

Chapter 6 Exercise 6A

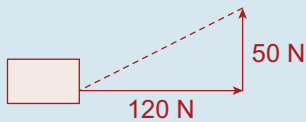
Q. 1. (i) $Work = Fs$
 $= 80(30)$
 $= 2,400 \text{ J}$

(ii) $Power = \frac{Work}{Time}$
 $= \frac{2,400}{10}$
 $= 240 \text{ W}$

Q. 2. (i) $Work = Fs$
 $= 200(12)$
 $= 2,400 \text{ J}$

(ii) $Power = \frac{2,400}{8}$
 $= 300 \text{ W}$

Q. 3.



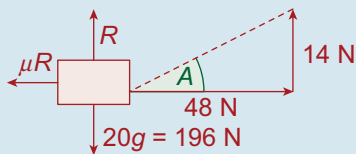
(i) $Work = Fs$
 $= 120(50)$
 $= 6,000 \text{ J}$

(ii) $Power = \frac{6,000}{60}$
 $= 100 \text{ W}$

Q. 4. $Power = Fv$
 $= 600(20)$
 $= 12,000 \text{ W}$

Q. 5. $P = Fv$
 $\Rightarrow 100,000 = F(5)$
 $\Rightarrow F = 20,000 \text{ N}$

Q. 6. Since $\tan A = \frac{7}{24}$, $\cos A = \frac{24}{25}$, $\sin A = \frac{7}{25}$



(i) $R + 14 = 196$
 $\Rightarrow R = 182 \text{ N}$

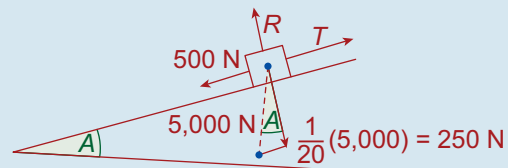
(ii) $\mu R = \frac{1}{7}(182)$
 $= 26 \text{ N}$

(iii) $Work = Fs$
 $= 48(30)$
 $= 1,440 \text{ J}$

(iv) $F = ma$
 $\Rightarrow (48 - 26) = 20a$
 $\Rightarrow a = 1.1 \text{ m/s}^2$

(v) $Power = \frac{Work}{Time}$
 $= \frac{1,440}{20}$
 $= 72 \text{ W}$

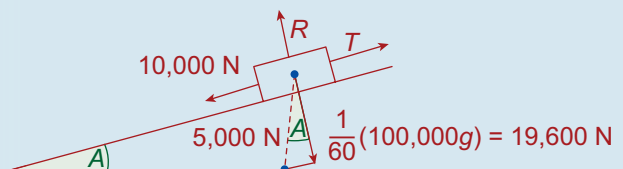
Q. 7. $\sin A = \frac{1}{20}$



No acceleration $\Rightarrow T = 500 + 250$
 $= 750 \text{ N}$

$Power = Fv$
 $= 750(12)$
 $= 9,000 \text{ W}$

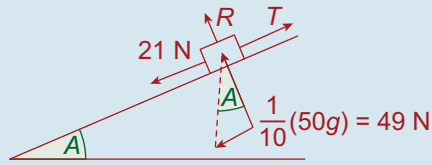
Q. 8.



No acceleration $\Rightarrow T = 19,600 + 10,000$
 $= 29,600 \text{ N}$

$Fv \Rightarrow P = (29,600)(10)$
 $= 296,000 \text{ W}$
 $= 296 \text{ kW}$

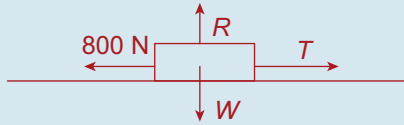
Q. 9.



