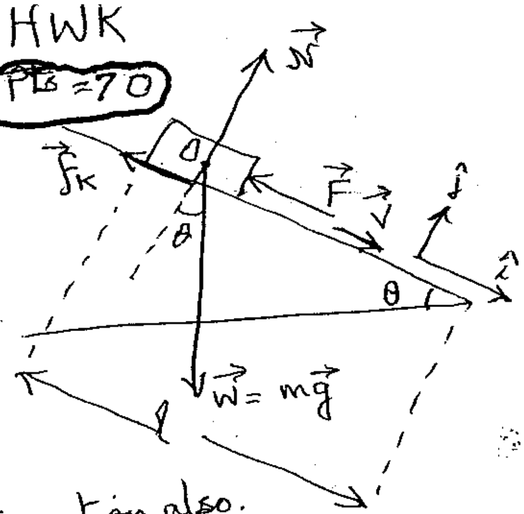
P-151/002 Random Graded HWK

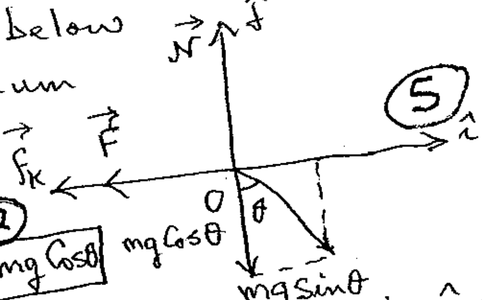
Total Pts = 70



6-8 $m = 330\,kg$, $l = 3.6\,m$, $\theta = 28^\circ$, $\mu_K = 0.4$,

20 V = constant, F = ? The Freebody diagram is shown below

There is a equilibrium in $\hat{j}$ direction,



$\Rightarrow \sum F_y = 0$ (2)

$\Rightarrow N - mg\cos\theta = 0$, $\boxed{N = mg\cos\theta}$

(2) Since V = const, there is no net force in $\hat{i}$ direction also.

$mg\sin\theta - F - f_K = 0$, $f_K = \mu_K N = \mu_K (mg\cos\theta)$ (1)

$\Rightarrow \sum F_x = 0 \Rightarrow$

(a) $\Rightarrow F = -f_K + mg\sin\theta = -\mu_K(mg\cos\theta) + mg\sin\theta = -mg(\mu_K\cos 28^\circ - \sin 28^\circ)$

$= -330\,kg\,(9.8\,\frac{m}{s^2})[0.4 \times 0.883 - 0.470] = -3234\,N\,(0.353 - 0.470)$

$= 3234\,N\,(0.117) = \underline{377.73\,N}$ (2)

(b) Since piano is sliding down, opposite to the direction of $\vec{F}$, a negative work (W_F) will be done on the piano,

$W_F = -F\,l = -377.73\,N\,(3.6\,m) = \underline{-1360\,Nm}$ ($\equiv J$) (2)

(c) $\vec{f}_K$ will also do a negative work on the piano.

$W_f = -f_K l = -\mu_K mg\cos\theta\,(l) = -0.4\,(3234\,N)\,0.883\,(3.6\,m)$

$= \underline{-4112\,J}$ (2)

(d) Work done by the component of gravity along the incline ($\hat{i}$ direction)

$W_g = mg\sin\theta(l) = 3234\,N\,(0.470)\,3.6\,m = \underline{5472\,J}$ (2)

(e) Since piano is not accelerating (its KE does not change), we expect no net work done on the piano,

$\Rightarrow W = W_F + W_f + W_g = -1360\,J - 4112\,J + 5472\,J = \underline{\text{ZERO}}$, as expected (2)

