



GCE AS/A LEVEL

2420U10 – 1

THURSDAY, 15 MAY 2025 – AFTERNOON

**PHYSICS – AS UNIT 1
MOTION, ENERGY AND MATTER**

**1 hour 30 minutes plus your additional
time allowance**

Surname: _____

First name(s): _____

Centre Number: _____

Candidate Number: 2 _____

FOR EXAMINER'S USE ONLY		
Question	Maximum Mark	Mark Awarded
1.	8	
2.	8	
3.	13	
4.	15	
5.	16	
6.	9	
7.	11	
Total	80	

(Turn over)

ADDITIONAL MATERIALS

In addition to this examination paper you will require a calculator and DATA BOOKLET.

ITEMS INCLUDED WITH QUESTION PAPER

A separate Diagram Booklet.

The Diagram Booklet MUST be handed in to the invigilators and sent for marking.

(Turn over)

INSTRUCTIONS TO CANDIDATES

Use black ink, black ball–point pen, black felt tip or your usual method.

Write your name, centre number and candidate number in the spaces on the front cover.

Answer ALL questions.

Write your answers in the spaces provided. If you run out of space, use the additional page(s) at the back of this booklet, taking care to number the question(s) correctly.

(Turn over)

INFORMATION FOR CANDIDATES

The total number of marks available for this paper is 80

The number of marks is given in brackets at the end of each question or part – question.

The assessment of the quality of extended response (QER) will take place in Question 6 (a).

(Turn over)

Answer ALL questions.

- 1. (a) Explain what is meant by the centre of gravity of a body.**

[1 mark]

continued on the next page . . .

(Turn over)

Question 1 continued

- 1. (b) Refer to the diagram for Question 1 (b) in the separate Diagram Booklet. The diagram shows a uniform cylinder of length 15 cm and diameter, d , placed on a rough surface that is gradually tilted. No sliding occurs.**

- (i) The cylinder is shown when it is about to topple.
INDICATE ON THE DIAGRAM the line of action of the cylinder's weight.**

[1 mark]

continued on the next page . . .

(Turn over)

Question 1 (b) continued

- 1. (b) (ii) When the cylinder is about to topple, θ is 18.7° . Show that the diameter of the cylinder is approximately 5 cm.**

[2 marks]

continued on the next page . . .

(Turn over)

Question 1 (b) continued

- 1. (b) (iii) Use the following information to determine the metal from which the cylinder is made, given that it has a mass of 2400 g.**

Metal	Density / g cm⁻³
copper	9 • 0
brass	8 • 6
iron	7 • 9

(Turn over)

[3 marks]

continued on the next page . . .

(Turn over)

Question 1 continued

1. (c) Aluminium has a density of
 2.7 g cm^{-3}

A student believes that a cylinder made from aluminium, but with the **SAME LENGTH AND DIAMETER** as the cylinder in part (b), would topple when θ is less than 18.7°
Discuss whether the student is correct.

[1 mark]

(Total for Question 1 = 8 marks)

(Turn over)

2. Refer to the diagram for Question 2 in the separate Diagram Booklet.

The diagram shows a gate on a public footpath. The accompanying diagram gives details of the mechanism for opening the gate. The gate is opened by applying a force to the handle as shown. This moves the bolt to the right, compressing the spring. When the handle is released, the spring pushes the bolt back to its original position.

To open the gate, a force, F , is applied at right angles to the handle as shown.

continued on the next page . . .

(Turn over)

Question 2 continued

- 2. (a) The spring used in the gate has a spring constant, k , of 160 N m^{-1} . To open the gate, the bolt must be moved 8.0 cm . This compresses the spring by the same distance. Assuming Hooke's law applies, calculate the force applied directly to the spring.**

[2 marks]

continued on the next page . . .

(Turn over)

2. (b) In designing the gate, the manufacturer requires that the force, F , is of a reasonable value to allow nearly all users to open the gate. They believe that this value should be approximately 5 N. Determine whether the arrangement shown in the diagram meets this requirement.

[3 marks]

continued on the next page . .

(Turn over)

Question 2 continued

- 2. (c) After using the gate, a user suddenly releases the handle. Calculate the speed with which the bolt returns to its original position. Assume the mass of the bolt is 0.3 kg and that only 20% of the energy stored in the spring is transferred to the bolt.**

(Turn over)

16

[3 marks]

(Total for Question 2 = 8 marks)

(Turn over)

- 3. (a) Refer to the diagram for Question 3 (a) in the separate Diagram Booklet. The diagram represents a cannon. A cannonball is fired in a horizontal direction, as shown.**

The following statements refer to the flight of the cannonball after it has left the barrel of the cannon. Complete the statements by inserting ONE of the words or phrases at the end of each statement.

continued on the next page . . .

