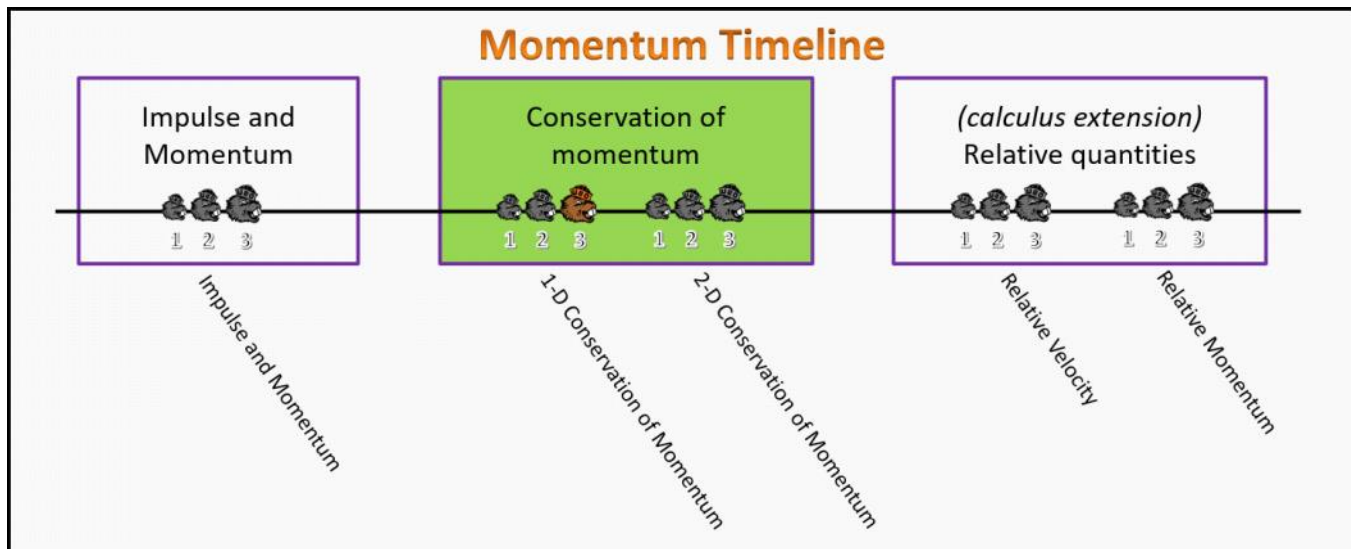


Conservation of Momentum Foundation Stage (CM.L1.3)

Post-Lecture 1 1-D Conservation of Momentum



Questions

CM.L1.3-01

Description: Possible final states of a collision

Learning Objectives: [x]

Problem Statement: An object is moving to the right when it collides with a second stationary object. Which of the following are possible outcomes from this collision.

- ① Both objects move to the right.
- ② The first object comes to rest while the second object moves to the right.
- ③ The first object comes to rest while the second object moves to the left.
- ④ Both objects move to the left.
- ⑤ The first object recoils to the left while the second moves to the right.

CM.L1.3-02

Description: Nuclear fission and momentum

Learning Objectives: [x]

Problem Statement: A uranium nucleus is at rest, undergoes fission, and splits into two fragments, one heavy and one light. Which of these statements is true?

- F
T
F
F
- (1) The lighter and heavier fragments have the same speed
 - (2) The lighter fragment is moving faster than the heavy
 - (3) The lighter fragment is moving slower than the heavy
 - (4) The lighter fragment has more momentum than the heavier fragment
 - (5) The lighter fragment has an equal but opposite momentum as the heavier fragment
 - (6) The lighter fragment has less momentum than the heavier fragment

CM.L1.3-03

Description: Increased mass and resulting velocity change

Learning Objectives: [x]

Problem Statement: What is the speed of a garbage truck that is 1.20×10^4 kg and is initially moving at 25.0 m/s just after it hits and adheres to a trash can that is 80.0 kg and is initially at rest?

