

AQA GCSE PHYSICS (HIGHER) • 8463

PHYSICS



EXAM QUESTION PACK

4.5.7 MOMENTUM (PACK 1)

SCORE

/70

PERCENTAGE

%

STEMUP

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Q1.

Figure 1 shows a man using a resistance band when exercising.

The resistance band behaves elastically.

Figure 1



- (a) What happens to the store of elastic potential energy of the resistance band when the band is stretched?

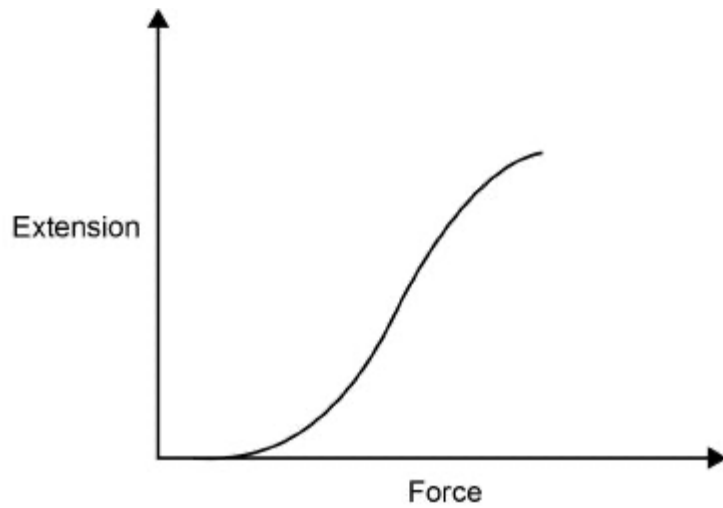
(1)

- (b) Explain what happens to the resistance band as it is released.

(2)

- (c) **Figure 2** shows how the extension of the resistance band changes as the force applied changes.

Figure 2



Describe the trend shown in the graph.

(2)

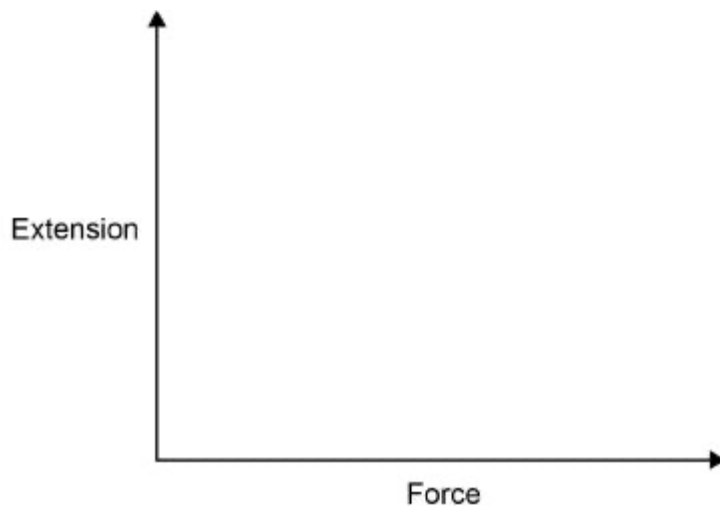
Figure 3 shows a chest expander.

Figure 3



- (d) Sketch a graph on **Figure 4** to show how the extension of a spring in the chest expander changes as the force applied changes.

Figure 4



(2)

When a force is applied to a spring, the spring extends by 7.5 cm

(e) Write down the equation that links extension, force and spring constant.

(1)

(f) Calculate the force applied to the spring.

The spring has a spring constant of 1 600 N/m

Use your equation from part (e)

Force = _____ N

(3)

(Total 11 marks)

Q2.

The diagram below shows an ice skater, Skater A.



- (a) Write down the equation that links mass, momentum and velocity.

_____ (1)

- (b) Skater **A** travels with a velocity of 3.2 m/s and has a momentum of 200 kg m/s

Calculate the mass of Skater **A**.

Mass = _____ kg (3)

- (c) Skater **A** bumps into another skater, Skater **B**. Skater **B** is stationary.

The skaters move off together in a straight line.

Explain what happens to the velocity of each of the skaters.

Use the idea of conservation of momentum.

