

Impulse Momentum Collisions in 1D

$$\textcircled{1} \sum \vec{J} = \Delta \vec{p} = m \Delta \vec{v} = m(\vec{v} - \vec{v}_0) = 15 \text{ kg}(14 \text{ m/s} - (-6.0 \text{ m/s})) = 300 \frac{\text{kg m}}{\text{s}} = \boxed{300 \text{ N s}}$$

$$\textcircled{2} \sum \vec{J} = \Delta \vec{p} \Rightarrow \sum \vec{F} t = m \Delta \vec{v} \Rightarrow t = \frac{m(\vec{v} - \vec{v}_0)}{\sum \vec{F}} = \frac{75 \text{ kg}(11 \text{ m/s} - 0 \text{ m/s})}{125 \text{ N}} = \boxed{6.6 \text{ s}}$$

$$\textcircled{3} \sum \vec{J} = \Delta \vec{p} \Rightarrow \sum \vec{F} t = m \Delta \vec{v} \Rightarrow m = \frac{\sum \vec{F} t}{\Delta \vec{v}} = \frac{7500 \text{ N} \left(6.0 \text{ min} \times \frac{60 \text{ s}}{\text{min}}\right)}{(41 \text{ m/s} - (-14 \text{ m/s}))} = \boxed{49000 \text{ kg}}$$

b. East

$$\textcircled{4} \boxed{36000 \text{ N right}} \quad (\text{Newton's 3rd Law of Motion})$$

$$\textcircled{5} \quad \sum \vec{p}_0 = \sum \vec{p}$$

$$m_1 \vec{v}_{10} + m_2 \vec{v}_{20} = m_1 \vec{v}_1 + m_2 \vec{v}_2$$

$$0.150 \text{ kg}(12 \text{ m/s}) + 0.250 \text{ kg}(0 \text{ m/s}) = 0.150 \text{ kg} \vec{v}_1 + 0.250 \text{ kg}(6.0 \text{ m/s})$$

$$\frac{0.150 \text{ kg}(12 \text{ m/s}) - 0.250 \text{ kg}(6.0 \text{ m/s})}{0.150 \text{ kg}} = \vec{v}_1$$

$$\boxed{\vec{v}_1 = 2.0 \text{ m/s right}}$$

$$\textcircled{6} \quad \sum \vec{p}_0 = \sum \vec{p}$$

$$m_1 \vec{v}_{10} + m_2 \vec{v}_{20} = m_1 \vec{v}_1 + m_2 \vec{v}_2$$

$$0.150 \text{ kg}(12 \text{ m/s}) + 0.250 \text{ kg}(3.0 \text{ m/s}) = 0.150 \text{ kg}(5.0 \text{ m/s}) + 0.250 \text{ kg} \vec{v}_2$$

$$\boxed{\vec{v}_2 = 7.2 \text{ m/s right}}$$

$$\textcircled{7} \quad \sum \vec{p}_0 = \sum \vec{p}$$

$$m_1 \vec{v}_{10} + m_2 \vec{v}_{20} = m_1 \vec{v}_1 + m_2 \vec{v}_2$$

$$(0.150 \text{ kg})(12 \text{ m/s}) + 0.250 \text{ kg}(-3.0 \text{ m/s}) = 0.150 \text{ kg} \vec{v}_1 + 0.250 \text{ kg}(4.0 \text{ m/s})$$

$$\boxed{\vec{v}_1 = 0.33 \text{ m/s right}}$$

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$$\sum \vec{p}_0 = \sum \vec{p}$$

$$m_1 \vec{v}_{01} + m_2 \vec{v}_{02} = (m_1 + m_2) \vec{v}$$

$$0.150 \text{ kg} (12 \text{ m/s}) + 0.250 \text{ kg} (-3.0 \text{ m/s}) = (0.150 \text{ kg} + 0.250 \text{ kg}) \vec{v}$$

(They are stuck together!)

$$\vec{v} = 2.6 \text{ m/s right}$$

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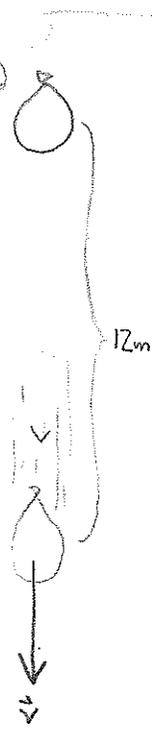
$$\sum \vec{p}_0 = \sum \vec{p}$$

$$m_1 \vec{v}_{01} + m_2 \vec{v}_{02} = (m_1 + m_2) \vec{v}$$

$$2.0 \text{ kg} (6.0 \text{ m/s}) + m_2 (-4.0 \text{ m/s}) = (2.0 \text{ kg} + m_2) (-3.0 \text{ m/s})$$

$$m_2 = 18 \text{ kg}$$

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$$\left. \begin{aligned} d &= 12 \text{ m} \\ a &= 9.8 \text{ m/s}^2 \\ v_0 &= 0 \text{ m/s} \\ v &= ? \end{aligned} \right\} \begin{aligned} v^2 &= v_0^2 + 2ad \\ v &= \sqrt{2(9.8)(12)} \\ v &= 15.33623161 \text{ m/s (down)} \end{aligned}$$

