Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

STEM | Exam Builder

Forces and momentum

Time allowed: 1 hour 5 minutes

Subject code **0625**

Physics

Questions from Paper 3 and Paper 4

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.

Total marks

/ 66

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.

Information

- This paper has 10 questions worth 66 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

STEM | Exam Builder

Print at 100% (Actual size) so diagrams keep their real measurements.

1 Fig. 2.1 shows a cyclist travelling along a level road.

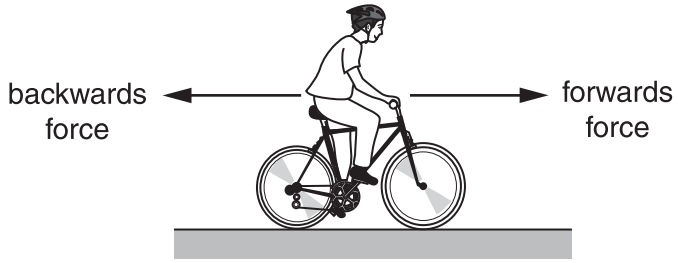


Fig. 2.1

(a) Describe the movement of the bicycle when the forces shown in Fig. 2.1 are of equal size.

..... [1]

(b) Fig. 2.2 shows the forces on the bicycle later in the journey.



Fig. 2.2

Determine the size and direction of the resultant force.

size of resultant force = ... N

direction of resultant force = ...

[2]

(c) At the end of the journey the cyclist applies the brakes to stop the bicycle.

Name and describe the force that causes the bicycle to stop.

force .....

description .....

.....

[2]

[Total: 5]

Resultant force, F = ma and circular motion Click for more variations

STEM | Exam Builder

1(a)(i)	constant speed/velocity	**B1**
1(a)(ii)	75 N	**B1**
	forwards	**B1**
1(b)	friction	**B1**
	two surfaces rubbing together owtte	**B1**
	Total	**5**

STEM | Exam Builder

2 **(a)** A student has a spring of length 14.0 cm. She stretches the spring by adding different loads to the spring.
She measures the length of the spring for each load. She plots a graph of the results.
Fig. 2.1 shows the graph of her results.

