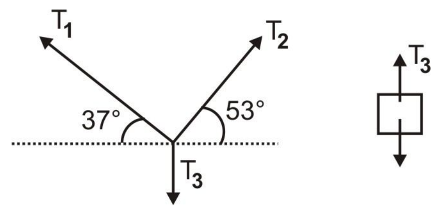
Hints and Solutions

3. For equilibrium,



(1) $T_3 = mg$

(2) $T_1 \cos 37° = T_2 \cos 53° \Rightarrow 4T_1 = 3T_2$

(3) $T_1 \sin 37° + T_2 \sin 53° = T_3$

$\Rightarrow 3T_1 + 4T_2 = 5T_3$

$\Rightarrow \left(\frac{9}{4}+4\right) T_2 = 5mg$

$\Rightarrow T_2 = \frac{4}{5}mg$ and $T_1 = \frac{3}{5}mg$

4. $F = T = kx = 100 \times 0.2 = 20$ Newtons

5. Acceleration = $\frac{50-32}{2+3+4} = 2m/s^2$

$\Rightarrow$ Net force on 2 kg block is = $2 \times 2 = 4N$

$\Rightarrow$ $50 - N = 4$

$\Rightarrow$ $N = 46$ Newtons.

6. Since, length $\alpha \frac{1}{K}$.

7. Let $a_A \downarrow$ and $a_B \uparrow$

(1) $mg - T = ma_A$

(2) $2T - mg = ma_B$

(3) Constraint Relation $\Rightarrow 2a_B = a_A$

From (1), (2) and (3)

$$a_B = \frac{g}{5}, a_A = \frac{2g}{5}$$

8. In case – I, $T = \left(\frac{2m_1m_2}{m_1+m_2}\right)g = \frac{4g}{3} \Rightarrow a = \frac{g}{3}$

In case – II, $T = 2mg \Rightarrow a = 2g$

9. Acceleration of system = $\frac{100}{100} = 1m/s^2$

$\therefore$ Tension = T = ma

$\Rightarrow$ T = ma

$\Rightarrow$ $T = 90 \times 1$

$\Rightarrow$ T = 90

11. Motion is upwards but acceleration is downwards.

12. $\vec{a}_{1/Pulley} = -\vec{a}_{2/Pulley}$

$\Rightarrow \quad a_1 - a = -(-a_2 - a)$

$\Rightarrow \quad a_1 - a_2 = 2a$

13. $\Delta p_{total in one second} = 20 \times \frac{20}{1000} \times 400 = 160N$

$\therefore$ acceleration = $\frac{160}{1600} = 0.1\, m/s^2 = 10\ cm/s^2$

14. $\frac{T_1}{T_2} = \frac{m(g+a)}{m(g-a)} = \frac{(3g/2)}{(g/2)} = 3:1$

16. $T = \frac{2m_1m_2g}{m_1+m_2} = 40 \Rightarrow x = \frac{40}{100} m = 40\,cm$.

17. Since, tension in the string is zero.

18. $\mu m_B g > m_A g$ (for no motion of block – B)

$\Rightarrow \quad \mu > \frac{m_A}{m_B} \Rightarrow \mu > \frac{1}{2}$

19. $f_{static} < \mu N$ and $f_{static} = mg\sin 30°$

20. As $t \propto \frac{1}{\sqrt{a}}$

$\Rightarrow \quad \sqrt{a_{smooth}} = 2\sqrt{a_{rough}}$

$\Rightarrow \quad a_{smooth} = 4a_{rough}$

$\Rightarrow \quad g\sin 45° = 4(g\sin 45° - \mu\cos 45°)$

$\Rightarrow \quad \mu = \frac{3}{4}$

21. Let friction = f and both the blocks are moving together

$\therefore \quad a = \frac{100}{40+10} = \frac{f}{40} \Rightarrow f = 80N$

As $f_{max} = \mu_s(10g) = 58.8N$ which is less than 80 N, so there is slipping between block and slab.

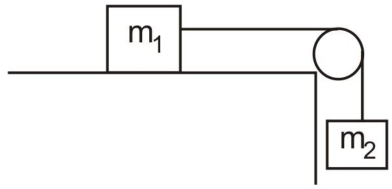
Hence, acceleration of slab = $\frac{\mu_k(10g)}{40} = 0.98\, m/s^2$

22. N = F cos 37° and F sin 37° > mg + μN

$\Rightarrow \quad \frac{3F}{5} > 100 + (0.5)\left(\frac{4F}{5}\right)$

$\Rightarrow \quad F > 500$

23. $m_1 = \frac{m(l - l_1)}{l}$; $m_2 = \frac{ml_1}{l}$



Now, $m_2g < \mu m_1g$

$\Rightarrow \quad \frac{ml_1}{l}g < \mu mg\left(\frac{l - l_1}{l}\right)$

$\Rightarrow \quad l_1 < \mu l - \mu l_1$

$\Rightarrow \quad (\mu + 1)l_1 < \mu l$

25. $F_1 = mg\sin 37° + \mu mg\cos 37°$

$= 120 + 160 = 280$

$F_2 = \mu mg\cos 37° - mg\sin 37°$

$= 160 - 120 = 40$

26. $T\cos\theta = mg$ & $T\sin\theta = \frac{mv^2}{\ell}$

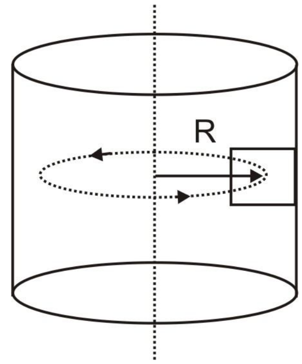
Dividing, $\tan\theta = \frac{v^2}{Rg} \Rightarrow \tan\theta = \frac{v^2}{lg\sin\theta}$

$\Rightarrow \quad \tan\theta\sin\theta = \frac{30^2}{2000}$

$\Rightarrow \quad \frac{\sin^2\theta}{\cos\theta} = \frac{9}{20} \Rightarrow \theta = 37°$

$\therefore \quad T = \frac{mg}{\cos\theta} = \frac{5mg}{4}$

27. f = mg ⇒ mg ≤ μN



$\Rightarrow \quad mg \le \mu \frac{mv^2}{R}$

$\Rightarrow \quad \mu \ge \frac{Rg}{v^2}$

29. After time t,

V = u + at

$\therefore \quad T = \frac{mv^2}{R} = \frac{m(u+at)^2}{R} \Rightarrow$ concave upwards parabola.

30. Static friction = $f_s = \sqrt{\left(\frac{mv^2}{R}\right)^2 + (ma)^2}$

$\therefore \quad \left(\frac{mv^2}{R}\right)^2 + (ma)^2 \le (\mu mg)^2$

$\Rightarrow \quad a \le \sqrt{\mu^2 g^2 - \frac{v^4}{R^2}}$