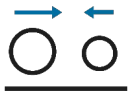
Higher Physics
Momentum and Impulse
Past paper questions and marking instructions



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The questions are in the four parts of the Momentum and Impulse slides. A long question can be split across parts.

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Question	What it covers	Marks	Answers
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Sources and credits

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Part 1: Momentum

2023 Paper 1 Question 3

Higher Physics 2023 Paper 1 (multiple choice), Question 3. Total: 1 mark

3. The momentum of an object of mass 4 kg is 20 kg m s^{-1}.

The kinetic energy of the object is

A 10 J

B 50 J

C 100 J

D 400 J

E 800 J.

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2023 Paper 1 Question 3: marking instructions

Question	Answer	Mark
3.	B	1

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Part 2: Collisions and explosions

2013 Revised Higher Question 6

Higher Physics 2013 Revised Higher, Section A (multiple choice), Question 6. Total: 1 mark

6. A cannon of mass $2{\cdot}0 \times 10^3$ kg fires a cannonball of mass 5·00 kg.

The cannonball leaves the cannon with a speed of $50{\cdot}0\ \text{m s}^{-1}$.

The speed of the cannon immediately after firing is

A $0{\cdot}125\ \text{m s}^{-1}$

B $8{\cdot}00\ \text{m s}^{-1}$

C $39{\cdot}9\ \text{m s}^{-1}$

D $40{\cdot}1\ \text{m s}^{-1}$

E $200\ \text{m s}^{-1}$.

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2013 Revised Higher Question 6: marking instructions

Question			Acceptable Answer/s
6			A

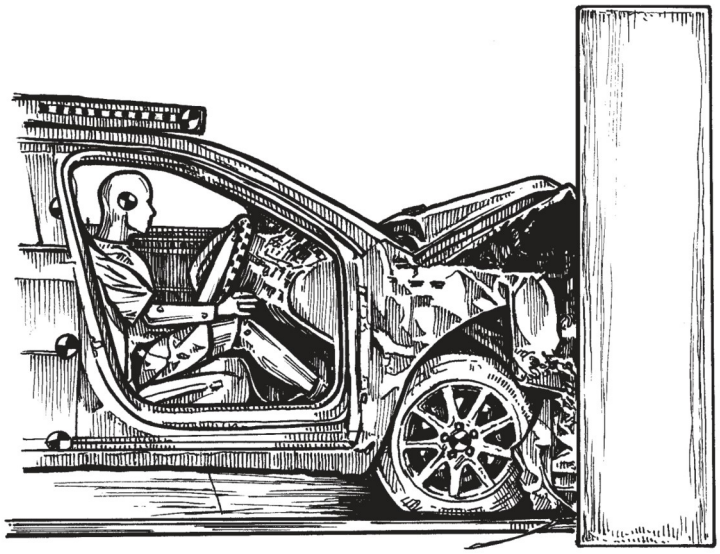
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2013 Revised Higher Question 22 (a)

Higher Physics 2013 Revised Higher, Section B, Question 22 (a). Total: 1 mark

22. The force applied by a seat belt on a crash test dummy is being investigated. The crash test dummy is placed in a car.

The car then travels along a test track at a speed of $13{\cdot}4\ \text{m s}^{-1}$, collides with a wall and comes to rest.



(*a*) State the law of conservation of linear momentum. **1**

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2013 Revised Higher Question 22 (a): marking instructions

Question	Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
22. (a)	total momentum before a collision is equal to total momentum after collision, ½ in the absence of external forces ½	**Must have total and collision or interaction** first ½ needed first "for an isolated/**closed** system"	**1**	**8**

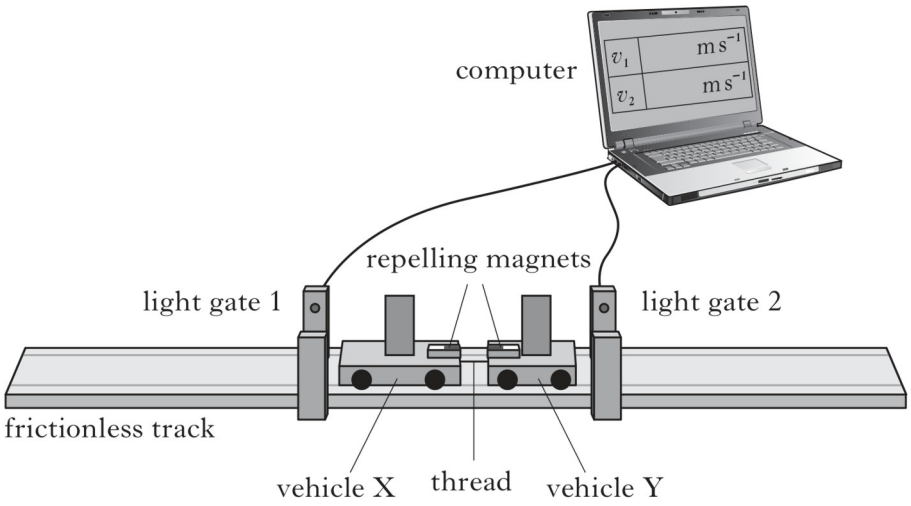
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2014 Revised Higher Question 22

Higher Physics 2014 Revised Higher, Section B, Question 22. Total: 5 marks

22. Interactions between objects can be analysed using the law of conservation of momentum.

(*a*) An experiment is set up to verify that momentum is conserved when two vehicles explode apart.



Initially both vehicles are stationary on the horizontal track and are held together by a thread.

The thread is cut and the force between the magnets pushes the vehicles apart.

The computer then displays the speed of each vehicle as it passes through a light gate.

The following data is recorded:

Mass of vehicle X = 0·70 kg
Mass of vehicle Y = 0·30 kg
Speed of vehicle X through light gate 1 = 0·51 m s^{-1}
Speed of vehicle Y through light gate 2 = 1·19 m s^{-1}

Use this data to show that momentum is conserved in this interaction. **2**

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22. (continued)

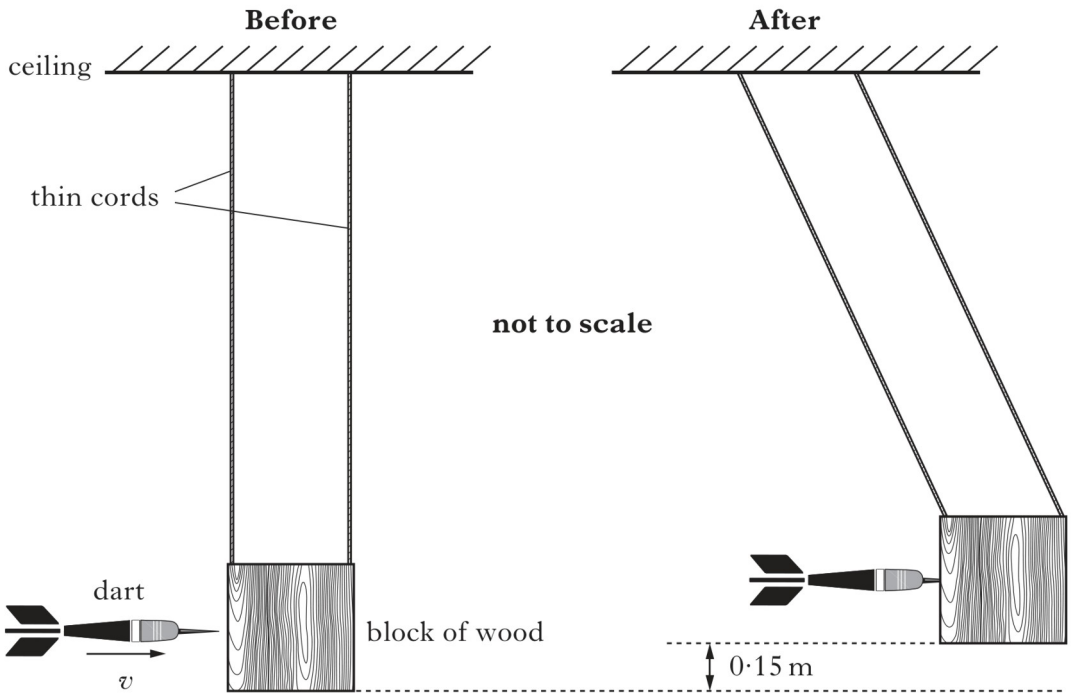
(*b*) In a second experiment, a block of wood of mass 0·20 kg is suspended from the ceiling by thin cords of negligible mass.

A dart of mass 0·050 kg is thrown at the stationary block of wood.

Just before the dart hits the block it is travelling horizontally at a velocity v.

The dart sticks into the block.

The dart and block then swing to a maximum height of 0·15 m as shown.



(i) Use conservation of energy to show that the velocity of the dart and block just after the collision is 1·7 m s^{-1}. **1**

(ii) Calculate the velocity v of the dart just before it hits the block. **2**

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2014 Revised Higher Question 22: marking instructions

Question		Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
22.	**(a)**	Total momentum before $= 0$ (kg m s^{-1}) **(½)** Total momentum after $= m_X v_X + m_Y v_Y$ **(½)** $= (0{\cdot}70 \times 0{\cdot}51) + (0{\cdot}30 \times -1{\cdot}19)$ **(½)** $= 0$ (kg m s^{-1}) **(½)** (same answers)	units are not required here, but deduct **(½)** if wrong units given. **not** $m_X v_X - m_Y v_Y$ If $m_X v_X$ and $m_Y v_Y$ are worked out separately, marks are only awarded if one is <u>negative</u> and they are <u>combined</u>.	**2**	**5**
	(b) (i)	$½mv^2 = mgh$ **(½)** $½ \times 0{\cdot}2 \times v^2 = 0{\cdot}2 \times 9{\cdot}8 \times 0{\cdot}15$ **(½)** $v = 1{\cdot}7$ (m s^{-1}) **[MUST BE SHOWN]**	Must have both formulas somewhere to get first **(½)**, otherwise **(0)**. Unit not required here, but deduct **(½)** if wrong unit given.	**1**	
	(ii)	<u>Total</u> momentum before = <u>Total</u> momentum after **(½)** $0{\cdot}05u + 0 = (0{\cdot}20 + 0{\cdot}050) \times 1{\cdot}7$ **(½)** $u = 0{\cdot}25 \times 1{\cdot}7/0{\cdot}05$ $u = 8{\cdot}5$ m s^{-1} **(1)**	Must have 'total' on both sides. If a candidate forgets to add the mass of the dart (0·050 kg), they will get $u = 6{\cdot}8$ m s^{-1} as their answer. This gets a max of **(½)** for the full formula, <u>but only if it is written down</u>.	**2**	

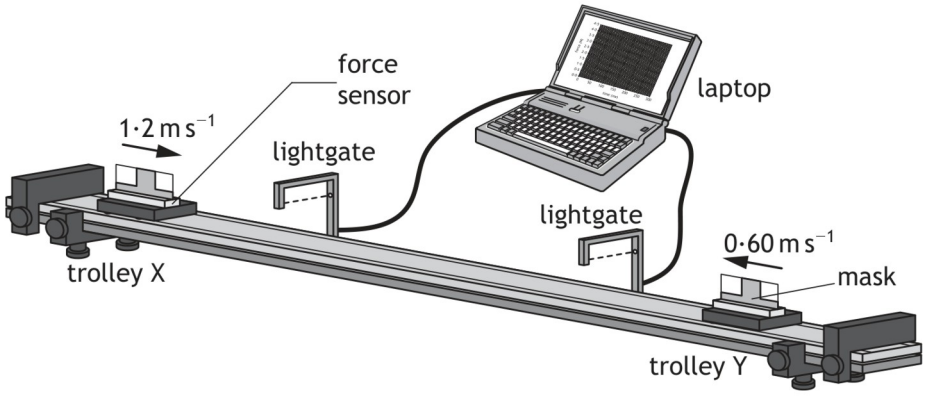
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2015 Question 2 (a)

Higher Physics 2015 Section 2, Question 2 (a). Total: 3 marks

MARKS | WRITE IN THIS MARGIN

2. A student sets up an experiment to investigate collisions between two trolleys on a long, horizontal track.



The mass of trolley X is 0·25 kg and the mass of trolley Y is 0·45 kg.

The effects of friction are negligible.

In one experiment, trolley X is moving at 1·2 m s^{-1} to the right and trolley Y is moving at 0·60 m s^{-1} to the left.

The trolleys collide and do not stick together. After the collision, trolley X rebounds with a velocity of 0·80 m s^{-1} to the left.

(a) Determine the velocity of trolley Y after the collision. **3**

Space for working and answer

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2015 Question 2 (a): marking instructions

Question		Answer	Max Mark	Additional Guidance
2.	(a)	(Total momentum before = total momentum after) $m_x u_x + m_y u_y = m_x v_x + m_y v_y$ **(1)** $(0\cdot25\times1\cdot20)+(0\cdot45\times-0\cdot60)$ $=(0\cdot25\times-0\cdot80)+(0\cdot45\times v_y)$ **(1)** $0\cdot30-0\cdot27=-0\cdot20+0\cdot45\times v_y$ $0\cdot45\times v_y=0\cdot23$ $v_y=0\cdot51\,\text{m s}^{-1}$ **(1)** *(to the right)*	**3**	If sign convention not applied then max (1) for formula. Answer must be consistent with sign convention in substitution line. $0\cdot5,\ 0\cdot511,\ 0\cdot5111$ Where candidates calculate the momentum of each trolley individually both before and after, no marks are awarded unless correct addition (including sign convention) and equating takes place.

