

Name: _____

DISC: _____

Score: _____ / 20

Instructions:

- Do your own work.
- Answer the questions below in the space provided.
- Make sure you show all your work and any equations that you use.
- Please place a box around your answers.
- Remember to give the correct units with all numerical answers.

Q1

Q2

Q3

Q4

10

5

5

5

1. You drop a ball from the roof of the John Hancock Center (height at the roof: 344 m). The ball has mass $m = 750 \text{ g}$.

- a. Which kind(s) of energy does the ball have half-way down the building:

Selection (1 pt):

- Potential Energy ($U = mgh$).
- Kinetic Energy ($K = \frac{1}{2}mv^2$)
- Neither
- Both

- b. Calculate the potential energy of the ball at the roof of the building.

Potential Energy (3 pts):

- c. Find the velocity of the ball at the height of 172 m. Ignore air resistance. (Hint: $E_{Total} = U + K$, and E_{Total} is conserved)

Velocity (3 pts):

- d. Does the gravitational force do work ($W = F d \cos \theta$) on the ball? Explain your answer.

Answer (3 pts):

2. Impulse changes momentum ($\vec{I} = \Delta\vec{p} = \vec{F}\Delta t$), so momentum and force are related. You throw a ball of mass $m = 750\text{ g}$ straight at the wall of your dorm room. The ball travels with $\vec{v}_i = 3\text{ m/s}$ before hitting the wall.

- a. The ball bounces straight off the wall with velocity $\vec{v}_f = -\vec{v}_i$. Calculate the change in momentum, $\Delta\vec{p} = m(\vec{v}_f - \vec{v}_i)$. Make sure to include a correct *sign*.

Answer (3 pts):

- b. If the ball interacts with the wall for 0.02 s , what is the average magnitude of the force experienced by the ball during the collision?

Answer (2 pts):

3. A block of mass 15 kg slides along a frictionless floor with velocity $\vec{v}_M = 2.5\text{ m/s}$ along the x-direction. It suddenly explodes breaking into two pieces: piece 1, $m_1 = 5\text{ kg}$ and piece 2, $m_2 = 10\text{ kg}$. The pieces still travel along the x-direction on the floor.

- a. Which of the following physical quantities is conserved:

- i. Momentum
- ii. Kinetic energy

Selection (1 pt):

- b. If the velocity of piece 1 after the explosion $\vec{v}_1 = 3.5\text{ m/s}$, what is v_2 , the *velocity* of piece 2 after the explosion?

Answer (2 pts):

- c. Which piece has the *larger* kinetic energy:

- i. Piece 1
- ii. Piece 2
- iii. Both have the same kinetic energy.

Solution (2 pts):