30-Minute Lesson Plan — Momentum (Grade 6, Physics)

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Lesson Overview

- Grade: 6
- Topic/Subtopic: Momentum (momentum = mass × velocity; qualitative conservation in collisions)
- Time: 30 minutes
- Approach: Classical (I-do / We-do / You-do — explicit instruction, modeling, guided practice, independent practice, reflection)
- Materials (low): 2 small balls of similar size but different mass (or one ball and one beanbag), meter stick or tape, stopwatch (or phone timer), whiteboard and marker, paper and pencil.
- Standards (jurisdiction CA; aligned to NGSS MS-PS2 concepts): Understand relationships among mass, speed, and motion; analyze interactions (collisions) qualitatively and compute momentum in simple cases.

Learning Objectives (measurable)

Students will be able to:

1. Define momentum as the product of mass and velocity and state its units (kg·m/s).
   Success criteria: Accurately state formula p = m × v and give units in 2/2 verbal responses.
2. Calculate momentum for a one-dimensional moving object given mass and velocity.
   Success criteria: Solve 3 calculation problems with correct numeric value and units for at least 2/3 problems.
3. Predict and justify, qualitatively, how changing mass or velocity affects momentum in simple collisions (apply conservation idea qualitatively).
   Success criteria: Correctly justify predictions in 2/3 collision scenarios using mass and velocity language.

Time Breakdown

- Hook & Set purpose: 3 minutes
- I-do (direct instruction + demonstration): 7 minutes
- We-do (guided practice + pulse check #1): 8 minutes
- You-do (independent practice + pulse check #2): 8 minutes
- Closure & metacognition reflection + pulse check #3: 4 minutes

Detailed Lesson Flow

Hook / Set Purpose (3 minutes)

- Teacher holds two objects: a light ball (beanbag) and a heavier ball. Ask: "Which one will be harder to stop when rolled at the same speed?" Solicit a quick pair of ideas (brief, teacher-led).
- State learning goals: define momentum, calculate it, and predict collision outcomes using mass and velocity.

I-do — Teacher Modeling (7 minutes)

- Explicit instruction (scripted steps):

  1. Write formula on board: p = m × v. Explain p stands for momentum.
  2. Define terms: mass (m) in kilograms, velocity (v) in meters per second, momentum units kg·m/s.
  3. Demonstration: roll the light object and the heavier object at the same speed across the floor (or simulate by describing if physical demo not possible). Observe which is harder to stop.
  4. Model calculation: Example 1 — mass = 0.5 kg, velocity = 2 m/s -> p = 0.5 × 2 = 1.0 kg·m/s. Show units and verbalize meaning: "This object has momentum of 1.0 kg·m/s in the forward direction."
  5. Model effect of doubling mass and doubling velocity separately: show how p changes proportionally.
  6. Present a simple collision idea qualitatively: when two objects collide on a friction-low surface, total momentum before ≈ total momentum after (introduce conservation qualitatively, not rigorous proof). Use teacher language: "If a light ball hits a heavy stationary ball, the heavy ball will move more slowly than the light ball would if the masses were equal; momentum distributes according to mass and velocity."

- Annotation: Circle units, underline multiplication, and annotate direction arrow on the board.

We-do — Guided Practice and Pulse Check #1 (8 minutes)

- Co-construct a worked example together:
  1. Problem: A 1.0 kg toy car moves right at 3.0 m/s. What is its momentum? (Teacher prompts steps; students answer aloud or write.)
     - Expected: p = 1.0 × 3.0 = 3.0 kg·m/s to the right.
  2. Problem: A 2.0 kg object moves left at 1.5 m/s. What is its momentum (include direction)? (Guide students through sign convention.)
     - Expected: p = 2.0 × (−1.5) = −3.0 kg·m/s (or 3.0 kg·m/s to the left).

- Pulse Check #1 (conceptual and calculation) — 2 minutes:

- Task: Students answer both parts below on paper or whiteboard within 90 seconds.
  1. Define momentum in one sentence including units.
  2. Calculate momentum for a 0.75 kg ball rolling at 4 m/s to the right.

- Success criteria:
  - Part 1: Correct formula p = m × v and correct units (kg·m/s) written (1/1).
  - Part 2: Numeric answer 3.0 kg·m/s to the right (1/1).

- Teacher quickly scans responses; provide brief corrective feedback.

You-do — Independent Practice and Pulse Check #2 (8 minutes)

- Independent problems (students work individually; teacher circulates to monitor and prompt with Socratic questions):
  1. A 0.4 kg ball moves at 5 m/s to the right. Calculate momentum.
  2. A 1.5 kg object moves at 2 m/s to the left. Calculate momentum (include direction).
  3. Without calculation: Which has greater momentum — a 2 kg cart at 1 m/s or a 1 kg cart at 3 m/s? Explain in one sentence.

- Pulse Check #2 (application/prediction) — immediately after independent items:
  - Task: Students show their answers for the three items to the teacher (paper up or verbal).
  - Success criteria:
    - Item 1 & 2: Correct numeric answer and units including direction in at least 2/2.
    - Item 3: Correct explanation that 1 kg at 3 m/s has momentum 3 kg·m/s vs 2 kg at 1 m/s has 2 kg·m/s, so the 1 kg cart has greater momentum, with correct numeric comparison (1/1).

