PROBLEM SET 2

CHAPTER 4: #8, 12, 30, 58, 82   4 marks each

CHAPTER 4 #8

The arrow is accelerated while it is in contact with the bow.

The arrow starts at rest, $v_i = 0$, and travels a distance x in the bow and leaves with speed v_f.

In case I, the force is F_1 and $v_{f1} = 25.0$ m/s

In case II, the force is $F_2 = 2F_1$ and v_{f2} is unknown

From Newton's 2nd law $F = ma$

From kinematics, $v_f^2 = v_i^2 + 2a x$

Applied to the 2 cases

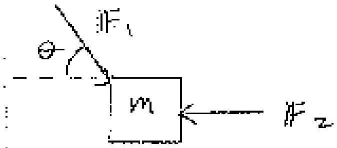
$$v_{1f}^2 = \frac{2xF_1}{m} \qquad v_{2f}^2 = \frac{2xF_2}{m} = \frac{4xF_1}{m}$$

$$\therefore \left(\frac{v_{2f}}{v_{1f}}\right)^2 = 2 \Rightarrow v_{2f} = \sqrt{2}\, v_{1f}$$

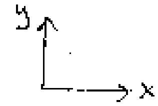
$$= \sqrt{2} \times 25.0$$

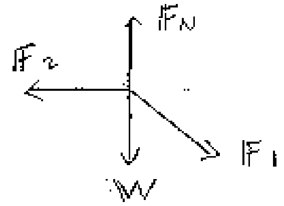
$$\boxed{v_{2f} = 35.4 \text{ m/s}}$$

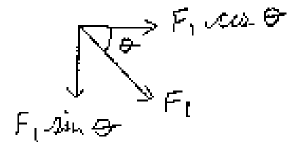
CHAPTER 4 #12



$F_1 = 45.0\,N$
$F_2 = 25.0\,N$
$m = 5.00\,kg$
$\theta = 65.0°$
$a_x = ?$







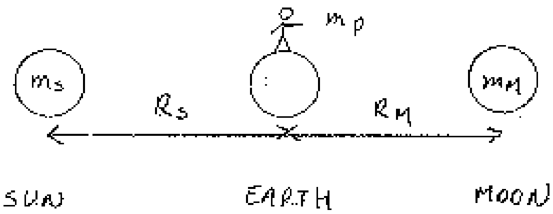
In the x-direction

$$F_1 \cos\theta - F_2 = m a_x$$

$$a_x = \frac{F_1 \cos\theta - F_2}{m} = \frac{45.0 \cos 65.0° - 25.0}{5.00}$$

$\boxed{a_x = -1.20\,m/s}$ 1.20 m/s to the left.

CHAPTER 4 # 30



$m_s = 1.99 \times 10^{30}$ kg
$m_M = 7.35 \times 10^{22}$ kg

$R_s = 1.50 \times 10^{11}$ m
$R_M = 3.85 \times 10^{8}$ m

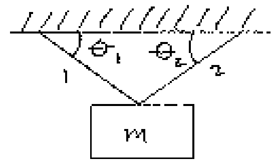
$$\frac{F_{SUN}}{F_{MOON}} = \frac{G\,\dfrac{m_s m_p}{R_s^2}}{G\,\dfrac{m_M m_p}{R_M^2}} = \left(\frac{m_s}{m_M}\right)\left(\frac{R_M}{R_s}\right)^2$$

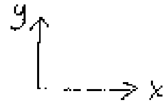
$$= \left(\frac{1.99 \times 10^{30}}{7.35 \times 10^{22}}\right)\left(\frac{3.85 \times 10^{8}}{1.50 \times 10^{11}}\right)^2$$

$$\boxed{\frac{F_{SUN}}{F_{MOON}} = 178}$$

The sun exerts a greater force on a person standing on the earth.

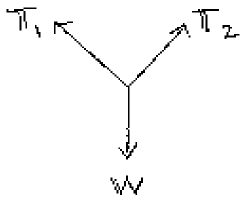
CHAPTER 4 # 58





$m = 43.8$ kg
$\theta_1 = 43.0°$
$\theta_2 = 55.0°$

$T_1, T_2 = ?$



x-direction
$(T_1)_x = -T_1 \cos\theta_1$
$(T_2)_x = T_2 \cos\theta_2$
$W_x = 0$

y-direction
$(T_1)_y = T_1 \sin\theta_1$
$(T_2)_y = T_2 \sin\theta_2$
$W_y = -mg$

Since the sign is not moving (accelerating)

$\sum F_x = \sum F_y = 0$

x-direction: $-T_1 \cos\theta_1 + T_2 \cos\theta_2 = 0$

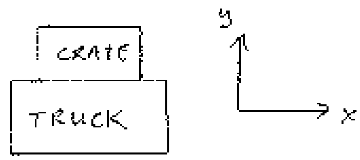
$$T_1 = T_2 \frac{\cos\theta_2}{\cos\theta_1}$$

y-direction: $T_1 \sin\theta_1 + T_2 \sin\theta_2 - mg = 0$

Solve for T_2, $T_2 = \dfrac{mg}{\sin\theta_1 \dfrac{\cos\theta_2}{\cos\theta_1} + \sin\theta_2} = \underline{317\ N}$

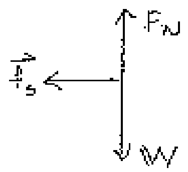
Solve for T_1, $T_1 = \dfrac{mg}{\sin\theta_2 \dfrac{\cos\theta_1}{\cos\theta_2} + \sin\theta_1} = \underline{249\ N}$

CHAPTER 4 #82



$\vec{v}_i = 25.0\ m/s$
$\mu_s = 0.650$
$x = ?$

Free body diagram for crate



y-direction $F_N - W = 0 \Rightarrow F_N = mg$

x-direction $-f_s^{MAX} = ma$

$\Rightarrow \mu_s F_N = \mu_s mg = -ma$
$a = -\mu_s g$

For no slipping the acceleration of crate must be equal to acceleration of truck.

For truck, $v_f^2 = v_i^2 + 2ax$

When truck comes to halt $v_f = 0$

$$x = -\frac{v_i^2}{2a} = \frac{v_i^2}{2\mu_s g} = \frac{25.0^2}{2 \times 0.650 \times 9.8}$$

$$\boxed{x = 49.1\ m}$$