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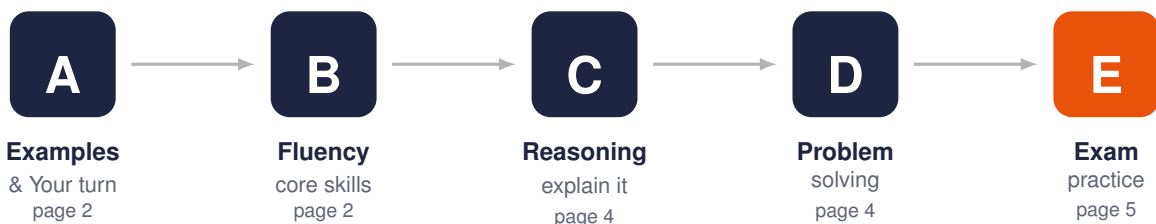
A-LEVEL MATHEMATICS • MECHANICS 1

Momentum and Impulse

Worked Solutions

Pearson Edexcel International A Level (WME01) & A Level (9MA0) • Calculator and statistical tables allowed: take $g = 9.8 \text{ m s}^{-2}$ and give answers to 2 or 3 s.f.

Full worked solutions for the free Momentum and Impulse worksheet, A-Level and International A-Level Maths



Tap a section to jump straight to it

Full worked solutions for every question on the Mechanics 1 Momentum and Impulse worksheet, in the same order and with the same question numbers.

How to mark your work. Tick each step you got right, not just the final answer. At A-level most marks are for method, so a wrong final answer can still earn most of the marks. If you lost marks, find the *first* line where your working is different from ours. That is the thing to fix.

In Section E: **M** = method mark, **dM** = method mark that depends on the previous M mark, **A** = accuracy mark (needs the M mark before it), **B** = independent mark.

Question sheet

Exam questions by topic

Mechanics 1 exam questions

More worksheets



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A**Your turn answers**

Compare each line of your working with the solution.

CORE

A1 $0.25(18)$: 4.5Ns

A2 $0.5(6) - 0.5(2)$: 2Ns

A3 $0.2(4 - (-10))$: 2.8Ns

STRETCH

A4 $3(5) = 5v$: 3ms^{-1}

A5 $12 - 6 = 4v + 2$: 1ms^{-1} right

A6 $I = 25(0.2) = 5$; $5 = 0.4v$: 12.5ms^{-1}

A7 $3(0.8) = 1.2v$: 2ms^{-1}

B**Fluency solutions**

One mark for each correct part. The notes in *italics* explain why each sequence was chosen.

CORE

B1 (a) 3Ns (b) $0.6(9 - 5)$: 2.4Ns (c) $0.6(4 + 5)$: 5.4Ns (d) $\frac{5.4}{0.02}$: 270N

A reversal adds the two speeds.

B2 (a) 30Ns (b) $\frac{30}{6}$: 5ms^{-1} (c) $16 + 2v = 30$: 7ms^{-1} (d) $2(7 - 3)$: 8Ns

The impulse on B equals the momentum A loses.



- B3** (a) $12 - 10$: 2Ns right (b) $\frac{2}{5}$: $0.4\text{ms}^{-1}\text{ right}$ (c) $2 = -6 + 2v$: $4\text{ms}^{-1}\text{ right}$ (d) $3(4 + 2)$: 18Ns

Choose right as positive before writing anything.

- B4** (a) $0.15(30 + 20)$: 7.5Ns (b) 1500N (c) 7.5Ns, opposite (d) $0.15(40)$: 6Ns

$I = Ft$ gives the average force.

CORE

- B5** (a) $60(2.5) = 80v$: 1.875ms^{-1} (b) 150Ns (c) 0

From rest, the total momentum stays zero.

- B6** (a) $2(6 - 2)$: 8Ns (b) $4m = 8$: $m = 2$ (c) 8Ns (d) $\frac{12}{2}$: 6ms^{-1}

The momentum P loses is the momentum Q gains.

STRETCH

- B7** (a) $4mu - 2mu = -mu + 2mv$: $1.5u$ in P 's original direction (b) $m(4u + u)$: $5mu$
(c) $5mu$ (d) **yes, it reverses**

Equal and opposite impulses: (c) needs no new working.

- B8** (a) $10 = 2v + 4w$: $w = \frac{10 - 2v}{4}$ (b) 2.5 (c) $v < 0$ gives $10 - 2v > 10$: $w > 2.5$ (d) $\frac{10 - 2v}{4} \geq v$:
 $v \leq \frac{5}{3}$

P cannot pass through Q , so $w \geq v$

- B9** (a) $\frac{2}{2}$: 1ms^{-1} (b) $0.1(2g)$: 1.96N (c) 0.98ms^{-2} (d) $\frac{1}{1.96}$: 0.510m

The collision sets the starting speed for the slide.