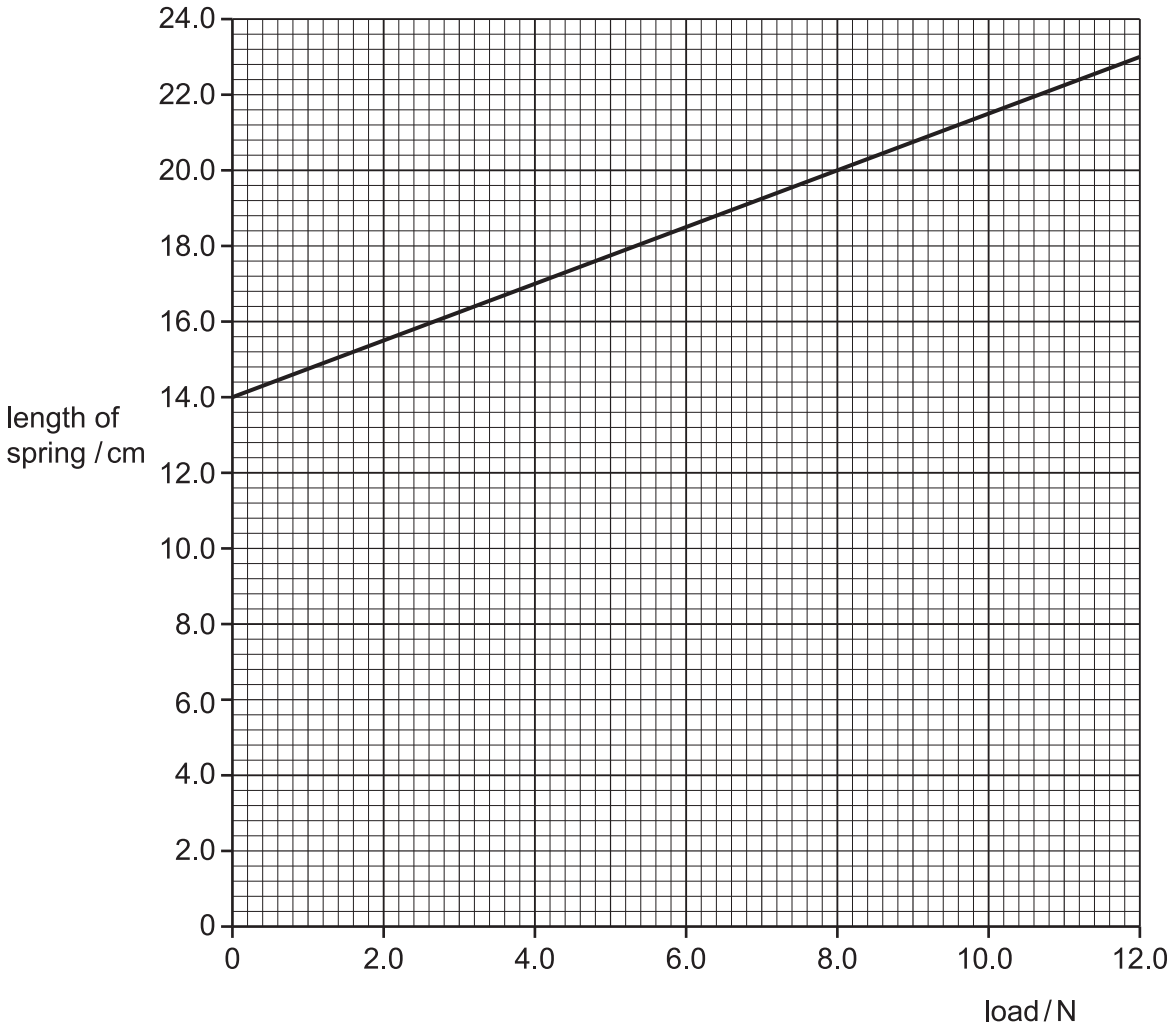


Fig. 2.1

(i) Use the graph to determine the length of the spring when the student adds a load of 8.0 N to the spring.

length of spring = ... cm [1]

(ii) Use the graph to determine the load added to the spring when the **extension** of the spring is 7.0 cm.

load for an extension of 7.0 cm = ... N [2]

STEM | Exam Builder

(b) Complete the sentence about effects of forces. Choose a word from the box.

charge	mass	power	shape	velocity

A load stretching a spring is an example of a force changing the size and the ..... of an object. [1]

(c) A clamp stand used in the experiment has a weight of 8.6 N.
Calculate the mass of the clamp stand.

mass of clamp stand = ... kg [3]

[Total: 7]

Springs and Hooke's law Click for more variations

Reduced to 77% to fit the page (wider than A4).

2(a)(i)	(length of spring with 8.0 N load =) 20 (cm)	**B1**
2(a)(ii)	(load for length of 21 cm =) 9.3 (N)	**A2**
	(extension of 7 cm = length of) 21 cm	**(C1)**
2(b)	shape	**B1**

2(c)	(m =) 0.88 (kg)	**A3**
	(m =) 8.6 ÷ 9.8	**(C2)**
	W = mg OR (m =) W ÷ g	**(C1)**

STEM | Exam Builder

3 A cricket ball is travelling at a speed of 25 m / s horizontally through the air. The mass of the ball is 0.14 kg.

A player catches the ball and the ball comes to rest.

(a) Calculate the change in momentum of the ball during the catch.

change in momentum = ... [2]

(b) The player's hands are in contact with the moving ball for 9.7 ms.

Calculate the horizontal force exerted by her hands to bring the ball to rest.

force = ... [3]

[Total: 5]

Momentum and impulse Click for more variations

Reduced to 77% to fit the page (wider than A4).