No acceleration $\Rightarrow T = 21 + 49$
 $= 70 \text{ N}$

$P = Fv \Rightarrow 350 = (70)v$
 $\Rightarrow v = 5 \text{ m/s}$

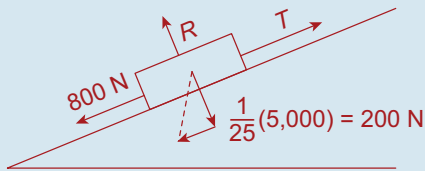
Q. 10. (i)



$T = 800 \text{ N}$

$P = Fv \Rightarrow P = 800(50)$
 $= 40,000 \text{ W}$
 $= 40 \text{ kW}$

(ii)



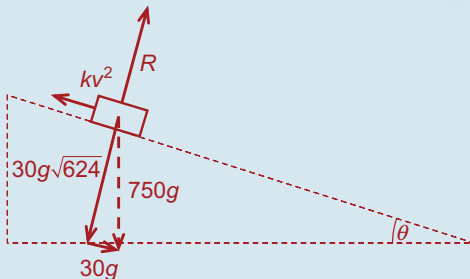
$T = 800 + 200 = 1,000$

$P = Fv \Rightarrow 40,000 = (1,000)v$
 $\Rightarrow v = 40 \text{ m/s}$

Q. 11. (i) Horizontal $= T \cos \theta$

$= 80 (0.8660)$
 $= 69.28 \text{ N}$

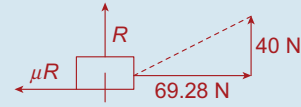
Q. 13. (i)



When train attains a speed of 30 m/s

$kv^2 = 30g$
 $\Rightarrow k(30)^2 = 30g$
 $\Rightarrow 30k = g \Rightarrow k = \frac{g}{30}$

Vertical $= T \sin \theta$
 $= 80(0.5)$
 $= 40 \text{ N}$

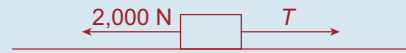


(ii) $R + 40 = 196 \Rightarrow R = 156 \text{ N}$

(iii) $\mu R = \frac{1}{3}(156) = 52 \text{ N}$
 $F = ma \Rightarrow (69.28 - 52) = 20a$
 $\Rightarrow a = 0.864 \text{ m/s}$

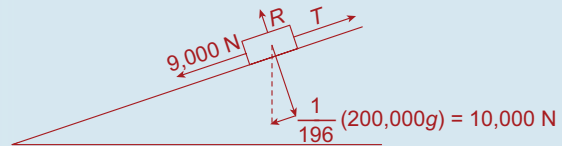
(iv) Work $= Fs$
 $= 69.28(0.5)$
 $= 34.64 \text{ J}$

Q. 12. (i)



$P = Tv \Rightarrow 500,000 = T(10)$
 $\Rightarrow T = 50,000$

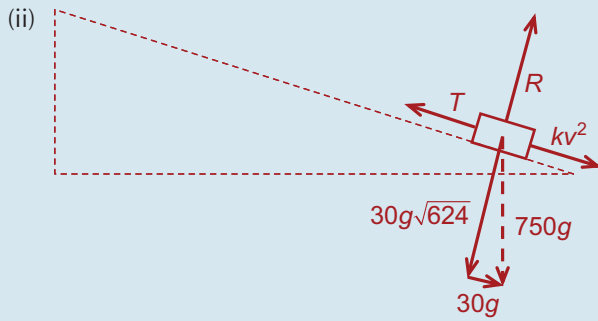
$F = ma \Rightarrow (50,000 - 2,000)$
 $= 200,000a$
 $\Rightarrow a = 0.24 \text{ m/s}^2$



(ii) $P = Tv \Rightarrow 500,000 = T(20)$
 $\Rightarrow T = 25,000 \text{ N}$

$F = ma$
 $\Rightarrow (25,000 - 10,000 - 9,000)$
 $= 200,000a$
 $\Rightarrow a = 0.03 \text{ m/s}^2$

