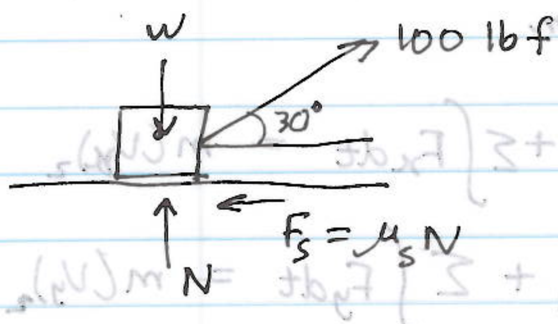
Principle of Linear Impulse & Momentum

F 15 – 2



by Principle ~~of~~ Impulse ~~and~~ Linear Momentum

$$m(V_x)_1 + \sum \int_{t_1}^{t_2} F_x \, dt = m(V_x)_2 \quad \text{--- (1)}$$

$m(V_x)_1$ = initial momentum = 0 because crate starts from rest

$$\text{Impulse} = \int_{t_1}^{t_2} (F_x - F_s)\, dt$$

$$= \int_0^4 \left[100 \cos 30 - 0.2(\cancel{9.81})(150) \right] dt$$

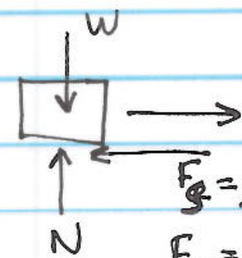
$$= 56.6 \left[t \right]_0^4 = 56.6\,(4) = 226.41 \text{ Ns}$$

from ~~Eq~~ Eqn (1)

$$0 + \cancel{86.6}\ 226.41 = 150 (V_x)_2$$

$$(V_x)_2 = 1.5 \text{ ft/s.}$$

F 15-3



$F_s = \mu_s N$ (applies at ~~initial~~ rest)

$F_k = \mu_k N$ (applies ~~at first~~ in motion)

Principle Linear Impulse and Momentum:

$$mV_1 + \sum \int F\,dt = mV_2 \quad \text{— (1)}$$

$mV_1 = 0$

Impulse: we were not given time before static friction is overcome for motion start, so we must find it.

$$F - F_s = 0$$
$$20t^2 - 0.3(25)(9.81) = 0$$
$$t = 1.91 \text{ s.}$$

so impulse associated with motion from $t = 1.91$ to $t = 4$ s.

So impulse associated the motion

$$= \int_{t=1.91}^{t=4} (F - F_k)\,dt$$

$$= \int_{1.91}^{4} \left[20t^2 - 0.25(25)(9.81) \right] dt$$

$$= \int_{1.91}^{4} \left[20t^2 - 61.31 \right] dt$$

$$= \left[20\frac{t^3}{3} - 61.31\, t \right]_{1.91}^{4}$$

$$= 20\frac{(4)^3}{3} - 61.31(4) - \left[20\frac{(1.91^3)}{3} - 61.31(1.91) \right]$$

$$= 252.07 \text{ N.S}$$

Back to Eqn(1)

$$0 + 252.07 = 25V_2$$

$$V_2 = 10.08 \text{ m/s.}$$

15 − 7

Principle of Linear Impulse and Momentum

$$mV_1 + \Sigma \int F\,dt = mV_2$$

for time 0 to 0.5

$$mV_0 + T(t_2 - t_1) = mV_{0.5}$$

$$0 + 30000(0.5) = 1500\,V_{0.5}$$

$$V_{0.5} = 10 \text{ m/s}$$

time 0.5 − 1 s

$$1500(10) + 60000(0.5) = 1500\,V_1$$

$$V_1 = 30 \text{ m/s}$$

time 1 − 1.5 s

$$1500(30) + 90000(0.5) = 1500\,V_{1.5}$$

$$V_{1.5} = 60 \text{ m/s}$$

1.5 − 2 s

$$1500(60) + 60000(0.5) = 1500\,V_2$$

$$V_2 = 80 \text{ m/s}$$

2 − 2.5 s

$$1500(80) + 30000(0.5) = 1500\,V_{2.5}$$

$$V_{2.5} = 90 \text{ m/s}$$

Those of doing Race Car analysis for your project! This would be a relevant analysis, but you would change the mass each time to account for loss of

mass due to fuel consumption