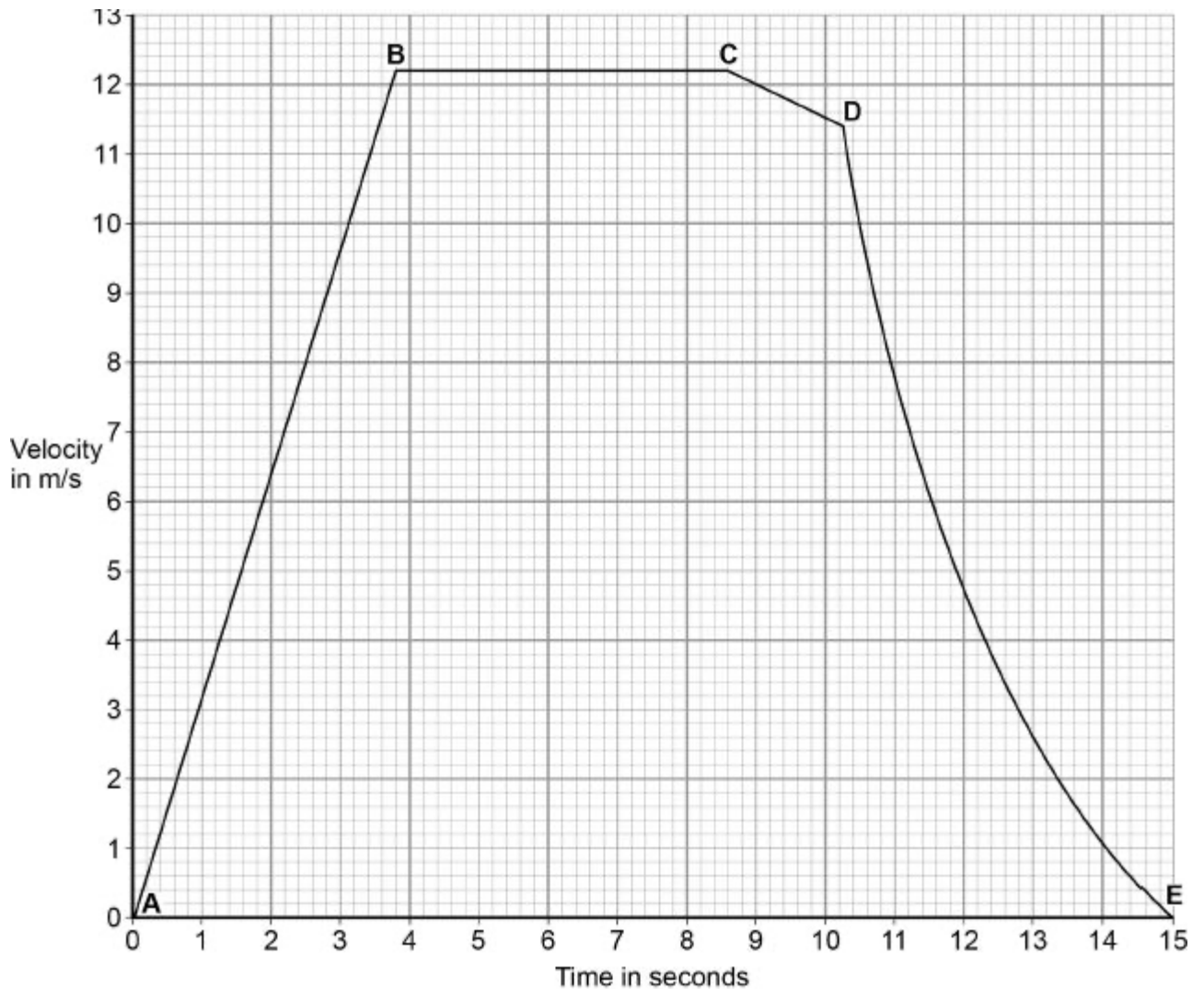
(3)
(Total 7 marks)

Q3.

An athlete takes part in a race on a straight, horizontal running track.

Figure 1 shows the velocity-time graph for the athlete during the race.

Figure 1



- (a) What is the main force that opposes the athlete's forward motion?

(1)

- (b) Which section of the graph represents a part of the race where the resultant force on the athlete is zero?

Tick **one** box.