3(a)	(–) 3.5 kgm / s	**A2**
	(Δp =) $m(\Delta)u$ **OR** $m\{v - u\}$ **OR** 0.14 × {25 (– 0)}	C1
3(b)	360 N	**A3**
	0.0097 (s) **OR** 9.7×10^{-3} (s) **OR** 3.6×10^{n}	C1
	(F =) (Δ)p / t **OR** 3.5 / 0.0097	C1

STEM | Exam Builder

4 Fig. 1.1 shows a force–extension graph for a spring.

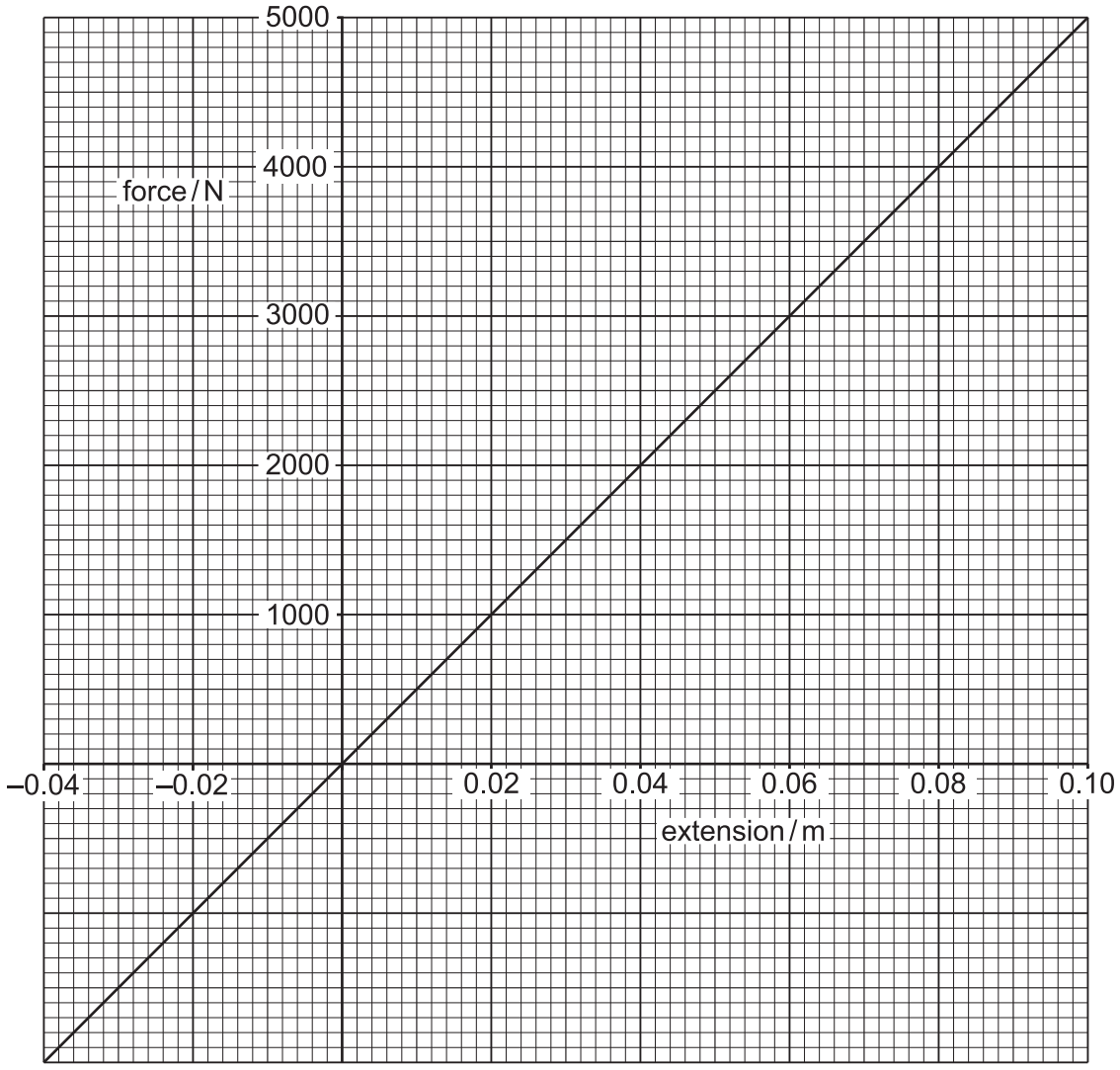


Fig. 1.1

(a) Calculate the spring constant *k* of the spring.

k = ... [2]

(b) A student states that the spring has **not** reached the limit of proportionality when a force of 4500 N is applied to it.

State how the graph shows that this statement is true.

.....

..... [1]

STEM | Exam Builder

(c) Springs can be compressed by forces. The spring described by Fig. 1.1 is compressed by a force F and has an extension of –0.025 m.

Determine F.

F = ... [2]

(d) State whether force is a scalar quantity or a vector quantity. Explain your answer.

.....

..... [1]

[Total: 6]

Springs and Hooke's law Click for more variations

Reduced to 77% to fit the page (wider than A4).

