MOMENTUM DAY 9: 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 Δt, 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).

a. Find the impulse (area under the curve).

b. 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.

a. Find p_{before}.

b. Find the final velocity v_f (include sign).

3 System Boundaries

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

a. Is momentum conserved for the system "ball only" during the bounce? Explain.

b. 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 kg·m/s east. Object B has momentum 12 kg·m/s north. They stick together.

a. Find the magnitude of the total momentum after they stick.

b. Find the direction (angle above east).

5 2D Collision with Numbers

A 0.60 kg puck moves east at 5.0 m/s. A 0.80 kg puck moves north at 2.5 m/s. They collide and stick.

a. Find the final speed of the combined mass.

b. Find the direction (angle above east).

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

MINI-FRQ (SYNTHESIS)

FRQ Crash + Impulse Explanation

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

a. Find the impulse on the car during the crash.

b. If the crash lasts 0.10 s, find the average force on the car.

c. If a crumple zone increases the crash time to 0.30 s (same Δp), what happens to the average force? Explain.

d. State a reasonable system to discuss momentum conservation during the crash and explain whether momentum is conserved for that system.

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