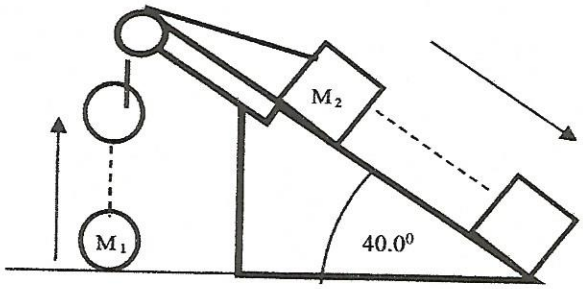
Physics
Chapter 5 Problems
Mr. Roy

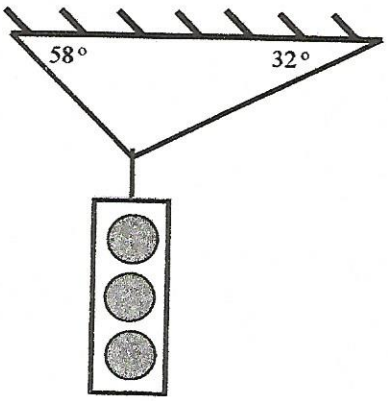
Name _____
Date _____
Period _____

1. A freight train has a mass of 1.5×10^7 kg. If the locomotive can exert a constant pull of 7.5×10^5 N, how long does it take to increase the speed of the train from rest to 80 km/hr if friction is negligible? b) How far does the train travel during this period? c) If the coefficient of friction, $\mu_s = 0.45$, what would be the magnitude of the frictional force and in which direction would it be applied?

2. Objects of masses $m_1 = 4.00$ kg and $m_2 = 9.00$ kg are connected by a light string that passes over a frictionless pulley on an incline of $\theta = 40.0°$. The objects are released from rest with m_1 resting on the floor and m_2 resting at the top of the incline. After release, m_2 slides down 1.00 m on the incline in 4.00 seconds. Determine a) the acceleration of each object, b) the tension in the string, and c) the coefficient of kinetic friction between m_2 and the incline.



3. A traffic light is suspended by two wires above the street according to the diagram provided below. The light has a mass of 35 kg. If the tension force of the first cable is at an angle of 58° with the horizontal and the second cable makes an angle of 32° with the horizontal, determine the tension force on each cable so that the light hangs in equilibrium.



Chapter 5 Problems Worksheet

1) $m = 1.5 \times 10^7 \text{ kg}$

$F = 7.5 \times 10^5 \text{ N}$

$v_0 = 0 \text{ m/s}$

$v_f = 80 \frac{\text{km}}{\text{hr}} \times \frac{1 \text{ hr}}{3600 \text{ sec}} \times \frac{1000 \text{ m}}{1 \text{ km}} = 22.2 \text{ m/s}$

$F_N = F_W = (1.5 \times 10^7)(9.8)$

$F_N = 1.47 \times 10^8 \text{ N}$

a) $a = \frac{F}{M} = \frac{7.5 \times 10^5 \text{ N}}{1.5 \times 10^7 \text{ kg}} = 0.05 \text{ m/s}^2$

$t = \frac{v_f - v_0}{a} = \frac{22.2 - 0}{0.05} = \underline{444 \text{ sec}}$

b) $\Delta x = \frac{v_f^2 - v_0^2}{2a} = \frac{22.2^2 - 0^2}{2(0.05)} = 4928 \text{ m} = \underline{4930 \text{ meters}}$

c) If $\mu = 0.45$ solve for F_f.

$F_f = \mu F_N = (0.45)(1.47 \times 10^8) = \underline{6.62 \times 10^7 \text{ N}}$

* Note that the $F_f > F$ so in real life the train would need more force to move or less friction.

