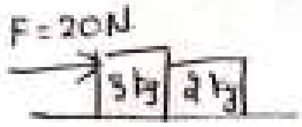
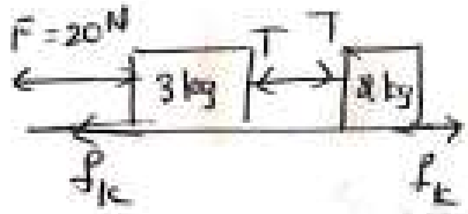
WS-6 - Types of friction

T bank

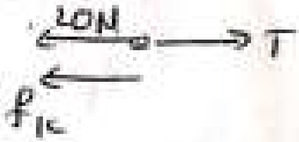
①



⇒



FBD For 3 kg



$\rightarrow -(f_k+20) - T = ma$

$\Rightarrow (f_k+20) - T = 3a \rightarrow ①$

FBD For 2 kg

$\Rightarrow T - f_k = 2a \rightarrow ②$

① + ②

$\cancel{T} - \cancel{f_k} + \cancel{f_k} + 20 = 2a + 3a$

$\Rightarrow 20 = 5a \quad \Rightarrow a = 4\ m/s^2$

∴ From ② $T - f_k = 2 \times 4$

$\Rightarrow T - \mu_k 2g = 8$ Given $\mu_k = 0.1$

$\Rightarrow T - (0.1) \times 2 \times 10 = 8 \rightarrow T - 2 = 8$

$\Rightarrow T = 10N$

②

Given $u = 3\ m/s$

$\mu = 0.5$

From $u^2 = 2as$

$\Rightarrow 3^2 = 2\mu g s$

$\Rightarrow 9 = 2 \times 0.5 \times 10\, s$

$\Rightarrow s = \frac{9}{10} = 0.9m$

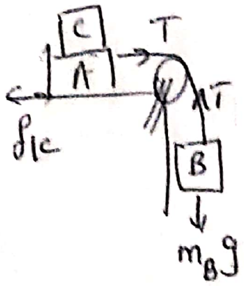
③ Since lift is falling freely

$a = g$

$N = m(g - a) = m(g - g)$

$= 0$

(4)



under Balancing [equilibrium]

$T = m_B g$; $T = f_k$.

$T = 2g$; $\Rightarrow T = (m_A + m_C)\mu g$

$m_B = 2\ kg$; $m_A = 3\ kg$

$\mu = 0.5$

$\Rightarrow 2g = (3 + m_C)\, 0.5 \times g$

$\Rightarrow 2 = (3 + m_C)(\frac{1}{2})$

$\Rightarrow 4 = 3 + m_C \Rightarrow m_C = 1\ kg$

(5)

$\omega = \cancel{10} \times \frac{\cancel{2}\pi}{\cancel{60}\,3}$ rad/s

$\omega = \frac{\pi}{3}$ rad/s

$r = 5\ m$

$f_k = m r \omega^2$

$\Rightarrow \mu_k \cancel{m} g = \cancel{m} r \omega^2$

$\Rightarrow \mu_k = \frac{r\omega^2}{g}$

$\Rightarrow \mu_k = \frac{\cancel{5}\left(\frac{\pi}{3}\right)^2}{\cancel{10}\,2}$

$\Rightarrow \mu_k = \frac{\pi^2}{9 \times 2} = \frac{\pi^2}{18}$

(6)

Here $F = 2T$; $F = 18\ N$; $\mu = 0.4$

$\Rightarrow 18 = 2T \Rightarrow T = 9\ N$

FBD for from fig

$T - \mu mg = ma$

$\Rightarrow 9 = ma + \mu mg$

$\Rightarrow 9 = m(a + \mu g)$

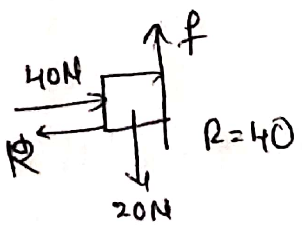
$\Rightarrow 9 = m(0.5 + 0.4 \times 10)$

$\Rightarrow 9 = m(0.5 + 4)$

$\Rightarrow 9 = m \times 4.5$

$\Rightarrow m = \frac{9}{4.5} = 2\ kg$

(7)



$f = \mu N$

$\Rightarrow 20 = \mu \times 40$

$\Rightarrow \mu = \frac{20}{40} = 0.5$

(8)

The frictional force from the two slider will be balancing the weight of man

$2\mu N = mg$

$\Rightarrow N = \frac{mg}{2\mu} = 250\ N.$

(9)

Given $m = 100$ kg

$\mu = 0.4$

$\Rightarrow f = \mu N$

$= \mu mg$

$= 0.4 \times 100 \times 9.8$

$= 392$ N

(10)

$F_{net} = \sqrt{N^2 + f^2}$

$\Rightarrow \sqrt{3}\, N = \sqrt{N^2 + \mu^2 N^2}$

squaring on both sides

$\Rightarrow (\sqrt{3}\, N)^2 = (\sqrt{N^2 + \mu^2 N^2})^2$

$\Rightarrow 3N^2 = N^2(1 + \mu^2)$

$\Rightarrow 3 = 1 + \mu^2$

$\Rightarrow \mu^2 = 3 - 1$

$\Rightarrow \mu = \sqrt{2}$.