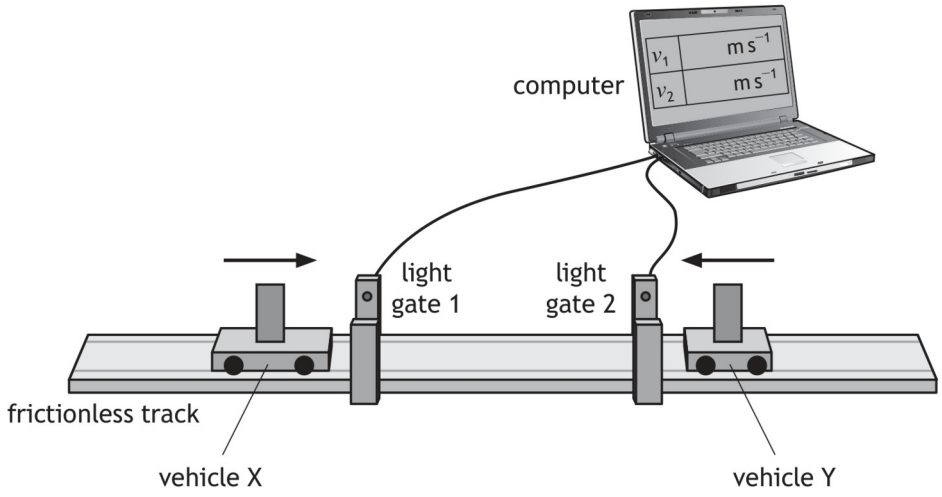
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2016 Question 3 (a) and (b)

Higher Physics 2016 Section 2, Question 3 (a) and (b). Total: 4 marks

MARKS | WRITE IN THIS MARGIN

3. The following apparatus is set up to investigate the law of conservation of linear momentum.



In one experiment, vehicle X is travelling to the right along the track and vehicle Y is travelling to the left along the track.

The vehicles collide and stick together.

The computer displays the speeds of each vehicle before the collision.

The following data are recorded:

Mass of vehicle X = 0·85 kg
Mass of vehicle Y = 0·25 kg
Speed of vehicle X before the collision = 0·55 m s^{-1}
Speed of vehicle Y before the collision = 0·30 m s^{-1}

(a) State the law of conservation of linear momentum. **1**

(b) Calculate the velocity of the vehicles immediately after the collision. **3**

Space for working and answer

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2016 Question 3 (a) and (b): marking instructions

Question			Answer	Max Mark	Additional Guidance
3.	(a)		Total momentum before (a collision) is equal to the total momentum after (a collision) in the absence of external forces (1)	1	Not: TMB = TMA An isolated system is equivalent to the absence of external forces
	(b)		$m_1u_1 + m_2u_2 = (m_1 + u_2)v$ (1) $(0{\cdot}85 \times 0{\cdot}55) + (0{\cdot}25 \times -0{\cdot}3)$ $= (0{\cdot}25 + 0{\cdot}85)v$ (1) $v = 0{\cdot}36 \text{ m s}^{-1}$ (1)	3	Sign of the answer must be consistent with the substitution of + and − velocities. Sig figs: Accept 0·4, 0·357, 0·3568 If candidate then goes on to state a direction which is not consistent with their substitution then maximum two marks can be awarded. Where candidates calculate the momentum of each trolley individually both before and after, no marks are awarded unless correct addition (including sign convention) and equating takes place.

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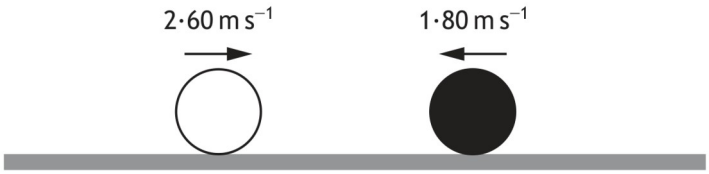
2017 Question 2 (a) (i)

Higher Physics 2017 Section 2, Question 2 (a) (i). Total: 3 marks

2. A white snooker ball and a black snooker ball travel towards each other in a straight line.

The white ball and the black ball each have a mass of 0·180 kg.

Just before the balls collide head-on, the white ball is travelling at 2·60 m s^{-1} to the right and the black ball is travelling at 1·80 m s^{-1} to the left.



After the collision, the black ball rebounds with a velocity of 2·38 m s^{-1} to the right.

(a) (i) Determine the velocity of the white ball immediately after the collision. **3**

Space for working and answer

MARGIN

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2017 Question 2 (a) (i): marking instructions

Question			Answer	Max mark	Additional guidance
2.	(a)	(i)	(total momentum before = total momentum after) $m_x u_x + m_y u_y = m_x v_x + m_y v_y$ (1) $(0{\cdot}180 \times 2{\cdot}60) + (0{\cdot}180 \times -1{\cdot}80)$ $= (0{\cdot}180 v_x + 0{\cdot}180 \times 2{\cdot}38)$ (1) $0{\cdot}468 - 0{\cdot}324 = 0{\cdot}180 v_x + 0{\cdot}4284$ $v_x = -1{\cdot}58\ \text{m s}^{-1}$ (1) (Accept '1·58 ms^{-1} to the left' or an indication of direction eg arrow left)	3	1 mark for equating the momentums before and after. 1 mark for the substitutions. 1 mark for answer including unit. Signs must be consistent. Allow cancellation of masses throughout the relationship. Accept $v_x = -1{\cdot}58\,\text{ms}^{-1}$ to the left as "loose" use of direction. Sig fig 1·6, 1·580, 1·5800

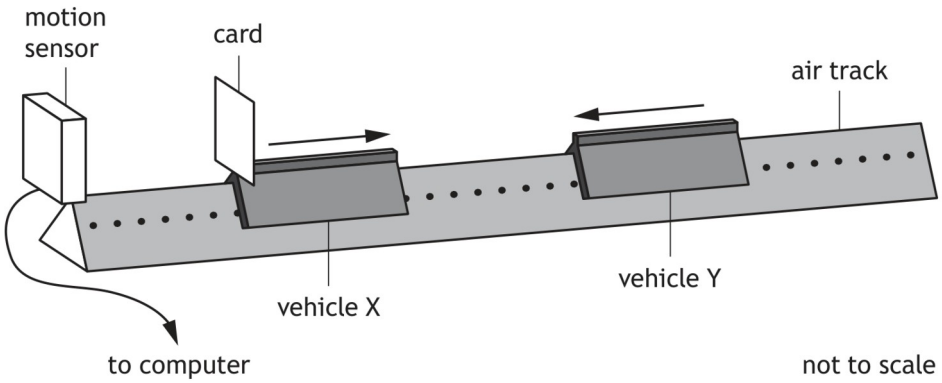
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2018 Question 3 (a)

Higher Physics 2018 Section 2, Question 3 (a). Total: 2 marks

MARGIN

3. A student sets up an experiment to investigate a collision between two vehicles on a frictionless air track.

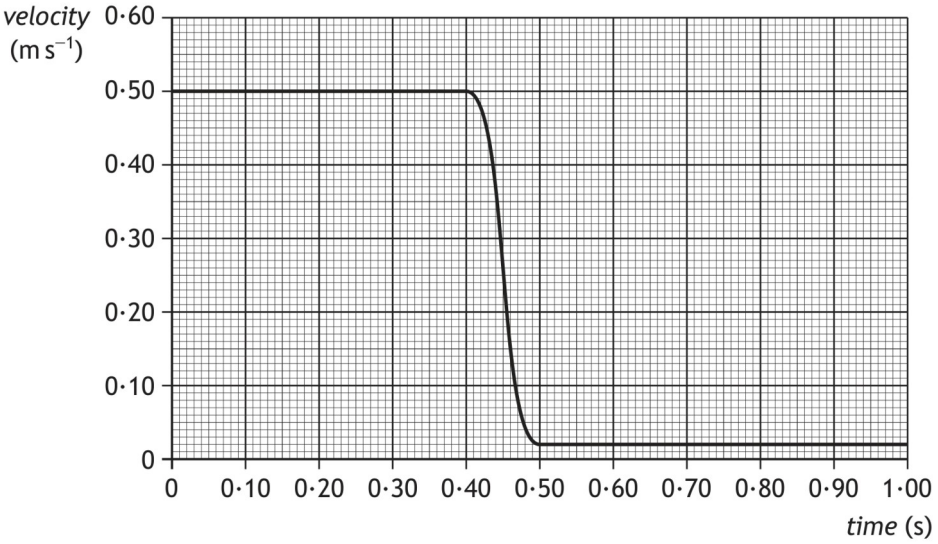


Vehicle X of mass 0·75 kg is travelling to the right along the track.

Vehicle Y of mass 0·50 kg is travelling to the left along the track with a speed of 0·30 m s^{-1}.

The vehicles collide and move off separately.

A computer displays a graph showing the velocity of vehicle X from just before the collision to just after the collision.



MARGIN

3. (continued)

(a) Show that the velocity of vehicle Y after the collision is 0·42 m s^{-1}. **2**

Space for working and answer

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2018 Question 3 (a): marking instructions

Question			Answer	Max mark	Additional guidance
3.	(a)		(Total momentum before = Total momentum after) $p = mv$ OR **(1)** $(m_x u_x + m_y u_y) = (m_x v_x + m_y v_y)$ $(0 \cdot 75 \times 0 \cdot 50) + (0 \cdot 50 \times -0 \cdot 30) = (0 \cdot 75 \times 0 \cdot 02) + (0 \cdot 50 v_y)$ **(1)** $v_y = 0 \cdot 42 \text{ m s}^{-1}$	2	**"SHOW" question** If sign convention is not applied then max 1 mark for formula.

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2020 Paper 1 Question 7

Higher Physics 2020 Paper 1 (multiple choice), Question 7. Total: 1 mark

7. A carpenter is building a doorframe using a nail gun. The nail gun of mass 5·0 kg fires a nail of mass 4·0 g.

The nail gun and nail are initially at rest.

The speed of the nail immediately after firing is 150 $m\,s^{-1}$.

The recoil speed of the nail gun immediately after firing is

A 0·005 $m\,s^{-1}$

B 0·05 $m\,s^{-1}$

C 0·12 $m\,s^{-1}$

D 1·2 $m\,s^{-1}$

E 120 $m\,s^{-1}$.

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2020 Paper 1 Question 7: marking instructions

Question	Answer	Mark
7.	C	1

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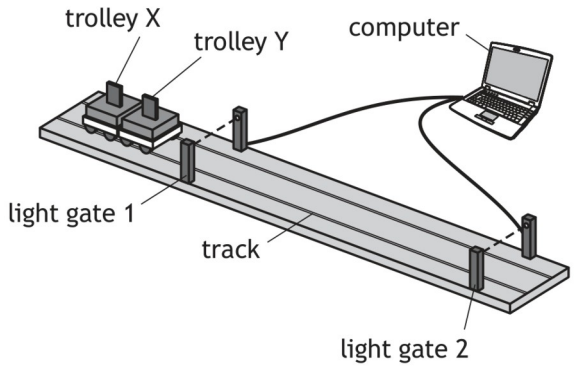
2022 Paper 2 Question 3 (b)

Higher Physics 2022 Paper 2, Question 3 (b). Total: 3 marks

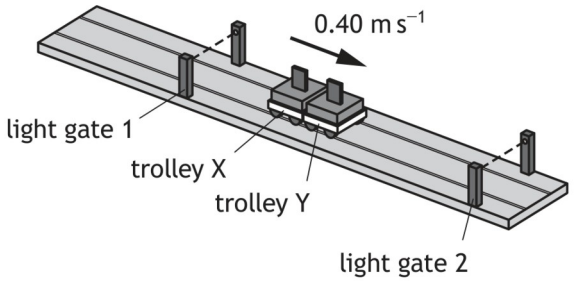
MARGIN

3. A student sets up an experiment to investigate the interaction between two trolleys on a smooth, horizontal track.

The mass of trolley X is 0.50 kg and the mass of trolley Y is 0.25 kg.



The trolleys X and Y are moving together to the right at 0.40 m s^{-1}.

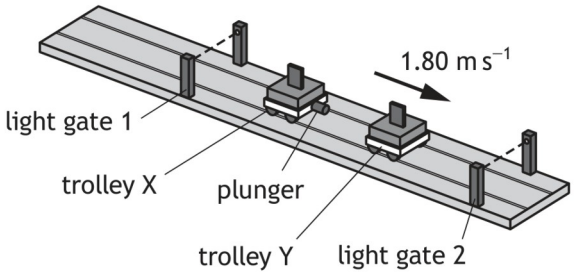


When the trolleys are between the light gates, a plunger in trolley X is activated.

The plunger extends and pushes trolley Y with an average force of 6.25 N for a short time, so that the trolleys separate.

Trolley Y now moves to the right at 1.80 m s^{-1}.

The effects of friction are negligible.



