WS-18- Types of friction   9th foundation+

TTeach

(1)

Given $m = 25\,kg$: $F = 122.5\,N$

Given the box just slides that

$f = \mu g$

$\Rightarrow \mu m g = F$

$\Rightarrow \mu \times 25 \times 10 = 122.5$

$\Rightarrow \mu = \frac{122.5}{250} = 0.49 \simeq 0.5$

(2)

Given initial velocity $u = 15\,m/s$; $V = 0$

distance $s = 25\,m$; $g = 10\,m/s^2$

From $v^2 - u^2 = 2as$ $(a = \mu g)$

$\Rightarrow 0^2 - (15)^2 = 2 \mu g \times s$

$\Rightarrow \cancel{225} = 2 \times \mu \times 10 \times \cancel{25}$

$\Rightarrow \mu = \frac{9}{20} = 0.45 \simeq 0.44$

(3)

Given $m = 12\,kg$: $\mu = 0.15$; $F = 5\,N$

when a block placed on horizontal surface, the static frictional force $f = \mu m g = 0.15 \times 12 \times 10$

$= 18\,N$

clearly frictional force > Applied force (5N)

so the block is at rest

frictional force = $F_{applied} = 5N$.

(4)

Given $\mu = 0.24$.

Maximum acceleration $a = \mu g = 0.24 \times 10$

$= 2.4 \ m/s^2$

(5)

Given speed $u = 4.9 \ m/s$; $\mu = 0.7$.

Final velocity $v = 0$

From $v^2 - u^2 = 2as$

$\Rightarrow (4.9)^2 - 0^2 = 2 \mu g s$

$\Rightarrow (\cancel{4.9})^{7} \times 4.9 = 2 \times \cancel{0.7} \times \cancel{9.8}^{2} \times s$

$\Rightarrow 7 = 4s$

$\Rightarrow s = \frac{7}{4} = 1.75 \ m$

(6)

Given $m = 0.1 \ kg$ $F_{applied} = 5N$; $\mu = 0.5$

Magnitude of frictional force $= \mu mg$

$= 0.5 \times 0.1 \times 10$

$\Rightarrow 0.5N$

here frictional force < $F_{applied}$

so magnitude of frictional force = 5N.

(7)

Given $F_{app} = 1.2$ kg.f ; $m = 1.5$ kg ; $\mu = 0.3$

Magnitude of frictional force $= \mu m g$

$= 0.3 \times 1.5 \times 9.8$

$= 4.4$ N.

$F_{applied} = 1.2 \times 9.8 = 11.76$ N

Net acceleration $= \dfrac{F_{app} - f}{m} = \dfrac{11.76 - 4.4}{1.5}$

$= 4.9$ m/s^2

(8)

Given initial velocity $u = 4$ m/s ; Final velocity $V = 0$

distance $S = 40$ cm $= 40 \times 10^{-2}$ m $= 0.4$ m

From $v^2 - u^2 = 2as$

$\Rightarrow 0^2 - (4)^2 = 2 \mu \times g (0.40)$

$\Rightarrow -4 \times 4 = 8 \mu$

$\Rightarrow \mu = \dfrac{4 \times 4}{8}$

$\Rightarrow \mu \simeq \dfrac{1}{2}$

(9)

Given $v = 6$ m/s ; $\mu = 0.3$

acceleration $a = \mu g = 0.3 \times 10 = 3$ m/s^2

From $v^2 - u^2 = 2as$

$\Rightarrow (6)^2 - 0^2 = 2 \times 3 \times s$

$\Rightarrow 36 = 6s \Rightarrow s = 6$ m

(10)

Given $P = 0.98\ kW$; $m = 100\ kg$; $S = 4m$; $\mu = 0.3$

Power $= \frac{W}{t} = \frac{F\,S}{t}$

$\Rightarrow 0.98 \times 10^3 = \frac{\mu m g\ S}{t}$

$\Rightarrow 98\cancel{0} = \frac{0.3 \times 10\cancel{0} \times \cancel{98} \times 4}{t}$

$\Rightarrow t = 0.3 \times 4 = 1.2\ sec$

(16)

Given $m = 60\,kg$; $\mu_s = 0.5$; $\mu_k = 0.4$

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

$= (0.5 - 0.4) \times 9.8$

$= 1\ m/s^2$ (or) $0.98\ m/s^2$

(17)