A-B	B-C	C-D	D-E
☐	☐	☐	☐

(1)

- (c) The athlete has a mass of 94.8 kg

Calculate the momentum of the athlete at a time of 6.0 s

Use **Figure 1**.

Momentum = _____ kg m/s

(3)

- (d) The acceleration is **not** constant from **D** to **E**.

Determine the acceleration at a time of 12.0 s

Use **Figure 1**.

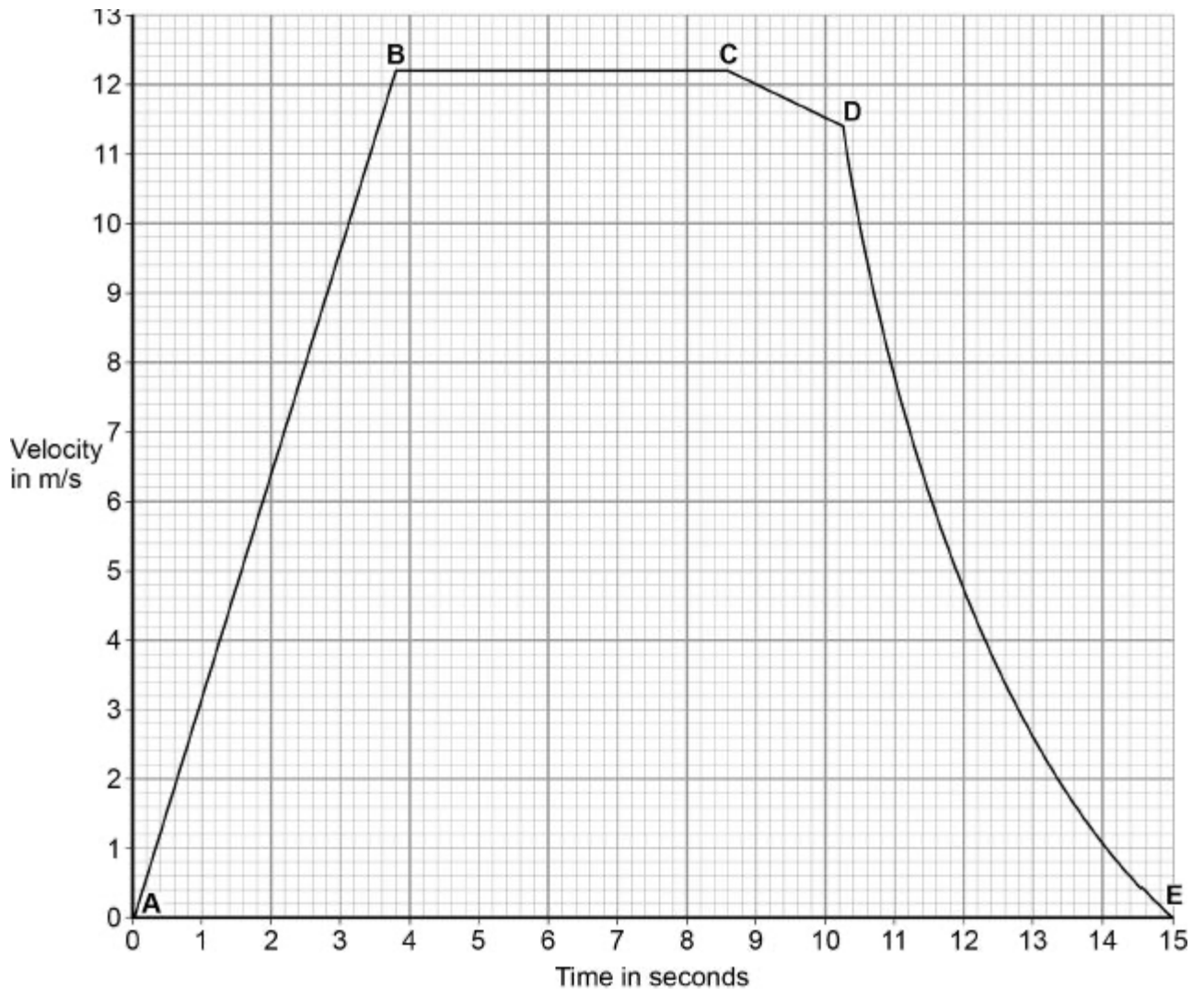
Give the unit.

