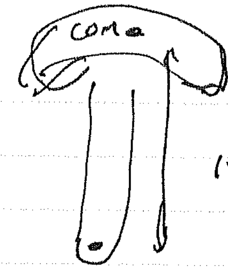
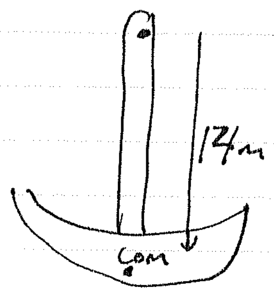
Chapter 6



initial moment of interest

#21



final moment of interest

a) find v @ bottom - this problem is most straightforwardly done w/ energy.

$$\Delta KE = W = (-mg)(h_f - h_i)$$

$$\tfrac{1}{2} m v_f^2 - \cancel{\tfrac{1}{2} m v_i^2}^{\,0} = mg\, 2R$$

$$\tfrac{1}{2} m v_f^2 = 2mgR$$

$$v_f = \sqrt{4gR} = 2\sqrt{gR}$$

b) $a_c = \dfrac{v^2}{R} = \dfrac{4gR}{R} = 4g$

c) $\vec{N}$ ← from seat

$\vec{F}_g$

d) $$\frac{\Sigma \vec{F}}{m} = \vec{a}$$

$$\frac{|N| - |mg|}{m} = a$$ ← centripital accel $a = \dfrac{v^2}{R}$

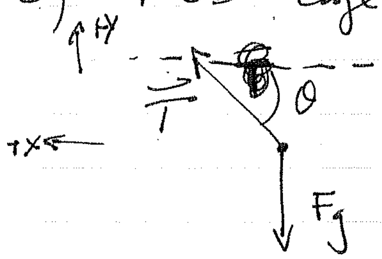
$$N - mg = ma = \frac{mv^2}{R}$$

$$N = mg + mv^2/R = m(g + v^2/R)$$

#29 a) $a_c = 10g = \omega^2 R$

$$\omega = \sqrt{\frac{10 \times 9.8\,m/s^2}{15\,m}} = 2.56\ \frac{rad}{s}$$

b) FBD cage



$$\Sigma F_y = |\vec{T}| \sin\theta - mg = 0$$

$$\frac{\Sigma F_x}{m} = \frac{T\cos\theta}{m} = a$$

so from y-direction

$$T\sin\theta = mg$$

$$T = \frac{mg}{\sin\theta}$$

from x-directi

$$T\cos\theta = ma = ma_c = m10g$$

combining

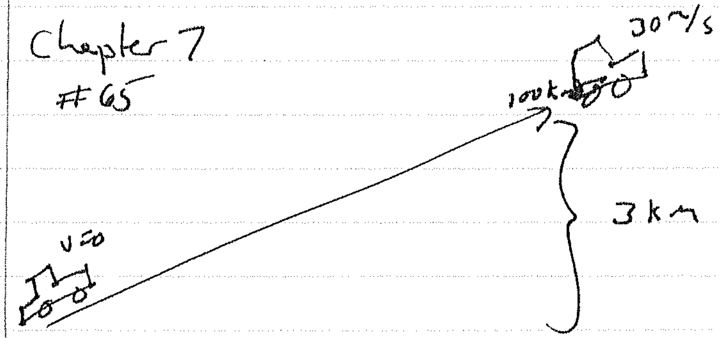
$$\left(\frac{\cancel{mg}}{\sin\theta}\right)\cos\theta = \cancel{m}\,10\cancel{g}$$

$$\frac{1}{10} = \frac{\sin\theta}{\cos\theta} = \tan\theta$$

$$\theta = \arctan 1/10 = 5.7°$$

Nearly straight out.

Chapter 7
#65



$$W_{engine} = \Delta KE + \Delta PE - W_{friction}$$

$$= \tfrac{1}{2} m v_f^2 + mgh + F_f \Delta r$$

$$= \tfrac{1}{2}(900\,kg)(30\,m/s)^2 + 900\,kg \times 9.8\,m/s^2 \times 3\times10^3\,m$$