4(a)	50 000 N / m **OR** 5.0×10^4 N / m	**A2**
	(k =) $F \div x$ **OR** k is (determined from) the gradient (of the line in Fig. 1.1)	C1
4(b)	Any one from: • The graph is a straight line (through the origin) • The slope / gradient is constant • The graph / line does not curve	**B1**
4(c)	1300 N	**B1**
	any negative number **OR** indication that force is in opposite direction	**B1**
4(d)	(Force is a) vector quantity. Forces have (both magnitude / size and) direction	**B1**

STEM | Exam Builder

5 Fig. 3.1 shows a collision at very slow speed between two cars travelling along a straight road.

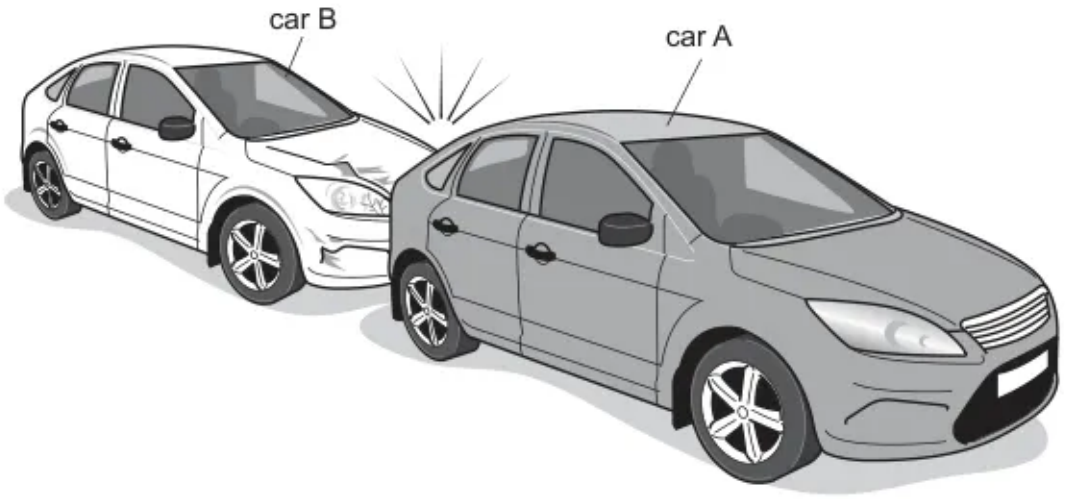


Fig. 3.1

Car B, of mass 800 kg, is moving at 2.0 m/s and collides with car A, of mass 1000 kg, which is stationary. After the collision, both cars travel in the same direction as the initial direction of car B.

(a) After the collision, car A moves at 1.3 m/s.

Show that the speed of car B after the collision is approximately 0.4 m/s.