Acceleration = _____ Unit _____

(5)

Figure 2 is a copy of **Figure 1** to help you answer the following questions.

Figure 2



A second athlete starts the race at the same time as the first athlete.

The second athlete moves with a constant acceleration of 1.6 m/s^2 for the first 6.0 seconds of the race.

The first athlete travels further than the second athlete during the first 6.0 seconds.

- (e) Draw a line on **Figure 2** to represent the motion of the second athlete for the first 6.0 seconds of the race.

(2)

- (f) Determine the extra distance travelled by the first athlete over the first 6.0 seconds of the race.

Use **Figure 2**.

Extra distance travelled by first athlete = _____ m

(4)

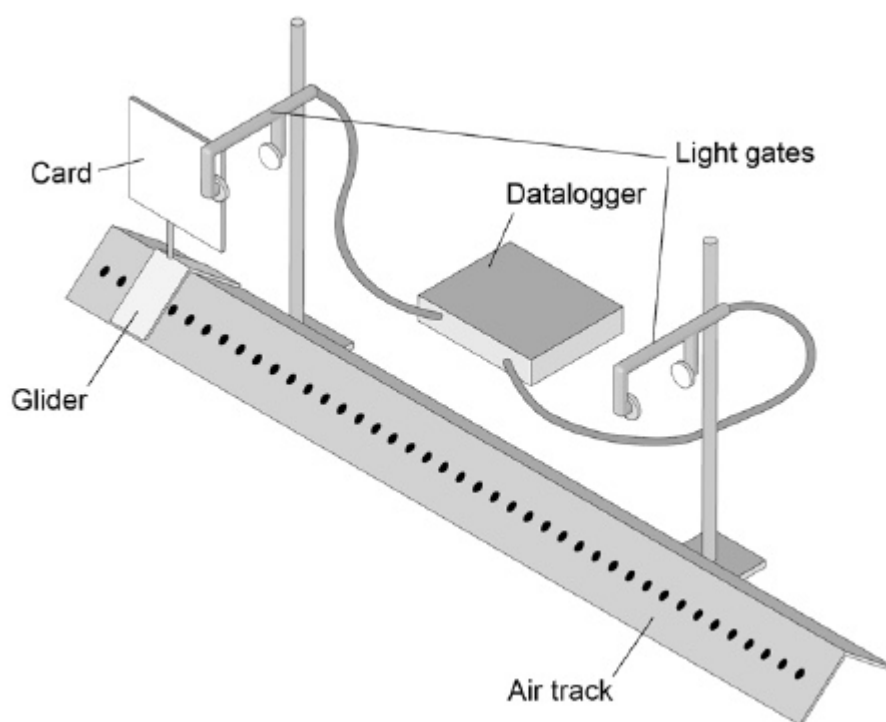
(Total 16 marks)

Q4.

A student investigated the motion of a glider on an air track.

Figure 1 shows the apparatus.

Figure 1



- (a) The speed of the glider is the same at both ends of the air track.

What is the tendency for objects to continue at the same speed in the same direction called?

(1)

- (b) The glider has a mass of 0.14 kg and a velocity of 17 cm/s

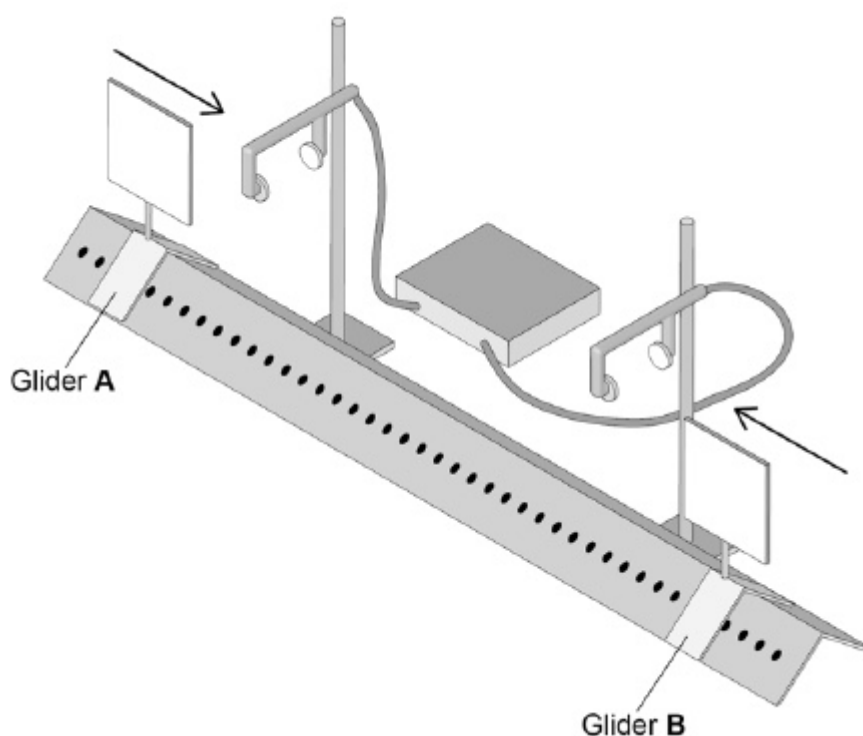
Calculate the momentum of the glider.

