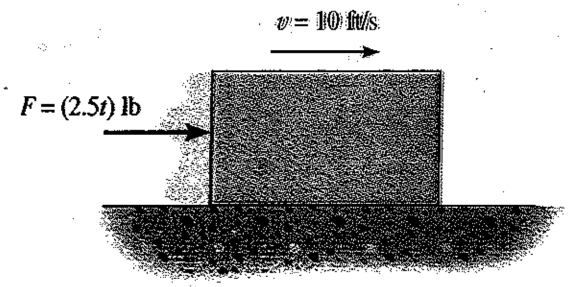
Problem 13.2 (Page 113)

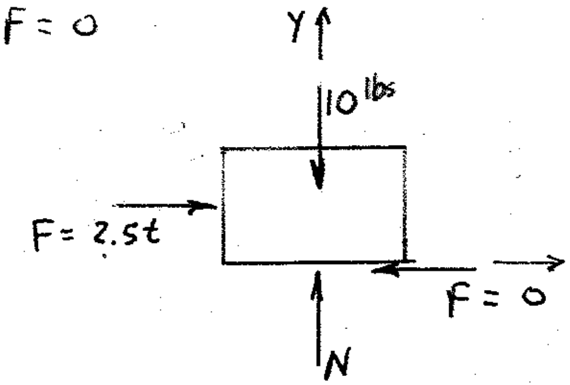
A 10-lb block has an initial velocity of 10 ft/sec on a smooth plane. If a force of 2.5 t (lbs), where t is in seconds, acts upon the block as shown for 3 seconds, determine the final velocity of the block and the distance the block travels during this time.



$$+\uparrow \sum F_y = N - 10 = 0$$

$$N = 10 \text{ lbs}$$

$$\overset{+}{\rightarrow} \sum F_x = 2.5t - F = \frac{10}{32.17} a \qquad F = 0$$



$$\frac{dV}{dt} = \frac{32.17(2.5)t}{10} = 8.04t$$

$$\int_{V_i}^{V_f} dV = 8.04 \int_0^3 t\,dt$$

$$V_f = V_i + \frac{8.04}{2}(3)^2 \quad \text{or} \quad V = 10 + 4.02t^2$$

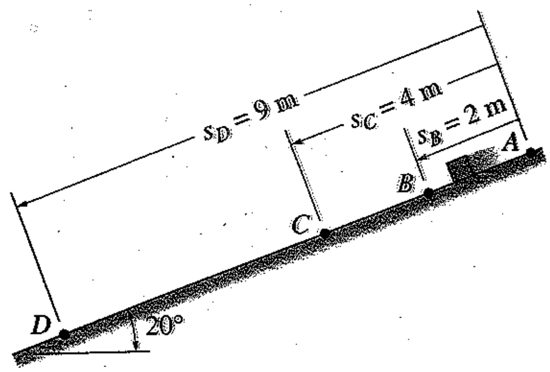
$$= 10 + 36.19 = 46.19 \text{ f/sec}$$

$$V = \frac{dx}{dt} \qquad dx = V\,dt = (10 + 4.02t^2)\,dt$$

$$x = \int_0^3 (10 + 4.02t^2)\,dt = 10(3) + \frac{4.02}{3}(3)^3 = 66.18 \text{ ft}$$

Problem 13.3 (Page 113)

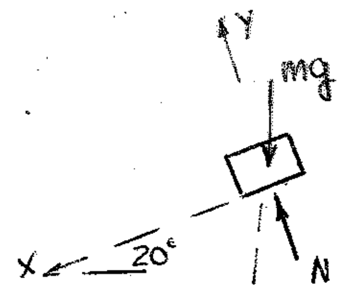
An inclined plane is used to retard the motion of a falling object, and thus to show that the fall is proportional to t^2. Show that this is the case by determining the times t_B, t_C and t_D needed for the block of mass m to slide from rest from point A to points B, C, and D. Neglect friction.