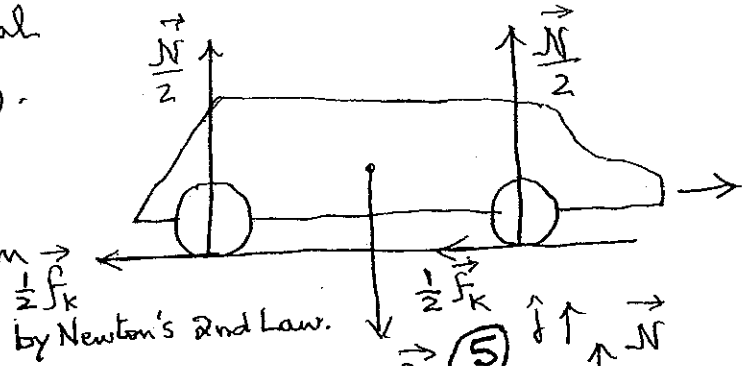
P-151 Random Graded HWK

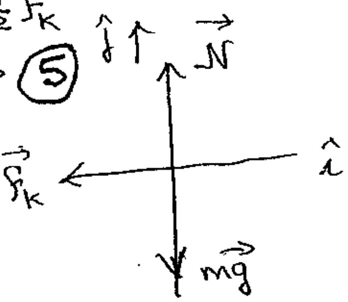
(6-22) Let V_i be the initial

10 speed of the car ($V_f = 0$).

$\Rightarrow (KE)_i = \frac{1}{2} m V_i^2$

There is an equilibrium in $\hat{j}$ direction $\Rightarrow \sum F_y = 0$ by Newton's 2nd Law.





$\Rightarrow N - mg = 0$, $N = mg$, $f_k = \mu_k N$

(2) $\Rightarrow \boxed{f_k = \mu_k mg}$ $\mu_k = 0.42$

Work done to stop the car (by friction) = Change in KE

$\Rightarrow W = \cancel{(KE)_f}^{\,0} - (KE)_i = -\frac{1}{2} m V_i^2$, $W = -f_k d = -\mu_k mg d$

$\Rightarrow \cancel{-}\mu_k \cancel{m} g d = \cancel{-}\frac{1}{2} \cancel{m} V_i^2$; note that mass of the car drops out of the equations.

$\Rightarrow V_i^2 = 2 \mu_k g d = 2(0.42)9.8 \frac{m}{s^2} (88\,m)$

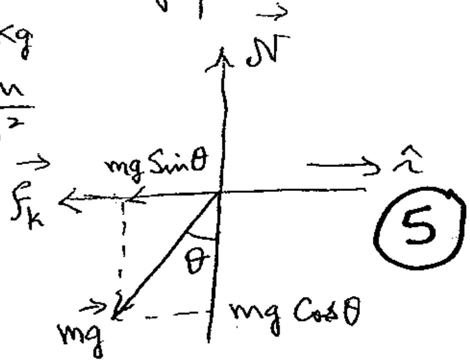
$\hookrightarrow = 724.4 \frac{m^2}{s^2} \Rightarrow \underline{V_i = 26.9 \frac{m}{s}}$ (3)

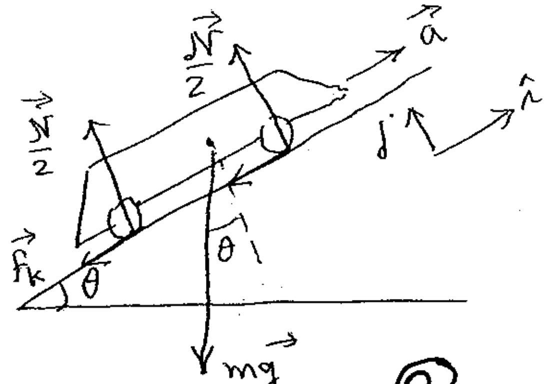
P-151 HWK Tonia

20 6-69

$m = 1200\ kg$

$g = 9.8\ \frac{m}{s^2}$





There is an equilibrium in $\hat{j}$ direction,

$\Rightarrow \sum F_y = 0 \Rightarrow N - mg\cos\theta = 0 \Rightarrow \boxed{N = mg\cos\theta}$ —(1)

and $\sum F_x = ma \Rightarrow f_k + mg\sin\theta = ma$, $f_k = 650\,N$ (given)

$\Rightarrow a = \frac{650\,N}{m} + 9.8\ \frac{m}{s^2}(\sin\theta) = \frac{650\ \cancel{kg}\frac{m}{s^2}}{1200\ \cancel{kg}} + 9.8\sin\theta\left(\frac{m}{s^2}\right)$

$\hookrightarrow = (0.54 + 9.8\sin\theta)\frac{m}{s^2}$ (3)

