Questions are for both separate science and combined science students unless indicated in the question

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. **(separate only)**

(1)

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

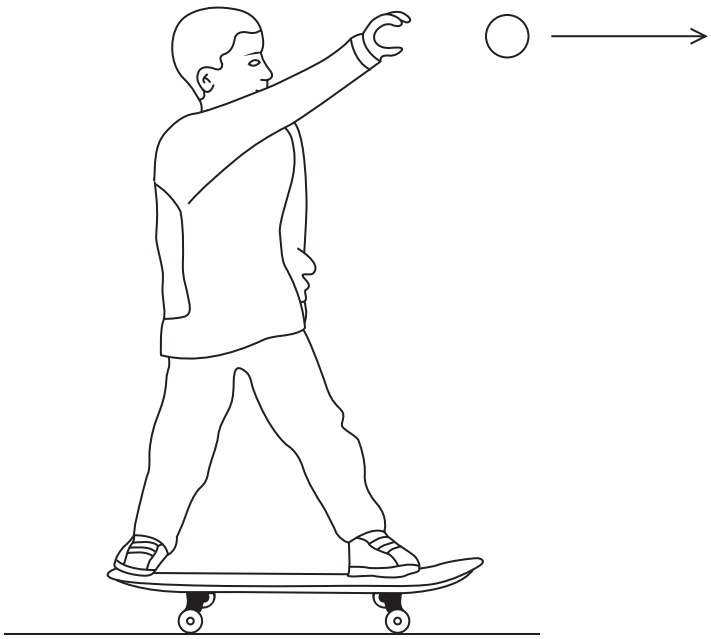
Using ideas about conservation of momentum, calculate the combined velocity of the boy and skateboard just after the boy lands on it. **(separate only)**

(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. **(separate only)**

(2)

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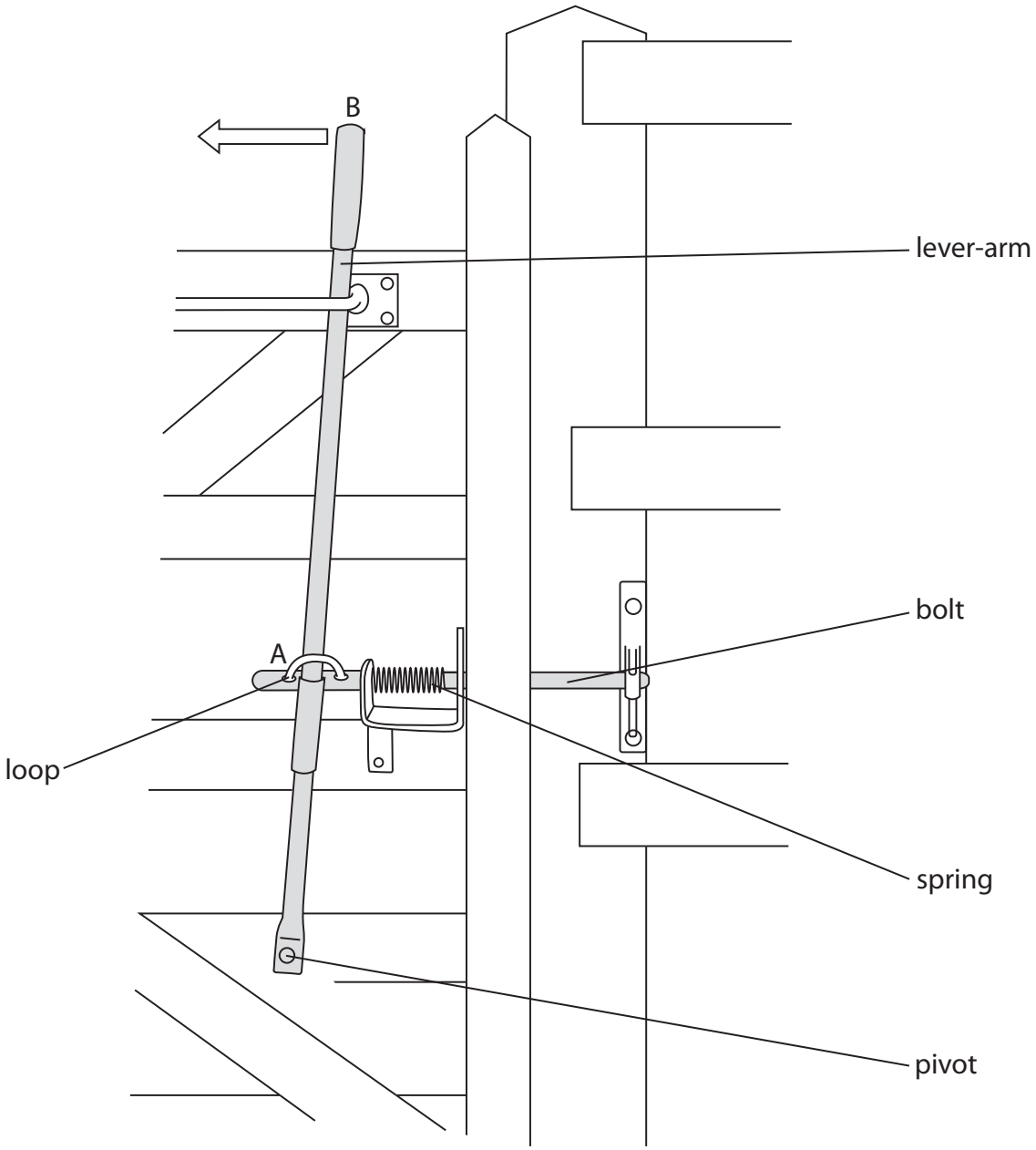
(Total for Question 1 = 7 marks)

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. **(separate only)**

(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. **(separate only)**

(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. **(separate only)**

(2)

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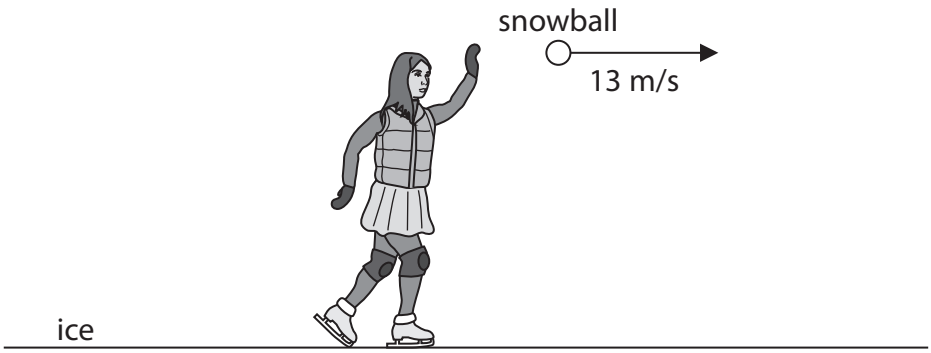
(Total for Question 2 = 8 marks)

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. **(separate only)**

(1)

(ii) Calculate the initial momentum of the snowball. **(separate only)**

(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. **(separate only)**

(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. **(separate only)**

(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. **(separate only)**

(1)

(ii) Calculate the momentum of the car. **(separate only)**

(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 22 500 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. **(separate only)**

(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. **(separate only)**

(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. **(separate only)**

(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. **(separate only)**

(1)

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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. **(separate only)**

(1)

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(Total for Question 5 = 8 marks)

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

(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. **(separate only)**

(3)

velocity = ... m/s

(Total for Question 6 = 4 marks)