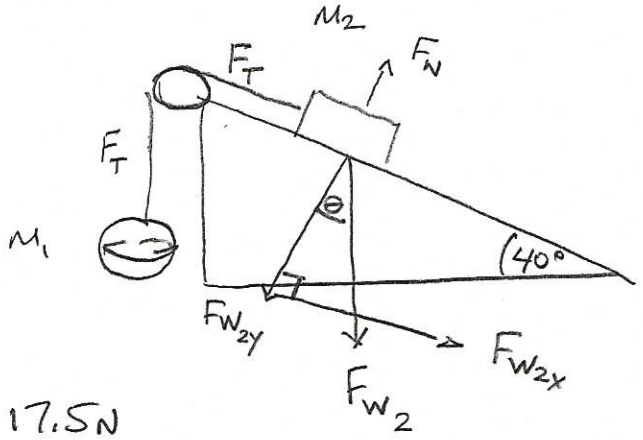
2. $F_{W_1} = m_1 g = 39.2N$

$F_{W_2} = m_2 g = 88.2N$

$F_{W_{2x}} = F_{W_2} \sin 40 = 56.7N$

$F_{W_{2y}} = F_{W_2} \cos 40 = 67.6N$

$F_N = F_{W_{2y}} = 67.N$



$F_{net} = F_{W_{2x}} - F_{W_1} = 56.7 - 39.2 = 17.5N$

a) $a_{net} = \frac{F_{net}}{m_{total}} = \frac{17.5N}{(4.00+9.00)} = 1.35 m/s^2$

b) $F_T - F_{W_1} = m_1 a$; $F_T = m_1 a + F_{W_1} = (4.00)(1.35) + 39.2 = 44.6N$

c) Friction is now being added which causes a change in the acceleration of the system.

$v_0 = 0 m/s$

$\Delta x = 1.00m$

$\Delta t = 4.00 sec$

$\Delta x = v_0 t + \frac{1}{2} a t^2$

$1.00 = 0(4.00) + \frac{1}{2} a (4.00)^2$

$1.00 = 8.00 a$

$a = 0.125 m/s^2$

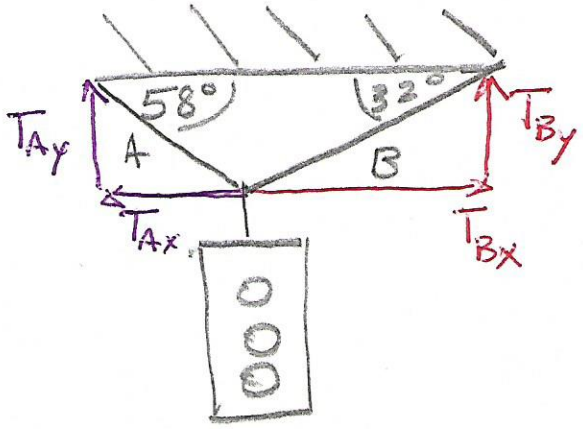
$F_{net} = m_{total} \times a = (9.00+4.00)(0.125) = 1.63N$

$F_f = F_{W_{2x}} - F_T - m_2 a = 56.7 - 44.6 - 1.13 = 11 N$

$\mu = \frac{F_f}{F_N} = \frac{11}{67.6} = 0.163$

3. $M = 35\ kg$

$F_W = (35)(9.8) = 343N$



$T_{Ax} = -T_A \cos 58°$

$T_{Ay} = T_A \sin 58°$

$T_{Bx} = T_B \cos 32°$

$T_{By} = T_B \sin 32°$

$\sum F_x \quad T_{Ax} + T_{Bx} = 0$

$T_{Bx} = -T_{Ax}$

$T_B \cos 32 = -(-T_a \cos 58)$

$T_B = T_a \frac{\cos 58}{\cos 32}$; $\cos 58 = \sin 32$

$T_B = T_a \frac{\sin 32}{\cos 32} = T_a \tan 32$

$\sum F_y \quad T_{Ay} + T_{By} - F_W = 0$

$T_A \sin 58 + T_B \sin 32 - 343 = 0$

$T_A \sin 58 + (T_A \tan 32)\sin 32 = 343$

$T_A (\sin 58 + \tan 32 \sin 32) = 343$

$T_A = \frac{343}{(\sin 58 + \tan 32 \sin 32)} = 291N$

$T_B = (291)\tan 32 = 182N$

$T_A = 291N$
$T_B = 182N$