Maximum Power of the Car $= 120\ \cancel{hp}\left(\frac{746}{1\cancel{hp}}W\right)$

$\hookrightarrow = 9.0\times10^4\ W$ (1)

Power $= \frac{\text{Work done}}{\text{time}}$ (by definition) $= \frac{\text{Force}\times\text{distance}}{\text{time}}$

(2) $\hookrightarrow$ = Force × speed $= (ma)v$, $v = 75\ \frac{km}{\cancel{h}}\left(\frac{1\cancel{h}}{3600\,s}\right)\frac{10^3 m}{1km}$

$\hookrightarrow = 20.8\ \frac{m}{s}$ (1)

$\Rightarrow 9\times10^4\ W = 1.2\times10^3\ kg\ (20.8\ \frac{m}{s})(0.54 + 9.8\sin\theta_{max})\frac{m}{s^2}$

$\Rightarrow 90\ \cancel{N}\frac{\cancel{m}}{s} = 25\ \cancel{N}\frac{\cancel{m}}{s}(0.54 + 9.8\sin\theta_{max})$

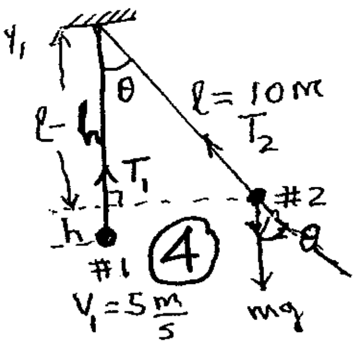
$\Rightarrow 3.6 - 0.54 = 9.8\sin\theta_{max}$

$\Rightarrow \sin\theta_{max} = \frac{3.06}{9.8} = 0.312$

$\Rightarrow \theta_{max} = 18.2^\circ$ (6)

P-151/002 Random Graded HWK

20 {6-86} By conservation of total mechanical energy,



(a) $(KE)_1 + (PE)_1 = (KE)_2 + (PE)_2$, $m = 65 kg$, $V_1 = 5 \frac{m}{s}$

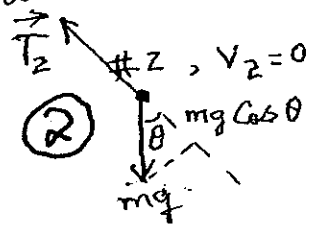
$\frac{1}{2} \cancel{m} V_1^2 + 0 = 0 + \cancel{m} g h \Rightarrow \boxed{h = \frac{V_1^2}{2g} = \frac{(5 \frac{m}{s})^2}{2(9.8 \frac{m}{s^2})}}$

$\Rightarrow h = 1.28 m$

From the diagram, $\cos\theta = \frac{l-h}{l} = 1 - \frac{h}{l}$

$\Rightarrow \cos\theta = 1 - \frac{1.28 \cancel{m}}{10 \cancel{m}} = 1 - 0.128 = 0.872 \Rightarrow \theta = 29.3°$ (5)

(b) At the release point, $V_2 = 0$ and there is no radial acceleration



$\Rightarrow (\Sigma F_r)_2 = 0 \Rightarrow T_2 - mg\cos\theta = 0 \Rightarrow T_2 = mg\cos\theta$

$\Rightarrow T_2 = 65 kg (9.8 \frac{m}{s^2}) 0.872$

$= 5.56 \times 10^2 N$ (4)

(c) At position #1 the student has a velocity $V_1 = 5 \frac{m}{s}$ and therefore a radial acceleration $= \frac{V_1^2}{l} = \frac{25 \frac{m^2}{s^2}}{10 \cancel{m}} = 2.5 \frac{m}{s^2}$

From Newton's 2nd Law

$(\Sigma F_r)_1 = ma$ $\cancel{\Rightarrow T_1 = 65 kg (12.5 \frac{m}{s^2})}$

$\Rightarrow T_1 - mg = ma \Rightarrow T_1 = m(g+a) = 65 kg (9.8 + 2.5) \frac{m}{s^2}$

$\Rightarrow T_1 = 65 kg (12.3 \frac{m}{s^2})$

$= 800 N$ (4)

Clearly $T_1 > T_2$ So tension is greatest at position #1 (1)