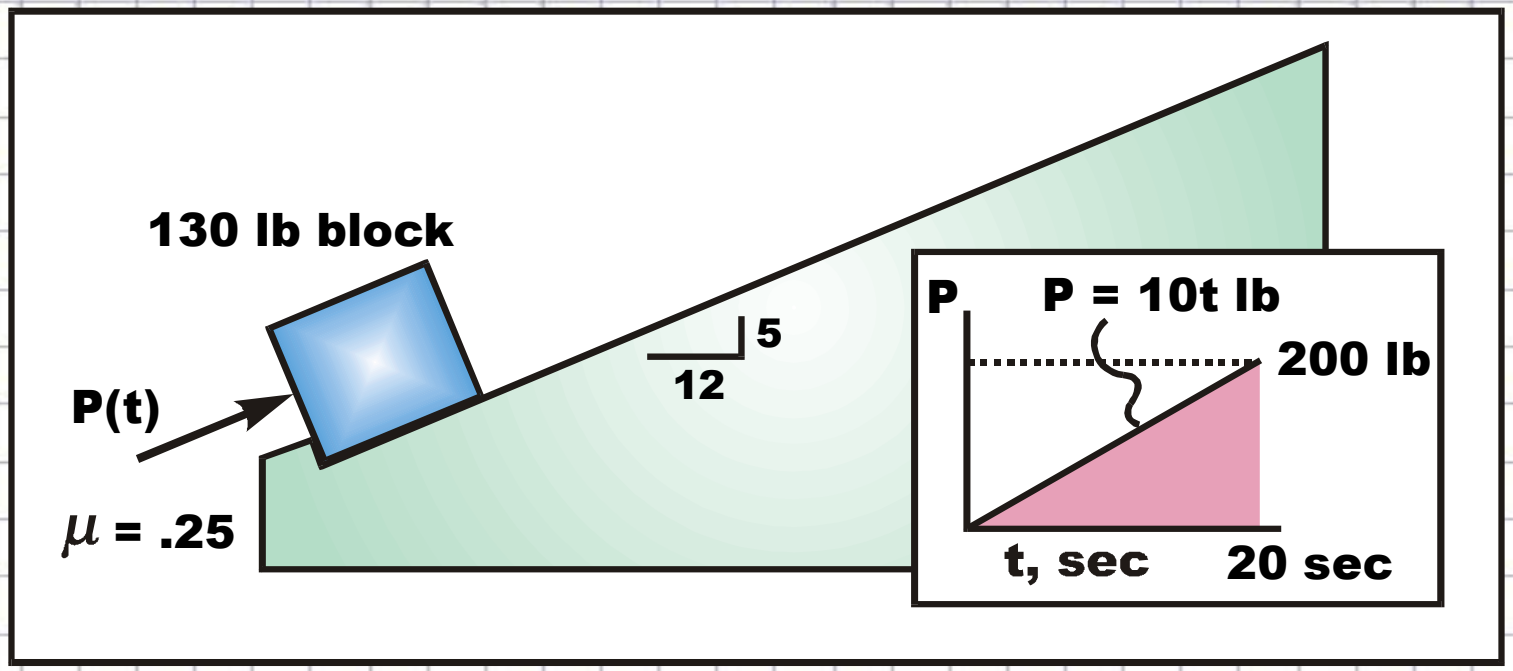
Particle Impulse-Momentum: Example Problem 2

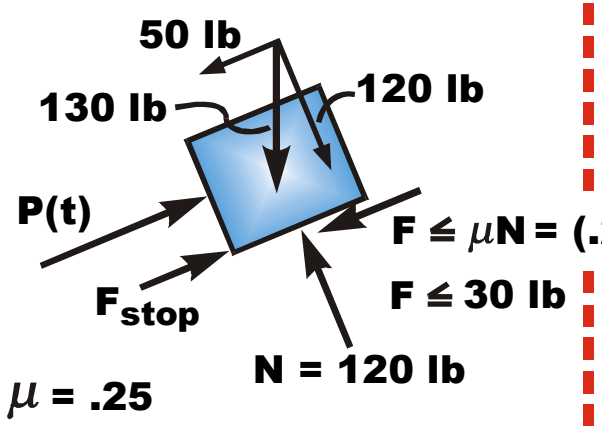
A 130 lb block rests on the slope shown below. A force P which increases with time (P = 10t lb) is applied to the block. Please determine the speed of the block up the slope at t = 20 seconds.



