15 minutes

PART I: LAB QUESTION (5 points towards the lab grade)
Select the correct statement below.

A. Impulse and momentum are different physical quantities, and they have different dimensions or units.

B. Impulse and momentum are different physical quantities, but they have the same dimensions or units.

C. Impulse and momentum are the same physical quantity, but they have different dimensions or units.

D. Impulse and momentum are the same physical quantity, and they have the same dimensions or units.

A. Multiple choice.

1. While we catch a baseball, we catch it at the front of the baseball glove and make the hands ride with ball backward several tenths of a meter before bringing the ball to a complete stop. Why is this? (circle one, 3 points)

A. To reduce impulse.  \[ I = \Delta P \text{ regardless of time taken} \]

\[ \text{B. To increase the time of contact between the ball and glove during the ball's deceleration to zero velocity.} \]

2. It is possible to receive a smaller impulse from large force then from a small force? (circle one, 3 points)

A. True.  \[ I = F \text{ at} \]

B. False.  \[ \text{can get a smaller impulse from larger force with much smaller duration.} \]

3. An empty 2000 kg truck has its center of mass (CM) 2.50 m behind the front of the truck. A crate of mass 500 kg is placed in the truck 3.00 m behind the front of the truck. How far behind the front of the truck is the CM for the truck and crate together? (circle one, 4 points)

A. 2.90 m  B. 2.75 m  C. 2.60 m  D. 2.55 m

\[ X_{CM} = \frac{M_1 x_1 + M_2 x_2}{M_1 + M_2} \]

\[ = \frac{(2000 \text{ kg})(2.50 \text{ m}) + (500 \text{ kg})(3.0)}{2000 \text{ kg} + 500 \text{ kg}} \]

\[ = 2.60 \text{ m} \]
B. Show work

4. (10 points total). Show all work in parts (a) and (b) including any equations and units for full or partial credit.

Two bumper cars in an amusement park each have mass 450 kg. Assume Car A has an initial velocity of 2.00 m/s and that Car B is initially stationary (initial velocity 0.00 m/s). Assume the cars are on a frictionless surface and that Car A collides head on with Car B.

(a) Assume that the collision is completely inelastic. What are the speed of Car A and the speed of Car B after the collision? (6 points)

\[ m_A \, v'_A + m_B \, v'_B = (m_A + m_B) \cdot V \]

\[ V = \frac{v'_A}{2} \quad (o.o \; v'_B = 0, \; m_A = m_B = 450 \text{ kg}) \]

\[ v'_A = v'_B = V = \frac{v'_A}{2} = \frac{2 \text{ m/s}}{2} = 1 \text{ m/s} \]

(b) Assume that the collision is completely elastic. What are the speed of Car A and the speed of Car B after the collision? (4 points)

\[ m_A \, v_A + m_B \, v_B = m_A \, v'_A + m_B \, v'_B \Rightarrow v_A = v'_A + v'_B \quad -1 \quad (o.o \; v_B = 0, \; m_A = m_B) \]

\[ \frac{1}{2} m_A v_A^2 + \frac{1}{2} m_B v_B^2 = \frac{1}{2} m_A v'_A^2 + \frac{1}{2} m_B v'_B^2 \Rightarrow v_A^2 = v'_A^2 + v'_B^2 \quad -2 \]

\[ v'_A = (v'_A + v'_B)^2 = v'_A^2 + v'_B^2 \]

\[ v'_A \cdot v'_B = 0. \]

\[ v'_B \neq 0, \text{ unless the car } A \text{ penetrates the car } B \]

\[ v'_A = 0, \; v'_B = v_A = 2 \text{ m/s} \quad (\text{from } 1) \]