[3]

(b) (i) Calculate the impulse exerted by car A on car B.

impulse = ... [2]

(ii) State the impulse exerted by car B on car A.

impulse = ... [1]

[Total: 6]

Momentum and impulse Click for more variations

5(a)	momentum before collision = momentum after collision	**B1**
	(initial momentum (*p*) =) 800 × 2 OR 1600 (kg m / s)	**B1**
	(v =) (1600 – 1300) / 800 OR 300 / 800 OR 0.38 (m / s)	**B1**
5(b)(i)	(impulse =) change in momentum	**C1**
	1300 Ns	**A1**
5(b)(ii)	same value as **(b)(i)** OR 1300 (Ns)	**B1**

STEM | Exam Builder

6 **(a)** Define impulse.

.....

..... [1]

(b) Fig. 2.1 shows a rocket and its exhaust gases.

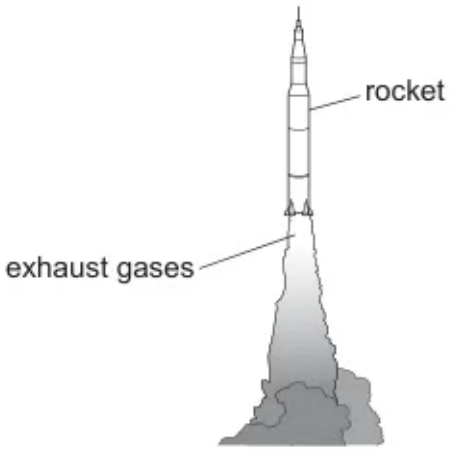


Fig. 2.1

The exhaust gases are emitted from the rocket with a velocity of 1400 m/s and at a rate of 2800 kg/s.

(i) Show that the force exerted on the rocket by the exhaust gases is 3900 kN.

State the equation you use.

[2]

(ii) Calculate the maximum mass that this force can lift from the ground. Ignore air resistance.

maximum mass = ... [3]

[Total: 6]

Mass and weight Click for more variations

6(a)	(**I**mpulse =) force × time (for which force acts)	**B1**
6(b)(i)	$F\Delta t = \Delta\{mv\}$ **OR** $(F =) \Delta\{mv\} / \Delta t$ **OR** $(F =) \Delta p / t$	**M1**
	{2800 × 1400} (/ 1) = 3 920 000 N **OR** {2800 × 1400} (/ 1) = 3920 kN	**A1**
6(b)(ii)	4.0×10^5 kg **OR** 400 000 kg	**A3**
	(at maximum mass) force = weight of rocket **OR** F = mg	(C1)
	$(m=) F / g$ **OR** $3.9 \times 10^6 / 9.8$ **OR** $4(.0) \times 10^N$ (kg)	(C1)

7 **(a)** Describe an experiment to determine the spring constant of a spring.

State:

- the apparatus you need
- details of how to take measurements
- how to calculate the spring constant

You may use the space below to draw a **labelled** diagram as part of your answer.

.....

.....

.....

.....

.....

.....

.....

..... [4]

STEM | Exam Builder

(b) Fig. 2.1 shows a baby in a baby bouncer. The baby bouncer consists of a holder suspended from a spring. The baby pushes his feet on the ground and bounces gently up and down.

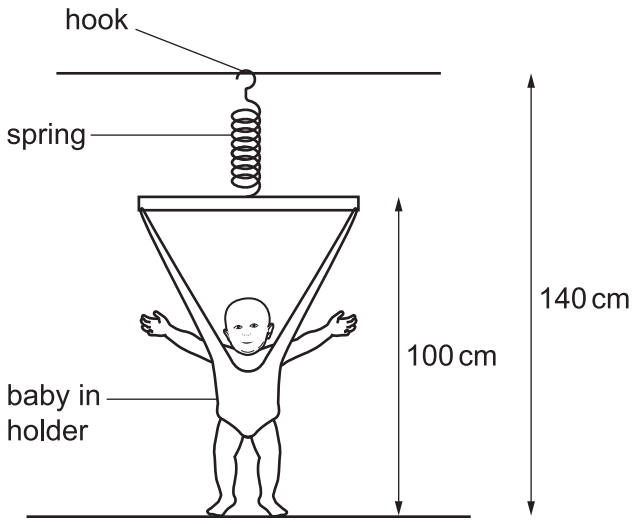


Fig. 2.1

(i) Two springs Q and R are tested to determine their spring constants.