$$+ 700\,N \times 10^5\,m$$

$$= 4.05\times10^5\,J + 2.6\times10^7\,J + 7\times10^7\,J$$

$$= 9.6\times10^7\,J$$

Gasoline has

$$33.41\ kWh/gal = 3.3\times10^4 \frac{Wh}{gal} \times \frac{3600\,s}{h}$$

$$= 1.2\times10^8\,J$$

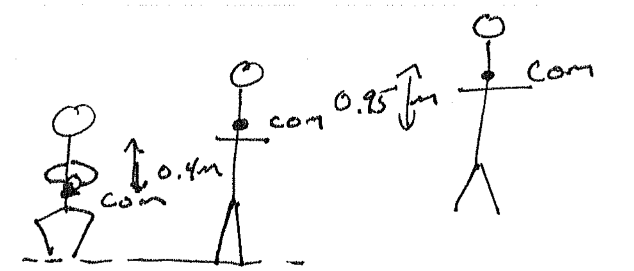
this implies an efficiency of

$$\frac{\text{Useful work}}{\text{Total energy}} = \frac{9.7\times10^7\,J}{12\times10^7\,J} = 81\%$$

which is not possible for an internal combustion engine.

Chapter 7

69 a)



moment 1 moment 2 moment 3

Between moments 2 & 3

use PE for gravity

$$KE_2 + PE_2 + \cancel{W_2}^{\to 0} = \cancel{KE_3}^{\to 0} + PE_3$$

$$KE_2 = PE_3 - PE_2 = \Delta PE$$

$$= mg\Delta h = 105\,kg \times 9.8\,m/s \times 0.95\,m$$

$$= \tfrac{1}{2} mv^2$$

or

$$v^2 = 2g\Delta h \to v = \sqrt{2g\Delta h}$$

$$= \sqrt{2 \times 9.8\,m/s^2 \times 0.95\,m}$$

$$= 4.3\,m/s$$

b) Between moments 1 & 2

$$\cancel{KE_1}^{\to 0} + PE_1 + W = KE_2 + PE_2$$

$$W = KE_2 + PE_2 - PE_1 = KE_2 + \Delta PE$$

$$= \tfrac{1}{2} m \cdot (4.3\,m/s)^2 + mg\,0.4\,m$$

$$= 1389\,J$$

not that this is the same as his change of GPE from crouch to peak of motion

so $\langle F \rangle \Delta r = W$

$$\langle F \rangle = W/\Delta r = \frac{1389\,J}{0.4\,m} = 3500\,N$$

c) this work is done to move him 0.4 m

$$\Delta x = \langle v \rangle t$$

$$= \left(\frac{v_f + \cancel{v_i}^{\,0}}{2}\right) t$$

$$t = \frac{2\,\Delta x}{v_f} = \frac{2 \times 0.4}{4.3\,\text{m/s}} = 0.19\,\text{s}$$

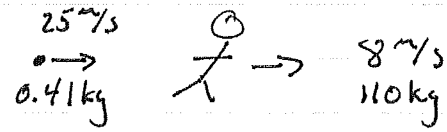
$$P = \frac{W}{t} = \frac{1389\,\text{J}}{0.19\,\text{s}} = 7300\,\text{W}$$

$$\simeq 9.6 \text{ Horse power}$$

Chapter 8

33

a)



$$p_i = p_f$$

$$m_b v_{b_i} + m_p v_{p_i} = (m_b + m_p) v_f$$

Ball momentum — person — they move together

$$v_f = \frac{m_b v_{bi} + m_p v_{pi}}{m_b + m_p} = \frac{0.41\ \text{kg} \times 25\ \text{m/s} + 110\ \text{kg}\ 8\ \text{m/s}}{110.41\ \text{kg}}$$

$$= 8.063\ \text{m/s}$$

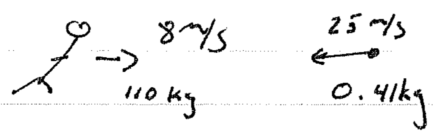
b)

$$\Delta KE = \tfrac{1}{2}(m_b + m_p) v_f^2 - \left(\tfrac{1}{2} m_b v_{bi}^2 + \tfrac{1}{2} m_p v_{pi}^2\right)$$

$$= 3589\ \text{J} - (128\ \text{J} + 3520\ \text{J})$$

$$= -59\ \text{J}$$

c)



