1.3 Momentum and moments (P)

Name: _____ Class: _____ Date: _____ **Total: 23 marks**

Objective

Build the skills to answer exam questions on **momentum and moments** : momentum $p = mv$, conservation of momentum in collisions, force as the rate of change of momentum, safety features, Newton's third law, and moments.

You must be able to:

- calculate momentum and use conservation of momentum
- calculate force from the change in momentum and the time taken
- explain how safety features reduce the force in a collision
- plan an experiment to test conservation of momentum

1 Key knowledge and worked examples

Momentum

idea	equation or rule
momentum	$p = m \times v$ (unit kg m/s)
conservation of momentum	total momentum before = total momentum after, if no external force acts
force and momentum	$F = (mv - mu) \div t$: force = change in momentum ÷ time
Newton's third law	when A pushes on B, B pushes back on A with an equal and opposite force
moment	force × perpendicular distance from the pivot (unit N m); balanced when clockwise moments = anticlockwise moments

Worked example 1: momentum. Find the momentum of a 0.15 kg ball moving at 20 m/s.

1. Known: $m = 0.15$ kg; $v = 20$ m/s.
2. Rule: $p = mv$.
3. Numbers: 0.15×20.
4. Result: 3.0 **kg m/s**.

Worked example 2: force. A 60 kg person slows from 15 m/s to rest in 0.20 s. Find the force.

1. Known: change in momentum $60 \times 15 = 900$ kg m/s; $t = 0.20$ s.
2. Rule: F = change in momentum $\div t$.
3. Numbers: $900 \div 0.20$.
4. Result: 4500 **N**.

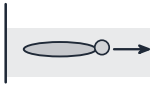
Answer shapes: take one direction as positive; a velocity the other way is negative.

2 Practice

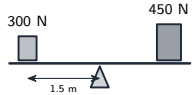
2.1 Calculate the momentum of a 1500 kg car moving at 12 m/s. [2]



2.2 State Newton's third law, and give an example. [2]

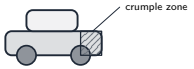


2.3 A child of weight 300 N sits 1.5 m from the pivot of a see-saw. Calculate the distance from the pivot at which a 450 N adult must sit to balance it. [2]



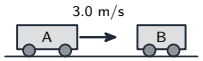
3 Exam-style questions

3.1 Explain how the crumple zone of a car reduces the force on the passengers in a crash. [3]



3.2 Trolley A (2.0 kg) moves at 3.0 m/s and hits trolley B (1.0 kg), which is at rest. The trolleys stick together and move off together.

(a) Calculate the momentum of trolley A before the collision. [2]



(b) Calculate the velocity of the two trolleys after the collision. [3]

(c) The collision lasts 0.10 s. Calculate the force on trolley B. [3]

(d) Describe how to use trolleys and light gates to test whether momentum is conserved in this collision. [6]

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