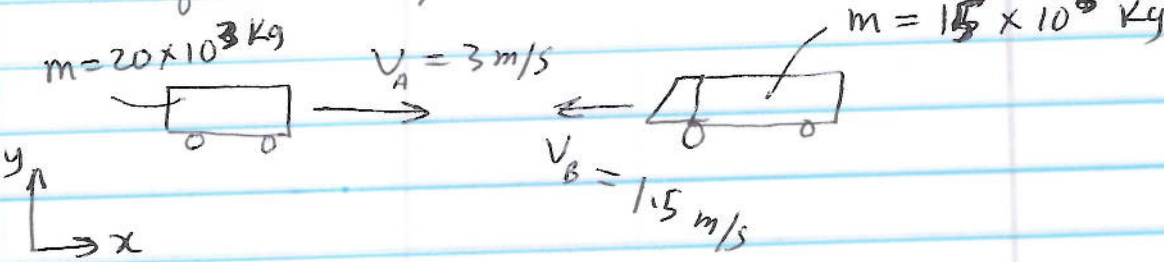
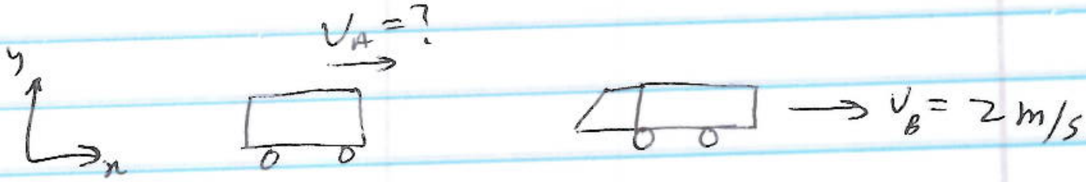
Impact

F 15 - 7

before impact



after impact



By Principle of Impulse and Momentum

$$\sum (m_i v_i)_1 + \sum \int F\,dt = \sum (m_i v_i)_2 \quad \text{—(1)}$$

before   impulse   final

Also from Principle of conservation of Momentum

$$m_A (V_A)_1 + m_B (V_B)_1 = m_A (V_A)_2 + m_B (V_B)_2$$

$$(V_A)_2 = \frac{m_A (V_A)_1 + m_B (V_B)_1 - m_B (V_B)_2}{m_A}$$

$$= \frac{20\times10^3 (3) + 15\times10^3(-1.5) - 15\times10^3(2)}{20\times10^3}$$

$$= 0.375 \text{ m/s} \longrightarrow \text{direction}$$

Note that we could have obtained $(V_B)_2$ using Principle of conservation of energy

$$T_1 + V_1 = T_2 + V_2$$

So impulse on A (from Eqn 1)

$$m_A(V_A)_1 + \Sigma\int F\,dt = m_A(V_A)_2$$

(impulse)

$$\int \Sigma F\,dt = m_A\left[(V_A)_2 - (V_A)_1\right]$$

$$= 20\times10^3\,(0.375 - 3)$$

$$= -52.5 \text{ kN.s}$$

Likewise impulse on B

$$\int \Sigma F\,dt = m_B\left[(V_B)_2 - (V_B)_1\right]$$

$$= 15\times10^3\left[2-(-1.5)\right] = 52.5 \text{ kN.s}$$

= [illegible]

~~Selecting either A or B~~

Average Impulse = $\frac{-52.5 \text{ [illegible]}}{\text{[illegible]}}$ = [illegible] kN.s

Average Impulsive force over t = 0.5 s = $-22.5(0.5) = -11.25$ MN

= 52.

~~Using the 2 magnitudes of impulse~~

~~Average~~

Selecting either A or B.

