

## MOMENTUM DAY 7: REVIEW

### Warm-Up (3 min): Formula Match

Match each quantity with the best equation: momentum, impulse, conservation.

A)  $m\Delta v$  B)  $mv$  C)  $\sum p_i = \sum p_f$

Momentum: \_\_\_\_\_ Impulse: \_\_\_\_\_ Conservation: \_\_\_\_\_

### WHAT YOU MUST BE ABLE TO DO

#### Impulse + graphs

- Find impulse as area under F-t
- Use  $J = \Delta p = m\Delta v$
- Explain padding (increase  $\Delta t$ , lower force)

#### Momentum conservation

- Choose a system + justify isolation
- Solve 1D inelastic collisions
- Solve 2D collisions using x/y components

### CORE EQUATIONS

$$\vec{p} = m\vec{v} \quad | \quad \vec{J} = \int \vec{F} dt = \Delta\vec{p} \quad | \quad \sum \vec{p}_i = \sum \vec{p}_f$$

In 2D: write separate equations for x and y components.

**Top mistakes:** (1) dropping +/- signs, (2) using momentum conservation for a non-isolated system, (3) confusing impulse with force, (4) forgetting vectors in 2D.

### QUICK CHECK (NO CALCULATOR)

#### QC1 Bouncing vs Stopping

A 0.20 kg ball hits a wall at 10 m/s and sticks. Then a second identical ball hits at 10 m/s and bounces straight back at 10 m/s.

Which ball experiences the larger impulse? \_\_\_\_\_ By what factor? \_\_\_\_\_

## MIXED PRACTICE (1D + IMPULSE)

### 1 Impulse from an F-t Graph (Triangle)

A force increases linearly from 0 N to 120 N over 0.20 s and then returns to 0 N at 0.40 s (a symmetric triangle).

- Find the impulse (area under the curve).
- If the object has mass 2.0 kg and starts at rest, find its final speed.

### 2 Perfectly Inelastic Collision

A 3.0 kg cart moving at +4.0 m/s collides with a 1.0 kg cart moving at -2.0 m/s. They stick.

- Find  $p_{\text{before}}$ .
- Find the final velocity  $v_f$  (include sign).

### 3 System Boundaries

A student drops a ball that hits the floor and bounces.

- Is momentum conserved for the system "ball only" during the bounce? Explain.
- Is momentum conserved for the system "ball + Earth" during the bounce? Explain.

## MIXED PRACTICE (2D MOMENTUM)

### 4 2D Inelastic Collision

Object A has momentum  $9 \text{ kg}\cdot\text{m/s}$  east. Object B has momentum  $12 \text{ kg}\cdot\text{m/s}$  north. They stick together.

- Find the magnitude of the total momentum after they stick.
- Find the direction (angle above east).

### 5 2D Collision with Numbers

A  $0.60 \text{ kg}$  puck moves east at  $5.0 \text{ m/s}$ . A  $0.80 \text{ kg}$  puck moves north at  $2.5 \text{ m/s}$ . They collide and stick.

- Find the final speed of the combined mass.
- Find the direction (angle above east).

**Speed check:** If objects stick, the final speed should be less than the largest initial speed.

**FRQ** Crash + Impulse Explanation

A 1200 kg car traveling east at 14 m/s crashes into a barrier and comes to rest.

- Find the impulse on the car during the crash.
- If the crash lasts 0.10 s, find the average force on the car.
- If a crumple zone increases the crash time to 0.30 s (same  $\Delta p$ ), what happens to the average force? Explain.
- State a reasonable system to discuss momentum conservation during the crash and explain whether momentum is conserved for that system.

**Final reminder before Day 8 test:** Momentum can be conserved even when kinetic energy is not. Always check the system and the time interval.