- (1) 0.166 m/s
- (2) 25.0 m/s
- (3) 24.8 m/s
- (4) 0.167 m/s

\vec{v}_{1i} $\vec{v}_{2i} = 0$
 $m_1 = 1.2 \times 10^4 \text{ kg}$ $m_2 = 80 \text{ kg}$

\vec{v}_{12f}
 $m_{12} = (1.2 \times 10^4 + 80) \text{ kg}$

$\sum \vec{F}_{\text{EXT},x} \Delta t = \Delta p_x$
 $\sum p_{i,x} = \sum p_{f,x}$

$m_1 v_{1i,x} + m_2 v_{2i,x} = m_{12} v_{12f,x}$

$(1.2 \times 10^4 \text{ kg})(25) = (1.2 \times 10^4 + 80) v_{12f,x}$

$v_{12f,x} = 24.834 \text{ m/s}$

CM.L1.3-04

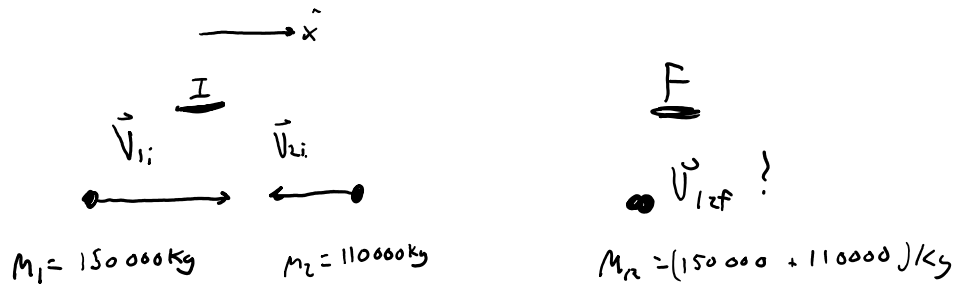
Description: Calculation with 1D conservation of momentum

Learning Objectives: [x]

Problem Statement: Train cars are coupled together by being bumped into one another. Suppose two loaded train cars are moving toward one another, the first having a mass of 150,000 kg and a velocity of 0.300 m/s, and the second having a mass of

110,000 kg and a velocity of -0.120 m/s. (The minus indicates direction of motion.) What is their final velocity?

- (1) 0.224 m/s
- (2) 31,800 m/s
- (3) 0.122 m/s
- (4) 58,200 m/s
- (5) -0.225 m/s
- (6) -0.122 m/s
- (7) -31,800 m/s



$$\sum \vec{F}_{\text{Ext } x} \Delta t = \Delta P_{s, x}$$

$$\sum P_{i, x} = \sum P_{f, x}$$

$$(150,000)(0.30) + (110,000)(-0.12) = (150,000 + 110,000) v_{12f}$$

$$45,000 \text{ N}\cdot\text{s} - 13,200 \text{ N}\cdot\text{s} = 260,000 v_{12f}$$

$$v_{12f} = 0.1223 \text{ m/s}$$

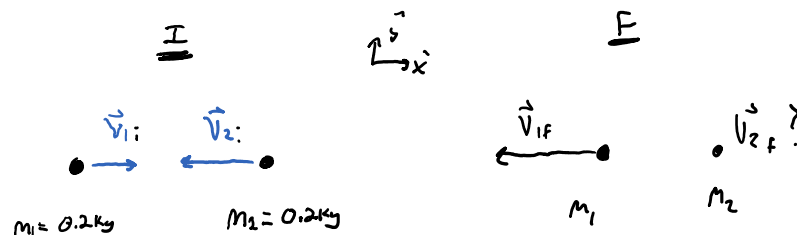
CM.L1.3-05

Description: Calculation with 1D conservation of momentum and recoil

Learning Objectives: [x]

Problem Statement: Two pucks collide on an air hockey table and bounce off each other in opposite directions. Each puck has a mass of 0.20 kg. Puck 1 has an initial velocity of 11 m/s, and puck 2 has an initial velocity of -25 m/s. After the collision, puck 1 recoils with a velocity of -25 m/s. What is the final velocity of puck 2?

