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WORKSHEETS
ATTEMPT | CHECK | CORRECT | IMPROVE

Newton’s laws momentum and impulse worksheet

AQA AS 7407 and first-year A Level 7408 | OCR A AS H156 and A Level H556

35–40 minutes independent practice + 15–20 minutes review | 40 marks

Specification points covered

- AQA 7407 / 7408: 3.4.1.5 Newton’s laws; 3.4.1.6 momentum change and force–time area; 3.4.1.3 selected constant-acceleration distance reasoning.
- OCR A H156 / H556: 3.5.1(a)–(e) laws, momentum, resultant force and impulse; 3.1.1(a) selected speed and distance reasoning.

HarbourLine tests a 600 kg loaded cargo tug and trailer on a straight level port lane. Take rightwards as positive. The operating tests are separate; the towbar is rigid and has negligible mass. Use the stated resultant forces and distinguish mutual interaction forces from forces balanced on one system.

1. Newton's laws - precise statements [4 marks]

Use complete statements about the resultant force and the interacting objects.

(a) State Newton's first law of motion. [1 mark]

(b) State Newton's second law of motion. [1 mark]

(c) State Newton's third law of motion. [2 marks]

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2. Momentum is a vector [5 marks]

Take motion to the right as positive throughout this question. The total mass of the loaded tug and trailer is 600 kg.

(a) Write the equation that defines linear momentum and state its SI unit. [1 mark]

(b) Calculate the momentum when the vehicle travels at +5.0 m s^{-1}. [1 mark]

(c) During a reversing test, the vehicle travels at -1.20 m s^{-1}. Calculate its momentum. [1 mark]

(d) Calculate the change in momentum from the motion in part (b) to the motion in part (c). Include the sign. [2 marks]

3. Resultant force and acceleration [6 marks]

The loaded tug and trailer have total mass 600 kg. During the first test, the driving force is 1.62 kN to the right and the total resistive force is 420 N to the left.

(a) Calculate the net (resultant) force on the vehicle. [1 mark]

(b) Calculate the acceleration of the vehicle. [1 mark]

(c) Later, the vehicle moves at constant velocity while the resistive force is 900 N to the left. Determine the driving force and explain your answer using Newton's first law. [2 marks]

(d) The trailer is disconnected, so the moving mass becomes 390 kg. In a calibration run the same 1.20 kN net force acts. Calculate the new acceleration and explain why it is greater than in part (b). [2 marks]

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4. Why F = ma is a special case [3 marks]

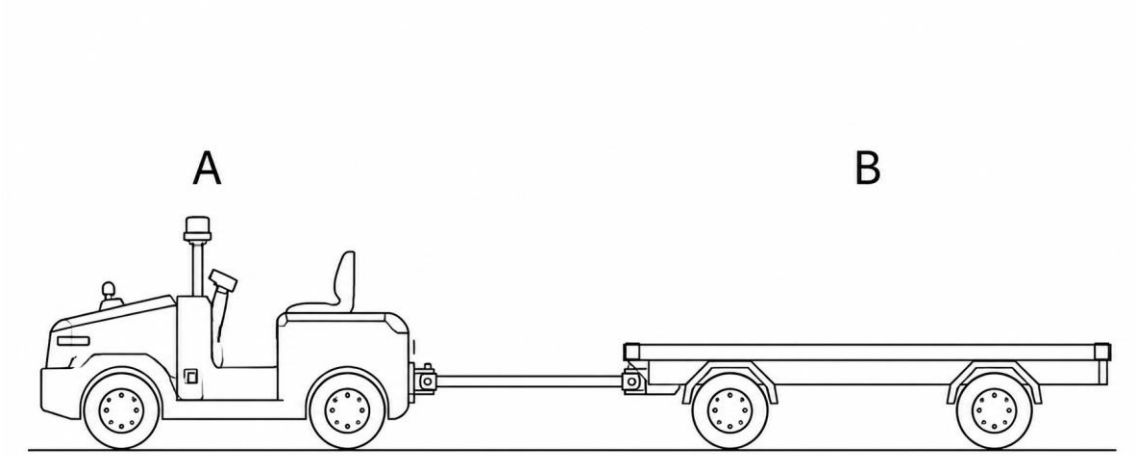
Use the general momentum form of Newton's second law.

