Solution to worksheet - 9

A.1: $f = ma = \mu mg \Rightarrow \mu = \frac{4}{10} = 0.4$

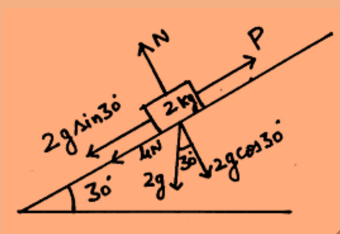
A.2: $a = \mu g$; $a = .1 \times 10 = 1\ m/s^2$

$v^2 = u^2 + 2as$

$0 = 10^2 + 2 \times (-1) \times s$

$s = 50m$

A.3: (a)



$N = 2g \cos 30^o$

$P = 2g \sin 30 + \mu N$

$= 2g \sin 30^o + \mu 2g \cos 30^o$

$= g + .4g \times \frac{\sqrt{3}}{2} = 13N$

(b) 0

A.4: KE = work done against friction

$\frac{p^2}{2m} = (\mu mg)x$

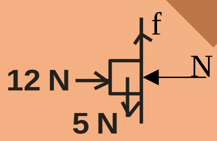
$\mu = \frac{p^2}{2m^2 gx}$

A.5: $f = \mu Mg = .4 \times 2 \times 10 = 8N > 2.5$

As static frition is self-adjusting in nature

$\therefore\ f = 2.5N$

A.6:



$f = \mu N = .6 \times 12 = 7.2\ N > 5N$,

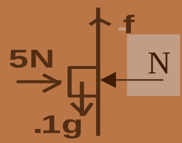
Block will not move down.

Resultant force, $F = \sqrt{12^2 + 5^2} = 13N$

A.7: To hold block stationary,

W = frictional force = μN, $= 0.2 \times 10 = 2N$

A.8:



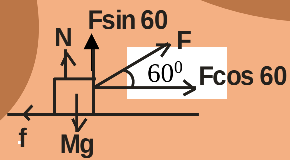
$W = 0.1g = .98N$

$f = \mu N$,

$f = .5 \times 5 = 2.5 > W$

$\Rightarrow$ Frictional force = .98N

A.9:



$f = \mu N$

$F\cos 60^o = \mu N$ ....(1)

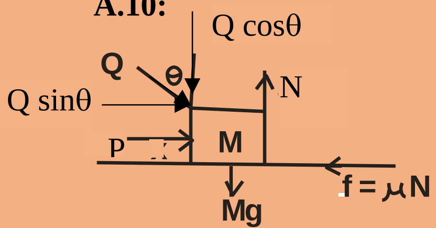
$F \sin 60 + N = Mg$ ....(2)

$\Rightarrow N = Mg - F\sin 60^o$

Now, $f = \mu N = \mu (Mg - F\sin 60^o)$

$f = \left(Mg - \frac{\sqrt{3}}{2} F \right)$

A.10:



Y-axis, $Q \cos\theta + Mg = N$ ....(1)

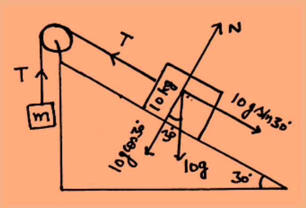
X-axis, $Q \sin\theta + P = \mu N$..........(2)

Divide equ. (2) by equ.(1)

$$N = \frac{Q\sin\theta + P}{Q\cos\theta + Mg}$$

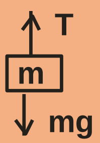
A.11:

(a)



$N = 10g\cos 30^0 = 5g\sqrt{3}$

$f = \mu N = .2 \times 5g\sqrt{3} = g\sqrt{3}$



$mg - T = m \times 0 = 0$

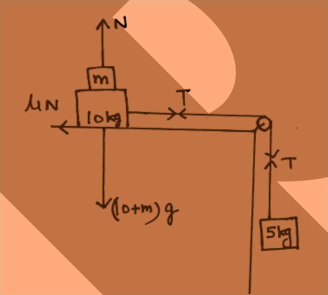
$T = mg$ ....(1)

For 10 Kg block

$10g \sin 30^o - (T + f) = m \times 0$

$5g - mg - \sqrt{3}g = 0 \Rightarrow m = 3.3kg$

(b)



$5g - T = 5 \times 0$

$T = 50N$

$N = (10 + m)g$

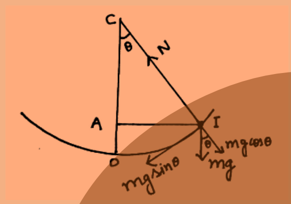
$f = \mu N = .2(10 + m)g$

$T - f = 0$

$50 = .2(10 + m)g$

$m = 15Kg$

A.13:



$N = mg\cos\theta$ ....(1)

$\mu N = mg\sin\theta$.....(2)

Divide equ. (2) by equ.(1)

