$L_1 + \text{Imp}_{1\to 2} = L_2$

$mv_1 + Ft = mv_2$

$Ft = mv_2 - mv_1$

$F = \frac{m(v_2 - v_1)}{t} = \frac{109(66-88)}{8} = \boxed{300\text{ lb}}$

Open notes, open book, and calculators allowed. Work neatly and clearly mark your answers. Partial credit may be given.

Name: _____

Question:	1	2	3	4	Total
Points:	10	20	30	40	100
Score:					

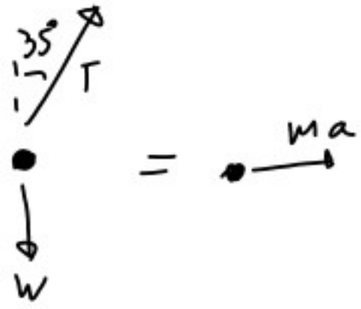
1. (10 points) A 3500 lb car decelerates from 60 mph to 45 mph in 8 seconds. Neglecting friction, what is the average force applied by the brakes?

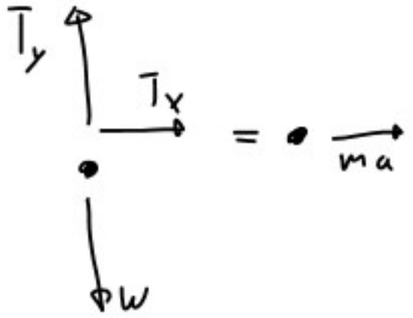
$60\text{ mph} = 88\text{ ft/s}$

$45\text{ mph} = 66\text{ ft/s}$

$\frac{3500\text{ lb}}{32.2\text{ ft/s}^2} = 109\text{ slugs}$

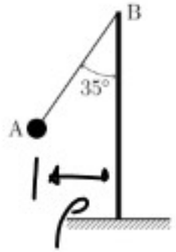
2. (20 points) In the game of tetherball, a "tether" connects the ball A to the top of the pole at B. This tether is 2 m long and makes the angle shown with the vertical pole. Assuming a constant velocity, what is the magnitude of the velocity and acceleration of the ball as it travels in a circular path around the pole?





$T_y = W$

$T_x = ma$



$$\frac{T_x}{T_y} = \tan 35^\circ = \frac{ma}{W} = \frac{ma}{mg} = \frac{a}{g}$$

$$g \tan 35^\circ = a$$

$$9.8 \tan 35^\circ = \boxed{6.86\ m/s^2}$$

$$a = \frac{V^2}{\rho} \Rightarrow V = \sqrt{a\rho}$$

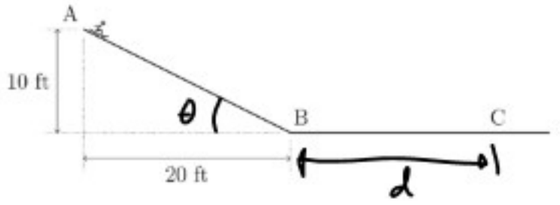
$$= \sqrt{6.86 \cdot 1.15}$$

$$\boxed{= 2.8\ m/s}$$

$$\rho = 2 \sin 35^\circ = 1.15\ m$$

3. (30 points) Dr. Devine is sledding down a hill after a snowstorm. He starts at rest at A in the figure below. He passes through point B and stops some distance later at C.
   (a) What is the distance between points B and C?
   (b) How long does it take for him to stop after he passes point B?

   The coefficient of friction between his sled and the snow is $\mu_k = 0.1$, and the total weight of the sled and rider is 130 lbs.