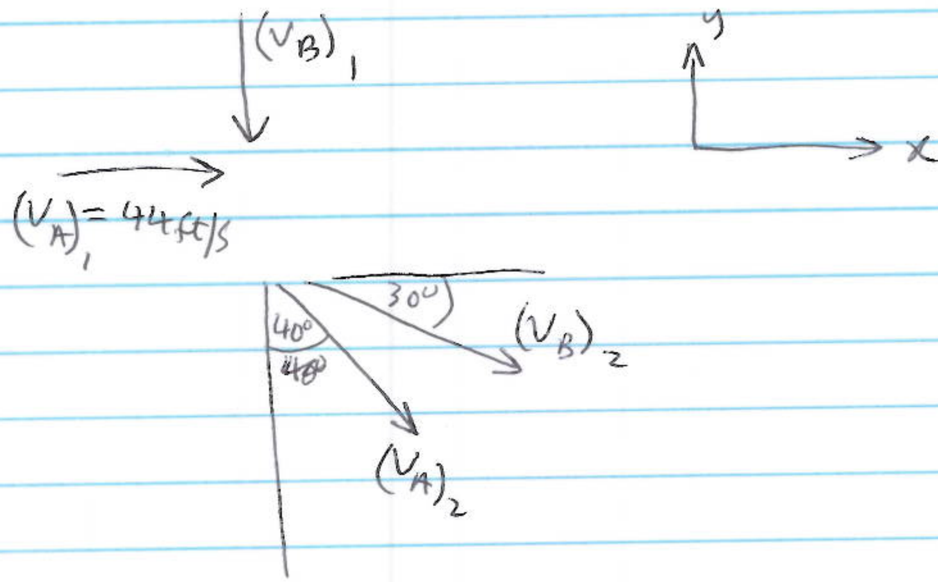
Impulse $\Sigma F \Delta t = 52.5$ KN, S

Impulsive force $\Sigma F = \frac{52.5}{0.5} = 105$ KN

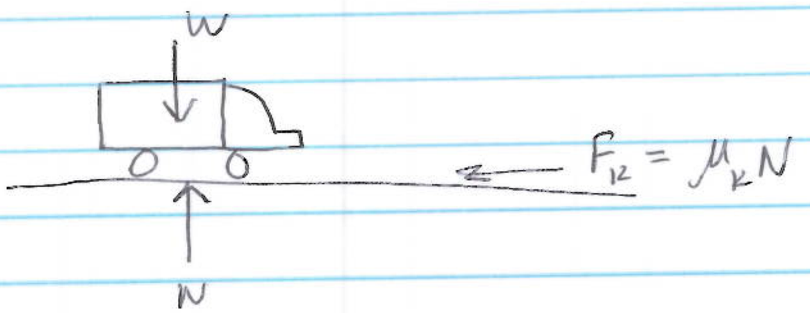
over 0.5 s

Oblique Impact

15–81



After impact, car B



$$\Sigma F = \mu_k N = ma$$

$$a = \frac{\mu_k N}{m} = \frac{0.15(4000)}{4000/32.2}$$

$$a = 4.83 \text{ ft/s}^2$$

car skidded 10 ft before stopping. from 3rd Eqn of motion

$$v^2 = u^2 + 2as$$

deceleration

$$0 = u^2 + 2(-4.83)(10)$$

$$u = 9.82 \text{ ft/s} \quad \text{or} \quad (V_A)_2 = 9.82 \text{ ft/s}$$

From Principle of Conservation of Momentum (in the x-plane)

$$m_A (V_A)_1 = m_A (V_A)_2 \sin 40 + m_B (V_B)_2 \cos 30$$

$$(V_B)_2 = \frac{m_A \left[(V_A)_1 - (V_A)_2 \sin 40 \right]}{m_B \cos 30}$$

$$= \frac{44 - 9.82 \sin 40}{\cos 30}$$

$$= 43.52 \text{ ft/s}$$

Now repeat process for y-plane

$$m(V_B)_1 = m(V_A)_2 \cos 40 + m(V_{B_2}) \sin 30$$

$$(V_B)_1 = (V_A)_2 \cos 40 + (V_B)_2 \sin 30$$

$$= 9.82 \cos 40 + 43.52 \sin 30$$

$$= 29.28 \text{ ft/s}$$

or 19.92 mi/h

Angular Momentum

F15-21

Principle of Angular Impulse and Momentum

$$(H_O)_1 + \sum \int M_O \, dt = (H_O)_2$$

initial angular momentum + moments applied over time interval = final angular momentum

$$1.5(5)(2) + 5(1.5)(3) = 1.5(5)V$$

$$V = \frac{5(2) + 5(3)}{5} = 5 \text{ m/s}$$

Propulsion

15-130

Thrust $T = V_{D/e} \cdot \frac{dm_e}{dt}$

$= 3000(4)$

$= 12\ KN$

$\Sigma F = ma$

neglecting self weight

$12000 = 5.7 \times 10^3\ a$

$a = 2.10\ m/s^2$

At empty $m = 5 \times 10^3\ Kg$

so

$12000 = 5 \times 10^3\ a$

$a = 2.4\ m/s^2$