Momentum = _____ kg m/s

(3)

- (c) **Figure 2** shows two identical gliders travelling at the same speed in opposite directions.

Figure 2



The gliders collide and stick together.

Explain what happens to the momentum and speed of the gliders.

(4)

- (d) The light gate on the air track shown in **Figure 3** aims a beam of light at a sensor.

A datalogger calculates the speed of the glider.

The datalogger divides the length of card by the time for which the card breaks the beam of light.

Figure 3

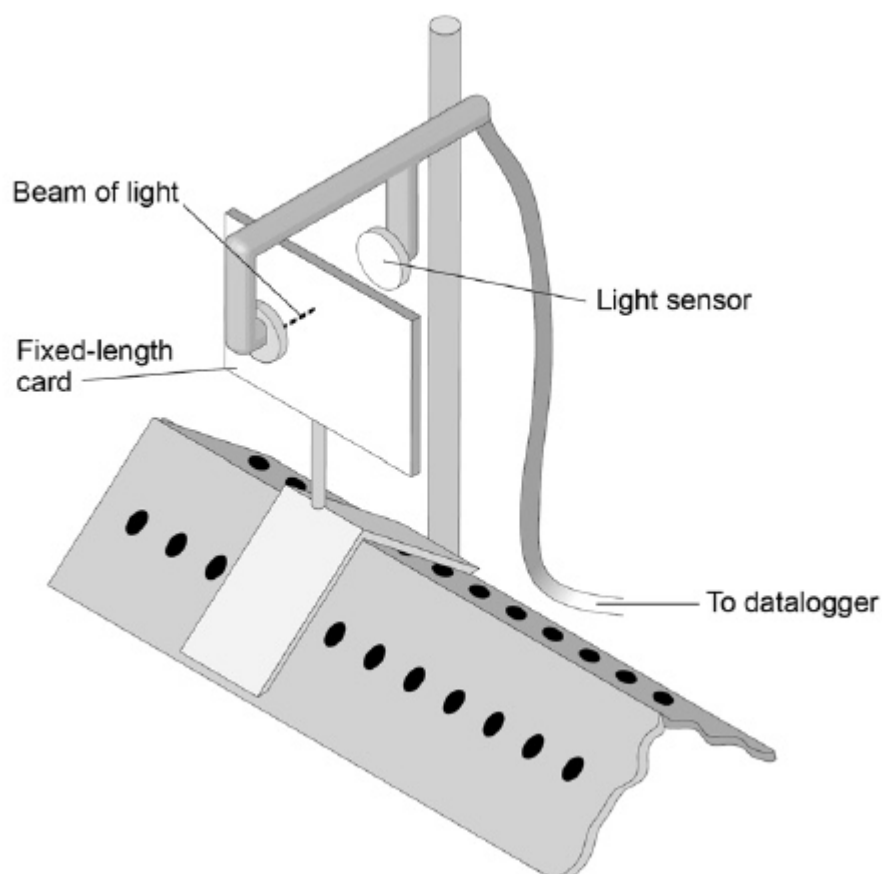
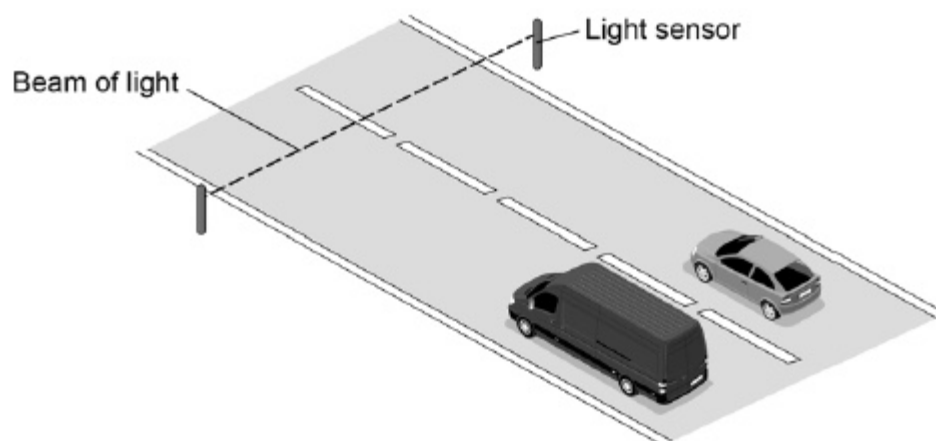