(b) Calculate the velocity of trolley X immediately after the trolleys separate. **3**

Space for working and answer

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2022 Paper 2 Question 3 (b): marking instructions

Question			Expected response	Max mark	Additional guidance
3.	(b)		(total momentum before = total momentum after) $m_x u_x + m_y u_y = m_x v_x + m_y v_y$ **(1)** $(0.50 \times 0.40) + (0.25 \times 0.40)$ $= (0.50 v_x) + (0.25 \times 1.80)$ **(1)** $v_x = -0.30$ m s^{-1} **(1)** **OR** $(m_x + m_y)u = m_x v_x + m_y v_y$ **(1)** $(0.50 + 0.25) \times 0.40$ $= (0.50 v_x) + (0.25 \times 1.80)$ **(1)** $v_x = -0.30$ m s^{-1} **(1)** (Accept '0.30 m s^{-1} to the left')	3	Accept: -0.3, -0.300, -0.3000 Equating the total momenta before and after **(1)** All substitutions **(1)** Final answer **(1)** Sign convention must be consistent. Do not accept: '$v_x = -0.30$ m s^{-1} to the left' Alternative methods: $\Delta mv = mv - mu$ $-0.35 = (0.50v) - (0.50 \times 0.40)$ $v = -0.30$ m s^{-1} Δmv and u must have opposite signs $Ft = mv - mu$ -6.25×0.056 $= (0.50v) - (0.50 \times 0.40)$ $v = -0.30$ m s^{-1} F and u must have opposite signs $F = ma$ $-6.25 = 0.50 \times a$ $v = u + at$ $v = 0.40 + \left(\left(\frac{-6.25}{0.5}\right) \times 0.056\right)$ $v = -0.30$ m s^{-1} F and u must have opposite signs Both relationships **(1)** Both substitutions **(1)** Final answer **(1)**

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2023 Paper 2 Question 3 (a)

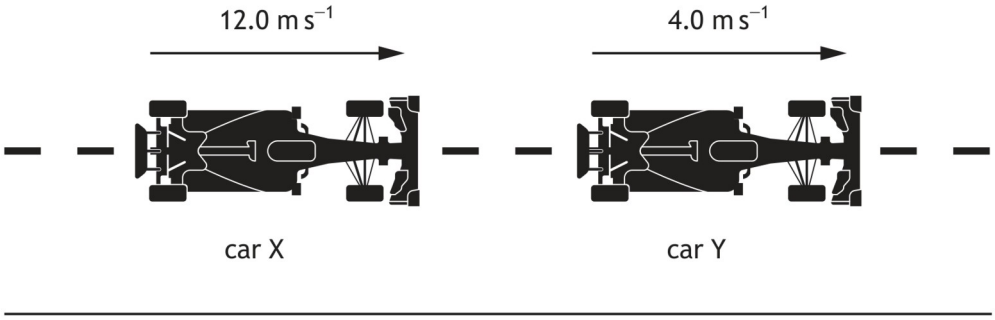
Higher Physics 2023 Paper 2, Question 3 (a). Total: 3 marks

MARGIN

3. During a practice session for a Grand Prix, two Formula 1 cars collide in the pit lane.

Car X has a mass of 760 kg and is travelling at 12.0 m s^{-1}.

Car Y has a mass of 840 kg and is travelling at 4.0 m s^{-1}.



The cars collide and move off separately.

Car Y moves off with a velocity of 8.5 m s^{-1}.

(a) Calculate the velocity of car X immediately after the collision. **3**

Space for working and answer

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2023 Paper 2 Question 3 (a): marking instructions

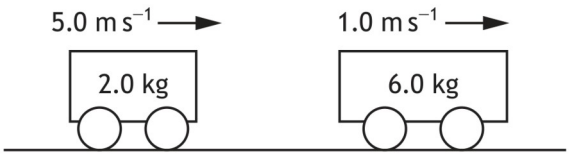
Question			Expected response		Max mark	Additional guidance
3.	(a)		$m_x u_x + m_y u_y = m_x v_x + m_y v_y$ $(760 \times 12.0) + (840 \times 4.0)$ $= (760 \times v_x) + (840 \times 8.5)$ $v_x = 7.0 \text{ m s}^{-1}$	(1) (1) (1)	3	Accept: 7, 7.03, 7.026 Equating the total momenta before and after (1) All substitutions (1) Final answer (1) If a direction is stated it must be to the right otherwise MAX 2 marks.

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2024 Paper 1 Question 6

Higher Physics 2024 Paper 1 (multiple choice), Question 6. Total: 1 mark

6. Two trolleys move along a level bench as shown.



The trolleys collide and stick together. They continue to move along the bench.

The velocity of the trolleys immediately after the collision is

A 0.50 m s^{-1}

B 1.3 m s^{-1}

C 2.0 m s^{-1}

D 2.7 m s^{-1}

E 8.0 m s^{-1}.

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2024 Paper 1 Question 6: marking instructions

Question	Answer	Mark
6.	C	1

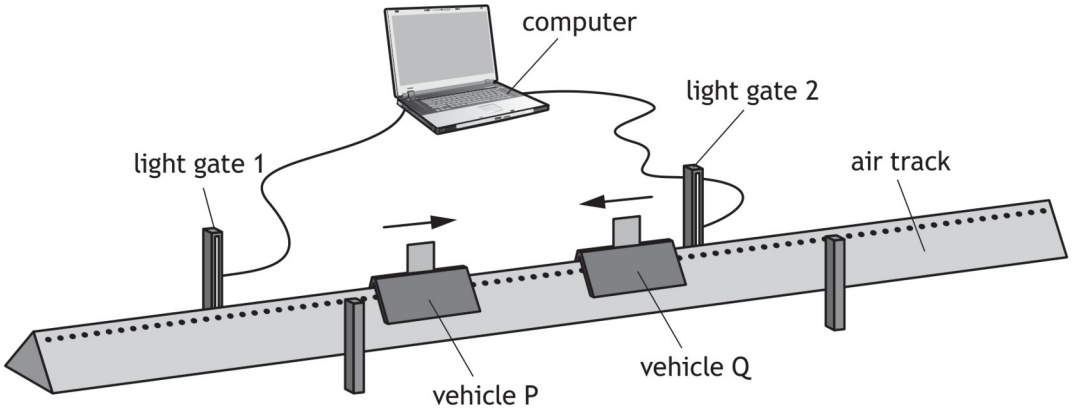
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2025 Paper 2 Question 2 (a) and (b)

Higher Physics 2025 Paper 2, Question 2 (a) and (b). Total: 4 marks

MARKS | DO NOT WRITE IN THIS MARGIN

2. A technician sets up the apparatus shown to demonstrate the law of conservation of linear momentum.



The mass of vehicle P is 0.18 kg and the mass of vehicle Q is 0.24 kg.

The effects of friction are negligible.

In one experiment, vehicle P is moving at 1.20 $m\,s^{-1}$ to the right and vehicle Q is moving at 0.64 $m\,s^{-1}$ to the left.

The vehicles collide and move off separately.

Vehicle P rebounds with a velocity of 0.76 $m\,s^{-1}$ to the left.

(a) State the law of conservation of linear momentum. **1**

(b) Calculate the velocity of vehicle Q immediately after the collision. **3**

Space for working and answer

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2025 Paper 2 Question 2 (a) and (b): marking instructions

Question			Expected response	Max mark	Additional guidance
2.	(a)		Total momentum before (a collision) is equal to the total momentum after (a collision) in the absence of external forces.	1	Do not accept: TMB = TMA. 'An isolated system' is equivalent to the absence of external forces.
	(b)		(total momentum before = total momentum after) $m_P u_P + m_Q u_Q = m_P v_P + m_Q v_Q$ (1) $(0.18 \times 1.20) + (0.24 \times -0.64) = (0.18 \times -0.76) + (0.24 \times v_Q)$ (1) $v_Q = 0.83 \text{ m s}^{-1}$ (1)	3	Accept 0.8, 0.830, 0.8300 Equating the total momenta before and after. (1) All substitutions. (1) Final answer. (1) If a direction is stated it must be 'to the right' otherwise MAX 2 marks.

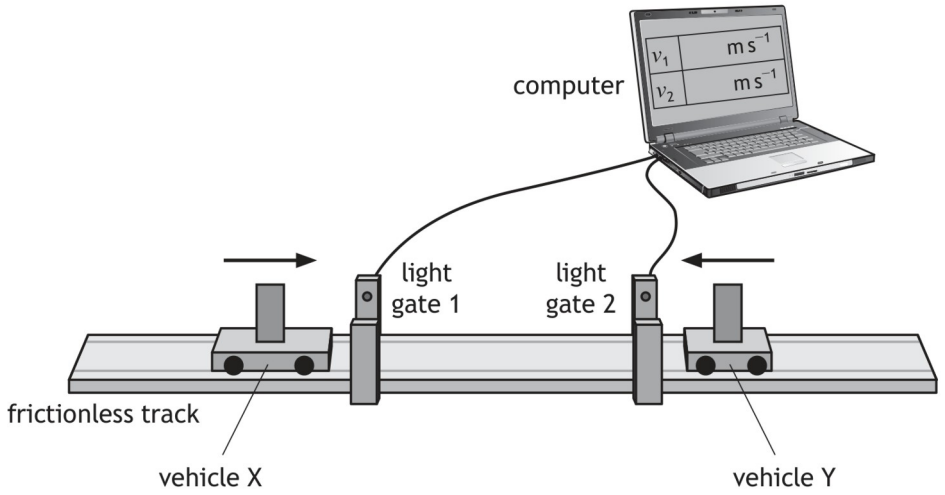
Part 3: Elastic and inelastic collisions

2016 Question 3 (c)

Higher Physics 2016 Section 2, Question 3 (c). Total: 4 marks

MARKS | WRITE IN THIS MARGIN

3. The following apparatus is set up to investigate the law of conservation of linear momentum.



In one experiment, vehicle X is travelling to the right along the track and vehicle Y is travelling to the left along the track.

The vehicles collide and stick together.

The computer displays the speeds of each vehicle before the collision.

The following data are recorded:

Mass of vehicle X = 0·85 kg
Mass of vehicle Y = 0·25 kg
Speed of vehicle X before the collision = 0·55 m s^{-1}
Speed of vehicle Y before the collision = 0·30 m s^{-1}

(c) Show by calculation that the collision is inelastic. **4**

Space for working and answer

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2016 Question 3 (c): marking instructions

Question			Answer	Max Mark	Additional Guidance
	(c)		$E_k = ½mv^2$ ANYWHERE (1) Before $E_k = ½m_Xv_X^2 + ½m_Yv_Y^2$ $= (½ \times 0{\cdot}85 \times 0{\cdot}55^2)$ $+ (½ \times 0{\cdot}25 \times 0{\cdot}3^2)$ $= 0{\cdot}14$ (J) (1) After $E_k = ½mv^2$ $= ½ \times 1{\cdot}1 \times 0{\cdot}36^2 = 0{\cdot}071$ (J) (1) Kinetic energy is lost. (Therefore inelastic.) (1)	4	Or consistent with (b) 1 mark for both substitutions If candidate answers 0·49 in (b), this gives 0·13 J for E_K after. $E_K before \neq E_K after$ is insufficient

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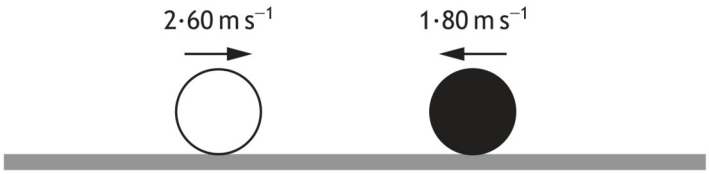
2017 Question 2 (a) (ii)

Higher Physics 2017 Section 2, Question 2 (a) (ii). Total: 1 mark

2. A white snooker ball and a black snooker ball travel towards each other in a straight line.

The white ball and the black ball each have a mass of 0·180 kg.

Just before the balls collide head-on, the white ball is travelling at 2·60 m s^{-1} to the right and the black ball is travelling at 1·80 m s^{-1} to the left.



After the collision, the black ball rebounds with a velocity of 2·38 m s^{-1} to the right.

MARGIN

(ii) The collision between the balls is inelastic.

State what is meant by an *inelastic collision*. **1**

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2017 Question 2 (a) (ii): marking instructions

Question			Answer	Max mark	Additional guidance
		(ii)	**kinetic** energy is lost/greater before the collision than after.	1	Do not accept: E_k before $\neq E_k$ after. E_k is not conserved.