Each spring is tested up to its limit of proportionality.

Define 'limit of proportionality'.

.....

..... [1]

(ii) Table 2.1 shows the results of the tests.

spring	spring constant / N/cm
Q	7.8
R	1.1

Table 2.1

The total weight of the baby and the holder is 120 N.

Calculate the extension of each spring for this weight.

extension of spring Q = ...

extension of spring R = ...

[1]

STEM | Exam Builder

(iii) The unstretched length of each spring is 25 cm.

State and explain which spring would be more suitable for the baby bouncer in Fig. 2.1.

spring .....

explanation .....

.....

[1]

[Total: 7]

Springs and Hooke's law Click for more variations

Reduced to 78% to fit the page (wider than A4).

7(a)	hang mass / weight on the bottom of the spring	**B1**
	use a ruler / metre rule ***AND*** measure / calculate <u>extension</u>	**B1**
	use of $k = F / x$ to calculate the spring constant ***OR*** k is the gradient of load-extension graph	**B1**
	any **one** of: • repeat measurements using different masses / weights and plot a load against extension graph • measure final length and initial length of spring and subtract to obtain (magnitude of) extension / change in length • use a pointer on the bottom of spring to obtain more accurate measurements on ruler	**B1**
7(b)(i)	maximum load that can be applied when the extension is proportional to load ***OR*** the maximum force up to which the extension is proportional to the load	**B1**
7(b)(ii)	(extension of spring Q =) 15 cm or 0.15 m ***AND*** (extension of spring R =) 110 cm or 1.1 m	**B1**
7(b)(iii)	Q ***AND*** extension produced by Q is the right length to allow baby to just reach the floor with feet ***OR*** Q ***AND*** extension produced by R is too big (for gentle bounces in the space provided) ***OR*** R would make the baby collapse on floor (so unsafe) ***OR*** bouncer would have to be hung higher if R was used	**A1**

STEM | Exam Builder

8 Trolley A and trolley B are on a horizontal, frictionless bench. Trolley A moves to the right with a constant velocity $u = 0.44\,m/s$. Trolley B is stationary.

Fig. 2.1 shows trolley A before it collides with trolley B.

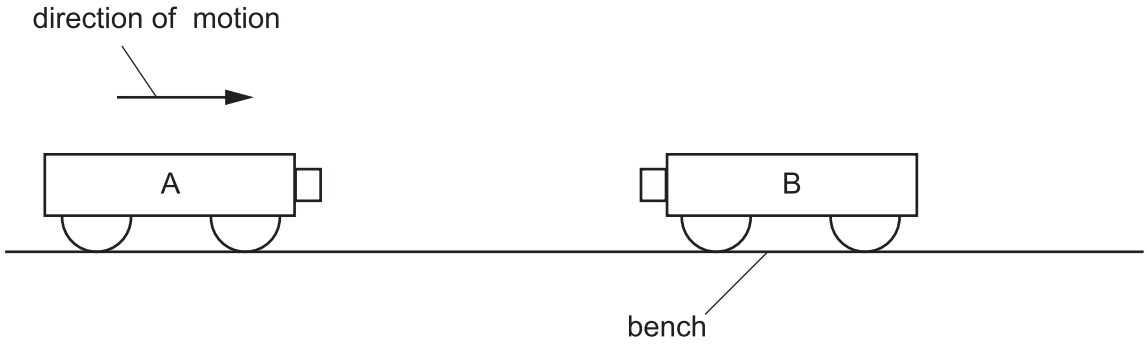


Fig. 2.1 (not drawn to scale)

(a) State the momentum of trolley B before the collision. Explain your answer.

statement .....

explanation .....