Figure 4 shows two vehicles on a road.

Figure 4



The beam of light and light sensor shown in **Figure 4** are not suitable for determining the speed of vehicles on the road.

Give **two** reasons why they are **not** suitable.

Give an explanation for each reason.

Reason 1 _____

Explanation _____

Reason 2 _____

Explanation _____

(4)

(Total 12 marks)

Q5.

A swimmer dives off a boat.

Look at **Figure 1**.

Figure 1



(a) What **two** factors determine the momentum of the swimmer?

1. _____

2. _____ (2)

(b) What is the unit of momentum?

Tick **one** box.

J / s

☐

kg m / s

☐

N m

☐

m / s²

☐

(1)

(c) The boat was stationary.

As the swimmer dives forwards, the boat moves backwards.

Use the idea of conservation of momentum to explain why the boat moves backwards.

(4)

(d) Explain what would happen to the motion of the boat if there were more people on the boat when the swimmer dived off.

(2)

(e)



The swimmer's speed increases as she swims away from the boat.

The swimmer has a top speed.

Explain why.

(5)

(Total 14 marks)

Q6.

The figure below shows an ice skater standing on the ice.



Mass
70 kg

- (a) Write down the equation that links acceleration, change in velocity and time.

(1)

- (b) As the skater pushes away across the ice there is a small frictional force.

After pushing, the skater starts to move with a velocity of 5 m / s.

He slows to 3 m / s in 6 seconds.

Calculate the acceleration of the skater.

Acceleration = _____ m / s²

(2)

- (c) Write down the equation that links acceleration, force and mass.

(1)

- (d) Friction reduces the speed of the skater.

Calculate the frictional force acting on the skater to slow him down.

Frictional force = _____ N

(2)

- (e) The skater stands still on the ice.

He throws his bag to a friend.

As he throws his bag forwards, the skater moves backwards across the ice.

Use the idea of conservation of momentum to explain why he moves backwards.

(4)

(Total 10 marks)

Mark schemes

Q1.

- (a) increases 1
- (b) the band returns to its original shape
allow band gets shorter 1
- because there is an elastic force
allow because the stretching force has been removed
if no other mark has been scored, allow for 1 mark the elastic potential energy decreases 1
- (c) any **two** from:
- initially the band does not stretch when a force is applied
allow a certain force is needed before the band extends
 - (when extending) as force increases the extension increases
 - the relationship is non-linear
allow the increase is not proportional
*do **not** accept directly proportional* 2
- (d) straight diagonal line from bottom left to top right
allow the line to curve upwards beyond the elastic limit 1
- straight line through the origin 1
- (e) force = spring constant $\times$ extension
allow $F = k e$ 1
- (f) 7.5 cm = 0.075 m 1
- $F = 1\,600 \times 0.075$
this mark may be awarded if e is incorrectly / not converted 1
- $F = 120 \text{ (N)}$
allow an answer that is consistent with their value of e 1
- an answer of 120 (N) scores 3 marks*
an answer of 12 000 (N) scores 2 marks

Q2.