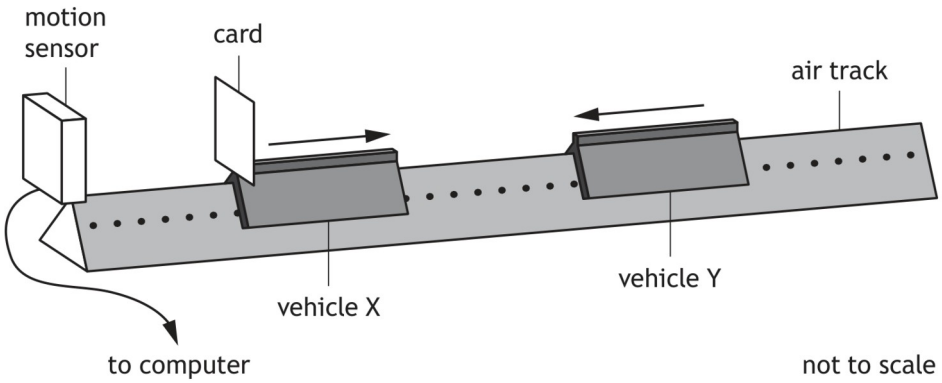
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2018 Question 3 (c)

Higher Physics 2018 Section 2, Question 3 (c). Total: 2 marks

MARGIN

3. A student sets up an experiment to investigate a collision between two vehicles on a frictionless air track.

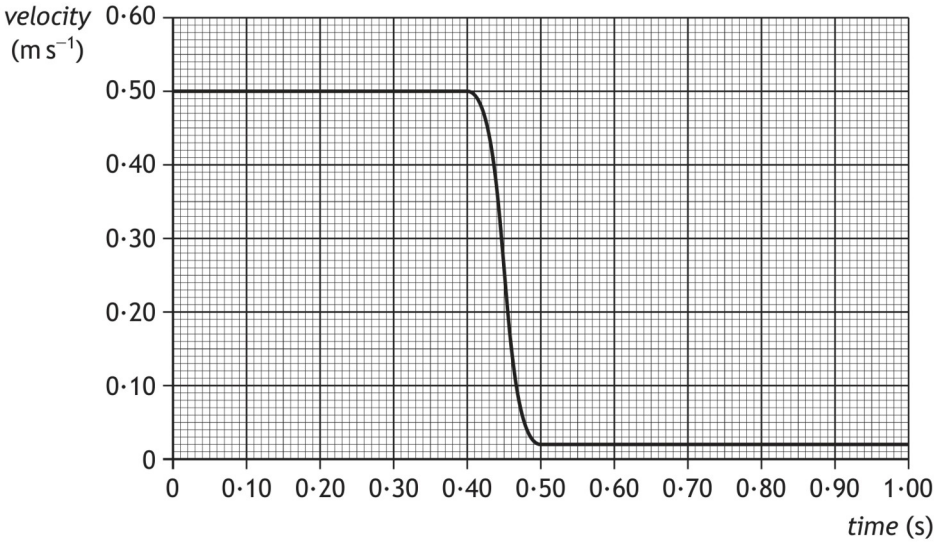


Vehicle X of mass 0·75 kg is travelling to the right along the track.

Vehicle Y of mass 0·50 kg is travelling to the left along the track with a speed of 0·30 m s^{-1}.

The vehicles collide and move off separately.

A computer displays a graph showing the velocity of vehicle X from just before the collision to just after the collision.



MARGIN

3. (continued)

(c) Explain how the student would determine whether the collision was elastic or inelastic. **2**

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2018 Question 3 (c): marking instructions

Question			Answer	Max mark	Additional guidance
	(c)		Calculate the <u>total</u> kinetic energy before and (<u>total</u> kinetic energy) after. **(1)** If E_k before is equal to E_k after the collision, is elastic. **OR** If E_k before is greater than E_k after, the collision is inelastic. **(1)**	**2**	Look for a statement relating to calculating/finding the <u>total</u> E_k before and after first, otherwise 0 marks. There must be an indication of total kinetic energy or equivalent term. Accept: If kinetic energy is not the same, collision is inelastic. Can show by calculation but would still require a statement for the second mark. Do not Accept: If kinetic energy is gained, collision is inelastic. If candidate says energy is lost then max 1 mark.

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2019 Paper 1 Question 6

Higher Physics 2019 Paper 1 (multiple choice), Question 6. Total: 1 mark

6. A student makes the following statements about an elastic collision.

I Total momentum is conserved.

II Total kinetic energy is conserved.

III Total energy is conserved.

Which of these statements is/are correct?

A I only

B II only

C I and II only

D I and III only

E I, II and III

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2019 Paper 1 Question 6: marking instructions

Question	Answer	Mark
6.	E	1

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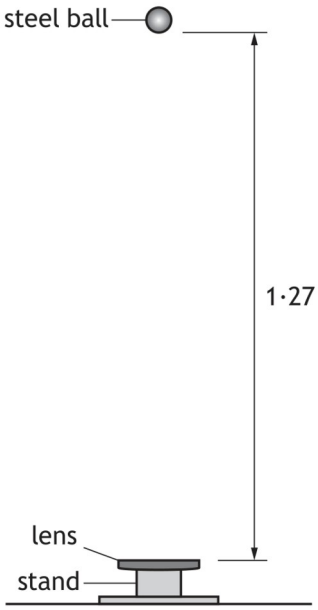
2020 Paper 2 Question 3 (c)

Higher Physics 2020 Paper 2, Question 3 (c). Total: 1 mark

3. A manufacturer tests whether a Perspex lens will break during an impact.

The lens is placed on a stand and a steel ball is dropped from rest onto the lens.

The ball has a mass of $1{\cdot}59 \times 10^{-2}$ kg and is dropped from a height of 1·27 m above the lens.



MARGIN

(c) The collision between the ball and the lens is inelastic.

Explain what is meant by an *inelastic collision*. **1**

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2020 Paper 2 Question 3 (c): marking instructions

Question	Expected response	Max mark	Additional guidance
(c)	Kinetic energy is greater before (the collision) than after. **OR** Kinetic energy is lost (during the collision)	1	Do not accept E_k before not equal to E_k after. Do not accept E_k is not conserved.

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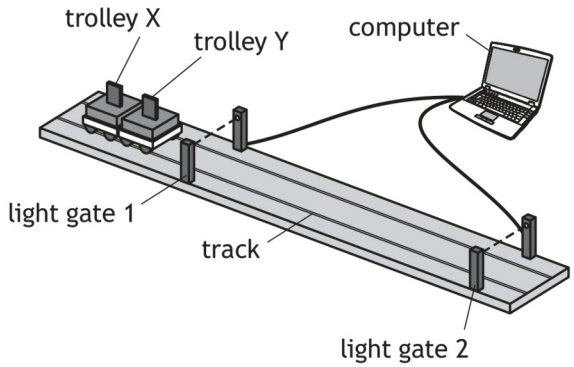
2022 Paper 2 Question 3 (c)

Higher Physics 2022 Paper 2, Question 3 (c). Total: 2 marks

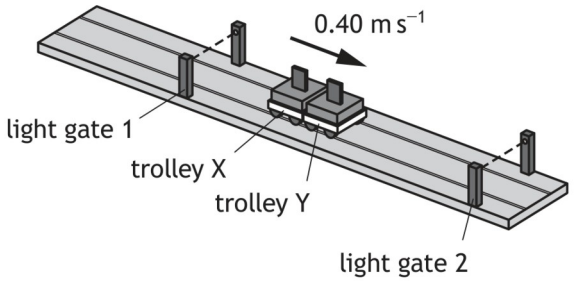
MARGIN

3. A student sets up an experiment to investigate the interaction between two trolleys on a smooth, horizontal track.

The mass of trolley X is 0.50 kg and the mass of trolley Y is 0.25 kg.



The trolleys X and Y are moving together to the right at 0.40 m s^{-1}.

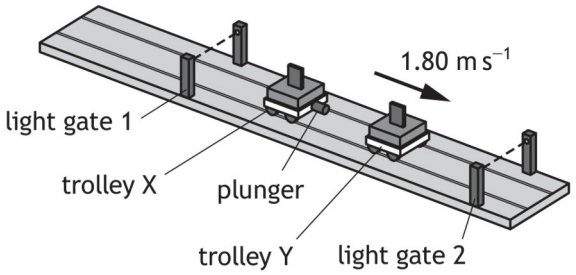


When the trolleys are between the light gates, a plunger in trolley X is activated.

The plunger extends and pushes trolley Y with an average force of 6.25 N for a short time, so that the trolleys separate.

Trolley Y now moves to the right at 1.80 m s^{-1}.

The effects of friction are negligible.



(c) Explain how the student would determine whether this interaction was elastic. **2**

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2022 Paper 2 Question 3 (c): marking instructions

Question			Expected response	Max mark	Additional guidance

3.	(c)		Calculate/compare the total kinetic energy before and (total kinetic energy) after. **(1)**
			
			If (total) kinetic energy before is equal to (total) kinetic energy after, the interaction is elastic. **(1)**
			
			OR
			
			If (total) kinetic energy is conserved, the interaction is elastic.
				2	Accept: E_k for 'kinetic energy'.
					
					Look for a statement relating to calculating/finding the total E_k before and after first, otherwise **(0)** marks.
					
					There must be an indication of total kinetic energy or equivalent term.
					
					Accept:
					Can show by calculation but would still require a statement for the second mark.
					
					Do not accept:
					If (total) kinetic energy is not conserved, the interaction is inelastic, on its own.

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2023 Paper 2 Question 3 (b)

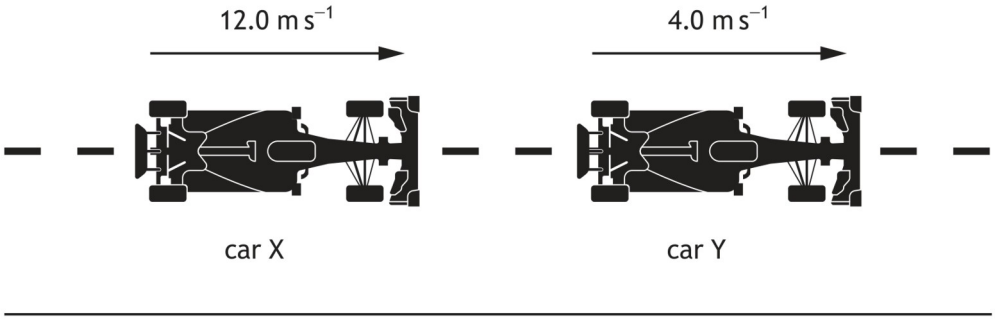
Higher Physics 2023 Paper 2, Question 3 (b). Total: 4 marks

MARGIN

3. During a practice session for a Grand Prix, two Formula 1 cars collide in the pit lane.

Car X has a mass of 760 kg and is travelling at 12.0 m s^{-1}.

Car Y has a mass of 840 kg and is travelling at 4.0 m s^{-1}.



The cars collide and move off separately.

Car Y moves off with a velocity of 8.5 m s^{-1}.

(b) Show by calculation that the collision is inelastic. **4**

Space for working and answer

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2023 Paper 2 Question 3 (b): marking instructions

Question	Expected response	Max mark	Additional guidance
(b)	$E_k = \frac{1}{2}mv^2$ *Before* $E_k = \frac{1}{2}m_x u_x^2 + \frac{1}{2}m_y u_y^2$ $E_k = (\frac{1}{2}\times 760 \times 12.0^2) + (\frac{1}{2}\times 840 \times 4.0^2)$ $E_k = 61440$ (J) *After* $E_k = \frac{1}{2}m_x v_x^2 + \frac{1}{2}m_y v_y^2$ $E_k = (\frac{1}{2}\times 760 \times 7.0^2) + (\frac{1}{2}\times 840 \times 8.5^2)$ $E_k = 48965$ (J) (Total) E_k before is greater than (total) E_k after, (the collision is inelastic).	4	Or consistent with (a) 1 mark for relationship 1 mark for **all** substitutions 1 mark for **both** total kinetic energies 1 mark for correct final statement Suspend significant figure rule for calculated values of total kinetic energies in this question. Kinetic energy is lost.(Therefore inelastic.) E_k before ≠ E_k after is insufficient.

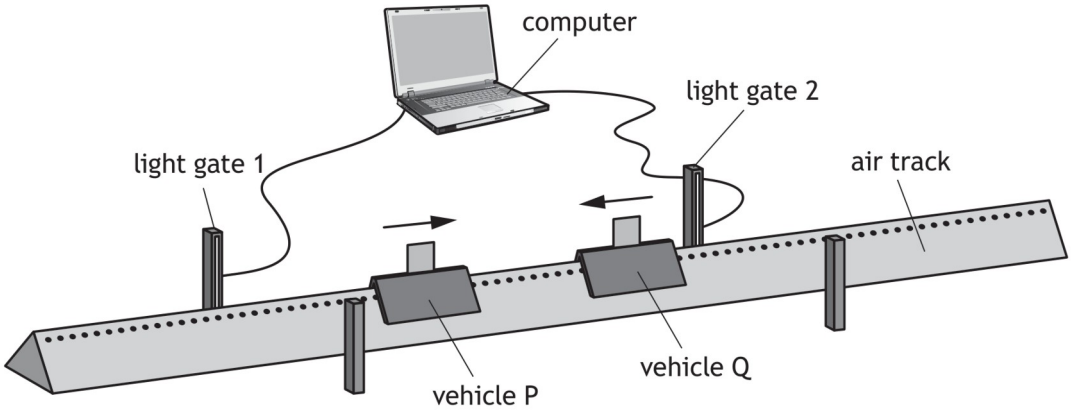
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2025 Paper 2 Question 2 (c)

Higher Physics 2025 Paper 2, Question 2 (c). Total: 4 marks

MARKS | DO NOT WRITE IN THIS MARGIN

2. A technician sets up the apparatus shown to demonstrate the law of conservation of linear momentum.



The mass of vehicle P is 0.18 kg and the mass of vehicle Q is 0.24 kg.

The effects of friction are negligible.

In one experiment, vehicle P is moving at 1.20 $m\,s^{-1}$ to the right and vehicle Q is moving at 0.64 $m\,s^{-1}$ to the left.

The vehicles collide and move off separately.

Vehicle P rebounds with a velocity of 0.76 $m\,s^{-1}$ to the left.