- B10** (a) $\sqrt{2g(1.25)}$: 4.95ms^{-1} (b) $\sqrt{2g(0.8)}$: 3.96ms^{-1} (c) $0.1(4.95 + 3.96)$: 0.891Ns (d) 0.495Ns

A rebound needs a bigger impulse than simply stopping.



C**Reasoning solutions**

Your wording can be different. Check that your reason makes the same point.

CORE

- C1** A speed is a magnitude: 2ms^{-1} ; the minus sign only means it moves in the negative direction.
- C2** Impulse is change in momentum, with no g : $0.5(6 - 2) = 2\text{Ns}$
- C3** They move in opposite directions, so one momentum is negative: $8 - 6 = 5v$: 0.4ms^{-1} in A's direction
- C4** A taut inextensible string keeps the particles a fixed distance apart, so they move with a common speed in the same direction.

STRETCH

- C5** In the same direction the speeds are subtracted: $2(7 - 3) = 8\text{Ns}$
- C6** By Newton's third law the forces are equal and opposite for the same time, so the impulses are equal in size; only the velocity changes differ.
- C7** The wall exerts an external impulse on the ball, so the ball's momentum is not conserved.
- C8** (a) B pushes on A with $-F$ for the same time: impulses Ft and $-Ft$: equal and opposite
 (b) $m_A v_A - m_A u_A = -(m_B v_B - m_B u_B)$, so $m_A u_A + m_B u_B = m_A v_A + m_B v_B$

D**Problem solving solutions**

There is often more than one correct method. Any complete, correct method scores full marks.

CORE

- D1** (a) Right positive: $2m(3u) - m(2u) = 2m(-u) + mv$: $6u$
 (b) $2m(3u + u)$: $8mu$



D2 (a) $2m(v - u) = 3mu$: $2.5u$

(b) $km(4u - 2u) = 3mu$: $k = 1.5$

D3 $60(1.5) = 45v$: 2 ms^{-1} ; impulse $60(1.5)$: 90 N s on each

D4 (a) $0.02(400) = 2v$: 4 ms^{-1}

(b) $1.98(4)$: 7.92 N s

STRETCH

D5 (a) Before: $\sqrt{2g(2.5)} = 7$; after: $\sqrt{2g(1.6)} = 5.6$; $0.2(7 + 5.6)$: 2.52 N s

(b) $\frac{2.52}{0.04}$: 63 N

D6 $3 = 0.5u$, so $u = 6$; deceleration $0.05g = 0.49$; $\frac{36}{0.98}$: 36.7 m

D7 (a) $5mu = -mu + 3mv$: $2u$

(b) $m(5u + u)$: $6mu$

D8 (a) $12 - 2v = 5w$; $w > 0$ needs $12 - 2v > 0$: $0 \leq v < 6$

(b) $5w = 12 - 18 = -6$: 1.2 ms^{-1} in Q 's original direction

E

Exam practice solutions

Mark-scheme notes are shown on the right of each line.



CORE

Exam questions for everyone

- E1** (a) $0.05(300) = 3v$ M1
 5ms^{-1} A1
 (b) $2.95(5 - 0)$ M1
 14.75Ns A1
 (c) deceleration $0.4g = 3.92$ M1
 $0 = 25 - 2(3.92)s$ M1
 3.19m A1
 (d) e.g. **the impact is instantaneous, so friction gives no impulse during it** B1

- E2** (a) Right positive (direction of A): $15 - 4 = 3(1) + 2v$ M1 A1
 4ms^{-1} , reversed (now in A's direction) A1
 (b) $3(5 - 1)$ M1
 12Ns A1
 (c) $2(4 + 3)$ M1
 14Ns A1
 (d) **B now moves at 3ms^{-1} towards A, which still moves towards the buffer at 1ms^{-1}** B1 B1

STRETCH

- E3** (a) Horizontal momentum: $400(3) = 500v$ M1
 2.4ms^{-1} A1
 (b) $100(2.4 - 0)$ M1
 240Ns A1
 (c) $0 = 2.4^2 - 2a(12)$, $a = 0.24$ M1 A1
 $500(0.24)$: 120N A1
 (d) $\frac{2.4}{0.24}$: 10s B1
 (e) **The floor of the cart exerts a vertical impulse that stops the sack's downward motion** B1 B1