$V_A + T_A + V_{A\to B} = T_B + V_B$ ($T_A = 0$, $V_B = 0$)

$mgh + Fd = T_B$

$130 \cdot 10 - 11.6\sqrt{10^2+20^2} = 1040$ lb ft

$T_B + V_{B\to C} = T_C$ ($T_C = 0$)

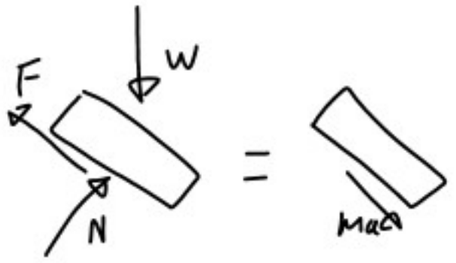
$1040 + Fd = 0$

$1040 = -Fd$

$1040 = 13d$

$\frac{1040}{13} = 80$ ft

$\tan\theta = \frac{10}{20} \Rightarrow \theta = 26.6°$



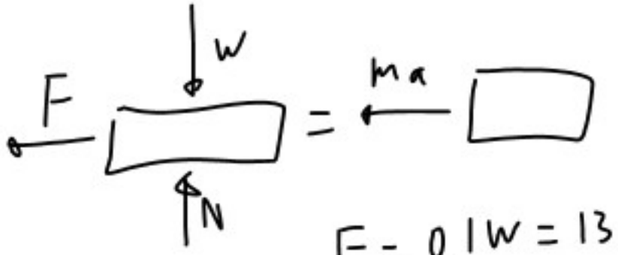
$N = W\cos\theta$

$F = \mu_K N$

$= 0.1\, W\cos\theta$

$= 0.1 \cdot 130 \cos 26.6°$

$= 11.6$ lb



$F = 0.1W = 13$ lb

$V = V_0 + at$

$0 = 22.7 - 3.22t$

$22.7 = 3.22t$

$\frac{22.7}{3.22} = t = 7s$

$T_{13} = 1040 = \frac{1}{2} m v^2 = \frac{1}{2} \frac{w}{g} v^2$

$\sqrt{\frac{2 \cdot 1040 \cdot g}{w}} = V$

$\sqrt{\frac{2 \cdot 1040 \cdot 32.2}{130}} = 22.7 ft/s$

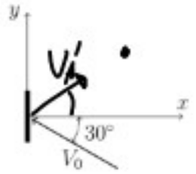
$F = ma$

$13 = \frac{w}{g} a$

$\frac{13g}{w} = a$

$\frac{13 \cdot 32.2}{130} = 3.22 ft/s^2$

4. (40 points) Wile E. Coyote runs into a painting of a tunnel at 15 mph at a 30° angle as shown below. After bouncing off of the painting with a coefficient of restitution $e = 0.8$ he slides along the ground with a coefficient of friction of $\mu_k = 0.4$. Where does he come to rest?



$V_0 = 15\text{ mph} = 22\text{ ft/s}$

$V_n = V_0 \cos 30° = 22\cos 30 = -19\text{ ft/s}$

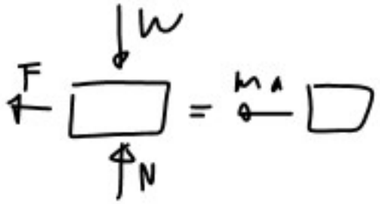
$V_t = V_0 \sin 30° = 22\sin 30 = 11\text{ ft/s}$

$\vec{V}_A' = 15.2\,i + 11\,j\text{ ft/s}$

$V_A' = \sqrt{15.2^2 + 11^2} = 18.76\text{ ft/s}$

$(V_A')_n = e(-V_A)$

$(V_A')_n = e(-V_A) = 0.8 \cdot 19 = 15.2\text{ ft/s}$



$F = 0.4N = 0.4W$

$= 0.4mg$

$T_A + U_{A\to B} = T_B$

$\frac{1}{2}mv^2 + Fd = 0$

$\frac{1}{2}m(18.76)^2 = 0.4mgd$

$\frac{18.76^2}{2g} = \frac{18.76^2}{2\cdot 32.2} = 5.46\text{ ft}$

$$\lambda = \frac{\vec{V}_A'}{V_A'} = \frac{15.2\,i + 11\,j}{13.76} = 0.31\,i + 0.59\,j$$

$$d\lambda = 13.66\,(0.31\,i + 0.59\,j) = \boxed{11\,i + 8\,j \ \text{FT}}$$