(a) Starting with p = mv and F = Δp / Δt, show that F = ma for an object of constant mass. [2 marks]

(b) A technician substitutes the 1.62 kN driving force into F = ma for Question 3(b). Explain why this is wrong. [1 mark]

5. Newton's third law at the towbar [5 marks]

During a separate manoeuvre, tug A pushes trailer B through a rigid, negligible-mass towbar. The towbar exerts a horizontal force of 820 N on B to the right.



(a) State the magnitude, direction and type of the force that B exerts on A. [2 marks]

(b) Explain why the two towbar forces do not cancel when calculating the acceleration of trailer B alone. [1 mark]

(c) At constant velocity, the driving force and total resistance on the complete vehicle are equal and opposite. Give two reasons why these forces are not a Newton's third-law pair. [2 marks]

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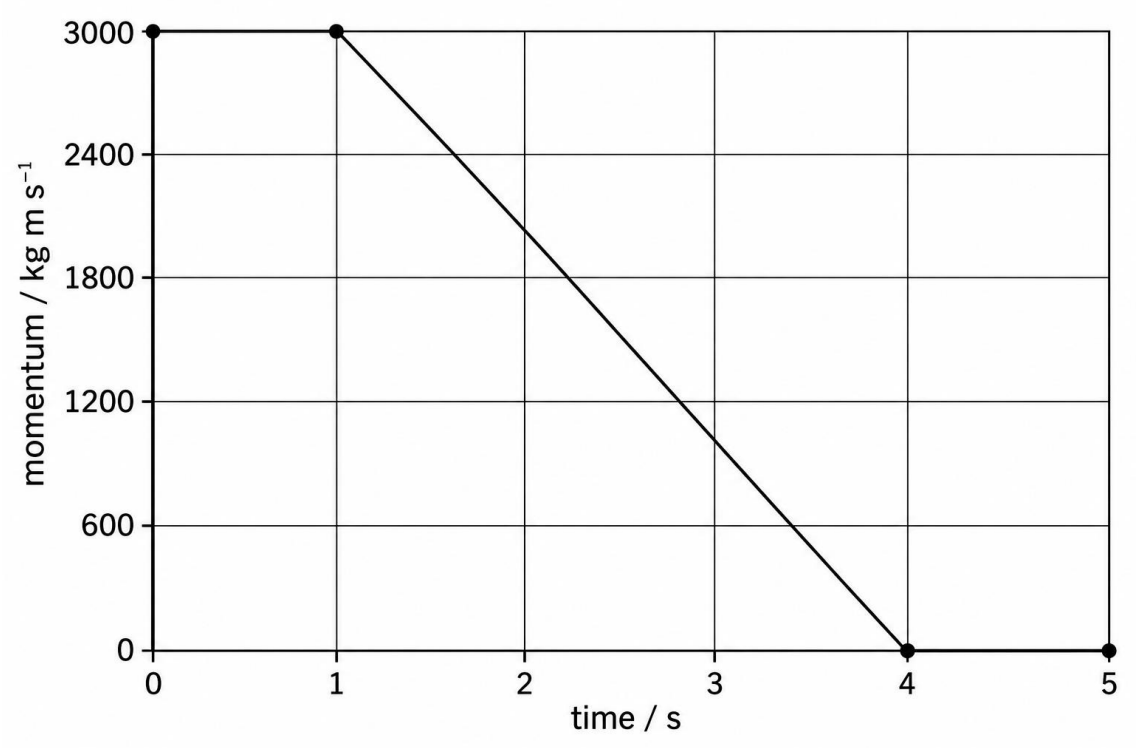
6. Reading a momentum-time graph [7 marks]

The 600 kg loaded vehicle moves to the right. The graph shows its momentum during a controlled braking test.