.....

[1]

(b) After the collision, the two trolleys are joined together and travel with a constant velocity $v = 0.18\,m/s$ to the right. The mass of trolley A is 0.75 kg.

Calculate the mass of trolley B.

mass of trolley B = ... [3]

STEM | Exam Builder

(c) (i) The trolleys move onto a rough surface which exerts a constant force F on the trolleys and brings them to rest in 2.6 s.

Calculate F.

F = ... [2]

(ii) A different rough surface exerts a smaller resistive force on the trolleys. State how this affects the time taken to bring the trolleys to rest. Explain your answer.

statement .....

explanation .....

.....

[1]

[Total: 7]

Momentum and impulse Click for more variations

Reduced to 77% to fit the page (wider than A4).

8(a)	(statement momentum is) zero / 0 **AND** (explanation) momentum is mass × velocity **OR** the velocity (of B) is zero	**B1**
8(b)	1.1 kg	**A3**
	Conservation of momentum **OR** momentum after (collision) = momentum before (collision) **OR** {0.75 × 0.44} = {0.75 + m} × 0.18	C1
	momentum before collision = 0.75 × 0.44 (+ m ×0 = 0.33) **OR** momentum after collision = (0.75 + m) × 0.18	C1
8(c)(i)	0.13 N	**A2**
	(F =) $\Delta p \div (\Delta)t$ **OR** (0.75 + 1.1) × 0.18 ÷ 2.6 **OR** (F =) 0.33 ÷ 2.6 $(F =)\{0.75 + \mathbf{2(b)}\} \times 0.18 \div 2.6$	C1
8(c)(ii)	(time taken) **I**ncreases **AND** use of $F(\Delta)t = \Delta\{mv\}$ **OR** $F \propto 1 / (\Delta)t$ **OR** same momentum change required	**B1**

STEM | Exam Builder

9 **(a)** A truck moves with a constant acceleration. The speed of the truck increases from 13 m/s to 22 m/s. The time taken for this increase in speed is 4.5 s. The mass of the truck is 3700 kg.

(i) Calculate the resultant force acting on the truck.

resultant force = ... [3]

(ii) The engine of the truck provides the forward force on the truck. State **two** forces acting on the truck in the opposite direction to the forward force.

.....

.....

..... [2]

STEM | Exam Builder

(b) Fig. 2.1 shows a car as it travels round a circular racing track.

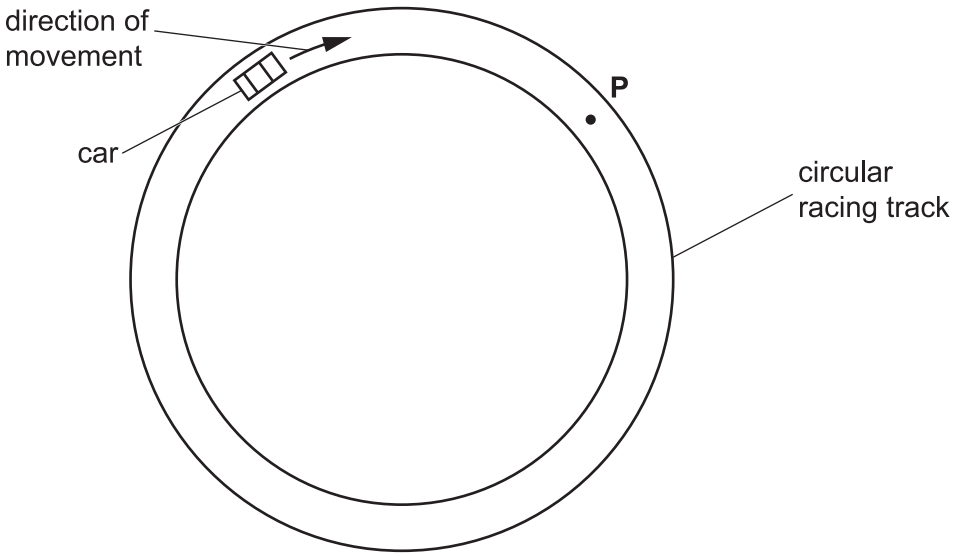


Fig. 2.1

(i) The car travels at constant speed.