Total mass $= m_A + m_B = 2 + 3 = 5\ kg$; $\mu = 0.1$

$F_{applied} = 45\ N$; frictional force $= (m_A + m_B)\,\mu g$

$= 5 \times 0.1 \times 10$

$\Rightarrow 5$

$\therefore$ Net acceleration $= \frac{F_{app} - \text{frictional force}}{\text{mass}}$

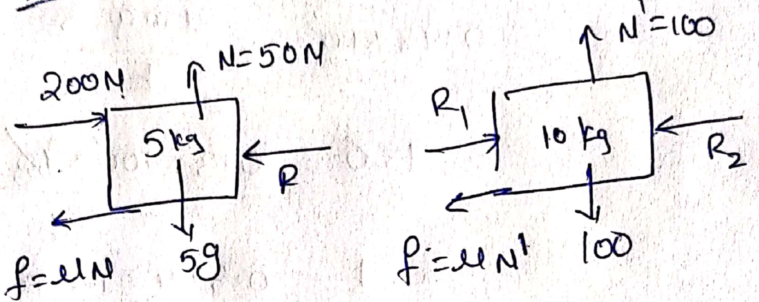
$\Rightarrow \frac{45 - 5}{5} = 8\ m/s^2$

(18)

Given $m_A = 5\ kg$, $m_B = 10\ kg$. $\mu = 0.15$

$F_{applied} = 200\ N$

Free body diagram for A & B



$R = 200 - f$

$= 200 - 0.15 \times 50$

$= 200 - 7.5$

$\Rightarrow 192.5\ N$

$R_2 = R_1 - f = R_1 - \mu N'$

$= 192.5 - 0.15 \times 100$

$= 192.5 - 15$

$= 177.5\ N.$

After removal of Partition, No reaction force is there

$$a = \frac{200 - f}{mass} = \frac{200 - (m_A + m_B) g \mu}{m_A + m_B}$$

$$= \frac{200 - 15 \times 10 \times 0.15}{15} = \frac{200 - 22.5}{15} \simeq 12 m/s^2$$

If we take $g = 9.8\ m/s^2$ we will get $12.8\ m/s^2$

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L Task

Jee mains level

1

Given $m = 2\,kg$; $u = 6\,m/s$ $v = 0$; $t = 10\,sec$

From $v = u + at$ $[a = -\mu g]$

$\Rightarrow 0 = 6 - \mu g t$

Here 'a' is -ve because the body is in retardation

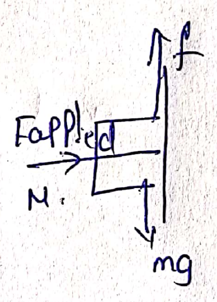
$\Rightarrow 6 = \mu \times 10 \times 10$

$\mu = \frac{6}{100} = 0.06$

2

Given $F_{applied} = 10\,N$; $\mu = 0.2$.

Here the block is at rest



$\therefore F_{applied} = N$

$\therefore f = \mu N \Rightarrow f = 0.2 \times F_{applied} = 0.2 \times 10 = 2\,N$

3

Given $m_t = 1\,kg$ $a_t = 5\,m/s^2$; $\mu = 0.6$.

$f = \mu m g$ $F_{Pseudo} = ma$

$\Rightarrow 0.6 \times 1 \times 10$ $= 1 \times 5$

$\Rightarrow 6\,N$ $= 5\,N$

here frictional force > F_{Pseudo} so the body is in motion

$\therefore f = 6\,N$

(4)

Given $m = 10\,kg$; $\mu = 0.5$; $F = 100\,N$

frictional force $= \mu mg$

$= 0.5 \times 10 \times 10 = 50\,N$

Net acceleration $a = \dfrac{F_{app} - f}{m} = \dfrac{100-50}{10}$

$= 5\,m/s^2$

(5)

Given initial velocity $u = 20\,m/s$

$\mu = 0.5$ Final speed $v = 0$

and the car is in retardation so $a = -ve$

From $v^2 - u^2 = 2as$ $a = \mu g$

$\Rightarrow 0^2 - 20^2 = -2a \times s$ $= 0.5 \times 10$

$\Rightarrow -400 = -2 \times 5 \times S$ $\Rightarrow 5$

$\Rightarrow S = 40m$

(6)