$\sin \theta = \frac{1}{25}$
 $\Rightarrow \cos \theta = \frac{\sqrt{624}}{25}$



$$T = kv^2 + 30g \quad \dots \text{maximum speed attained is } 20 \text{ m/s}$$

$$\Rightarrow T = \left(\frac{g}{30}\right)(20)^2 + 30g$$

$$\Rightarrow T = \frac{40}{3}g + 30g$$

$$\Rightarrow T = \frac{130g}{3} \text{ N}$$

$$P = Tv$$

$$= \left(\frac{130g}{3}\right)(20)$$

$$= \frac{2,600g}{3} \text{ watts}$$

(iii) $P = \frac{2,600g}{3}$



At maximum speed

$$T = kv^2 \quad \dots \text{but } T = \frac{P}{v} = \frac{2,600g}{3v}$$

$$\Rightarrow \frac{2,600g}{3v} = \left(\frac{g}{30}\right)v^2$$

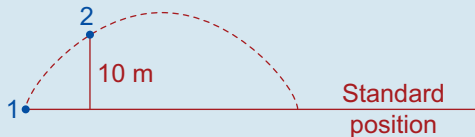
$$\Rightarrow 3v^3 = 78,000$$

$$\Rightarrow v^3 = 26,000$$

$$\Rightarrow v = 29.625 \text{ m/s}$$

Exercise 6B

Q. 1.



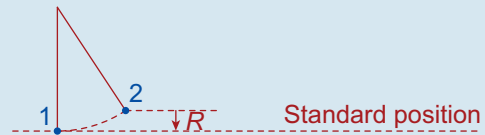
$$\frac{1}{2}M(20)^2 + Mg(0) = \frac{1}{2}Mv^2 + Mg(10)$$

$$\Rightarrow 200 = \frac{1}{2}v^2 + 98$$

$$\Rightarrow v = \sqrt{204}$$

$$= 14.28 \text{ m/s}$$

Q. 2.



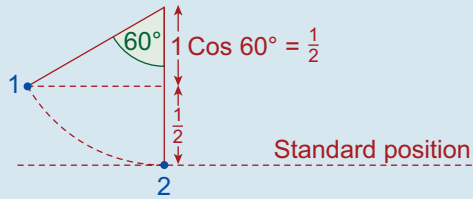
$$\frac{1}{2}M(2)^2 + Mg(0) = \frac{1}{2}M(0)^2 + Mgh$$

$$\Rightarrow 2 = 9.8h$$

$$\Rightarrow h = \frac{2}{9.8}$$

$$= \frac{10}{49} \text{ m}$$

Q. 3.

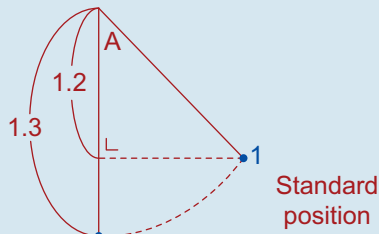


$$\begin{aligned} \frac{1}{2}M(0) + Mg\left(\frac{1}{2}\right) &= \frac{1}{2}Mv^2 + Mg(0) \\ \Rightarrow v^2 &= g \\ \Rightarrow v &= \sqrt{g} = 3.13 \text{ m/s} \end{aligned}$$

Q. 4.

$$\begin{aligned} \frac{1}{2}mu^2 + mgh_1 &= \frac{1}{2}mv^2 + mgh_2 \\ \frac{1}{2}(0.4)(7)^2 + (0.4)g(1) &= \frac{1}{2}(0.4)(0)^2 + (0.4)g(h) \\ \Rightarrow 13.72 &= 3.92h \\ \Rightarrow h &= 3.5 \text{ m} \end{aligned}$$

Q. 5.



$$\begin{aligned} \frac{1}{2}M(0) + Mg(0.1) &= \frac{1}{2}Mv^2 + Mg(0) \\ \Rightarrow v^2 &= 0.2g \\ \Rightarrow v &= \sqrt{0.2g} \\ &= \sqrt{\frac{g}{5}} \end{aligned}$$

Q. 6.

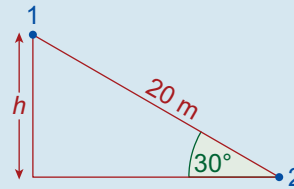
(i)

$$\begin{aligned} \frac{1}{2}mu^2 + mgh_1 &= \frac{1}{2}mv^2 + mgh_2 \\ \Rightarrow \frac{1}{2}m(14)^2 + mg(0.5) &= \frac{1}{2}m(0)^2 + mgh \\ \dots \text{ divide by } m \\ \Rightarrow 102.9 &= 9.8h \\ \Rightarrow h &= 10.5 \text{ m} \end{aligned}$$

(ii)