(Turn over)

Question 3 (a) continued

**Words or phrases may be used
once, more than once or not at all.
IGNORE THE EFFECTS OF AIR
RESISTANCE.**

- **increases**
 - **decreases**
 - **is constant, but not zero**
 - **is zero**
-
- **Velocity of cannonball in the
HORIZONTAL direction _____**
 - **Velocity of cannonball in the
VERTICAL direction _____**

continued on the next page . . .

(Turn over)

Question 3 (a) continued

- **Acceleration of cannonball in the
HORIZONTAL direction _____**
- **Acceleration of cannonball in the
VERTICAL direction _____**

[2 marks]

continued on the next page . . .

(Turn over)

Question 3 continued

- 3. (b) Refer to the diagram for Question 3 (b) in the separate Diagram Booklet. Two cannons are positioned, one directly above the other, on a pirate ship, as shown in the diagram.**

Both cannons are fired at the SAME INSTANT and the initial horizontal velocity of both cannonballs IS THE SAME.

Assume that air resistance has no effect on the cannonballs.

continued on the next page . . .

(Turn over)

Question 3 (b) continued

- 3. (b) (i) The height of the LOWER cannon above the sea is 3.0 m . Show that the time of flight through the air for this cannonball is approximately 0.8 s .**

(Turn over)

[3 marks]

continued on the next page . . .

(Turn over)

Question 3 (b) continued

- 3. (b) (ii) Calculate the vertical velocity of the cannonball fired from the UPPER cannon just before it strikes the sea.**

[2 marks]

continued on the next page . . .

(Turn over)

Question 3 (b) continued

- 3. (b) (iii) Refer to the diagram for Question 3 (b) (iii) in the separate Diagram Booklet. The cannonball fired from the UPPER cannon strikes the sea at an angle of 10° below the horizontal, as shown in the diagram.**

continued on the next page . . .

(Turn over)

Question 3 (b) (iii) continued

Use the information in the diagram and your answer to (b) (ii) to calculate the horizontal velocity of the cannonball.

[2 marks]

continued on the next page . . .

(Turn over)

Question 3 (b) continued

- 3. (b) (iv) Hence, calculate the horizontal distance travelled by the cannonball fired from the LOWER cannon before it strikes the sea.**

[2 marks]

continued on the next page . . .

(Turn over)

Question 3 continued

- 3. (c) Without further calculation, explain whether the cannonball fired from the LOWER cannon would strike the water at an angle greater than, equal to or less than 10° below the horizontal.**

[2 marks]

(Total for Question 3 = 13 marks)

(Turn over)

4. Refer to the diagram for Question 4 (a) in the separate Diagram Booklet. Alana uses the apparatus shown in the diagram to determine the Young modulus of copper in the form of a wire, labelled copper test wire in the diagram.

(a) Explain why the comparison wire is also made of copper.

(Turn over)

[2 marks]

continued on the next page . . .

(Turn over)

Question 4 continued

4. (b) Alana carefully increases the load on the copper test wire and records the extension (IN mm) for each load. Her results are shown in the table below.

Load, F (N)	Extension, x (mm)
0•0	0•00
4•9	1•06
9•8	2•25
14•7	3•19
19•6	4•15
24•5	5•32

continued on the next page . . .

(Turn over)

Question 4 (b) continued

- 4. (b) (i) Refer to the grid for Question 4 (b) (i) in the separate Diagram Booklet. On the grid, plot a graph of load (y –axis) against extension (x –axis) and draw a line of best fit.**

[4 marks]

continued on the next page . . .

(Turn over)

Question 4 (b) continued

- 4. (b) (ii) I. Alana uses a digital micrometer to determine the mean diameter of the wire to be 0.36 mm. Write down the resolution of the micrometer she used.**
-
-

[1 mark]

continued on the next page . . .

(Turn over)

Question 4 (b) (ii) continued

**4. (b) (ii) II. Determine the
cross – sectional area of
the wire in m²**

[2 marks]

continued on the next page . . .

(Turn over)

Question 4 (b) continued

- 4. (b) (iii) By calculating the gradient of the graph, determine the Young modulus of copper.**

The original length of the wire was 2.88 m. Give your answer in GPa and to an appropriate number of significant figures.

(Turn over)

[4 marks]

continued on the next page . . .

(Turn over)

Question 4 continued

- 4. (c) As part of her experimental procedure, Alana removes the load after taking each reading of extension and notes the reading on the vernier. Explain why she does this.**

[2 marks]

(Total for Question 4 = 15 marks)

(Turn over)

5. Refer to the photograph and graph for Question 5 (a) in the separate Diagram Booklet. Curling is an Olympic sport where players slide heavy polished stones on ice towards a target area as shown in the photograph.