(a) Determine the net force from t = 0 to t = 1.0 s. [1 mark]

(b) Determine the magnitude and direction of the net force from t = 1.0 s to t = 4.0 s. [2 marks]

(c) Calculate the speed at t = 1.0 s and at t = 4.0 s. [2 marks]

(d) Calculate the distance travelled between t = 1.0 s and t = 4.0 s. [2 marks]

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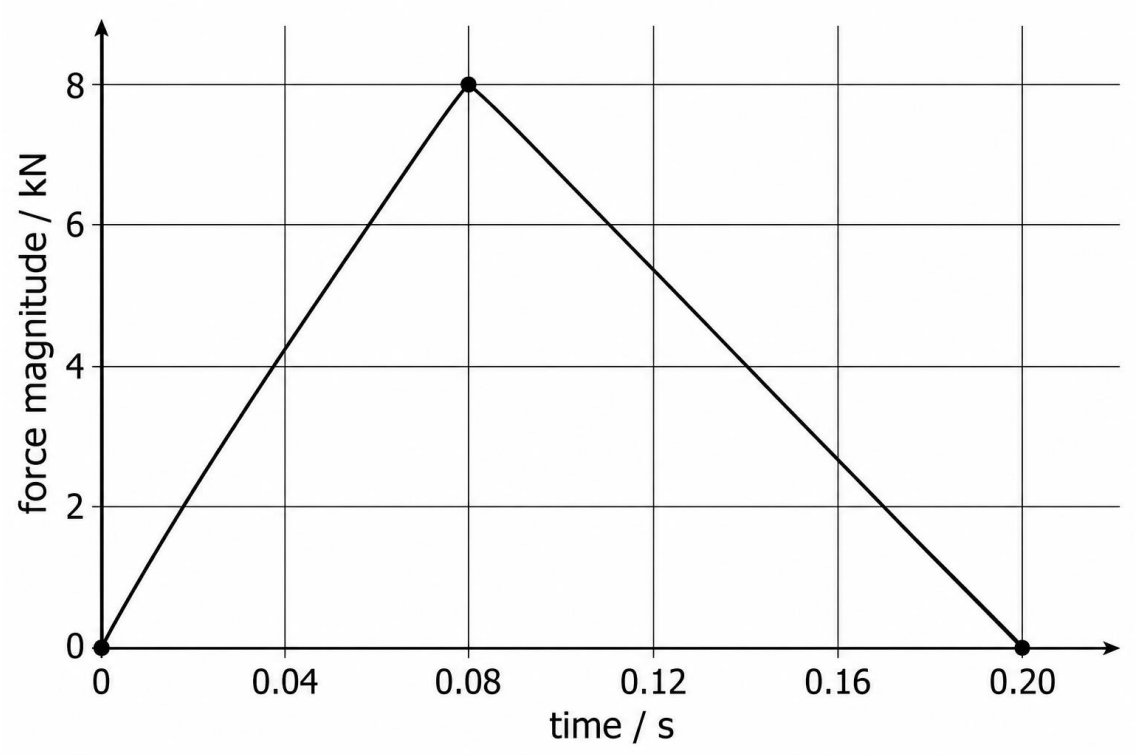
7. Impulse from the pneumatic buffer [6 marks]

The 600 kg vehicle reaches the end-of-lane buffer with momentum +600 kg m s^{-1}. The graph shows the magnitude of the buffer force on the vehicle. This force acts to the left throughout the contact. All other horizontal impulses during contact are negligible. This is a separate test from the braking run.



(a) Use the graph to determine the magnitude of the impulse exerted by the buffer. [2 marks]

(b) Calculate the final momentum of the vehicle, including its sign. [2 marks]

(c) Calculate the velocity after contact and state its direction. [2 marks]

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8. Correct the physics language [4 marks]

For each pupil statement, write one precise correction.

(a) "The momentum is accelerating while the brakes act." [1 mark]

(b) "At constant velocity, no forces act on the vehicle." [1 mark]

(c) "The 1.62 kN driving force in Question 3 is the force used in F = ma." [1 mark]

(d) "A Newton's third-law pair cancels because its forces are equal and opposite." [1 mark]

Review: name the body, choose a direction, identify the resultant, then use the relevant graph gradient or signed impulse. Third-law forces act on different objects.

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