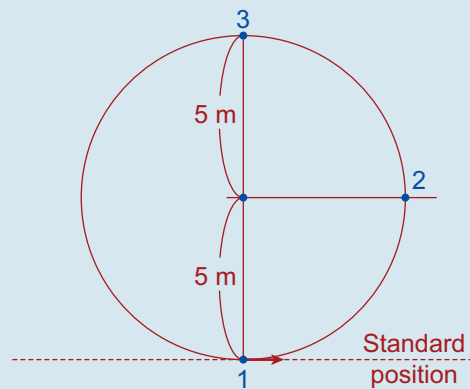
$$\begin{aligned} \frac{1}{2}mu^2 + mgh_1 &= \frac{1}{2}mv^2 + mgh_2 \\ \Rightarrow \frac{1}{2}m(0)^2 + mg(10.5) &= \frac{1}{2}mv^2 + mg(0) \\ \dots \text{ divide by } m \\ \Rightarrow 102.9 &= \frac{v^2}{2} \\ \Rightarrow v^2 &= 205.8 \\ \Rightarrow v &= 14.35 \text{ m/s} \end{aligned}$$

Q. 7. Since no force, apart from the gravitational force, does work on the sleigh.



$$\begin{aligned} h &= 20 \sin 30^\circ \\ &= 20\left(\frac{1}{2}\right) \\ &= 10 \text{ m} \\ \frac{1}{2}M(0)^2 + Mg(10) &= \frac{1}{2}Mv^2 + Mg(0) \\ \Rightarrow v^2 &= 20g \\ &= 196 \\ \Rightarrow v &= 14 \text{ m/s} \end{aligned}$$

Q. 8.



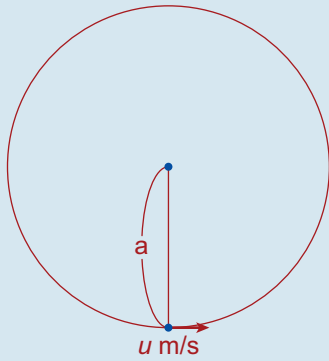
(i) From position 1 to position 2

$$\begin{aligned} \frac{1}{2}M(14)^2 + Mg(0) &= \frac{1}{2}Mv^2 + Mg(5) \\ \Rightarrow 98 &= \frac{1}{2}v^2 + 49 \\ \Rightarrow v^2 &= 98 \\ \Rightarrow v &= \sqrt{98} \\ &= 7\sqrt{2} \text{ m/s} \end{aligned}$$

(ii) From position 1 to position 3

$$\begin{aligned} \frac{1}{2}M(14)^2 + Mg(0) &= \frac{1}{2}Mv^2 + Mg(10) \\ \Rightarrow 98 &= \frac{1}{2}v^2 + 98 \\ \Rightarrow v &= 0 \text{ It will just reach (3)} \end{aligned}$$

Q. 9.

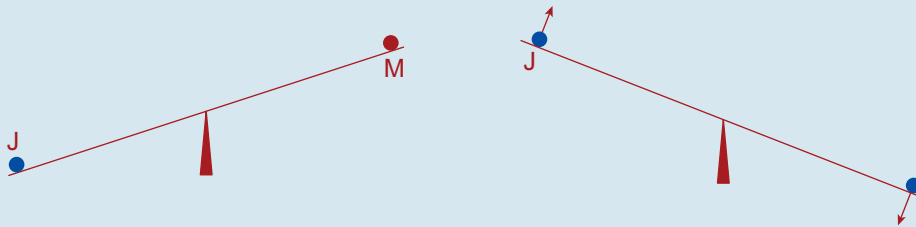


$$(i) \text{ K.E. + P.E.} = \frac{1}{2}M(2ga) + Mg(0) \\ = Mga$$

$$(ii) Mga = \frac{1}{2}M(0)^2 + Mgh \\ \Rightarrow h = a \\ = a$$

$$(iii) Mga = \frac{1}{2}Mv^2 + Mg\left(\frac{1}{2}a\right) \\ \Rightarrow v^2 = ga \\ \Rightarrow v = \sqrt{ga} \text{ m/s}$$

Q. 10.



Energy Before

=

Energy After

$$\begin{aligned} & \underbrace{\frac{1}{2}M(0)^2 + Mg(0)}_{\text{Johnny}} + \underbrace{\frac{1}{2}\left(\frac{3}{2}M\right)(0)^2 + \frac{3}{2}Mg\left(\frac{1}{2}\right)}_{\text{Margery}} = \underbrace{\frac{1}{2}Mv^2 + Mg\left(\frac{1}{2}\right)}_{\text{Johnny}} + \underbrace{\frac{1}{2}\left(\frac{3}{2}M\right)v^2 + \frac{3}{2}Mg(0)}_{\text{Margery}} \\ & \Rightarrow \frac{3}{4}Mg = \frac{1}{2}Mv^2 + \frac{1}{2}Mg + \frac{3}{4}Mv^2 \\ & \Rightarrow Mg = 5Mv^2 \\ & \Rightarrow v = \sqrt{\frac{g}{5}} \\ & = \sqrt{\frac{9.8}{5}} \\ & = \sqrt{1.96} \\ & = 1.4 \text{ m/s} \end{aligned}$$