(a) A player pushes a stone of mass 19.0 kg from REST for 5 seconds before releasing it with velocity, v . The resultant force applied to the stone as it is pushed is shown by the graph.

continued on the next page . . .

(Turn over)

Question 5 (a) continued

Use the graph to show that, when the stone is released at 5 seconds, its release velocity, v , is approximately 2 m s^{-1}

(Turn over)

[3 marks]

continued on the next page . . .

(Turn over)

Question 5 continued

- 5. (b) Refer to the diagram for Question 5 (b) in the separate Diagram Booklet. As the stone slides across the ice, frictional forces slow it down.**
- The diagram shows the point at which the stone is released (labelled A) and a distant point when the stone's velocity has reduced to 1.2 m s^{-1} (labelled B).**

continued on the next page . . .

(Turn over)

Question 5 (b) continued

- 5. (b) (i) Determine the work done against frictional forces between A and B.**

(Turn over)

[3 marks]

continued on the next page . . .

(Turn over)

Question 5 (b) continued

- 5. (b) (ii) Calculate the mean resistive force between A and B, given that the distance AB is 8.0 m.**

[2 marks]

continued on the next page . . .

(Turn over)

Question 5 (b) continued

- 5. (b) (iii) Determine the mean rate of energy transfer between A and B.**

(Turn over)

45

[4 marks]

continued on the next page . . .

(Turn over)

Question 5 continued

5. (c) The stone eventually comes to rest on the ice.

(i) Refer to the diagram for Question 5 (c) in the separate Diagram Booklet. Identify the forces *X* and *Y* acting on the stone in the diagram.

[2 marks]

continued on the next page . . .

(Turn over)

Question 5 (c) continued

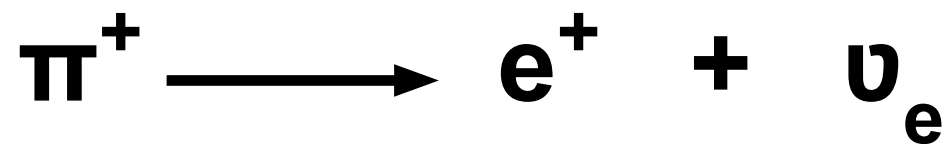
5. (c) (ii) Give TWO reasons why the forces shown DO NOT form a Newton 3rd law pair.

[2 marks]

(Total for Question 5 = 16 marks)

(Turn over)

6. (a) The following decay occurs in a time of approximately 10^{-8} s.



Give a detailed description of the process, including how conservation laws apply.

(Turn over)

[illegible]

(Turn over)

[6 QER marks]

continued on the next page . . .

(Turn over)

Question 6 continued

- 6. (b) (i) Rhian believes that the only possible combination of u and d quarks for a proton is uud. Justify Rhian's opinion.**

[2 marks]

continued on the next page . . .

(Turn over)

Question 6 (b) continued

- 6. (b) (ii) Circle the term(s) that can be used to describe a proton.**

baryon
lepton
meson
hadron
anti – particle
charged – pion

[1 mark]

(Total for Question 6 = 9 marks)

(Turn over)

7. (a) The Sun's surface temperature is 5800 K.

Calculate the wavelength of peak spectral intensity for the Sun.

[2 marks]

continued on the next page . . .

(Turn over)

Question 7 continued

- 7. (b) Refer to the graph for Question 7 (b) in the separate Diagram Booklet. The graph shows how the Sun's power output (luminosity), P , radius, R , and surface temperature, T , change over many billions of years when compared to the Sun in its current state.**

continued on the next page . . .

(Turn over)

Question 7 (b) continued

DATA FOR THE SUN IN ITS CURRENT STATE:

Luminosity, $P = 3.9 \times 10^{26}$ W

Radius, $R = 7.0 \times 10^8$ m

Surface temperature, $T = 5800$ K

- 7. (b) (i) Determine the luminosity of the Sun at 10 billion years of age.**

[1 mark]

continued on the next page . . .

(Turn over)

Question 7 (b) continued

7. (b) (ii) Calculate the surface area of the Sun at 10 billion years of age.

[2 marks]

continued on the next page . . .

(Turn over)

Question 7 (b) continued

- 7. (b) (iii) The graph indicates that the surface temperature at 10 billion years of age will only be slightly less than its current value. Using a suitable calculation, show that the decrease will be approximately 100 K.**

(Turn over)

[3 marks]

continued on the next page . . .

(Turn over)

Question 7 continued

- 7. (c) The answer to (b) (iii) indicates that there will be little change to the colour of the Sun until it is about 10 billion years old. An astronomer makes the following comment:**

“Between 11 and 12 billion years of age the colour of the Sun will change dramatically.”

