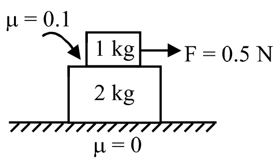
$W = \frac{1}{2}mV_f^2 - \frac{1}{2}mV_i^2 = \frac{1}{2}m(at_0)^2 - 0$

Paragraph 2

11. **[B]**

Sol. $a = \frac{F}{M+m} = \frac{1}{6}$ m/s^2

1kg will not slide w.r.t. lower block because $Ma < \mu mg$



Friction force on upper block due to lower block is opposite to the motion and it is, f = ma = 2 × 1/6 = 1/3 N ∴ W = –f .S = – 1/3 × 3 =–1 J

12. **[D]**

Sol. $\therefore$ Upper block is stationary w.r.t. lower block

$\therefore$ W = 0

Integer

1. 9

$w = (2\hat{i} + 3\hat{j} + 4\hat{k}).(-5\hat{i} + 5\hat{j} + \hat{k})$

= -10 + 15 + 4 = 9

2. 2

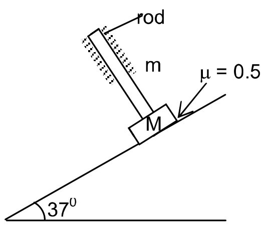
Work = $\int \vec{F} \, . \, \overrightarrow{dr}$

= Area under force–displacement curve.

= Area under F_x – X curve + Area

Under F_y – Y curve + Area under F_2 – Z curve.

3. **6**



For equilibrium of block

Mg sin θ = μ(N)

= μ(Mg cos θ + mg cos θ)

4. Acceleration = $\frac{\vec{F}}{m} = \frac{6\hat{i} + 8\hat{j}}{10}$ in the direction of force and displacement

$\vec{S} < \vec{u}t + \frac{1}{2}\vec{a}t^2$

$= 0 + \frac{1}{2}\left(\frac{6\hat{i} + 8\hat{j}}{10}\right) 100 = 30\hat{i} + 40\hat{j}$

So the displacement is 50m along $\tan^{-1}\frac{4}{3}$ with x-axis

5. As there is a load at P so tension in AP and PB will be different.

Let these be T_1 and T_2 respectively. For vertical equilibrium of P

$T_2 \cos 60^\circ = Mg \Rightarrow T_2 = 2Mg$ .... (1)

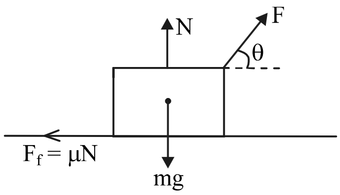
and for horizontal equilibrium of P

$T_1 = T_2 \sin 60^\circ = T_2 (\sqrt{3}/2)$ .... (2)

Substituting the value of T_2 from

equation(1) in (2) $T_1 = (2Mg) \times \sqrt{3}/2 = \sqrt{3}Mg$

6.



Since there is no upward motion

$N + F\sin\theta = mg$ .....(1)

Since the motion along the displacement direction is without any acceleration

$F\cos\theta = \mu N$ .....(2)

from eq. (1) & (2)

$$F = \frac{\mu mg}{\cos\theta + \mu\sin\theta}$$

$$= \frac{0.2\times 6\times 10}{\frac{1}{\sqrt{2}}(1+0.2)} = 10\sqrt{2} \text{ newton}$$

Work done $W = Fs\cos\theta$

$$= (10\sqrt{2}) \times 12 \times \frac{1}{\sqrt{2}} = 120 \text{ J}$$

7. **1**

$150 - \mu \times 20 \times g = 20a$

$\Rightarrow \quad a = 2.5$