- (a) momentum = mass
- $\times$
- velocity

allow $p = mv$

1

- (b)
- $200 = m \times 3.2$

1

$$m = \frac{200}{3.2}$$

1

$$m = 63 \text{ (kg)}$$

allow 62.5 (kg)

1

an answer of 63 (kg) scores 3 marks

- (c) (total) momentum before (collision) = (total) momentum after (collision)

1

either

momentum of skater A decreases and momentum of skater B increases

*allow (total) momentum is shared between skater**A and skater B*

1

velocity of skater A decreases and velocity of Skater B increases

1

or

momentum of skater A decreases and so velocity of skater A decreases (1)

momentum of skater B increases and so velocity of skater B increases (1)

[7]

Q3.

- (a) air resistance

*allow drag**ignore wind resistance*

1

- (b) B-C

1

- (c) (velocity =) 12.2 (m/s)

1

$$(\text{momentum} =) 94.8 \times 12.2$$

1

$$(\text{momentum} =) 1160 \text{ (kg m/s)}$$

*allow an answer that rounds to 1160 (kg m/s)**an answer of 1147 / 1150 scores 2 marks*

	<i>an answer of 1160 (kg m/s) scores 3 marks</i>	1
(d)	tangent drawn at 12 s	1
	correct readings of Δv and Δt from tangent	1
	(acceleration) = $\frac{\text{their value of } \Delta v}{\text{their value of } \Delta t}$	1
	-2.4 (m/s ²)	
	<i>allow value in range -2.2 to -2.6 (m/s²)</i>	
	<i>allow a correctly calculated answer from</i>	
	<i>$\frac{\text{their value of } \Delta v}{\text{their value of } \Delta t}$</i>	1
	m/s ²	
	<i>allow m/s/s</i>	1
(e)	straight line (with gradient of 1.6) from origin to 6 s, 9.6 m/s	
	<i>allow 1 mark for a straight line below A-B with a positive gradient from origin to 6 s</i>	2
(f)	(calculation of distance travelled by first athlete)	
	$(2.2 \times 12.2) = 26.84 \text{ (m)}$	1
	$(0.5 \times 3.8 \times 12.2) = 23.18 \text{ (m)}$	1
	<i>an answer of 50.02 (m) scores 2 marks</i>	
	(calculation of distance travelled by second athlete)	
	$(0.5 \times 9.6 \times 6 =) 28.8 \text{ (m)}$	
	<i>allow ecf from part (e)</i>	
	<i>allow $(9.6^2 - 0 = 2 \times 1.6 \times s =) 28.8 \text{ (m)}$</i>	1
	(calculate difference) = 21.22 (m)	
	<i>allow their distance for athlete 1 minus their distance for athlete 2</i>	1
	<i>an answer of 21.22 (m) scores 4 marks</i>	
		[16]

Q4.

(a)	inertia	1
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(b)	17 cm/s = 0.17m/s	1
	$P = mv = 0.14 \times 0.17$	1
	= 0.024 (kg m/s)	
	<i>an answer of 0.024 (kg m/s) scores 3 marks</i>	1
(c)	the total momentum before the collision is zero	1
	and momentum is conserved	1
	so the total momentum after the collision is zero	1
	so the speed after the collision is zero	1
(d)	more than one car may pass through a beam at a time	
	<i>allow a description of this eg cars overtaking, cars passing in opposite directions etc</i>	1
	(so) the light gate could not accurately measure the time for one car to pass	1
	the length of each car would be unknown	
	<i>allow cars come in different lengths.</i>	1
	(so) speed could not be calculated without the length	
	<i>ignore references to the data logger</i>	1
		[12]

Q5.

(a)	mass	1
	velocity	1
(b)	kg m / s	1
(c)	momentum before = momentum after	1
	and before diving in the momentum of the diver and (small) boat is zero	1
	after diving the diver has forwards momentum / momentum to the right	1
	therefore the (small) boat has equal backwards momentum / equal momentum to	

the left	1
(d) the boat moves back more slowly	1
because there is more mass (but momentum stays the same)	1
(e) as she swims there is a drag force	1
as speed increases so does the drag force	1
she accelerates less	1
drag force = thrust force <i>accept resultant force = 0</i>	1
the swimmer reaches terminal velocity	1
	[14]

Q6.