(c) Show by calculation whether the collision is elastic or inelastic. **4**

Space for working and answer

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2025 Paper 2 Question 2 (c): marking instructions

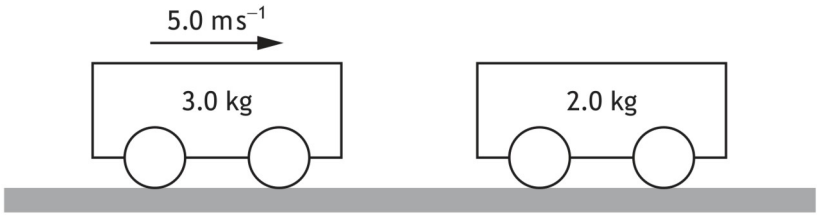
Question			Expected response	Max mark	Additional guidance
	(c)		$E_k = \frac{1}{2}mv^2$ *before* $E_{k_{before}} = \left(\frac{1}{2}\times 0.18\times 1.20^2\right)+\left(\frac{1}{2}\times 0.24\times 0.64^2\right)$ $E_{k_{before}} = 0.18$ J *after* $E_{k_{after}} = \left(\frac{1}{2}\times 0.18\times 0.76^2\right)+\left(\frac{1}{2}\times 0.24\times 0.83^2\right)$ $E_{k_{after}} = 0.13$ J The collision is inelastic.	**4**	Or consistent with (b). 1 mark for relationship anywhere. 1 mark for **all** substitutions. 1 mark for **both** total kinetic Energies. 1 mark for correct final statement. Suspend significant figure rule for calculated values of total kinetic energies in this question. Final statement mark only available if calculation for total E_k is attempted.

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2026 Paper 1 Question 4

Higher Physics 2026 Paper 1 (multiple choice), Question 4. Total: 1 mark

4. A trolley of mass 3.0 kg is travelling along a level bench towards a stationary trolley of mass 2.0 kg.



The speed of the 3.0 kg trolley just before it collides with the 2.0 kg trolley is 5.0 m s^{-1}.

After the collision the trolleys stick together.

The effects of friction are negligible.

Which row in the table gives the total kinetic energy of the trolleys immediately before the collision and the total kinetic energy of the trolleys immediately after the collision?

	Total kinetic energy of the trolleys before the collision (J)	Total kinetic energy of the trolleys after the collision (J)
A	7.5	7.5
B	23	38
C	38	23
D	38	29
E	75	45

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2026 Paper 1 Question 4: marking instructions

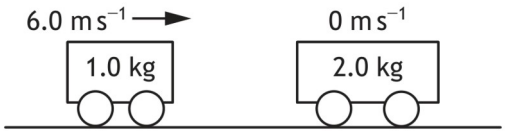
Question	Answer	Mark
4.	C	1

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Specimen Paper 1 Question 5

Higher Physics Specimen paper, Paper 1 (multiple choice), Question 5. Total: 1 mark
The same question was 2012 Revised Higher Question 3 and 2018 specimen Section 1 Question 5.

5. The diagram shows the masses and velocities of two trolleys just before they collide on a level bench.



After the collision, the trolleys move along the bench joined together.

The kinetic energy lost in this collision is

A 0.0 J
B 6.0 J
C 12 J
D 18 J
E 24 J.

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Specimen Paper 1 Question 5: marking instructions

Question	Answer	Mark
5.	C	1

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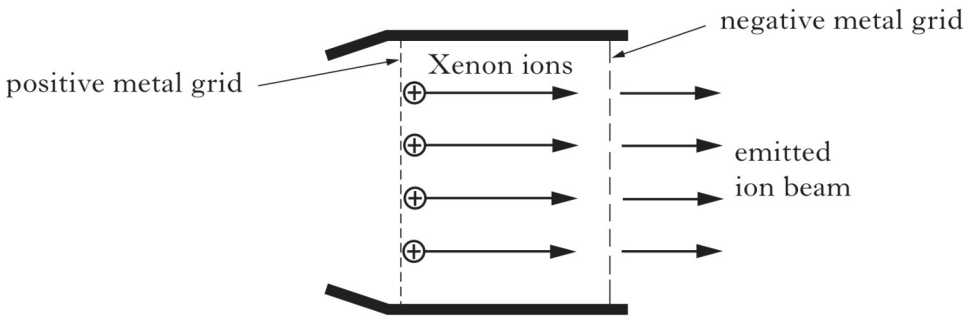
Part 4: Impulse

2012 Revised Higher Question 23 (b) and (c)

Higher Physics 2012 Revised Higher, Section B, Question 23 (b) and (c). Total: 4 marks

23. An ion propulsion engine can be used to propel spacecraft to areas of deep space.

A simplified diagram of a Xenon ion engine is shown.



The Xenon ions are accelerated as they pass through an electric field between the charged metal grids. The emitted ion beam causes a force on the spacecraft in the opposite direction.

The spacecraft has a total mass of 750 kg.

The mass of a Xenon ion is $2{\cdot}18 \times 10^{-25}$ kg and its charge is $1{\cdot}60 \times 10^{-19}$ C. The potential difference between the charged metal grids is 1·22 kV.

(*b*) The ion beam exerts a constant force of 0·070 N on the spacecraft. Calculate the change in speed of the spacecraft during a 60 second period of time. **2**

(*c*) A different ion propulsion engine uses Krypton ions which have a smaller mass than Xenon ions. The Krypton engine emits the same number of ions per second at the same speed as the Xenon engine.

Which of the two engines produces a greater force?

Justify your answer. **2**

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2012 Revised Higher Question 23 (b) and (c): marking instructions

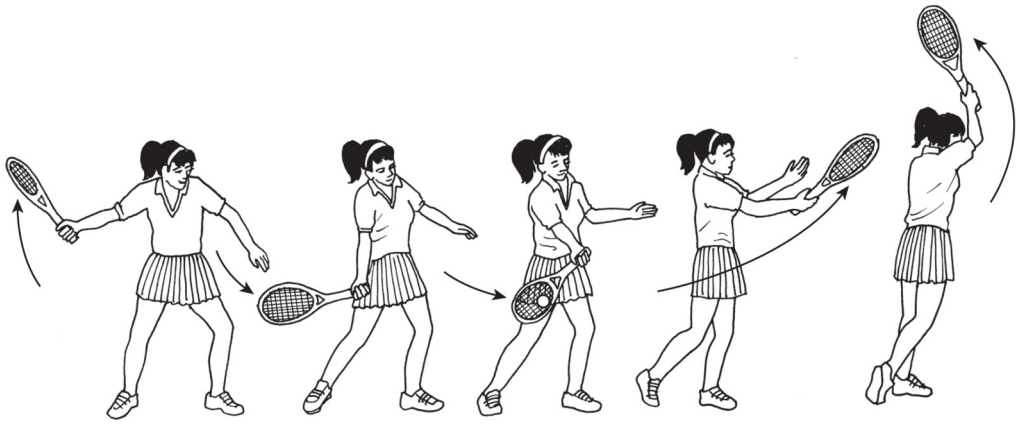
Sample Answer and Mark Allocation			Notes	Inner Margin	Outer Margin
(b)	$Ft = \Delta mv$	(½)	if $Ft = mv - mu$	2	
	$0{\cdot}07 \times 60 = 750 \times \Delta v$	(½)	$0{\cdot}07 \times 60 = 750 \times v - 750 \times 0$		
	$\Delta v = 5{\cdot}6 \times 10^{-3}\ \text{m s}^{-1}$	(1)	$v = 5{\cdot}6 \times 10^{-3}\ \text{m s}^{-1}$		
(c)	Force from Xenon engine greater	(1)	Must have force from Xenon engine greater or zero marks	2 (2A)	
	Change in momentum of the Xenon ions would be greater (than Krypton ions)	(½)	Alternative: force from Xenon ion engine greater (1)		
	Impulse from Xenon ions would be greater	(½)	E_k of xenon ions greater (than krypton ions) (½)		
			more work done ($E_w = Fd$) (½)		
			Must name the engine – saying the 'first' engine means nothing in this question.		

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2012 Revised Higher Question 24

Higher Physics 2012 Revised Higher, Section B, Question 24. Total: 3 marks

24. Tennis players are coached to swing "through the ball" when striking it rather than stopping the tennis racquet suddenly.



Use your knowledge of physics to comment on why this causes the ball to leave the racquet with a greater speed. **(3)**

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2012 Revised Higher Question 24: marking instructions

Sample Answer and Mark Allocation			Notes	Inner Margin	Outer Margin
24.	Demonstrates no understanding Limited understanding Reasonable understanding Good understanding	(0) (1) (2) (3)	Open ended question – a variety of physics arguments can be used to answer this question. Marks are awarded on the basis of whether the answer overall demonstrates 'no', 'limited', 'reasonable' or 'good' understanding.	3 (1A)	3

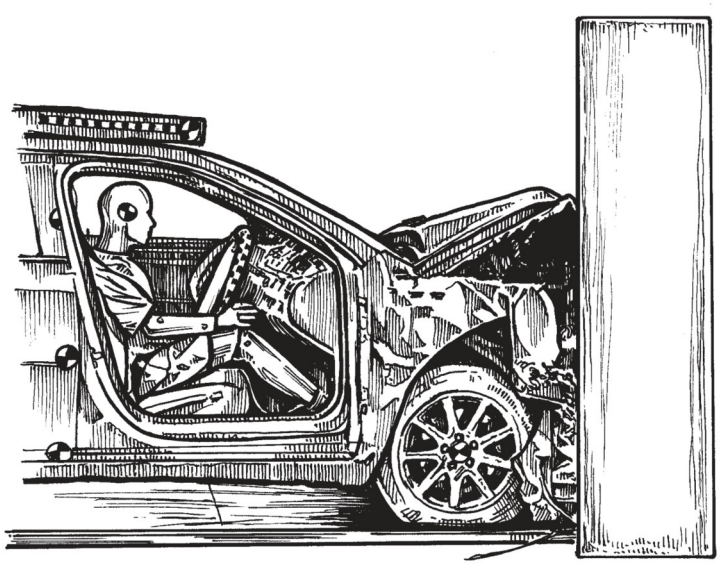
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2013 Revised Higher Question 22 (b), (c) and (d)

Higher Physics 2013 Revised Higher, Section B, Question 22 (b), (c) and (d). Total: 7 marks

22. The force applied by a seat belt on a crash test dummy is being investigated. The crash test dummy is placed in a car.

The car then travels along a test track at a speed of $13{\cdot}4\ \text{m s}^{-1}$, collides with a wall and comes to rest.



(*b*) The total mass of the car and dummy is 1200 kg.

Calculate the change in momentum of the car and dummy in the collision. **2**

(*c*) The crash test dummy has a mass of 75 kg and is wearing a seat belt. During the collision the dummy travels a distance of 0·48 m while coming to rest.

Calculate the average force exerted on the dummy by the seat belt. **3**

(*d*) This seatbelt is designed to stretch slightly during the collision.

Explain, in terms of forces, an advantage of this design. **2**

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2013 Revised Higher Question 22 (b), (c) and (d): marking instructions

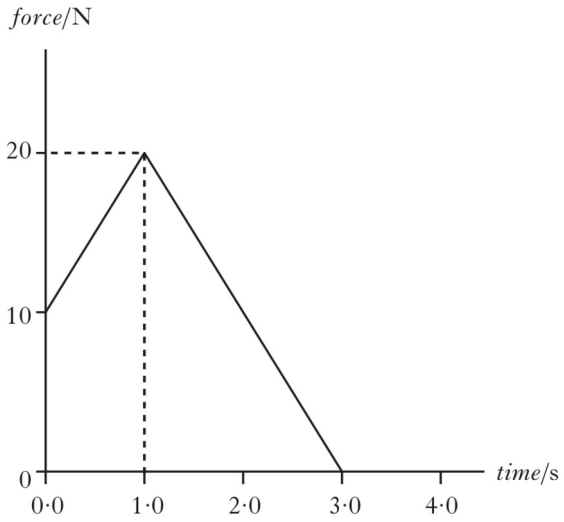
Question	Sample Answers and Mark Allocation	Notes	Inner Margin	Outer Margin
(b)	$\Delta mv = mv - mu$ ½ **Values in line 2 must be final - initial** $\Delta mv = 1200 \times 0 - 1200 \times 13{\cdot}4$ ½ $\Delta mv = -16080$ kg m s^{-1} $\Delta mv = -1{\cdot}6 \times 10^4$ kg m s^{-1} **1**	**i.e.** if u and v wrong way round, formula ½ only **must have change in momentum i.e. '*mv*' or '*p*' = 16080 kg m s^{-1} gets *0 marks***	**2•**	
(c)	$v^2 = u^2 + 2as$ $0 = 13{\cdot}4^2 + 2 \times a \times 0{\cdot}48$ $a = -187{\cdot}04$ m s^{-2} **1** $F = ma$ ½ $F = 75 \times (-)187{\cdot}04$ ½ $F = (-)14\,028$ N **if stop here sig fig error deduct** ½ $F = 1{\cdot}4 \times 10^4$ N **1**	**OR,** $E_k = ½ mv^2$ $= ½ \times 75 \times 13{\cdot}4^2$ $= 6733{\cdot}5$ (J) **1** $E_w = F \times d$ ½ $6733.5 = F \times 0{\cdot}48$ ½ $\Rightarrow F = 1{\cdot}4 \times 10^4$ N **1** **OR** **s = (u + v)t/2** **0·48 = (13·4 + 0)t/2** **t = 0·072 1** **F t = m(v – u)** ½ **F × 0·072 = 75(0–13·4)** ½ **F = 1·4 × 10^{4}N 1**	**3+**	
(d)	Time (of collision) increased ½ **change in momentum is the same** ½ (Average) force (acting on dummy/passenger) is decreased**/reduced/smaller** **1**	**Look for "smaller force" first. Zero marks if this is not there.** **Do not accept arrows for "increases" or "decreases".**	**2 (1A)**	

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2014 Revised Higher Question 3

Higher Physics 2014 Revised Higher, Section A (multiple choice), Question 3. Total: 1 mark

3. The graph shows how the force acting on an object of mass 5·0 kg varies with time.



The change in momentum of the object is

A $7{\cdot}0\ \text{kg m s}^{-1}$

B $30\ \text{kg m s}^{-1}$

C $35\ \text{kg m s}^{-1}$

D $60\ \text{kg m s}^{-1}$

E $175\ \text{kg m s}^{-1}$.