- (1) -14m/s
- (2) +11m/s
- (3) -11m/s
- (4) +14m/s
- (5) +25 m/s
- (6) -25 m/s



$$\sum \vec{F}_x \Delta t = \Delta P_x$$

$$\sum P_{i, x} = \sum P_{f, x}$$

$$m_1 = m_2$$

$$m_1 = m_2$$

$$\sum P_{ix} = \sum P_{fx}$$

$$m_1 v_{1ix} + m_2 v_{2ix} = m_1 v_{1fx} + m_2 v_{2fx}$$

$$v_{1ix} + v_{2ix} = v_{1fx} + v_{2fx}$$

$$11 - 25 = -25 + v_{2fx}$$

$$v_{2fx} = 11 \text{ m/s}$$

CM.L1.3-06

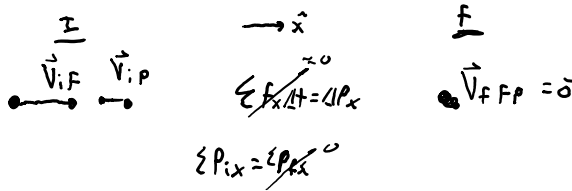
Description: Proportional reasoning in Conservation of Momentum

Learning Objectives: [x]

Problem Statement: A Peregrine Falcon (F), who is twice the mass of one of its prey, collides with a Pidgeon (P) in midair. Right after the collision, and before gravity has time to change their momentum, they are stationary.

(a) Which of the following relationships describes the initial speed of the birds.

- (1) $v_{i,F} = v_{i,P}$
- (2) $v_{i,F} = 2 v_{i,P}$
- (3) $v_{i,F} = 4 v_{i,P}$
- (4) $2 v_{i,F} = v_{i,P}$
- (5) $4 v_{i,F} = v_{i,P}$



$$m_F v_{i,Fx} + m_P v_{i,Px} = 0$$

$$2 m_P v_{i,Fx} + m_P v_{i,Px} = 0$$

$$2 v_{i,Fx} = -v_{i,Px}$$

(b) If falcon's initial speed is tripled, but the outcome is still the same, by what factor must the pigeon's speed change?

- (1) Stay the same
- (2) Double
- (3) Triple
- (4) Times six
- (5) Times nine

$$2 v_{i,Fx} = -v_{i,Px}$$

$$v_{i,Fx} \propto v_{i,Px}$$

DIRECTLY PROPORTIONAL

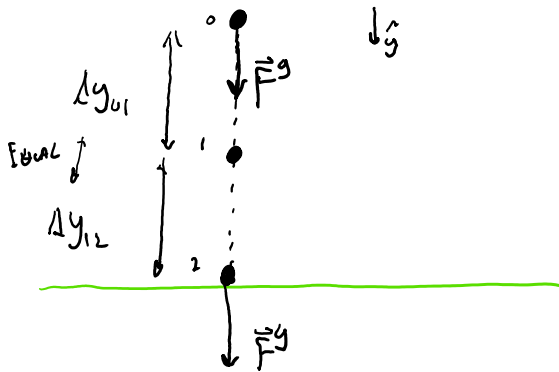
CM.L1.3-07

Description: Momentum change free-fall question.

Learning Objectives: [x]

Problem Statement: Joe throws a ball up into the air. On its way down, which of the following statements are true?

- (1) The ball will gain an equal amount of momentum during the first half, time wise, as it will during the second half.
- (2) The ball will gain more momentum during the first half, time wise, as it will during the second half.
- (3) The ball will gain less momentum during the first half, time wise, as it will during the second half.
- (4) The ball will gain an equal amount of momentum during the first half, distance wise, as it will during the second half.
- (5) The ball will gain more momentum during the first half, distance wise, as it will during the second half.
- (6) The ball will gain less momentum during the first half, distance wise, as it will during the second half.



$$\sum F_y \Delta t = \Delta P_y$$

$$9.8 \Delta t$$

$$\Delta t_{01} > \Delta t_{12}$$

so

$$\sum F_y \Delta t_{01} > \sum F_y \Delta t_{12}$$

thus

$$\Delta P_{y01} > \Delta P_{y12}$$