Exercise 6C

Q. 1. $I = Mv - Mu$

$$= (0.125)(40) - (0.125)(0)$$

$$= 5 \text{ Ns}$$

Q. 2. $I = Mv - Mu$

$$= \left(\frac{1}{4}\right)(20) - \frac{1}{4}(-40)$$

$$= 15 \text{ Ns}$$

Q. 3. $M_1U_1 + M_2U_2 = M_1V_1 + M_2V_2$

(Hammer) (Stake) (Hammer) (Stake)

$$\Rightarrow 4(2) + 1(0) = 4(0) + 1(V_2)$$

$$\Rightarrow V_2 = 8 \text{ m/s}$$

(i) $\vec{I} = M\vec{v} - M\vec{u}$

$$= (1)(-8\vec{j}) - (1)(0)$$

$$= -8\vec{j} \text{ Ns}$$

(ii) $\vec{I} = M\vec{v} - M\vec{u}$

$$= 4(\vec{0}) - 4(-2\vec{j})$$

$$= 8\vec{j} \text{ Ns}$$

Q. 4. $I = |M\vec{v} - M\vec{u}|$

$$= |(0.1)(0) - (0.1)(8)|$$

$$= 0.8 \text{ Ns}$$

Q. 5. $I = |M\vec{v} - M\vec{u}|$

$$= |2(0) - 2(5)|$$

$$= 10 \text{ Ns}$$

Q. 6. (i) $4m(12) + m(0) = 5m(v)$... divide by m

$$\Rightarrow 5v = 48$$

$$\Rightarrow v = 9.6 \text{ m/s}$$

(ii) $5m(12) + nm(0) = (5 + n)m(7.5)$

... divide by m

$$\Rightarrow 60 = 37.5 + 7.5n$$

$$\Rightarrow 7.5n = 22.5$$

$$\Rightarrow n = 3$$

Q. 7. $M_1U_1 + M_2U_2 = M_1V_1 + M_2V_2$

$$\Rightarrow (0.15)(200) + (3)(0) = (0.15)(100) + (3)V_2$$

$$\Rightarrow V_2 = 5 \text{ m/s}$$

Q. 8. $M_1\vec{U}_1 + M_2\vec{U}_2 = (M_1 + M_2)\vec{v}^2$

$$(0.1)400\vec{i} + (3)(10\vec{j}) = (0.1 + 3)\vec{v}^2$$

$$\Rightarrow 3.1\vec{v}^2 = 40\vec{i} + 30\vec{j}$$

$$\Rightarrow \vec{v} = \frac{10}{31}(40\vec{i} + 30\vec{j})$$

$$\Rightarrow |\vec{v}^2| = \frac{10}{31}\sqrt{40^2 + 30^2}$$

$$= \frac{500}{31} = 12.9 \text{ m/s}$$

Q. 9. $M_1U_1 + M_2U_2 = (M_1 + M_2)\vec{V}$

$$(0.1)(200) + M_2(0) = (0.1 + M_2)10$$

$$\Rightarrow 20 = 1 + 10M_2$$

$$\Rightarrow M_2 = 1.9 \text{ kg}$$

Q. 10. $M_1U_1 + M_2U_2 = (M_1 + M_2)V$

$$(0.05)U_1 + (1.45)(0) = (0.05 + 1.45)(4)$$

$$\Rightarrow 0.05U_1 = 6$$

$$\Rightarrow U_1 = 120 \text{ m/s}$$

Q. 11. Step 1: Find the speed of the joint mass after impact.

$$\frac{1}{2}MV_1^2 + Mgh_1 = \frac{1}{2}MV_2^2 + Mgh_2$$

$$\frac{1}{2}(3)V_1^2 + (3)g(0) = \frac{1}{2}(3)(0)^2 + (3)(9.8)(10),$$

since it rises 10 m.

