Laws of Motion

Ans.1 Both will reach the top at the same time because, length of the two segments of the rope on the two sides of the pulley will always remain equal

Ans.2 (a) When the monkey climbs up, the Length of the segment of the rope (between monkey and the pulley) decreases in length. Immediately, the segment of the rope holding the mirror will also decrease, so that it always becomes equal to the segment of the rope held by the monkey. So, the mirror will remain in front of the monkey and he will always see his image in the mirror.

(b) In this case, the segment of the rope holding the monkey will increase but, the monkey will see his image in the mirror.

(c) If the monkey releases the rope, both the mirror and the monkey will fall freely under gravity and hence the monkey will see his image.

Ans.3 (a) $T = Mg\sin\theta - f$

$$13 = 8\times10\sin 20^0 - f$$
$$13 = 80\times0.342 - f$$
$$13 = 27.36 - f$$
$$f = 14.36N$$

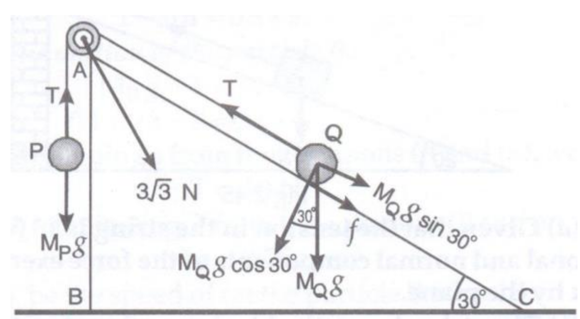
$$R = Mg\cos\theta = 8\times10\times\cos 20^0 = 80\times0.939 = 75.18N$$

(b) When the string is cut, the block remains at rest, but is on the point of slipping down the plane, it means angle of repose is 20°.

$$\mu = \tan 20^0 = 0.364$$

Ans.4 (a) The tension T in each segment of the string makes an angle of 30° with the direction of the resultant force exerted on the pulley by the string.

$$T\cos 30^0 + T\cos 30^0 = 3\sqrt{3}$$
$$2T\cos 30^0 = 3\sqrt{3}$$
$$2T\times\frac{\sqrt{3}}{2} = 3\sqrt{3}$$
$$T = 3N$$



(b) For motion of particle Q, $T = M_Q g\sin 30^0 + f$

$$T = M_Q g\sin 30^0 + \mu M_Q g\cos 30^0 \quad \left[\because f = \mu M_Q g\cos 30^0\right]$$

$$3 = M_Q\times10\times\frac{1}{2} + 0.75\times M_Q\times10\times\frac{\sqrt{3}}{2}$$

$$3 = 5M_Q + 6.5M_Q$$

$$M_Q = \frac{3}{11.5} = 0.261kg$$

Ans.5 (a) The man would exert a force of 980 N on the rope, if he grasped it and held firmly. Since the rope would break, if a force greater than 755 N was exerted ; he should use the rope only to slow down himself and not to stop completely. Therefore, if the man slides down the rope, so that the frictional force is less than or equal to 755 N, the rope will not break.

(b) If the man applies the frictional force 755 N on the rope i.e. equal to the maximum weight, it can support, he will come down under the effect of a minimum force

$$F = 980 - 755 = 225N$$

Mass of man, $M = \frac{980}{9.8} = 100kg$

So least acceleration, he can have without breaking the rope, $a = \frac{225}{100} = 2.25ms^{-2}$