$\mu = \tan\theta$

$\frac{1}{\sqrt{3}} = \tan\theta$ or $\theta = 30^0$

In Δ CAI,

$\cos\theta = \frac{CA}{CI} \Rightarrow R\cos\theta = CA$

$R\cos 30^0 = CA$

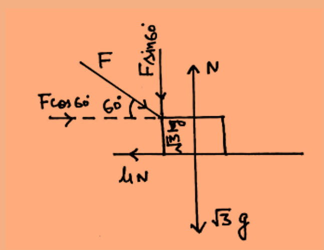
$R\frac{\sqrt{3}}{2} = CA$

From figure, R – CA = OA

$\Rightarrow OA = R - \frac{R\sqrt{3}}{2} = R\left(1 - \frac{\sqrt{3}}{2}\right)$

$= R(1 - .866) = 0.134 R$

A.14:



$\mu N = F\cos 60$.....(1)

$N = F\sin 60 + \sqrt{3}g$ ....(2)

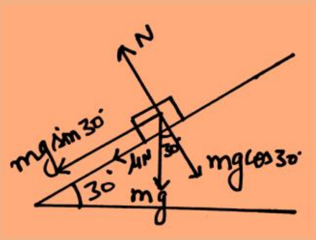
Put (ii) in (i)

$\mu\left(F\sin 60^0 + \sqrt{3}g\right) = F\cos 60^0$

$$\frac{1}{2\sqrt{3}}\left(F\frac{\sqrt{3}}{2}+\sqrt{3}g\right)=F\frac{1}{2}$$

F = 20N

A.15:



$N = mg\cos 30^0 = mg\frac{\sqrt{3}}{2}$

$ma = mg\sin 30^0 + \mu N$

$a = \frac{g}{2} + .1g\frac{\sqrt{3}}{2}$

$a = 5 + .5\sqrt{3}$

a = 5.865 m/s^2

$v^2 - u^2 = 2as \Rightarrow -(10)^2 = 2\times(-5.865)s$

$\Rightarrow$ s = 8.53m

A.16:

Resistance due to friction = 5×100 = 5000N

F = mg sin θ + 5000N

$= 10^5 \times 9.8 \times \frac{1}{100} + 5000$

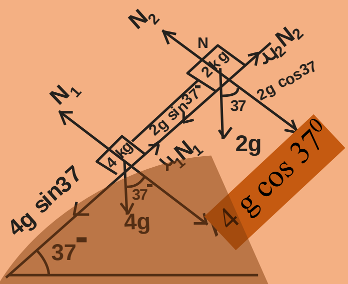
= 14800 N

$P = \vec{F}.\vec{v} = Fv\cos 0$

= 14800 × 10 = 148000W

= 148 kW

A.17:



For common acceleration let us assume both block as a single system

(4gsin37 + 2g sin37) – $(\mu_1 N_1 + \mu_2 N_2) = (4+2)a$ ....(1)

$N_1 = 4g\cos 37,\ N_2 = 2g\sin 37$

$\mu_1 = .75$ $\mu_2 = .25$

Put in equation (i) we get

$$\left(4g\times\frac{3}{5}+2g\times\frac{4}{5}\right)-\left(.75\times 4g\times\frac{4}{5}+.25\times 2g\times\frac{3}{5}\right)=6a$$

a = 4/3 m/s^2

for 4 kg block,

$4g\sin 37^0 - (\mu_1 N_1 + T) = 4a$

$4g\frac{3}{5} - (.75\times 4g\times\frac{4}{5} + T) = 4\times\frac{4}{3}$

T = 5.3N

A.18:

Without friction

$v = u + at$

$v = 0 + g\sin 45.t_1$

$t_1 = \frac{v}{g\sin 45^o}$

With friction,

$ma = mg\sin 45 - \mu g\cos 45$

$a = g\sin 45 - \mu g\cos 45$

$$t_2 = \frac{v}{g\sin 45^o - \mu g\cos 45^o}$$

According to the question

$t_2 = 2t_1$

$$\frac{v}{g\sin 45^o - \mu g\cos 45^o} = \frac{2v}{g\sin 45^o}$$

Or $\mu = 0.5$

A.19: v = 60×5/18 = 50/3 m/s

$$\tan\theta = \frac{v^2}{rg}$$

$$\tan\theta = \frac{(50/3)^2}{100\times 9.8} = .283$$

$\theta = 15.8^0$

A.20: v = 72 × 5/18 =20m/s

$$\tan\theta = \frac{v^2}{rg} = \frac{20^2}{625\times 10} = \frac{40}{625} = .064$$

$\theta = 3.7^0$

We know $\frac{h}{b} = \frac{v^2}{rg}$

$$\frac{h}{1.5} = \frac{(20)^2}{625\times 10}$$

h = .096m = 9.7 cm