1 (a) A boy of mass 43.2 kg runs and jumps onto a stationary skateboard.



The boy lands on the skateboard with a horizontal velocity of 4.10 m/s.

(i) State the relationship between momentum, mass and velocity.

(1)

(ii) The skateboard has a mass of 2.50 kg.

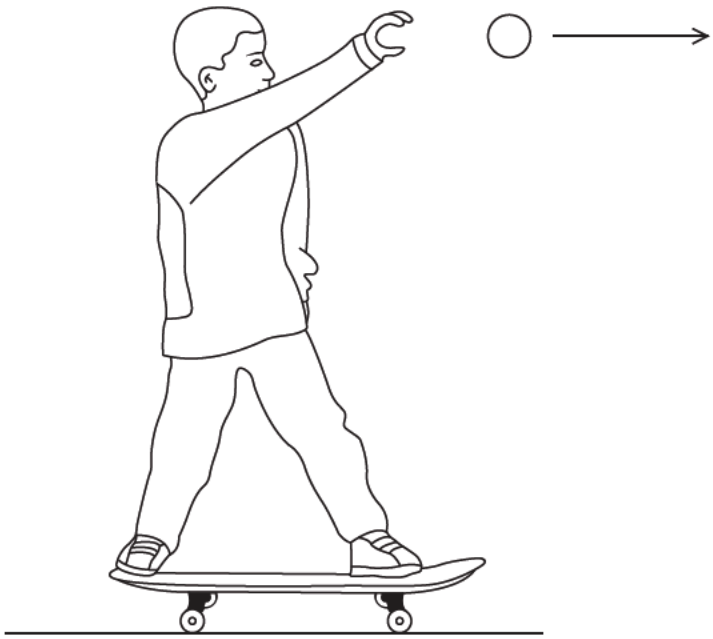
Using ideas about conservation of momentum, calculate the combined velocity of the boy and skateboard just after the boy lands on it.

(4)

combined velocity = ... m/s

(b) The boy holds a heavy ball as he stands on a stationary skateboard.

The boy throws the ball forwards while still standing on the skateboard.



Explain what happens to the boy and the skateboard.

(2)

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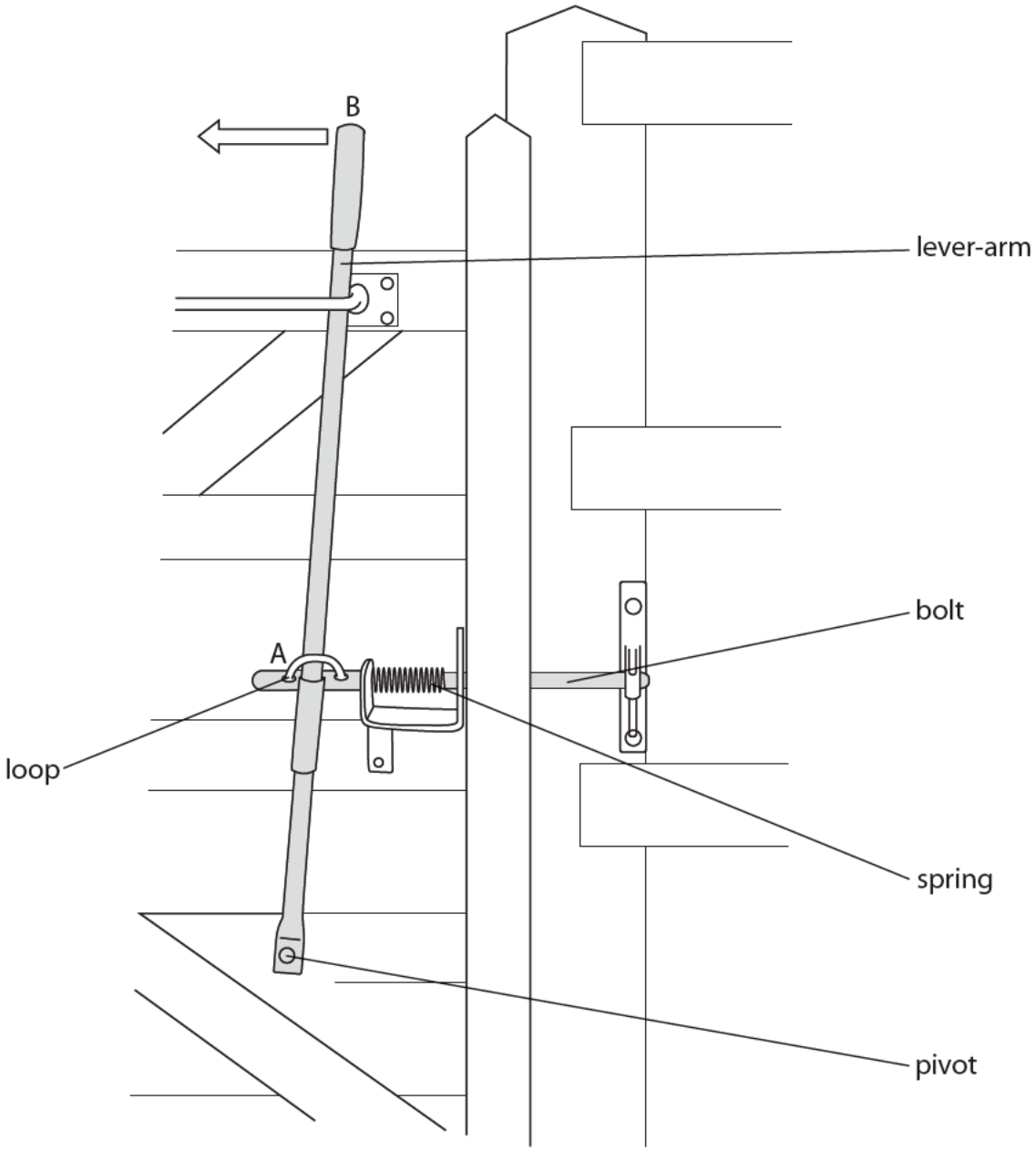
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(Total for Question 1 = 7 marks)