$$\Rightarrow V_1^2 = 196$$

$$\Rightarrow V_1 = 14 \text{ m/s}$$

Step 2: To find speed of the bullet before impact:

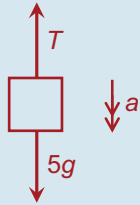
$$M_1U_1 + M_2U_2 = (M_1 + M_2)V$$

$$(0.1)U_1 + (2.9)(0) = (0.1 + 2.9)(14)$$

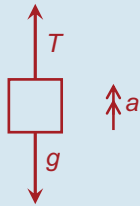
$$\Rightarrow U_1 = 420 \text{ m/s}$$

Exercise 6D

- Q. 1. (i) Let a = the common acceleration of the particles during the first second.



$$5g - T = 5a \quad \text{Equation 1}$$



$$T - g = a \quad \text{Equation 2}$$

Adding equations 1 and 2 we get:

$$4g = 6a$$

$$\Rightarrow a = \frac{2}{3}g \text{ m/s}^2$$

After 1 second, the distance travelled by the 5 kg particle will be given by

$$s = ut + \frac{1}{2}at^2$$

$$\Rightarrow s = (0)(1) + \frac{1}{2}\left(\frac{2}{3}g\right)(1)^2$$

$$\Rightarrow s = \frac{1}{3}g \text{ m}$$

- (ii) Firstly, we must calculate the speed just before the 2 kg mass is picked up:

$$v = u + at = 0 + \left(\frac{2}{3}g\right)(1)$$

$$= \frac{2}{3}g \text{ m/s}$$

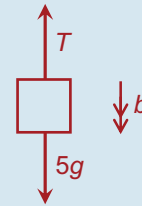
$$m_1u = m_2v$$

$$\Rightarrow 6\left(\frac{2}{3}g\right) = 8v$$

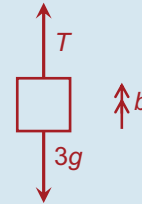
$$\Rightarrow 8v = 4g$$

$$\Rightarrow v = \frac{1}{2}g \text{ m/s} \quad \dots \text{ speed directly after 2 kg mass is picked up.}$$

Let b = the new common acceleration of the particles.



$$5g - T = 5b \quad \text{Equation 3}$$



$$T - 3g = 3b \quad \text{Equation 4}$$

Adding equations 3 and 4 we get:

$$2g = 8b$$

$$\Rightarrow b = \frac{1}{4}g \text{ m/s}^2$$

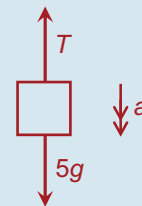
\Rightarrow The distance travelled in the 2nd second is given by

$$s = ut + \frac{1}{2}at^2$$

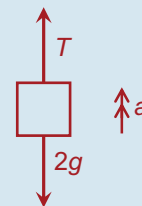
$$\Rightarrow s = \left(\frac{1}{2}g\right)(1) + \frac{1}{2}\left(\frac{1}{4}g\right)(1)^2$$

$$\Rightarrow s = \frac{5}{8}g \text{ m}$$

- Q. 2. Let a = the common acceleration of the particles during the first 3 seconds.



$$5g - T = 5a \quad \text{Equation 1}$$



$$T - 2g = 2a \quad \text{Equation 2}$$

Adding equations 1 and 2 we get:

$$3g = 7a$$

$$\Rightarrow a = \frac{3}{7}g \text{ m/s}^2$$

After 3 seconds, the speed of each particle will be given by

$$v = u + at$$

$$\Rightarrow v = 0 + \left(\frac{3}{7}g\right)(3)$$

$$\Rightarrow v = \frac{9}{7}g \text{ m/s}$$

At this point, the 2 kg mass picks up a particle of mass 4 kg.