$$v_f = \frac{m_p |v_{pi}| - m_b |v_{bi}|}{m_b + m_p} = 7.877\ \text{m/s}$$

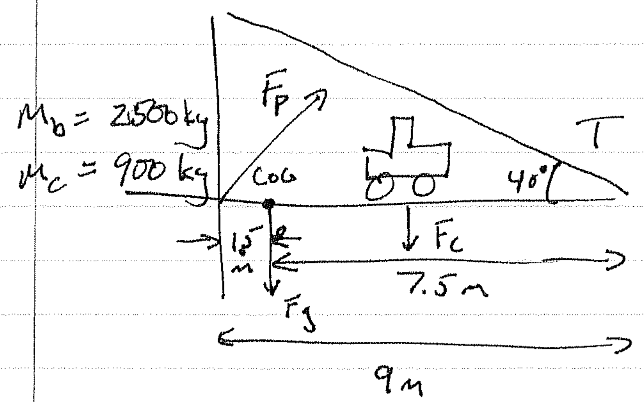
$$\Delta KE = KE_f - KE_i$$

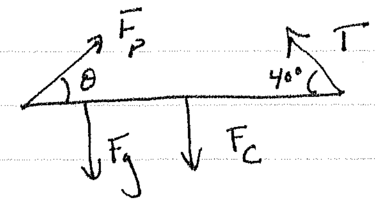
$$= \tfrac{1}{2}(110.41\ \text{kg})(7.877\ \text{m/s})^2 - 3648\ \text{J}$$

$$= 3426 - 3648\ \text{J} = -222\ \text{J}$$

Chapter 9

~~#~~13





this Bridge is in static Equilibrium so

$$\Sigma \vec{\tau} = 0 \quad \text{and} \quad \Sigma \vec{F} = 0$$

use hinge as pivot so

$$\Sigma \tau = \cancel{\tau_p}^{0} + \tau_g + \tau_c + \tau_T = 0$$

$$0 = -(m_b g)\,1.5\,m - (m_c g)\,4.5\,m + T\,9\,m \sin 40$$

so $$\frac{m_b g \times 1.5 + m_c g \times 4.5}{9 \sin 40°} = T$$

$$= 1.3 \times 10^4\ N$$

looking @ ΣF_x

$$F_{px} - T\cos 40° = 0$$

$$F_{px} = T\cos 40° = 1.0 \times 10^4\ N$$

looking @ ΣF_y

$$F_{py} - F_g - F_c + T\sin 40° = 0$$

$$F_{py} = F_g + F_c - T\sin 40°$$

$$= 3.3 \times 10^4 - 0.8 \times 10^4\ N$$

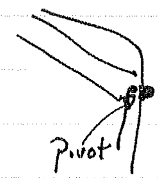
$$= 2.5 \times 10^4$$

$$\vec{F}_p = \begin{pmatrix} 1.3 \times 10^4\ N \\ 2.5 \times 10^4\ N \end{pmatrix} \quad \text{or} \quad \|\vec{F}_p\| = 2.8 \times 10^4\ N$$

$$\theta = 63°$$

Chapter 10

#13



← muscle anchor

moment arm = 0.019 m

so $\tau = Fr$

and

$\tau = I\alpha \Rightarrow Fr = I\alpha$

$F = \frac{I\alpha}{r}$

$= \frac{0.75 \times 30}{0.019}$ N

$= 1184$ N

$\simeq 1200$ N

31

w/o friction we have

$PE_1 + KE_1 = PE_2 + KE_2 = PE_3 + KE_3$

and by statement of problem

$KE_1 = KE_3 = 0$

so

$PE_1 = PE_2 + KE_2 = PE_3$

since $PE_1 = PE_3$

$h_1 = h_3$ as

$\cancel{m}gh_1 = \cancel{m}gh_3$

$h_1 = h_3$ independent of KE between

Now at the bottom

$KE_2 = KE_T + KE_R$

$= \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

for the slider

$KE_R = 0$

for the roller

$KE = \frac{1}{2} I \omega^2$

and $I = mR^2$ so

$KE = \frac{1}{2} m R^2 \omega^2 = \frac{1}{2} m v^2$

w/ $h = 0$ @ bottom

$\cancel{P}E_1 = KE_2 = PE_2$

and

for slider

$PE_1 = KE_2 = \frac{1}{2} m v^2$

$\cancel{m} g h = \frac{1}{2} \cancel{m} v^2$

$v^2 = 2gh$

$v = \sqrt{2gh}$

for roller

$PE_1 = KE_2 = \frac{1}{2} m v^2 + \frac{1}{2} m v^2 = m v^2$

$\cancel{m} g h = \cancel{m} v^2$

$v^2 = gh$

$v = \sqrt{gh}$.

slower, it will take more time to move from pt 1 to pt 3.