2 The diagram shows a gate with a lever-operated catch.

A loop on the bolt fits around the lever-arm at A.



(a) (i) Describe how the lever-arm is used to move the bolt.

(1)

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(ii) Suggest why the spring is needed.

(1)

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(b) The lever-arm operates using the principle of moments.

(i) State the principle of moments.

(1)

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(ii) The force applied at point B is 22 N.

The pivot is 110 cm from point B and 38 cm from point A.

Calculate the force exerted on the lever-arm at point A by the spring.

(3)

force at point A = ... N

(iii) Explain how the force applied at point B would need to change if the distance from the pivot to point A is increased.

(2)

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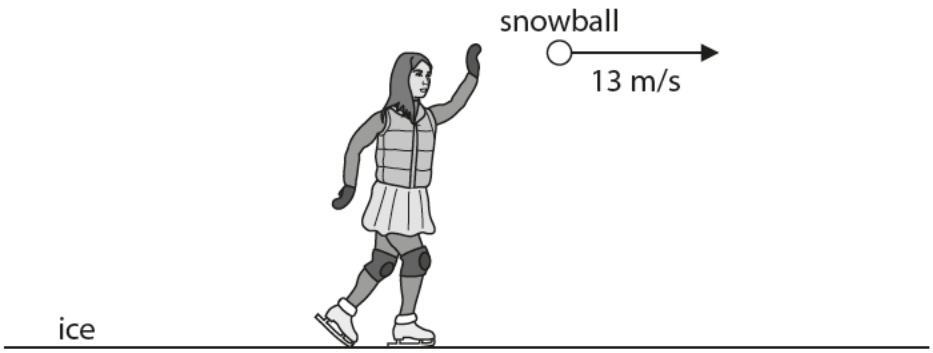
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(Total for Question 2 = 8 marks)

3 An ice skater throws a 0.23 kg snowball with a velocity of 13 m/s.



(a) (i) State the equation linking momentum, mass and velocity.

(1)

(ii) Calculate the initial momentum of the snowball.

(2)

initial momentum = ... kg m/s

(b) When the skater throws the snowball forwards, she slides backwards on the ice.

Explain why she moves in this direction.

(3)

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(c) The skater wears soft knee pads that compress easily.

Explain how the pads protect her knees when she falls on the ice.

(3)

(Total for Question 3 = 9 marks)

4 Some quantities are vectors, others are scalars.

(a) Complete the table ticking the boxes to show which quantities are vectors and which are scalars.

One has been done for you.

(2)

Quantity	Vector	Scalar
distance		
force		
momentum	✓	
speed		
velocity		

(b) A car travels at 20 m/s.

The mass of the car is 1500 kg.

(i) State the equation linking momentum, mass and velocity.

(1)

(ii) Calculate the momentum of the car.

(2)

momentum = ... kg m/s

(c) In a crash test, a car runs into a wall and stops.



(Author: Brady Holt, 2010)

The momentum of the car before the crash is 22500 kg m/s.

The car stops in 0.14 s.

(i) Calculate the average force on the car during the crash.

(2)

average force = ... N

(ii) Use ideas about momentum to explain how seat belts can reduce injuries to passengers during a crash.

(3)

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(Total for Question 4 = 10 marks)

5 Cars have a number of features that make them safer in a collision.

(a) Apart from seat belts, name two safety features that reduce the risk of serious injury in a car crash.

(2)

1 .....

2 .....

(b) Photograph A shows a person wearing a seat belt.



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Photograph A

(i) Using ideas of momentum and force, explain how a seat belt reduces the risk of serious injury in a car crash.

(4)

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(ii) Photograph B shows a full-body harness used in a racing car.



Photograph B

Suggest why a full-body harness is used in a racing car, instead of an ordinary seatbelt.

(1)

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.....

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(c) Photograph C shows a crash-test dummy in a car. The car has crashed into a concrete wall.



© Peter Ginter/Getty Images

Photograph C

State what happens to the momentum of the car during the crash.

(1)

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(Total for Question 5 = 8 marks)

6 (a) State the equation linking momentum, mass and velocity.

(1)

(b) A truck of mass 10 000 kg is moving with a velocity of 4.5 m/s.

A car of mass 1500 kg has the same momentum as the truck.

Calculate the velocity of the car.

(3)

velocity = ... m/s

(Total for Question 6 = 4 marks)