- Teacher records common errors for the closure.

Closure & Metacognition Reflection (4 minutes)

- Closure: Teacher restates key points: p = m × v, units, direction, and qualitative idea of momentum distribution in collisions.
- Pulse Check #3 (metacognitive & transfer) — 2 minutes:
  - Prompt (written short reflection): "Describe one real-world example you saw today, at home, or in sports where momentum matters. Explain in 2–3 sentences how mass and speed determine the outcome."
  - Success criteria:
    - Student names a real-world example and explicitly links how mass and/or speed affects

momentum (mentions mass or speed and the resulting effect) in 2–3 coherent sentences.

- Collect reflections or read a few aloud (teacher-led).

Assessment: 10 Quiz-Style Checkpoints (quick checks with success criteria)

Use these as exit ticket items or a short quiz. Each item includes explicit success criteria.

1. Define momentum in one sentence and give its units.
   Success: Correct formula p = m × v and units kg·m/s written.

2. Calculate momentum: m = 0.5 kg, v = 4 m/s to the right.
   Success: p = 2.0 kg·m/s to the right (numeric and units).

3. Calculate momentum: m = 2 kg, v = 0.75 m/s to the left.
   Success: p = 1.5 kg·m/s to the left (or −1.5 kg·m/s).

4. Identify direction: A momentum written as −6 kg·m/s; what does the negative sign mean?
   Success: Student explains negative indicates motion in the opposite (left) direction relative to the chosen positive direction.

5. Compare: Which has greater momentum — 3 kg at 1 m/s or 1 kg at 3 m/s? Show quick work.
   Success: Correct comparison with numbers (3 kg·m/s vs 3 kg·m/s) and statement whether equal or which is greater.

6. Predict: A small ball (mass small) at high speed hits a large stationary ball. Which is more likely to move more after collision? Provide qualitative justification using momentum.
   Success: Student predicts the small ball will slow dramatically while the large ball moves slowly; explanation uses mass and momentum distribution language.

7. Unit conversion/basic: Convert 500 g to kilograms, then find momentum if velocity = 2 m/s.
   Success: 500 g -> 0.5 kg; momentum 1.0 kg·m/s with units.

8. Sign use: If right is positive, a 2 kg object moving left at 2 m/s has what momentum notation?
   Success: p = −4 kg·m/s or 4 kg·m/s to the left.

9. Quick reasoning: If you double the velocity of an object while mass stays constant, what happens to momentum?
   Success: Momentum doubles; student states proportional relationship p ∝ v.

10. Conservation idea (qualitative): Two identical carts collide; one moving, one stationary. After the collision, the moving cart stops and the other moves forward. Explain this observation

using momentum language.
Success: Student states total momentum before equals total momentum after; momentum transferred from first cart to second (qualitative, no numeric proof required).

Grading note: Students meeting success criteria on 8/10 items demonstrates strong mastery; 6–7/10 indicates partial mastery requiring targeted re-teach.

Differentiation and Supports

- For learners needing support:
  - Provide mass and velocity values with units pre-converted.
  - Use physical objects to demonstrate instead of abstract numbers.
  - Offer step-by-step calculation frames (line for m × v, line for units).

- For advanced learners:
  - Ask to compute a two-step problem combining unit conversion and momentum computation.
  - Pose a conceptual extension: discuss momentum conservation in a two-object elastic collision qualitatively.

Teacher Notes and Safety

- Keep demonstrations low-speed to avoid projectiles. Use soft objects and a flat floor.
- Emphasize units and direction every time.
- Monitor for confusion between mass and weight; remind students mass is amount of matter (kg).
- Time management: Limit guided discussion to prompts; use quick scans during pulse checks.

Metacognition Prompts (embedded)

- Short reflection (Closure pulse check): "Describe one real-world example you saw today, at home, or in sports where momentum matters. Explain in 2–3 sentences how mass and speed determine the outcome."
  Success criteria: Example named and connection to mass/speed stated in 2–3 sentences.
- End-of-class written prompt for homework: "How does understanding momentum help explain why heavier vehicles take longer to stop than lighter ones at the same speed? Write 3–4 sentences."
  Success criteria: Mentions mass, speed, momentum magnitude, and links to stopping difficulty.
- Optional extension reflection (for higher mastery): "Give two everyday safety measures that use ideas of momentum (e.g., seatbelts, helmets) and explain how they reduce harm in terms of

momentum change or distribution."
Success criteria: Names two measures and explains reduction of momentum change effect or distribution in 2–3 sentences each.

Materials Checklist (low)

- Two small objects of different masses (balls, beanbags, toy cars)
- Meter stick or tape measure
- Stopwatch or timer
- Whiteboard/marker and paper/pencil

Exit Ticket / Quick Record

- Collect either:
  - Pulse Check #3 written reflections, or
  - The 10-item quiz (select a subset if short time) with scoring against success criteria.