On Fig. 2.1, draw an arrow to show the direction of the force acting on the car. [1]

(ii) A different car travels around the same track and slides off the track at point P.

State **two** possible reasons that cause the car to slide off the track.

.....

.....

.....

..... [2]

[Total: 8]

Resultant force, F = ma and circular motion Click for more variations

Reduced to 77% to fit the page (wider than A4).

9(a)(i)	7400 N	**A3**
	$a = \Delta v / \Delta t$ **OR** $a = \{22 - 13\} / 4.5$ **OR** 2.0 (m/s^2) SEEN	C1
	($F =$) ma **OR** 3700×2.0	C1
9(a)(ii)	air resistance **OR** drag	**B1**
	friction (between tyres and road)	**B1**
9(b)(i)	arrow from car pointing towards the centre of the circle	**B1**
9(b)(ii)	any **two** from: • car has higher speed • less friction (between car and track) **OR** not enough friction • larger mass	**B2**

STEM | Exam Builder

10 Fig. 2.1 shows an object of mass 2.0 kg on a bench. This object is connected by a cord, passing over a pulley, to an object of mass 3.0 kg.

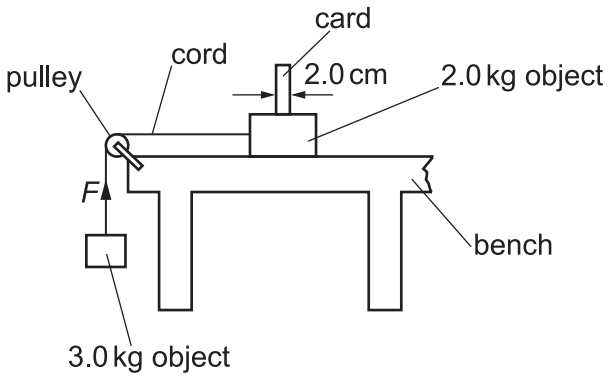


Fig. 2.1

The 2.0 kg object is released from rest and accelerates at 4.0 m / s^2.

(a) Calculate the resultant force acting on the 2.0 kg object.

force = ... [2]

(b) Calculate the upward force *F* exerted by the cord on the 3.0 kg object.

force *F* = ... [3]

(c) The objects have a constant acceleration.

(i) Show that the speed of the objects 0.80 s after release is 3.2 m / s.

[2]

(ii) A card, of width 2.0 cm, is fixed to the 2.0 kg object. As the 2.0 kg object moves to the left, the card passes through a beam of light that is perpendicular to the card.

Using the speed given in **(c)(i)**, calculate the time taken for the card to pass through the beam of light.

STEM Exam Builder

time = ... [2]

[Total: 9]

Resultant force, F = ma and circular motion Click for more variations

10(a)	(F = 2.0 × 4.0 =) 8.0 N	**A2**
	(F =) ma in any form	C1

10(b)	(F = 30 – 12 =) 18 N	**A3**
	resultant force on 3 kg mass (3 × 4 =) 12 (N)	C1
	(weight of 3 kg mass = 3 × 10) = 30 (N)	C1
10(c)(i)	(Δv =) 4.0 × 0.80 (= 3.2 m / s)	**A2**
	(Δ)v = at in any form	C1
10(c)(ii)	(t = 0.020 / 3.2 =) 0.0063 s OR 6.3 × 10^{-3} s	**A2**
	(t =) d / v in any form	C1

STEM | Exam Builder