Important: You cannot just find the area under this P-t curve. You must draw a FBD to view all forces, and find t_{start}.

Draw a FBD. YOU MUST FIND t_{start} on this kind of problem.

FBD



$F \leq \mu N = (.25)(120)$

$F \leq 30$ lb

Friction is an INequality!
F = 30 lb only when
the block is on verge of motion.

Sum forces along slope...

$P(t) - 50 - F + F_{stop} = \text{Net Force}$

Think!

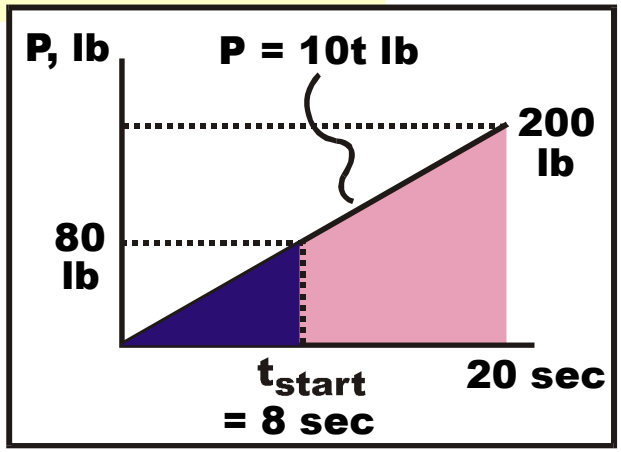
When P(t) = 0, $F_{stop} \cong 50$ lb, friction F << 30 lb.
As P(t) grows, F_{stop} decreases, friction F grows.

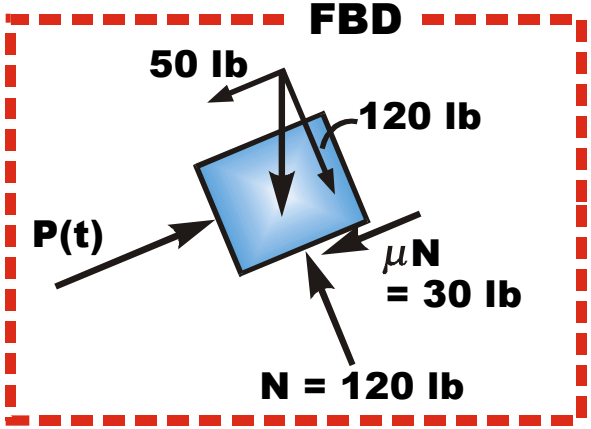
When does the block begin to move?
On the verge of motion....

$P(t) - 50 - F + \cancel{F_{stop}}^{0} = 30$ lb

$P(t) = 80$ lb

$t_{start} = 8$ sec

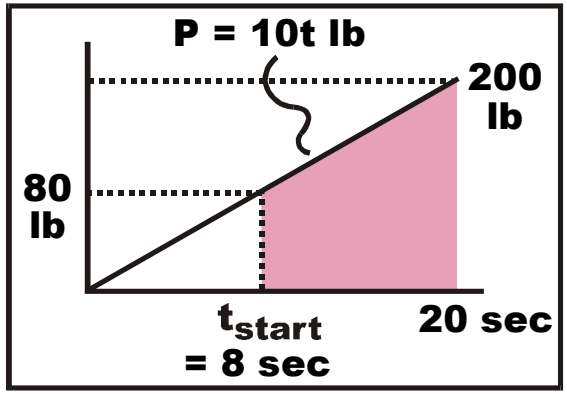




Use the Impulse Momentum Eqn....

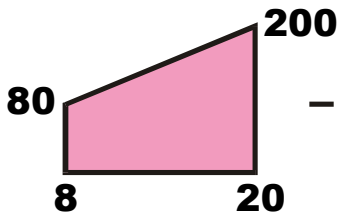
$$m\vec{v}_1 + \sum\left(\int \vec{F}dt\right) = m\vec{v}_2$$

Sum of impulses...
in the direction of interest...



Write the I-M Equation along the slope....

$$+\nearrow \quad \cancel{m\vec{v}_1}^{\,0} + \sum \text{Impulses} = m\vec{v}_2$$



$$+\nearrow \quad -(50 + 30)(12) = \frac{130}{32.2} v_2$$

$$-80(12) = -960$$

$$4.037\ v_2$$

Area = 12(140)
= 1680 lb-sec

$$1680 - 960 = 4.037\ v_2$$

$$+\nearrow \quad \boxed{v_2 = 178.3 \text{ fps} \nearrow}$$