Given $m = 60\,kg$; $S = 0.9\,m$; $\mu = 0.15$

work done against friction - $W = f\,s$

$= \mu mg\,s$

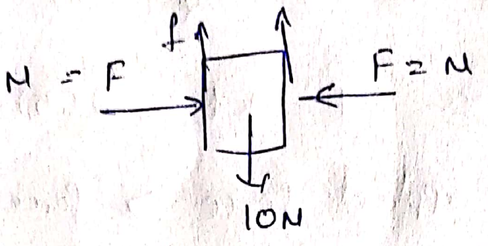
$\Rightarrow 0.15 \times 60 \times 10 \times 0.9$

$\Rightarrow \simeq 80\,J$

(7)

Given weight of box $= 10\,N = mg$

$F_{applied} = 25\,N$



$f = 10\,N$

$\therefore$ frictional force $= \mu N \times 2$

$f = \mu \times 25 \times 2$

$\Rightarrow 10 = \mu \times 25 \times 2$

$\mu = \dfrac{10}{2\times 25} = \dfrac{5}{25} = \dfrac{1}{5} = 0.2$

(8)

$F_{applied} = 10\,N$ Pulling force $F = 5\,N$

when 10N applied on the body, then it starts moving so the limiting friction is 10N. As we apply 5N force which is less than the limiting friction. Therefore, the force of friction that will come into play is equal to 5N

(9)

Here force of friction $f = Mg$

$\Rightarrow \mu N = Mg$

$\Rightarrow N = \dfrac{Mg}{\mu} = \dfrac{60\times 10}{0.5} = 1200\,N$

(15)

Given, $m = 4\ kg$; $F = kt\ [k = 2\ N/s]$; $t = 5\ sec$; $\mu = 0.2$

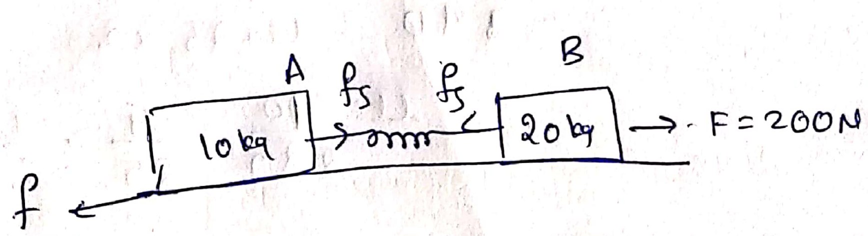
$$f_{max} = \mu mg = 0.2 \times 4 \times 10 = 8\ N$$

At $t = 2$ sec $\quad F = kt = 2(5) = 10\ N$

Since applied force > force of friction

∴ the frictional force = 8 N.

(16)



$\mu = 0.1$; $a_A = 12\ m/s^2$

For A :-

$$F_s - f = m_A a$$

$$\Rightarrow kx - \mu m_A g = 10(12)$$

$$\Rightarrow kx - 0.1 \times 10 \times 10 = 120$$

$$\Rightarrow kx = 130.$$

For B:-

$$200 - kx - \mu m_B g = m_B a$$

$$\Rightarrow 200 - 130 - 0.1 \times 20 \times 10 = 20a$$

$$\Rightarrow a = 2.5\ m/s^2$$

(17), (18), (19)

Given $M = 4\ kg$; $S = 20\ m$

$m = 0.01\ kg$ $\mu = 0.25$

force of friction $f = \mu_k N$

Since the system is on horizontal surface $N = (M+m)g$

$\Rightarrow \boxed{N = (4+0.01) \times 10 = 40.1\ N. \simeq 39.29\ N}$

$\therefore \boxed{f_k = \mu_k N = 0.25 \times 40.1 = 10.025\ N \simeq 9.8\ N}$

$\therefore a = \dfrac{f_k}{m+M} = \dfrac{10.025}{4.01} \simeq 2.5\ m/s^2$

For calculating speed $v^2 - u^2 = 2as$ $[a = -ve = -2.5\ m/s^2]$

$\Rightarrow 0^2 - v^2 = -2 \times 2.5 \times 20$

$\Rightarrow v^2 = 100 \Rightarrow V = 10\ m/s$

According to law of conservation of linear momentum

$mu = (M+m)V$

$\Rightarrow 0.01\ u = (4+0.01) \times 10$

$\Rightarrow \boxed{u = 4010\ m/s}$