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2014 Revised Higher Question 3: marking instructions

Section A

3. C

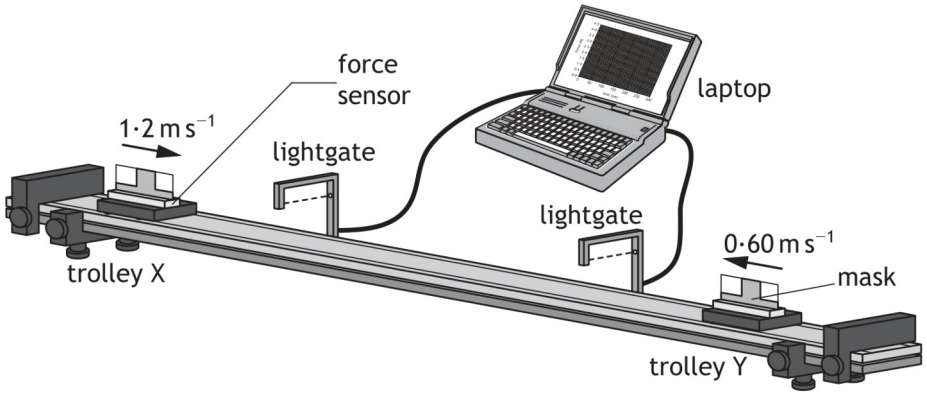
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2015 Question 2 (b)

Higher Physics 2015 Section 2, Question 2 (b). Total: 7 marks

MARKS | WRITE IN THIS MARGIN

2. A student sets up an experiment to investigate collisions between two trolleys on a long, horizontal track.



The mass of trolley X is 0·25 kg and the mass of trolley Y is 0·45 kg.

The effects of friction are negligible.

In one experiment, trolley X is moving at 1·2 m s^{-1} to the right and trolley Y is moving at 0·60 m s^{-1} to the left.

The trolleys collide and do not stick together. After the collision, trolley X rebounds with a velocity of 0·80 m s^{-1} to the left.

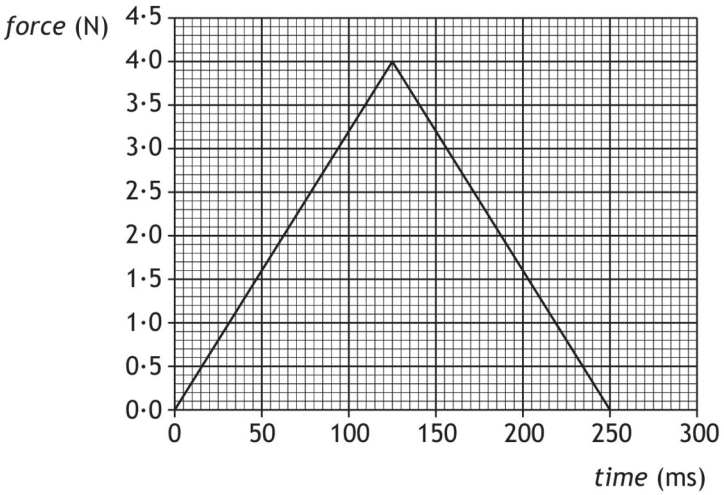
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MARKS WRITE IN THIS MARGIN

2. (continued)

(b) The force sensor measures the force acting on trolley Y during the collision.

The laptop displays the following force-time graph for the collision.



(i) Determine the magnitude of the impulse on trolley Y. **3**

Space for working and answer

(ii) Determine the magnitude of the change in momentum of trolley X. **1**

MARKS WRITE IN THIS MARGIN

2. (b) (continued)

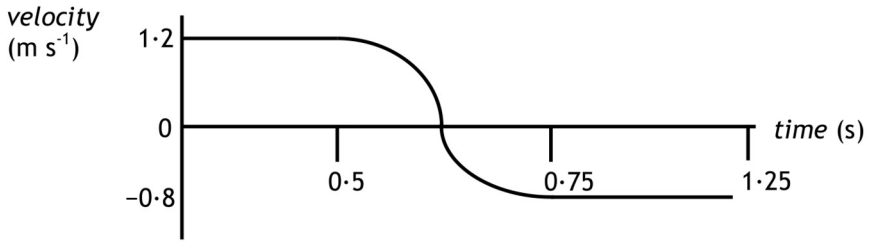
(iii) Sketch a velocity-time graph to show how the velocity of trolley X varies from 0·50 s before the collision to 0·50 s after the collision. **3**

Numerical values are required on both axes.
You may wish to use the square-ruled paper on *Page thirty-six*.

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2015 Question 2 (b): marking instructions

Question			Answer	Max Mark	Additional Guidance
	(b)	(i)	*impulse = area under graph* $\left(=\frac{1}{2}b\times h\right)$ (1) $=\frac{1}{2}\times 0\cdot 25\times 4\cdot 0$ (1) $=0\cdot 50$ N s (1) Accept $0\cdot 5$, $0\cdot 500$, $0\cdot 5000$	3	Impulse $= mv - mu$ $= (0\cdot 45\times 0\cdot 51) - (0\cdot 45\times -0\cdot 60)$ $= 0\cdot 50$ N s For alternative method accept: $0\cdot 5$, $0\cdot 500$, $0\cdot 4995$ Accept kg m s^{-1}
		(ii)	$0\cdot 50$ kg m s^{-1} (1)	1	Or consistent with (i) Accept N s Accept $0\cdot 5$

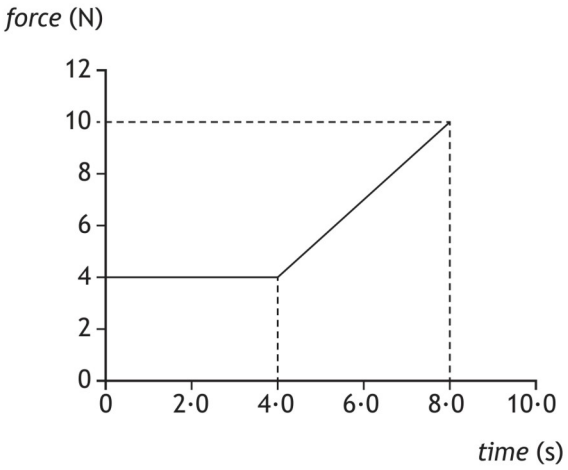
Question			Answer	Max Mark	Additional Guidance
		(iii)	 Constant velocity at correct values and signs before and after collision (1) Velocity change from initial to final in $0\cdot 25$ s. (1) Shape of change of velocity correct ie initially gradual, increasing steepness then levelling out to constant velocity. (1)	3	The origin and at least one axis must be labelled with quantity or unit or both otherwise maximum 2 marks.

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2016 Section 1 Question 4

Higher Physics 2016 Section 1 (multiple choice), Question 4. Total: 1 mark
Almost the same question was 2018 specimen Section 1 Question 6.

4. The graph shows the force which acts on an object over a time interval of 8·0 seconds.



The momentum gained by the object during this 8·0 seconds is

A $12\,kg\,m\,s^{-1}$
B $32\,kg\,m\,s^{-1}$
C $44\,kg\,m\,s^{-1}$
D $52\,kg\,m\,s^{-1}$
E $72\,kg\,m\,s^{-1}$.

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2016 Section 1 Question 4: marking instructions

Question	Answer	Max Mark
4.	C	1

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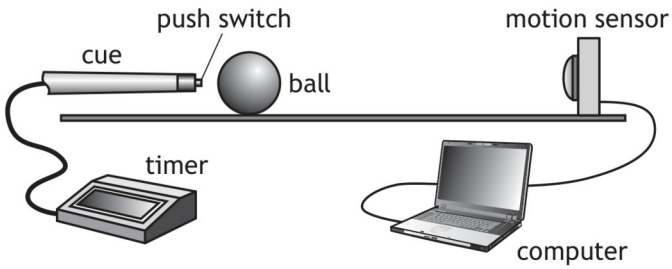
2017 Question 2 (b)

Higher Physics 2017 Section 2, Question 2 (b). Total: 5 marks

2. (continued)

MARKS | DO NOT WRITE IN THIS MARGIN

(b) A student carries out an experiment to measure the average force exerted by a cue on a ball.



The cue hits the stationary ball.

The timer records the time the cue is in contact with the ball.

The computer displays the speed of the ball.

The results are shown.

Time of contact between the cue and the ball = $(0{\cdot}040 \pm 0{\cdot}001)$ s

Speed of the ball immediately after contact = $(0{\cdot}84 \pm 0{\cdot}01)$ m s^{-1}

Mass of the ball = $(0{\cdot}180 \pm 0{\cdot}001)$ kg

(i) Calculate the average force exerted on the ball by the cue. An uncertainty in this value is not required. **3**

Space for working and answer

(ii) Determine the percentage uncertainty in the value for the average force on the ball. **2**

Space for working and answer

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2017 Question 2 (b): marking instructions

Question			Answer	Max mark	Additional guidance
	(b)	(i)	$Ft = mv - mu$ (1) $F \times 0{\cdot}040 = (0{\cdot}180 \times 0{\cdot}84) - (0{\cdot}180 \times 0)$ (1) $F = 3{\cdot}8\,\text{N}$ (1)	3	Accept: $a = \frac{v-u}{t}$ $a = \frac{0{\cdot}84(-0)}{0{\cdot}040}$ $a = 21\,(\text{m s}^{-2})$ $F = ma$ $F = 0{\cdot}180 \times 21$ $F = 3{\cdot}8\,\text{N}$ Sig figs 4, 3·78, 3·780 Note: 1 mark for **ALL** equations 1 mark for **ALL** substitutions 1 mark for **correct answer** Ignore any uncertainty calculations within this question.
		(ii)	$\left(\frac{0{\cdot}01}{0{\cdot}84} \times 100 = 1{\cdot}2\right)$ $\left(\frac{0{\cdot}001}{0{\cdot}180} \times 100 = 0{\cdot}56\right)$ $\frac{0{\cdot}001}{0{\cdot}040} \times 100\ (=2{\cdot}5)$ (1) (Uncertainty in F is) 2·5% (1)	2	1 mark for correct or implied working for % uncertainty in t. 1 mark for indicating 2·5% as the largest. Must have % in final answer - equivalent to 'unit'. Accept: 3%

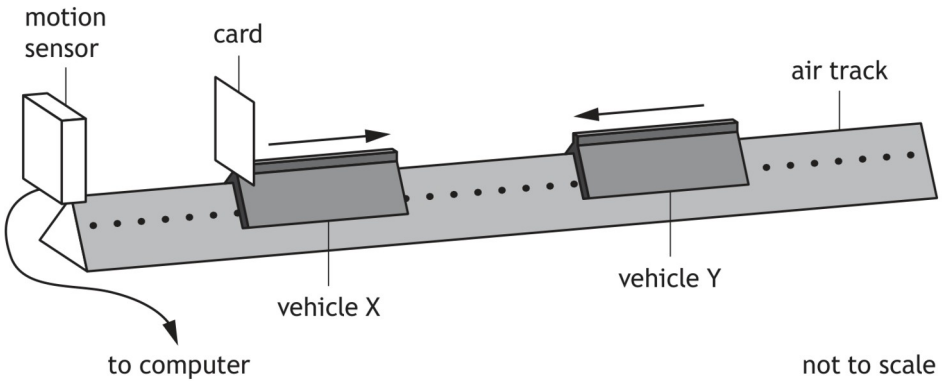
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2018 Question 3 (b)

Higher Physics 2018 Section 2, Question 3 (b). Total: 3 marks

MARGIN

3. A student sets up an experiment to investigate a collision between two vehicles on a frictionless air track.

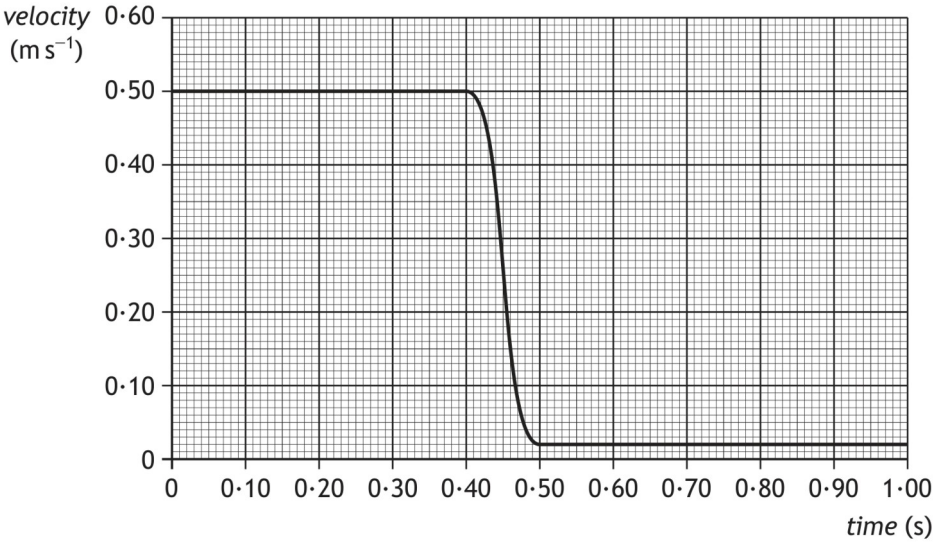


Vehicle X of mass 0·75 kg is travelling to the right along the track.