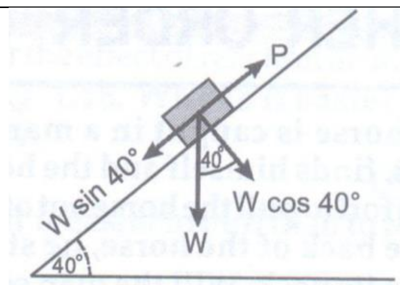
(c) $v^2 - u^2 = 2as$

$v^2 - 0^2 = 2 \times 2.25 \times 8$

$v^2 = 36$

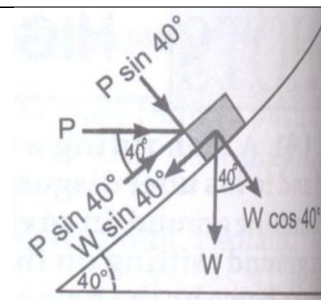
$v = 6ms^{-1}$

Ans.6



(i) As the block is in equilibrium

$P = W \sin 40^0 = 12 \times 0.643 = 7.71N$

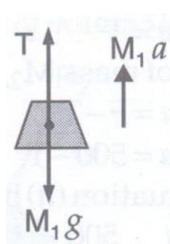


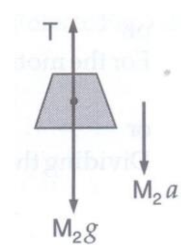
(ii) As the block is in equilibrium

$P \cos 40^0 = W \sin 40^0$

$P = W \tan 40^0 = 12 \times 0.839 = 10.07N$

Ans.7





For mass M1: $M_1 a = T - M_1 g \rightarrow (1)$

For mass M2: $M_2 a = M_2 g - T \rightarrow (2)$

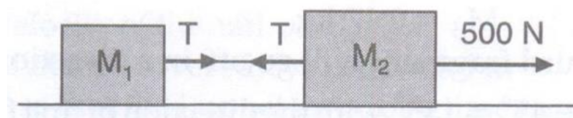
From (1) and (2) $(M_1 + M_2)a = (M_2 - M_1)g$

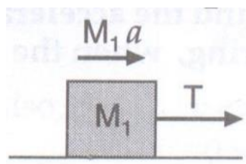
$$a = \frac{(M_2 - M_1)g}{(M_1 + M_2)} = \frac{(12-7)9.8}{(12+7)} = 2.58ms^{-2}$$

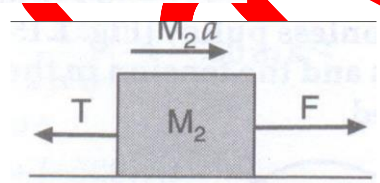
From (1) $T = M_1a + M_1g = M_1(a+g) = 7(2.58+9.8) = 86.6N$