- a. DOWN
- b. DOWN
- c. $\vec{J} = \Delta \vec{p} = 9.20 \text{ kg m/s DOWN} \Rightarrow \vec{J} = 9.20 \text{ N}\cdot\text{s}$
- d. Gravity from Earth

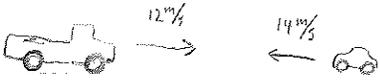
e. $\Delta \vec{p} = m \Delta \vec{v}$

$$\frac{\Delta \vec{p}}{\Delta \vec{v}} = m$$

$$\frac{9.20 \text{ kg m/s}}{(15.33 \dots \text{ m/s} - 0 \text{ m/s})} = m = 0.5998866106 \text{ kg}$$

$$m = 0.60 \text{ kg}$$

11.



A. $\sum \vec{p} = \sum \vec{p}_0$
 $(M+m)\vec{v} = M\vec{v}_0 + m\vec{v}_{c0}$
 $\vec{v} = \frac{2500\text{kg}(12\text{ m/s}) + 1600\text{kg}(-14\text{ m/s})}{(2500\text{kg} + 1600\text{kg})} = 1.853658537\text{ m/s}$

$\vec{v} = 1.9\text{ m/s}$ NORTH

B. $\Delta \vec{p}_c = \vec{p}_c - \vec{p}_{c0} = 1600\text{kg}(1.853658537\text{ m/s}) - 1600\text{kg}(-14\text{ m/s}) = 25365.85366\text{ kg m/s}$

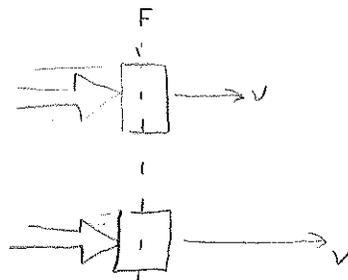
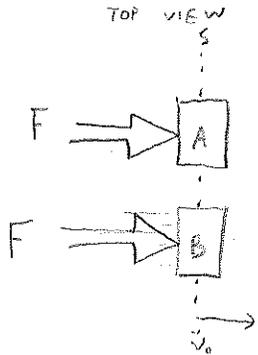
$\Delta \vec{p}_c = 25000\text{ kg m/s}$ NORTH

C. $\Delta \vec{p}_t = \vec{p}_t - \vec{p}_{t0} = 2500\text{kg}(1.853658537\text{ m/s}) - 2500\text{kg}(12\text{ m/s}) = -25365.85366\text{ kg m/s}$

$\Delta \vec{p}_t = 25000\text{ kg m/s}$ SOUTH

D. HOLY TOLEDO! They're equal and opposite!!

12. Sketch a diagram:



OK, time to think. Same mass, same Force so same _____

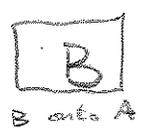
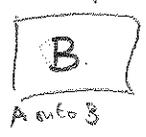
Same \vec{a} , but _____ has a greater initial _____

Which object takes more time to reach the finish? _____

And now $\Delta \vec{p} = \vec{F}t$ (same \vec{F} !)

So....

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(C) If it is moving **MUCH FASTER.** (in fact of

$$0.025 v_R > 1235000 v_T$$

$$v_R > \frac{1235000}{0.025} v_T$$

$$v_R > 49400000 v_T$$

The rock's speed must be more than 49 400 000 times greater than the train.

- 15 a. Carr B
- b. Carr B
- c. Carr B

16 a. $\Delta p = p - p_0$

$$\Delta p = 0.450 \text{ kg} (20.0\% / \text{s})$$

$$\Delta p = 9.00 \text{ kg} \cdot \text{m} / \text{s}$$

b. $\vec{J} = \Delta \vec{p}$

$$\vec{J} = 9.00 \text{ N} \cdot \text{s}$$

c. $\vec{J} = \vec{F} t$

$$F = \frac{J}{t} = \frac{9.00 \text{ N} \cdot \text{s}}{0.085 \text{ s}}$$

$$F = 106 \text{ N}$$

- 17. a. THE SAME AS
- b. THE SAME AS
- c. THE SAME AS
- d. LESS THAN
- e. LESS THAN
- f. LESS THAN