(a) acceleration = change in velocity / time taken <i>allow $a = \Delta v / t$</i>	1
(b) $= \frac{(3 - 5)}{6}$	1
−0.33 (m / s ²) <i>allow 0.33 m / s² with no working shown for 2 marks</i>	1
(c) force = mass × acceleration <i>allow $F = m a$</i>	1
(d) 70×0.33 <i>allow ecf from 4.3</i>	1
23.1 (N) <i>allow 23.1 with no working shown for 2 marks</i>	1
(e) before throwing the bag the momentum of the skater and bag is zero	1
when it is thrown the bag has momentum forwards	1
because momentum before = momentum after	

the skater has equal backwards momentum so will move backwards

Examiner reports

Q1.

- (a) Just over 42% gave correct descriptions such as “increases” or “gets bigger”. Some students gave responses of “stronger” which did not gain credit.
- (b) Although 55% gained one mark for describing what happened to the resistance band, only 1% gained two marks for a complete explanation. Explain questions always require more than a one-mark response.
- (c) Similarly, 58% gained one mark for describing the extension increasing as the force increased. References to the start of the graph at which the band did not stretch even though a force was applied, or the overall relationship being non-linear were much less common with only 5% scoring two marks.

Lower attaining students often referred to just one variable or to the shape of the graph.

- (d) Only 16% scored both marks with a further 13% scoring one mark. Many copied the sketch graph from the previous page rather than sketching the graph for a spring. Others produced various curves and squiggles which indicated they were unfamiliar with the extension of a spring.
- (e) 24% of the students correctly recalled this equation. Many quoted the equation for elastic potential energy having referred to the Physics Equations Sheet.
- (f) Of those that gave the correct equation, most failed to convert the centimetres to metres. Only 2% gained three marks with a further 30% scoring two marks.

Q2.

- (a) 82% scored this mark, with many giving the equation in the form $\text{mass} = \text{momentum} \div \text{velocity}$.
- (b) 86% were able to gain 3 marks in this question and only a very small number multiplied the two numerical values.
- (c) Fewer than 2% scored full marks for this question. Very few attempted to describe what happened to the velocity of the skaters, in spite of the very clear lead in the stem of the question. Whilst many realised that the velocity of the two skaters was the same after collision, they talked of velocity being ‘shared’ rather than saying what had happened to each skater.

A significant number did gain a mark for saying that the momentum before the collision was equal to that after, although many missed this mark, simply repeating the stem of the question.

Q3.

- (a) Most correct answers gave air resistance, though drag was also credited. Incorrect responses included friction, gravity, wind, wind resistance, resistance, types of energy and acceleration.
- (b) 86% of students were able to interpret the graph correctly.

- (c) 23% of students achieved all three marks. Some students were not able to correctly apply the scale and incorrectly read the value for the velocity for the graph. The only incorrect velocity value which was credited when used in marking points two and three was 12.1 m/s. Many students incorrectly used the time of 6 s given in the question as the velocity.
- (d) To access the first four marking points, students had to draw a tangent. 4% of students who had the necessary mathematical skills were able to achieve full marks. A significant number used the co-ordinates of the point on the graph, whilst others made a triangle out of the deceleration part of the graph and tried to work from the x and y readings despite there being a curve on the third side. The unit mark was scored by the majority of students. Relatively few did not attempt this question.
- (e) 38% of students realised that the acceleration value given led to a velocity of 9.6 m/s after six seconds and then correctly drew the line to obtain two marks. Others who didn't use the acceleration value given drew their line to a velocity of 1.6 m/s or 12.2 m/s.

Some students drew a vertical line upwards from six seconds until it reached the other athlete's 'steady speed' section at 12.2 m/s.

- (f) Those students who knew that the area under the graph represented distance were often then able to go on and achieve four marks. Others who gained some marks found it easier to calculate the area of the triangle for the distance travelled by the second athlete, rather than calculating the area of the trapezium for the first athlete. Few used the equation for the area of a trapezium, more usually splitting the trapezium into a rectangle and triangle.

For the calculation of the distance travelled by the second athlete an error carried forward was allowed from their answer to part (e). Some tried to use the equation $v^2 - u^2 = 2as$ for both athletes, without appreciating that this could only be used for the second athlete.

Many tried to use $d = s \times t$ gaining an overall answer of 15.6 m. They were awarded marking point four if they had clearly indicated they had calculated the distance travelled for both athletes. Others just subtracted the two velocities after six seconds.