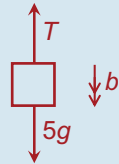
$$m_1u = m_2v$$

$$\Rightarrow 7\left(\frac{9}{7}g\right) = 11v$$

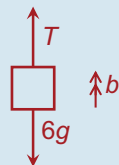
$$\Rightarrow 9g = 11v$$

$$\Rightarrow v = \frac{9}{11}g \text{ m/s} \dots \text{ speed directly after 4 kg mass is picked up.}$$

Let b = the new common acceleration of the particles.



$$5g - T = 5b \quad \text{Equation 3}$$



$$T - 6g = 6b \quad \text{Equation 4}$$

Adding equations 3 and 4 we get:

$$-g = 11b$$

$$\Rightarrow b = -\frac{1}{11}g \text{ m/s}^2$$

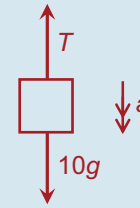
\Rightarrow The distance travelled by the 5 kg mass before stopping is given by

$$s = \frac{v^2 - u^2}{2a}$$

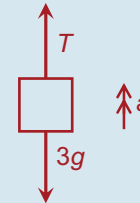
$$\Rightarrow s = \frac{0^2 - \left(\frac{9}{11}g\right)^2}{2\left(-\frac{1}{11}g\right)} = \frac{81g^2}{\frac{2g}{11}}$$

$$= \frac{81g^2}{121} \times \frac{11}{2g} = \frac{81}{22}g \text{ m}$$

Q. 3. (i) Let a = the common acceleration of the particles during the first 2 seconds.



$$10g - T = 10a \quad \text{Equation 1}$$



$$T - 3g = 3a \quad \text{Equation 2}$$

Adding equations 1 and 2 we get:

$$7g = 13a$$

$$\Rightarrow a = \frac{7}{13}g \text{ m/s}^2$$

After 2 seconds, the distance travelled by the 10 kg particle will be given by

$$s = ut + \frac{1}{2}at^2$$

$$\Rightarrow s = (0)(2) + \frac{1}{2}\left(\frac{7}{13}g\right)(2)^2$$

$$\Rightarrow s = \frac{14}{13}g \text{ m}$$

(ii) Firstly, we must calculate the speed just before the 2 kg mass is picked up:

$$v = u + at = 0 + \left(\frac{7}{13}g\right)(2)$$

$$= \frac{14}{13}g \text{ m/s}$$

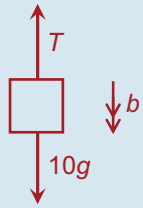
$$m_1u = m_2v$$

$$\Rightarrow 13\left(\frac{14}{13}g\right) = 15v$$

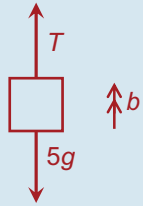
$$\Rightarrow 15v = 14g$$

$$\Rightarrow v = \frac{14}{15}g \text{ m/s} \dots \text{ speed directly after 2 kg mass is picked up.}$$

Let b = the new common acceleration of the particles.



$$10g - T = 10b \quad \text{Equation 3}$$



$$T - 5g = 5b \quad \text{Equation 4}$$

Adding equations 3 and 4 we get:

$$5g = 15b$$

$$\Rightarrow b = \frac{1}{3}g \text{ m/s}^2$$

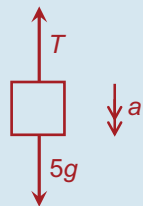
\Rightarrow The distance travelled in the next 2 second period is given by

$$s = ut + \frac{1}{2}at^2$$

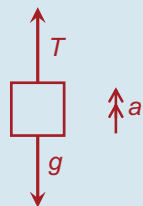
$$\Rightarrow s = \left(\frac{14}{15}g\right)(2) + \frac{1}{2}\left(\frac{1}{3}g\right)(2)^2$$

$$\Rightarrow s = \frac{38}{15}g \text{ m}$$

- Q. 4.** (i) Let a = the common acceleration of the particles during the first 2 seconds.



$$5g - T = 5a \quad \text{Equation 1}$$



$$T - g = a \quad \text{Equation 2}$$

Adding equations 1 and 2 we get:

$$4g = 6a$$

$$\Rightarrow a = \frac{2}{3}g \text{ m/s}^2$$

After 2 seconds, the 5 kg mass hits the table. The 1 kg mass now behaves like a projectile.

Firstly, we must find the speed of the two particles just as the 5 kg mass hits the table.

$$u = 0, \quad a = \frac{2}{3}g, \quad t = 2$$

$$v = u + at$$

$$\Rightarrow v = 0 + \left(\frac{2}{3}g\right)(2)$$

$$\Rightarrow v = \frac{4}{3}g \text{ m/s}$$

Now, examine the motion of the 1 kg mass after the 5 kg mass hits the table:

$$u = \frac{4}{3}g, \quad a = -g, \quad v = 0$$

$$s = \frac{v^2 - u^2}{2a}$$

$$\Rightarrow s = \frac{0 - \frac{16g^2}{9}}{-2g}$$

$$\Rightarrow s = \frac{8}{9}g \text{ m}$$

- (ii) The 1 kg mass falls back down. When the string becomes taut, the speed will once again be $\frac{4}{3}g$ m/s.