Vehicle Y of mass 0·50 kg is travelling to the left along the track with a speed of 0·30 m s^{-1}.

The vehicles collide and move off separately.

A computer displays a graph showing the velocity of vehicle X from just before the collision to just after the collision.



(b) Determine the impulse on vehicle Y during the collision. **3**

Space for working and answer

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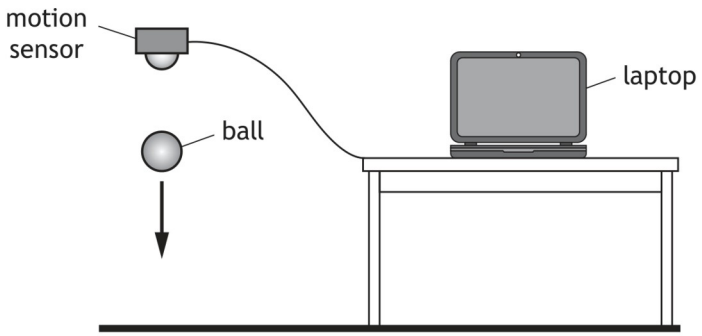
2018 Question 3 (b): marking instructions

Question			Answer		Max mark	Additional guidance
	(b)		$Ft = mv - mu$ $Ft = (0 \cdot 50 \times 0 \cdot 42) - (0 \cdot 50 \times -0 \cdot 30)$ $Ft = 0 \cdot 36$ N s	(1) (1) (1)	3	Accept: 0·4 Accept: Impulse $= mv - mu$ v and u must have opposite sign. Accept: kg m s^{-1}

2019 Paper 2 Question 1 (b)

Higher Physics 2019 Paper 2, Question 1 (b). Total: 6 marks

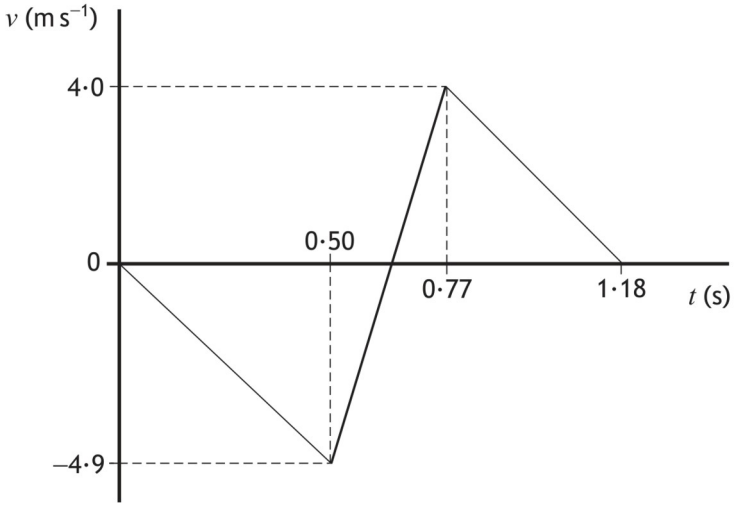
1. A student carries out an experiment with a tennis ball and a motion sensor connected to a laptop.



not to scale

The ball is released from rest below the sensor.

The graph shows how the vertical velocity v of the ball varies with time t, from the moment the ball is released until it rebounds to its new maximum height.



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MARGIN

1. (continued)

(b) The mass of the ball is 57·0 g.

(i) Determine the magnitude of the change in momentum of the ball during the bounce. **3**

Space for working and answer

(ii) Determine the magnitude of the average force exerted by the ball on the ground during the bounce. **3**

Space for working and answer

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2019 Paper 2 Question 1 (b): marking instructions

Question			Expected response	Max mark	Additional guidance
	(b)	(i)	$\Delta mv = mv - mu$ (1) $= (0{\cdot}0570 \times 4{\cdot}0) - (0 \times 0570 \times -4{\cdot}9)$ (1) $= 0{\cdot}51\,\text{kg m s}^{-1}$ (1)	3	Accept: 0·5, 0·507, 0·5073 Accept: $\Delta p = m\Delta v$ $Ft = mv - mu$ Do not accept: $p = mv - mu$ - 0 marks Sign convention must be consistent within this part of the question. v and u must have opposite signs. $p = mv$ (1) **all** substitutions **including** subtraction (1) final answer (1)

Question			Expected response	Max mark	Additional guidance
1.	(b)	(ii)	$Ft = mv - mu$ (1) $F \times 0{\cdot}27 = 0{\cdot}51$ (1) $F = 1{\cdot}9\,\text{N}$ (1)	3	Or consistent with (b)(i) Accept: 2, 1·89, 1·889 Alternative method: Sign convention must be consistent for this method. v and u must have opposite signs. $v = u + at$ $4{\cdot}0 = -4{\cdot}9 + a \times 0{\cdot}27$ $(a = 32{\cdot}96296296\,(\text{m s}^{-2}))$ $F = ma$ $F = 0{\cdot}0570 \times 32{\cdot}96296296$ $F = 1{\cdot}9\,\text{N}$ For **this** method accept 2, 1·88, 1·879 Both relationships (1) Both substitutions (1) Final answer (1)

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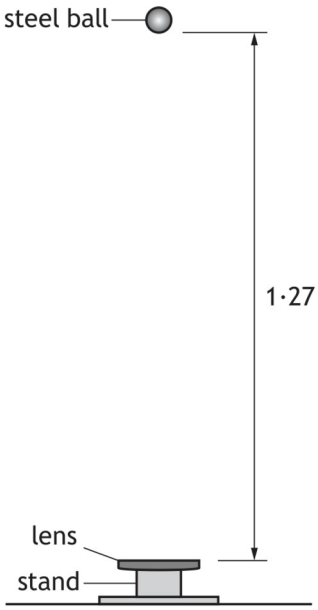
2020 Paper 2 Question 3 (a), (b) and (d)

Higher Physics 2020 Paper 2, Question 3 (a), (b) and (d). Total: 8 marks

3. A manufacturer tests whether a Perspex lens will break during an impact.

The lens is placed on a stand and a steel ball is dropped from rest onto the lens.

The ball has a mass of $1{\cdot}59 \times 10^{-2}$ kg and is dropped from a height of 1·27 m above the lens.



(a) Calculate the speed of the ball as it reaches the lens. **3**

Space for working and answer

MARGIN

3. (continued)

(b) The ball collides with the lens and rebounds upwards.

The magnitude of the change in momentum of the ball is 0·14 kg m s^{-1}.

Calculate the speed of the ball immediately after it rebounds from the lens. **3**

Space for working and answer

MARGIN

(d) The test is repeated with a second lens made of a softer material.

Explain why this would make the lens less likely to break. **2**

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2020 Paper 2 Question 3 (a), (b) and (d): marking instructions

Question			Expected response	Max mark	Additional guidance
3.	(a)		$v^2 = u^2 + 2as$ **(1)** $v^2 = 0^2 + 2\times(-)9{\cdot}8\times(-)1{\cdot}27$ **(1)** $v = 5{\cdot}0$ m s^{-1} **(1)**	3	Accept: 5, 4·99, 4·989 a and s **must** have the same sign, otherwise max 1 mark. For alternative methods: 1 mark for **all** relationships 1 mark for **all** substitutions 1 mark for final answer eg $E_p = mgh$ $E_p = 1{\cdot}59\times10^{-2}\times9{\cdot}8\times1{\cdot}27$ $E_k = \frac{1}{2}mv^2$ $\left(1{\cdot}59\times10^{-2}\times9{\cdot}8\times1{\cdot}27\right) = \frac{1}{2}\times1{\cdot}59\times10^{-2}\times v^2$ $v = 5{\cdot}0$ ms^{-1}
	(b)		$Ft = mv - mu$ **(1)** $0{\cdot}14 = \left(1{\cdot}59\times10^{-2}\times v\right) - \left(1{\cdot}59\times10^{-2}\times -5{\cdot}0\right)$ **(1)** $v = 3{\cdot}8$ m s^{-1} **(1)**	3	**Or** consistent with (a) Accept: 4, 3·81, 3·805 Ft and u must have opposite signs otherwise max 1 mark. Accept: $\Delta p = mv - mu$ $p = mv$ Do not accept $p = mv - mu$
	(d)		(Softer material would) increase the time of contact **(1)** and decrease the (maximum/ average) force **(1)**	2	Independent marks

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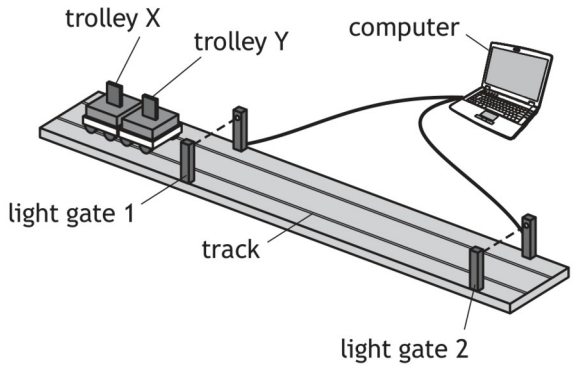
2022 Paper 2 Question 3 (a)

Higher Physics 2022 Paper 2, Question 3 (a). Total: 6 marks

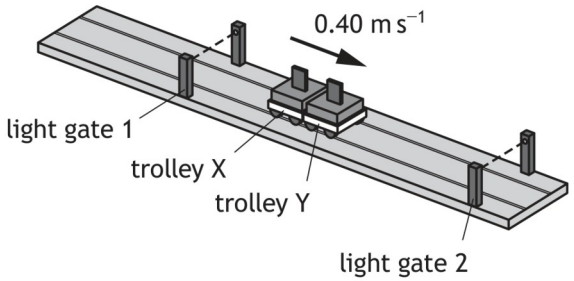
MARGIN

3. A student sets up an experiment to investigate the interaction between two trolleys on a smooth, horizontal track.

The mass of trolley X is 0.50 kg and the mass of trolley Y is 0.25 kg.



The trolleys X and Y are moving together to the right at 0.40 m s^{-1}.

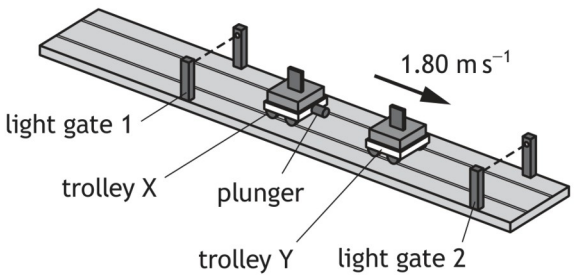


When the trolleys are between the light gates, a plunger in trolley X is activated.

The plunger extends and pushes trolley Y with an average force of 6.25 N for a short time, so that the trolleys separate.

Trolley Y now moves to the right at 1.80 m s^{-1}.

The effects of friction are negligible.



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3. (continued)

MARGIN

(a) (i) Calculate the magnitude of the change in momentum of trolley Y when the plunger is activated. **3**

Space for working and answer

(ii) Calculate the time during which the plunger exerts a force on trolley Y. **3**

Space for working and answer

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2022 Paper 2 Question 3 (a): marking instructions

Question			Expected response	Max mark	Additional guidance
3.	(a)	(i)	$\Delta mv = mv - mu$ **(1)** $\Delta mv = (0.25 \times 1.80) - (0.25 \times 0.40)$ **(1)** $\Delta mv = 0.35$ kg m s^{-1} **(1)**	3	Accept: 0.4, 0.350, 0.3500 Accept: $\Delta p = m\Delta v$ $Ft = mv - mu$ $p = mv$ Do not accept: $p = mv - mu$ - 0 marks For alternative methods: Acceptable relationship **(1)** **all** substitutions **including subtraction** **(1)** Final answer **(1)** Sign convention must be consistent within this part of the question. v and u must have same sign. Accept N s
		(ii)	$Ft = mv - mu$ **(1)** $6.25 \times t = 0.35$ **(1)** $t = 0.056$ s **(1)**	3	**OR** consistent with (a)(i) Accept: 0.06, 0.0560, 0.05600 Alternative method: $F = ma$ $6.25 = 0.25 \times a$ $v = u + at$ $1.80 = 0.40 + \left(\frac{6.25}{0.25}\right) \times t$ $t = 0.056$ s Both relationships **(1)** Both substitutions **(1)** Final answer **(1)**

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2023 Paper 2 Question 3 (c) and (d)

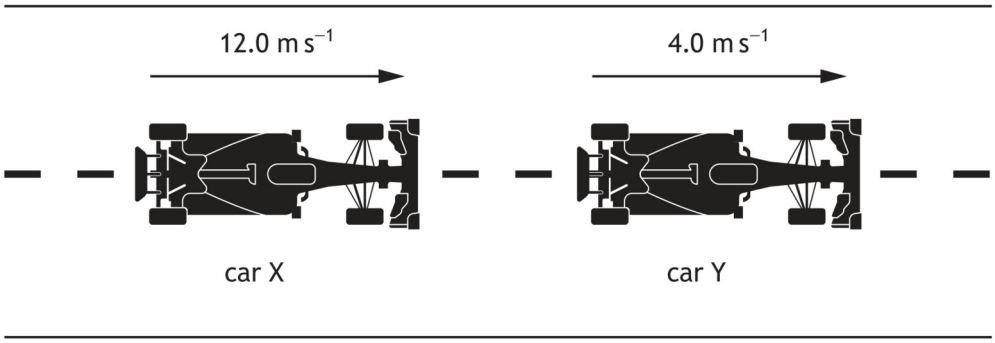
Higher Physics 2023 Paper 2, Question 3 (c) and (d). Total: 5 marks

MARGIN

3. During a practice session for a Grand Prix, two Formula 1 cars collide in the pit lane.

Car X has a mass of 760 kg and is travelling at 12.0 m s^{-1}.