$$+\swarrow \sum F_x = mg \sin 20^\circ = m a_x$$

$$\frac{dV_x}{dt} = g \sin 20^\circ = 3.355 \ m/s^2$$

$$\int_0^{V_x} dV_x = \int_0^t 3.355 \, dt$$



$$V_x = 3.355 t = \frac{dx}{dt}$$

$$X = \frac{3.355 t^2}{2}$$

or $t = .772 \sqrt{X}$

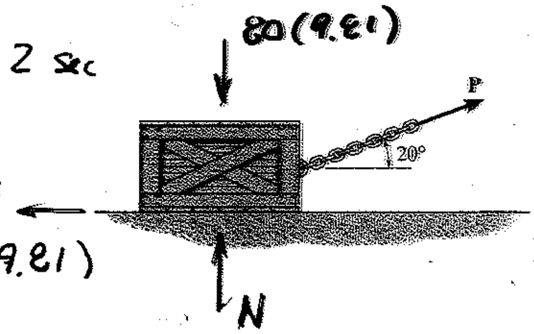
For $X_B = 2$ m $\quad t_B = 1.092$ sec

$X_C = 4$ m $\quad t_C = 1.544$ sec

$X_D = 9$ m $\quad t_D = 2.316$ sec

Problem 13.10 (Page 114)

A crate has a mass of 80 kg and is being towed by a chain that is directed at 20° from the horizontal as shown. Determine the crate's acceleration after 2 seconds if the coefficient of static friction, $\mu_s = 0.4$, the coefficient of kinetic friction, $\mu_k = 0.3$, and the towing force is given by $\mathbf{P} = 90\,t^2$ (N), where t is in seconds.



For static equilibrium $t = 2$ sec

$= 90(2)^2 = 360^N$

$+\uparrow \sum F_y = N + 360 \sin 20^\circ - 80(9.81) = 0$

$N = 661.67^N$

$\xrightarrow{+} \sum F_x = 360 \cos 20^\circ - F_f = 0 \qquad F_f = 338.29^N$

Since $F_f > F_{f\,max} = \mu_s N = .4\,(661.67) = 264.67^N$
the crate accelerates.

$+\uparrow \sum F_y = N - 80(9.81) + 360 \sin 20^\circ = 80(0) = 0$

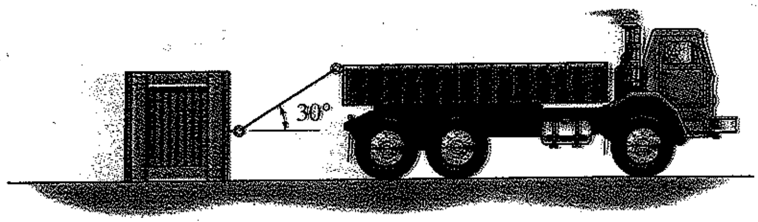
$N = 661.67^N$

$\xrightarrow{+} \sum F_x = 360 \cos 20^\circ - .3\,(661.67) = 80\,a$

$a = 1.75 \text{ m/s}^2$

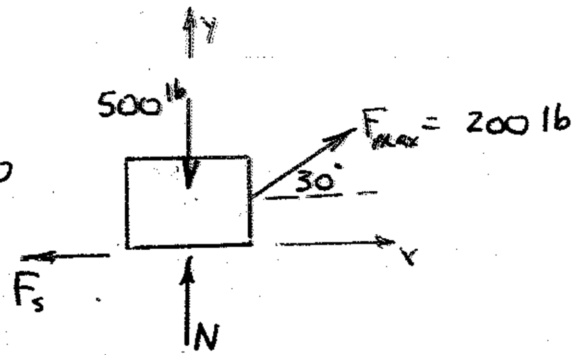
Problem 13.15 (Page 115)

A rope with a 200 lb tensile strength is used to tow a 500 lb crate that is originally at rest. Determine the greatest acceleration the truck can have if the coefficients of friction $\mu_s = 0.4$ and $\mu_k = 0.3$.



$$\overset{+}{\rightarrow} \sum F_x = 200 \cos 30^\circ - F_s$$

$$= m\, a_x$$



$$+\uparrow \sum F_y = N - 500 + 200 \sin 30^\circ = 0$$

$$N = 400 \text{ lbs}$$

$$F_{s_{max}} = .4(400) = 160 \text{ lbs}$$

$200 \cos 30^\circ = 173.2$ lb > 160 lb $\therefore$ Crate will move

$$F_s = .3(400) = 120 \text{ lbs}$$

$$200 \cos 30^\circ - 120 = \frac{500}{32.174} a \qquad a = 3.423 \text{ f/s}^2$$