Using Conservation of Momentum for the system, we have:

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$

$$\Rightarrow (1)\left(\frac{4}{3}g\right) + (5)(0) = 6v$$

$$\Rightarrow 6v = \frac{4}{3}g$$

$$\Rightarrow v = \frac{2}{9}g \text{ m/s} \quad \dots \text{ speed at which 5 kg mass begins to rise.}$$

- Q. 5. Part 1:** Motion of 2 kg falling mass:

$$u = 0, \quad a = g, \quad s = 1$$

$$v = \sqrt{u^2 + 2as}$$

$$\Rightarrow v = \sqrt{0^2 + 2g(1)}$$

$$\Rightarrow v = \sqrt{2g} \text{ m/s}$$

Part 2: Coalescence of 2 kg masses:

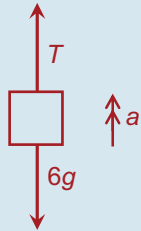
$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$

$$\Rightarrow 2\sqrt{2g} + 8(0) = 10v$$

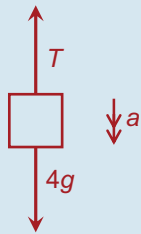
$$\Rightarrow v = \frac{\sqrt{2g}}{5} \text{ m/s} \quad \dots \text{ speed at which}$$

connected particles
start to move.

Part 3: Calculate acceleration of system
(which should be negative):



$$T - 6g = 6a \quad \text{Equation 1}$$



$$4g - T = 4a \quad \text{Equation 2}$$

Adding equations 1 and 2 gives

$$-2g = 10a$$

$$\Rightarrow a = -\frac{1}{5}g \text{ m/s}^2$$

Part 4: Upward motion of 6 kg mass:

$$u = \frac{\sqrt{2g}}{5}, \quad a = -\frac{1}{5}g, \quad v = 0$$

$$s = \frac{v^2 - u^2}{2a}$$

$$\Rightarrow s = \frac{0 - \frac{2g}{25}}{-\frac{2g}{5}}$$

$$= \frac{2g}{25} \times \frac{5}{2g}$$

$$= \frac{1}{5} \text{ m}$$

$$= 20 \text{ cm}$$

Q. 6. (i) Motion of 1 kg mass while falling:

$$u = 0, \quad s = 2.5, \quad a = g$$

$$v = \sqrt{u^2 + 2as}$$

$$\Rightarrow v = \sqrt{0 + 2g(2.5)}$$

$$\Rightarrow v = \sqrt{5g}$$

$$= 7 \text{ m/s}$$

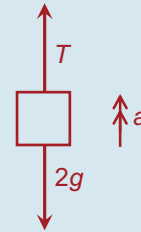
Conservation of momentum once string becomes taut:

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$

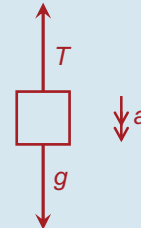
$$\Rightarrow (1)(7) + (2)(0) = 3v$$

$$\Rightarrow v = \frac{7}{3} \text{ m/s}$$

(ii) Motion of system:



$$T - 2g = 2a \quad \text{Equation 1}$$



$$g - T = a \quad \text{Equation 2}$$

Adding equations 1 and 2 we get:

$$-g = 3a$$

$$\Rightarrow a = -\frac{1}{3}g \text{ m/s}^2$$

Consider subsequent motion of 1 kg mass:

$$u = \frac{7}{3}, \quad a = -\frac{1}{3}g, \quad v = 0$$

$$s = \frac{v^2 - u^2}{2a}$$

$$\Rightarrow s = \frac{0 - \frac{49}{9}}{-\frac{2g}{3}} = \frac{49}{9} \times \frac{3}{2g} = \frac{5}{6} \text{ m}$$

Since the motion of the system began with the 1 kg mass being 1 m from the table, it follows that the 1 kg mass will not reach the table.