Car Y has a mass of 840 kg and is travelling at 4.0 m s^{-1}.



The cars collide and move off separately.

Car Y moves off with a velocity of 8.5 m s^{-1}.

(c) During the collision, the cars are in contact for 0.82 s.

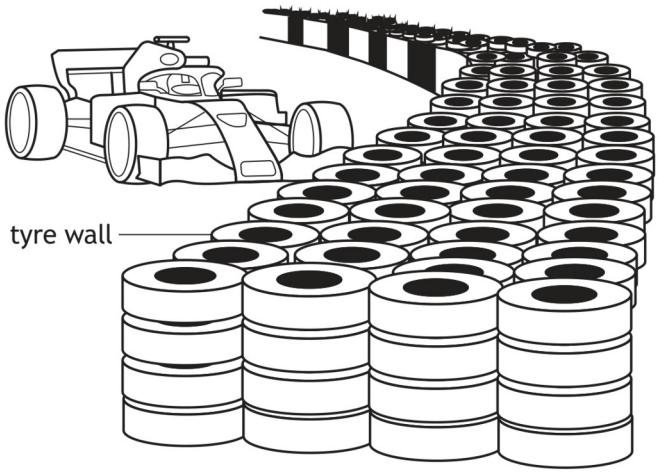
Calculate the magnitude of the average force car X exerts on car Y. **3**

Space for working and answer

MARGIN

3. (continued)

(d) One safety feature on Formula 1 racetracks is the use of tyre walls on bends. Tyre walls are designed to protect the driver in the event of their car leaving the track.



Explain how tyre walls protect the driver. **2**

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2023 Paper 2 Question 3 (c) and (d): marking instructions

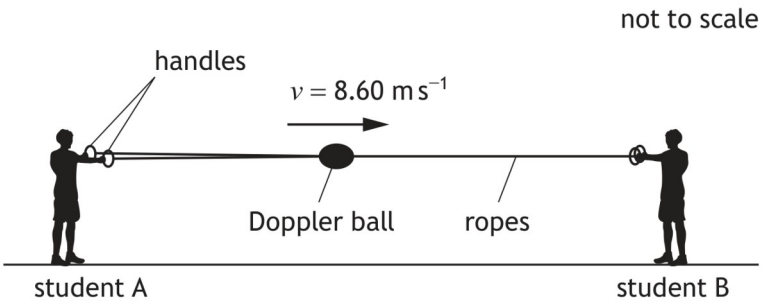
Question			Expected response	Max mark	Additional guidance
	(c)		$Ft = mv - mu$ **(1)** $F \times 0.82 = (840 \times 8.5) - (840 \times 4.0)$ **(1)** $F = 4.6 \times 10^3$ N **(1)**	3	Accept: 5, 4.61, 4.610 Accept: Impulse = $mv - mu$ u and v must be substituted correctly If the force that car Y exerts on car X is calculated, then there must be a statement that the forces have equal magnitude for final mark, otherwise MAX 2 marks. For this method - Accept: 5, 4.63, 4.634 (when v = 7.0) Or consistent with (a)
	(d)		(During a collision the tyre wall will) increase the time of contact (between the car and the wall). **(1)** (this will) reduce the (magnitude of the) force (experienced by the driver). **(1)**	2	**INDEPENDENT MARKS** Accept: time/duration of collision Accept: 'rate of change in momentum' for force.

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2024 Paper 2 Question 1 (b) (ii)

Higher Physics 2024 Paper 2, Question 1 (b) (ii). Total: 2 marks

(b) The Doppler ball is now threaded onto two ropes. There are handles at either end of the ropes.



The circuit in the Doppler ball is switched on. The loudspeaker produces a sound of frequency 622 Hz.

Student A pulls the ropes apart and the Doppler ball travels along the ropes towards student B.

The ball travels horizontally along the ropes at a constant velocity of $8.60\ \text{m s}^{-1}$.

MARGIN

1. (b) (continued)

(ii) The foam Doppler ball collides with the handles at the end of the ropes held by student B and comes to rest.

Explain how the foam ball protects the circuit board during the collision. **2**

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2024 Paper 2 Question 1 (b) (ii): marking instructions

Question			Expected response	Max mark	Additional guidance
		(ii)	(The foam) increases the time of contact (with the handles) **(1)** The force (on the circuit board) is less **(1)**	**2**	INDEPENDENT MARKS Accept: time/duration of collision Accept: force on ball is less Accept: 'rate of change of momentum' for force

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2024 Paper 2 Question 4 (b) (ii)

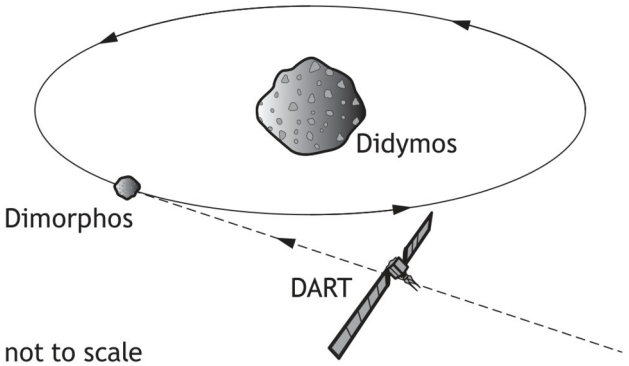
Higher Physics 2024 Paper 2, Question 4 (b) (ii). Total: 1 mark

MARGIN

4. On 26 September 2022, Double Asteroid Redirection Test (DART) collided with Dimorphos, a small asteroid that is in orbit around the larger asteroid Didymos.

The aim of the mission was to test a defence system that could be used to redirect an asteroid that is on a collision course with Earth.

When DART collided with Dimorphos, the kinetic energy of DART was transferred to Dimorphos. This caused Dimorphos to change its path.



(b) DART had a mass of 570 kg and was travelling at 6.6 km s^{-1} when it collided head-on with Dimorphos.

MARGIN

4. (b) (continued)

(ii) Complete the sketch graph of force F against time t for the force exerted on Dimorphos by DART during the collision.

Numerical values are not required on either axis. **1**

(An additional diagram, if required, can be found on *page 53*.)



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2024 Paper 2 Question 4 (b) (ii): marking instructions

Question			Expected response	Max mark	Additional guidance
		(ii)	Force-time graph with bell-shaped curve or equivalent triangle	1	

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2025 Paper 1 Question 6

Higher Physics 2025 Paper 1 (multiple choice), Question 6. Total: 1 mark

6. A ball of mass 0.164 kg is dropped from rest and falls towards the ground.

The ball collides with the ground and rebounds upwards.

The speed of the ball just before it hits the ground is 4.85 $m\,s^{-1}$.

The ball is in contact with the ground for 0.180 s.

The speed of the ball immediately after it rebounds from the ground is 3.96 $m\,s^{-1}$.

The mean force exerted by the ball on the ground during the collision is

A 0.146 N

B 0.811 N

C 0.645 N

D 1.44 N

E 8.03 N.

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2025 Paper 1 Question 6: marking instructions

Question	Answer	Mark
6.	E	1

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2025 Paper 1 Question 7

Higher Physics 2025 Paper 1 (multiple choice), Question 7. Total: 1 mark

7. Two samples of modelling clay, X and Y, have the same shape and mass.

Sample X is made of a softer clay than sample Y.

The samples are both released from the same height and fall towards the ground.

Both samples come to rest when they collide with the ground.

A student makes the following statements about the samples colliding with the ground.

I Sample X comes to rest in less time than sample Y.

II The mean force exerted by the ground on sample X is less than the mean force exerted by the ground on sample Y.

III The change in momentum of sample X is less than the change in momentum of sample Y.

Which of these statements is/are correct?

A I only

B II only

C I and II only

D I and III only

E II and III only

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2025 Paper 1 Question 7: marking instructions

Question	Answer	Mark
7.	B	1

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2026 Paper 1 Question 5

Higher Physics 2026 Paper 1 (multiple choice), Question 5. Total: 1 mark

5. A toy car of mass 0.50 kg is travelling along a frictionless track with a constant speed of 0.80 $m\,s^{-1}$.

A constant force of 1.2 N is now applied to the toy car, in the same direction as the car is travelling, for a time of 1.5 s.

The **change in speed** of the toy car is

A 2.4 $m\,s^{-1}$

B 2.8 $m\,s^{-1}$

C 3.6 $m\,s^{-1}$

D 4.4 $m\,s^{-1}$

E 9.0 $m\,s^{-1}$.

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2026 Paper 1 Question 5: marking instructions

Question	Answer	Mark
5.	C	1

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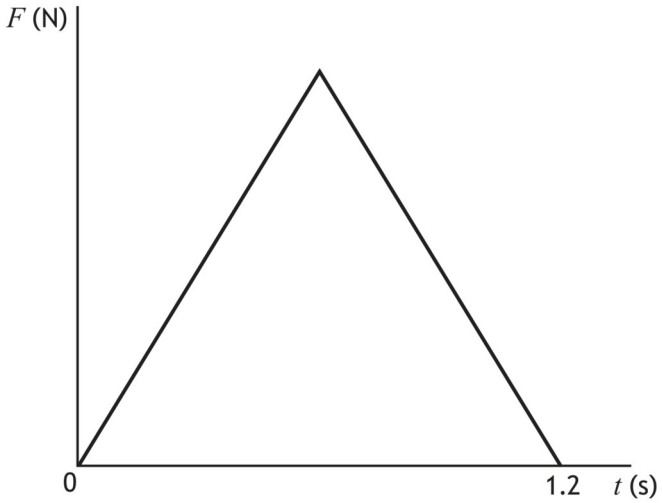
2026 Paper 1 Question 6

Higher Physics 2026 Paper 1 (multiple choice), Question 6. Total: 1 mark

6. A car of mass 1400 kg is travelling at a speed of 18 m s^{-1}.

A force is now applied to the car bringing it to rest.

The graph shows how the force F applied to the car varies with time t.



The magnitude of the average force applied to the car during this time is

A 1.1×10^4 N

B 2.1×10^4 N

C 2.5×10^4 N

D 4.2×10^4 N

E 5.0×10^4 N.

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2026 Paper 1 Question 6: marking instructions

Question	Answer	Mark
6.	B	1

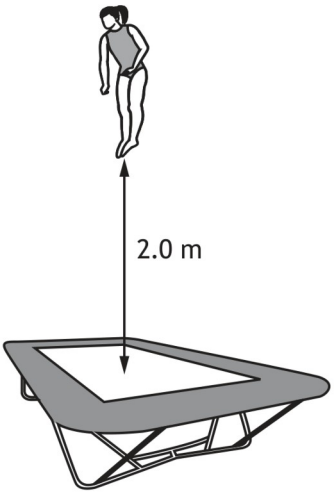
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Specimen Paper 2 Question 2 (a)

Higher Physics Specimen paper, Paper 2, Question 2 (a). Total: 8 marks
The same question was 2018 specimen Section 2 Question 3 (a).

MARGIN

2. (a) A gymnast of mass 42 kg is practising on a trampoline.



(i) At maximum height, the gymnast's feet are 2.0 m above the trampoline.

Show that the speed of the gymnast, as they land on the trampoline, is 6.3 m s^{-1}. **2**

Space for working and answer

(ii) The gymnast rebounds with a speed of 5.3 m s^{-1}.

Calculate the magnitude of the change in momentum of the gymnast. **3**

Space for working and answer

MARGIN

2. (a) (continued)

(iii) The gymnast was in contact with the trampoline for 0.50 s.

Calculate the magnitude of the average force exerted by the trampoline on the gymnast. **3**

Space for working and answer

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Specimen Paper 2 Question 2 (a): marking instructions

Question			Expected response		Max mark	Additional guidance
2.	(a)	(i)	$v^2 = u^2 + 2as$	(1)	2	SHOW question
			$v^2 = 0 + 2 \times 9.8 \times 2.0$	(1)		If final line is not shown then a maximum of **1 mark** can be awarded.
			$v = 6.3$ ms^{-1}			
			OR			
			$mgh = \frac{1}{2}mv^2$	(1)		If using the second method, accept a substitution without the mass providing there is a clear indication that the mass on each side of the relationship cancels.
			$42 \times 9.8 \times 2.0 = \frac{1}{2} \times 42 \times v^2$	(1)		
			$v = 6.3$ ms^{-1}			
		(ii)	$\Delta p = mv - mu$	(1)	3	Accept: 500, 487, 487.2
			$\Delta p = (42 \times 5.3) - (42 \times (-6.3))$	(1)		Accept: alternative sign convention for direction
			$\Delta p = 490$ kgms^{-1}	(1)		
		(iii)	$Ft = mv - mu$	(1)	3	Or consistent with (a)(ii)
			$F \times 0.50 = 490$	(1)		Accept: 1000, 980.0
			$F = 980$ N	(1)		

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