(16)

$\mu_s = 0.5$; $\mu_k = 0.4$

F = Force applied

$f_s = \mu_s mg = F$

$F_{net} = F - f_k$

$ma = \mu_s mg - \mu_k mg$

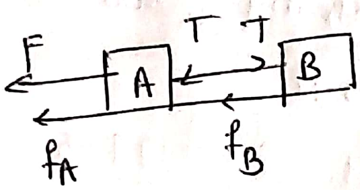
$ma = \cancel{m}g(\mu_s - \mu_k)$

$a = g(\mu_s - \mu_k)$

$a = 9.8(0.5 - 0.4)$

$= 0.98\ m/s^2$

(17)



Given $m_A = 2$ kg ; $m_B = 3$ kg

$\mu = 0.1$ $\quad F = 45$ N

$f_A = \mu m_A g$; $f_B = \mu m_B g$

$F_{net} = F - (f_A + f_B)$

$\Rightarrow (m_A + m_B)a = F - (\mu m_A g + \mu m_B g)$

$\Rightarrow (2+3)a = \cancel{F =} 45 - \mu g(m_A + m_B)$

$\Rightarrow 5a = 45 - 0.1 \times 10(2+3)$

$\Rightarrow 5a = 45 - 5$

$\Rightarrow 5a = 40$

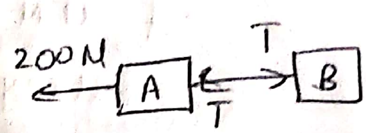
$\Rightarrow a = 8\ m/s^2$

(18), (19) (20)

Given $m_A = 5$ kg ; $m_B = 10$ kg   Applied force $F = 200N$

$\mu_s = 0.15$

$f_s = \mu (m_A + m_B) g$



$= 0.15 (5 + 10) \times 10$

$T \rightarrow$ Reaction force

$= 22.5$ N.

Net force acting on partition $= 200 - 22.5$

$= 177.5$ N.

Reaction force between A & B is

$T + f_k = 200 \Rightarrow T = 200 - f_k$.

$T = 200 - \mu_k mg = 200 - 0.15 \times 5 \times 10$

$T = 192.5$ N

Acceleration $= \dfrac{F_{net}}{m_A + m_B} = \dfrac{177.5}{5 + 10}$

$= \dfrac{177.5}{15} = 11.86 \ m/s^2$

L Task   SAQ

(1) The frictional force acting on the block is 0. Since external force on block is zero.

(2) maximum static friction $= \mu mg$

$= 0.4 \times 20 \times 10$

$= 80$ N.

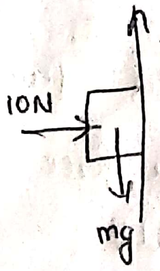
So the kinetic friction will acts on the block

$f_k = \mu_k mg$

$= 0.3 \times 20 \times 10$

$= 60$ N.

(3)



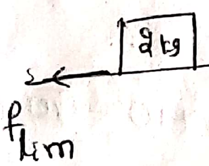
Normal Reaction

$R = 10N$

Since the block is just held stationary maximum friction held $f = \mu R = 0.2 \times 10$

$f = 2\ N$.

(4)



$\mu_k = 0.2$

$\mu_s = 0.6$

$$a = \frac{F_{net}}{m} = \frac{F_{lm} - f_k}{m}$$

$$a = \frac{\mu_s mg - \mu_k mg}{m}$$

$$a = \frac{(0.6 - 0.2)\, mg}{m}$$

$$a = 0.4 \times 10$$

$$= 4\ m/s^2$$

(5)

It stops after some time so it as constant retardation due to friction and it stop after 10 sec. By using

$$v = u + at$$

$$\Rightarrow a = \frac{v}{t} = \frac{6}{10} = 0.6\ m/s^2$$

$$f = \mu m g$$

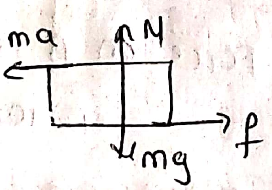
$$2(0.6) = \mu \times 2 \times 10$$

$$\Rightarrow 2(0.6) = \mu \times 2 \times 10$$

$$\Rightarrow \mu = \frac{0.6}{10} = 0.06$$

(6)

$$a = \frac{20}{4} = 5\ m/s^2$$



For suitcase to remain at rest

$$f = ma$$

$$\Rightarrow \mu_k mg = ma$$

$$\Rightarrow \mu = \frac{a}{g} = \frac{5}{10}$$

$$= 0.5$$

(7)

Force of friction is same in both cases

As frictional force is independent of the surface in contact with ground.

Force is same for all surfaces