Ans.8 *Given*: $F = 500N$, $m_1 = 10kg$ $m_2 = 20kg$

(a) Case 1







$T = M_1a = 10a$ $T = F - M_2a = 500 - 20a$

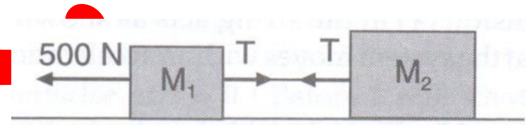
So, $10a = 500 - 20a$

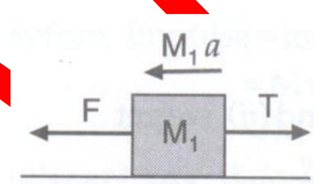
$30a = 500$

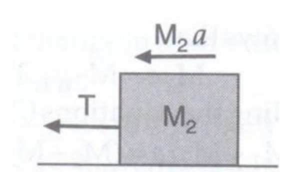
$a = \frac{50}{3}ms^{-2}$

$\therefore T = 10 \times \frac{50}{3} = 166.7N$

(b) Case 2







$T = F - M_1a = 500 - 10a$ $T = M_2a = 20a$

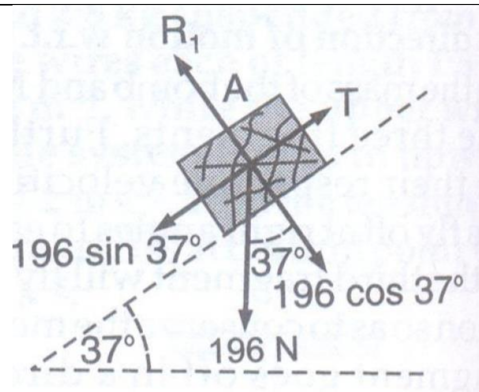
So, $20a = 500 - 10a$

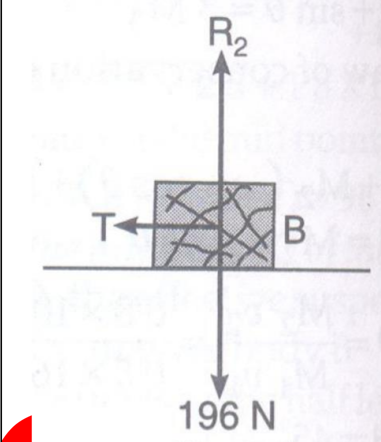
$30a = 500$

$a = \frac{50}{3}ms^{-2}$

$\therefore T = 20 \times \frac{50}{3} = 333.3N$

Ans.9 (i) Weight of each block $W = mg = 20 \times 9.8 = 196N$





$T = 196\sin 37^0 - 20a = 196 \times 0.6018 - 20a = 117.95 - 20a$	$T = 20a$

So, $20a = 117.95 - 20a$

$$40a = 117.95$$

$$a = \frac{117.95}{40} = 2.95ms^{-2}$$

(ii) $\therefore T = 10 \times 2.95 = 59N$

(iii) $Given: \quad u = 0, \quad a = 2.95, \quad s = 1m$

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

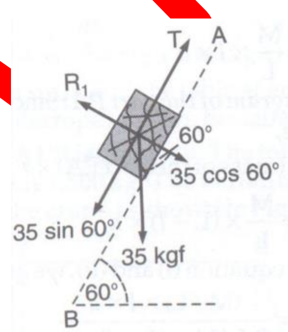
$$1 = 0t + \frac{1}{2} \times 2.95 \times t^2$$

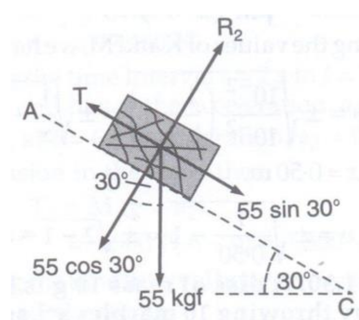
$$1 = \frac{1}{2} \times 2.95 \times t^2$$

$$t^2 = 0.677$$

$$t = 0.82s$$

Ans.10





Weight of block $W = mg = 35 \times 9.8 = 343N$

$$T = 343\sin 60^0 + 35a = 343 \times \frac{\sqrt{3}}{2} + 35a$$

Weight of block $W = mg = 55 \times 9.8 = 539N$

$$T = 539\sin 30^0 - 55a = 539 \times \frac{1}{2} - 55a$$

$$\text{So, } 343\times\frac{\sqrt{3}}{2}+35a=539\times\frac{1}{2}-55a$$

$$90a=\frac{539}{2}-\frac{343\sqrt{3}}{2}$$

$$a=\frac{539-594.08}{180}=-\frac{55.08}{180}=-0.306ms^{-2}$$

$$\therefore T=539\times\frac{1}{2}-55(-0.306)=269.5+16.83=286.33N$$

Ans.11 As the clamp will come out of the ground, when an upward force of 270n acts on it, so maximum tension in the rope

$$T\sin 60^0=270$$

$$T\times\frac{1}{2}=270$$

$$T=540N$$

If 'a' is the maximum acceleration with which the boy can climb safely, $T=Mg+Ma$

$$540=45\times10+45a$$

$$45a=540-450$$

$$45a=90$$

$$a=2ms^{-2}$$

Ans.12 For A : $T=f+M_Aa=0.6+0.4a$

For B : $T=M_Bg-M_Ba=0.1\times9.8-0.1\text{a}$

$$\text{So, } 0.6+0.4a=0.1\times9.8-0.1\text{a}$$

$$0.5\text{a}=0.38$$

$$\text{a}=0.76\,\text{ms}^{-2}$$

$$\therefore T=0.6+0.4\times0.76=0.6+0.3=0.9N$$

(b) $v=u+at=0+0.76\times1.5=1.125ms^{-1}$