HW 5 Solns

5.33) a) By conservation of energy,

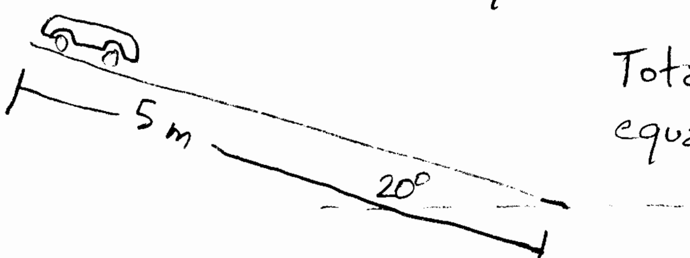
$$\frac{1}{2}k(.120\text{ m})^2 = (.02\text{ kg})(9.8\text{ m/s}^2)(20\text{ m})$$

$$\Longrightarrow k = 544\text{ N/m}$$

b) $$\frac{1}{2}(544\text{ N/m})(.120\text{ m})^2 = \frac{1}{2}(.02\text{ kg})v^2 + (.02\text{ kg})(9.8\text{ m/s}^2)(.120\text{ m})$$

$$\Longrightarrow v = 19.7\text{ m/s}$$

41)

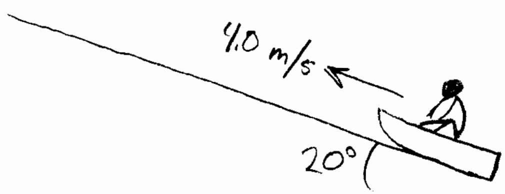


Total energy at the bottom is equal to that at the top, plus work done by friction:

$$(2.1\times 10^3\text{ kg})(9.8\text{ m/s}^2)(5\text{ m})(\sin 20°) - (4.0\times 10^3\text{ N})(5\text{ m})$$

$$= \frac{1}{2}(2.1\times 10^3\text{ kg})v_{bottom}^2 \Longrightarrow v_{bottom} = 3.8\text{ m/s}$$

46)



Potential energy at highest point equals total energy at bottom plus work done by friction:

$$\frac{1}{2}(20\text{ kg})(4.0\text{ m/s})^2 - (20\text{ kg})(9.8\text{ m/s}^2)(\cos 20°)(.2)$$

$$= (20\text{ kg})(9.8\text{ m/s}^2)(\sin 20°)\,d$$ (where d is the distance traveled up the incline by the sled)

$$\Longrightarrow d = 2.18\text{ m}$$

51) Power generated $= (1.2 \times 10^6\ kg/s)(9.8\ m/s^2)(50\ m)$

$= 5.9 \times 10^8\ W$

(This is the work done by gravity every second)

6.5) a) $p_{bullet} = p_{baseball} \longleftrightarrow (.003\ kg)(1.5 \times 10^3\ m/s) = (.145\ kg) V_{baseball}$

$\Longrightarrow V_{baseball} = 31\ m/s$

b) The bullet has greater kinetic energy (KE is $\frac{1}{2}mv^2 = p^2/2m$, which is clearly greater for the baseball)

15) b) $\frac{1}{2}(1400\ kg)(25\ m/s)^2 - F_{avg}(1.20\ m) = 0$

$\Longrightarrow F_{avg} = 3.65 \times 10^5\ N$

a) $0 - (1400\ kg)(25\ m/s) = (3.65 \times 10^5\ N) \cdot \Delta t$

$\Longrightarrow \Delta t = 9.6 \times 10^{-2}\ s$

c) acceleration $= \left(\frac{0 - 25.0\ m/s}{9.6 \times 10^{-2}\ s}\right) \cdot \frac{1\text{"g"}}{9.8\ m/s^2} = 26.6\ g$

20) a) $p_{initial} = p_{final} \longleftrightarrow 0 = -\frac{(30\ N)}{9.8\ m/s^2} \cdot V_{recoil} + (.005\ kg)(300\ m/s)$

$\Longrightarrow V_{recoil} = .5\ m/s$

b) $p_{initial} = p_{final} \longleftrightarrow 0 = -\frac{(30N + 700N)}{9.8\ m/s^2} \cdot V_{recoil} + (.005\ kg)(300\ m/s)$

$\Longrightarrow V_{recoil} = .02\ m/s$

47) Impulse $= \Delta p \longleftrightarrow$ Impulse $= (.4\ kg)(15\ m/s) - (.4\ kg)(22\ m/s)$
$= 14.8\ kg \cdot m/s$ in the direction of final velocity

49) The car and truck exert forces of equal magnitude on eachother. Since the car has the smaller mass, it will experience greater acceleration ($\vec{F} = m\vec{a}$). Acceleration during impact indicates the potential for injury in a head on collision.
In a perfectly inelastic collision, momentum is conserved, but energy is not (the cars move together following the collision)

$$p_{initial} = p_{final} \longleftrightarrow (600\ kg)(8\ m/s) + (4000\ kg)(-8\ m/s)$$
$$= (4800\ kg)\, V_{truck\ \&\ car}$$

$$\Longrightarrow V_{truck\ \&\ car} = -5.3\ m/s$$

So, since impulse $= \bar{F}(\Delta t) = \Delta p$ for each, for the car driver, we have:

$$\bar{F}_c(.120\ s) = (-5.3\ m/s)(80\ kg) - (8\ m/s)(80\ kg)$$
$$\longrightarrow \bar{F}_c = 8.89 \times 10^3\ N$$

and for the truck driver:

$$\bar{F}_t(.120\ s) = (-5.3\ m/s)(80\ kg) - (-8.0\ m/s)(80\ kg)$$
$$\Longrightarrow \bar{F}_t = 1.78 \times 10^2\ N$$

So you're better off in the truck.