Justify this comment.

(Turn over)

60

[3 marks]

(Total for Question 7 = 11 marks)

TOTAL FOR PAPER = 80 MARKS

END OF PAPER

(Turn over)

Question number	Additional pages, if required. Write the question number(s) in the left – hand margin.

(Turn over)

Question number	Additional pages, if required. Write the question number(s) in the left – hand margin.

(Turn over)

[illegible]



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**PHYSICS – AS UNIT 1
MOTION, ENERGY AND MATTER**

Diagram Booklet

**The Diagram Booklet MUST be handed in
to the invigilators and sent for marking.**

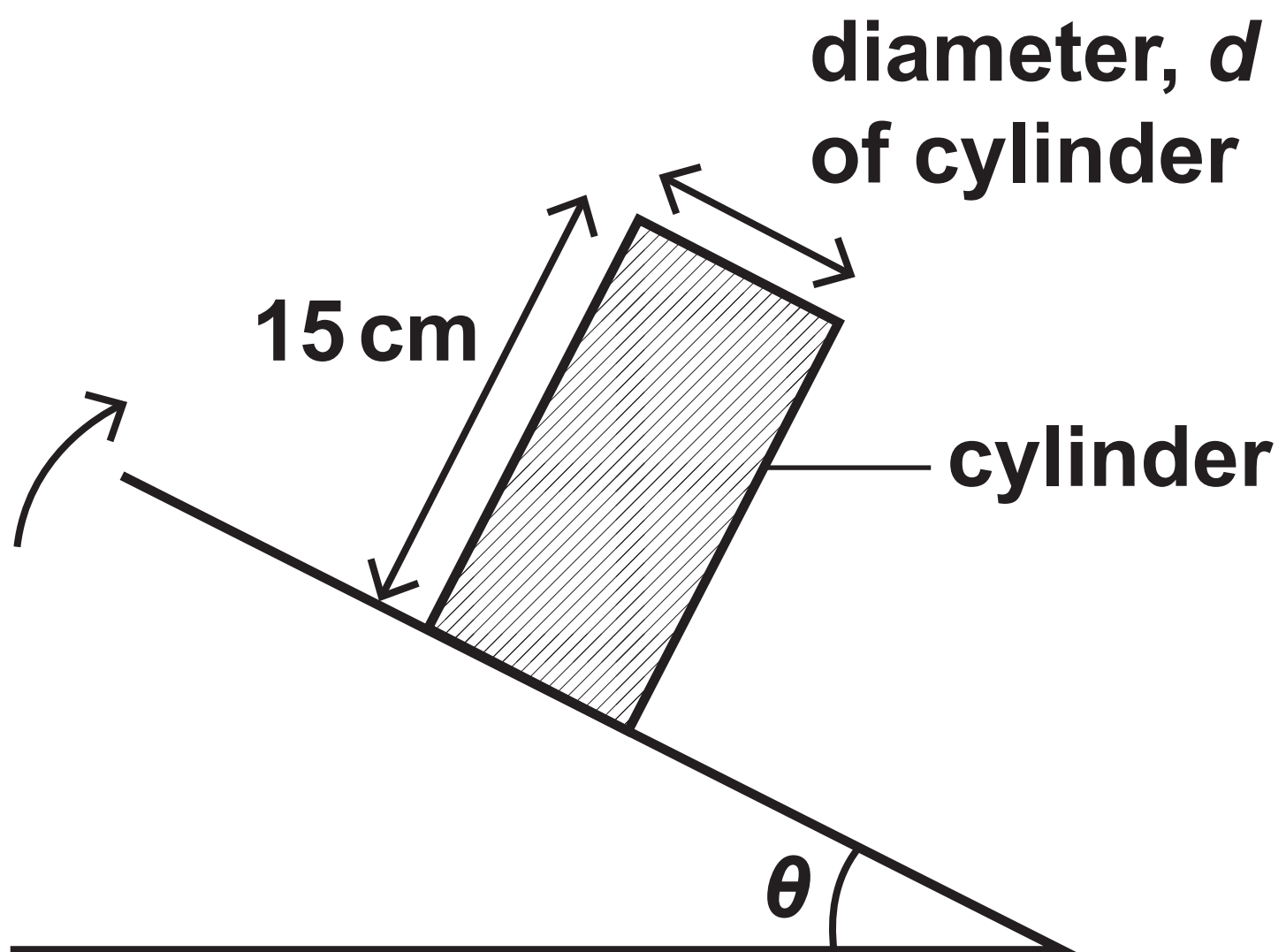
Surname: _____

First name(s): _____

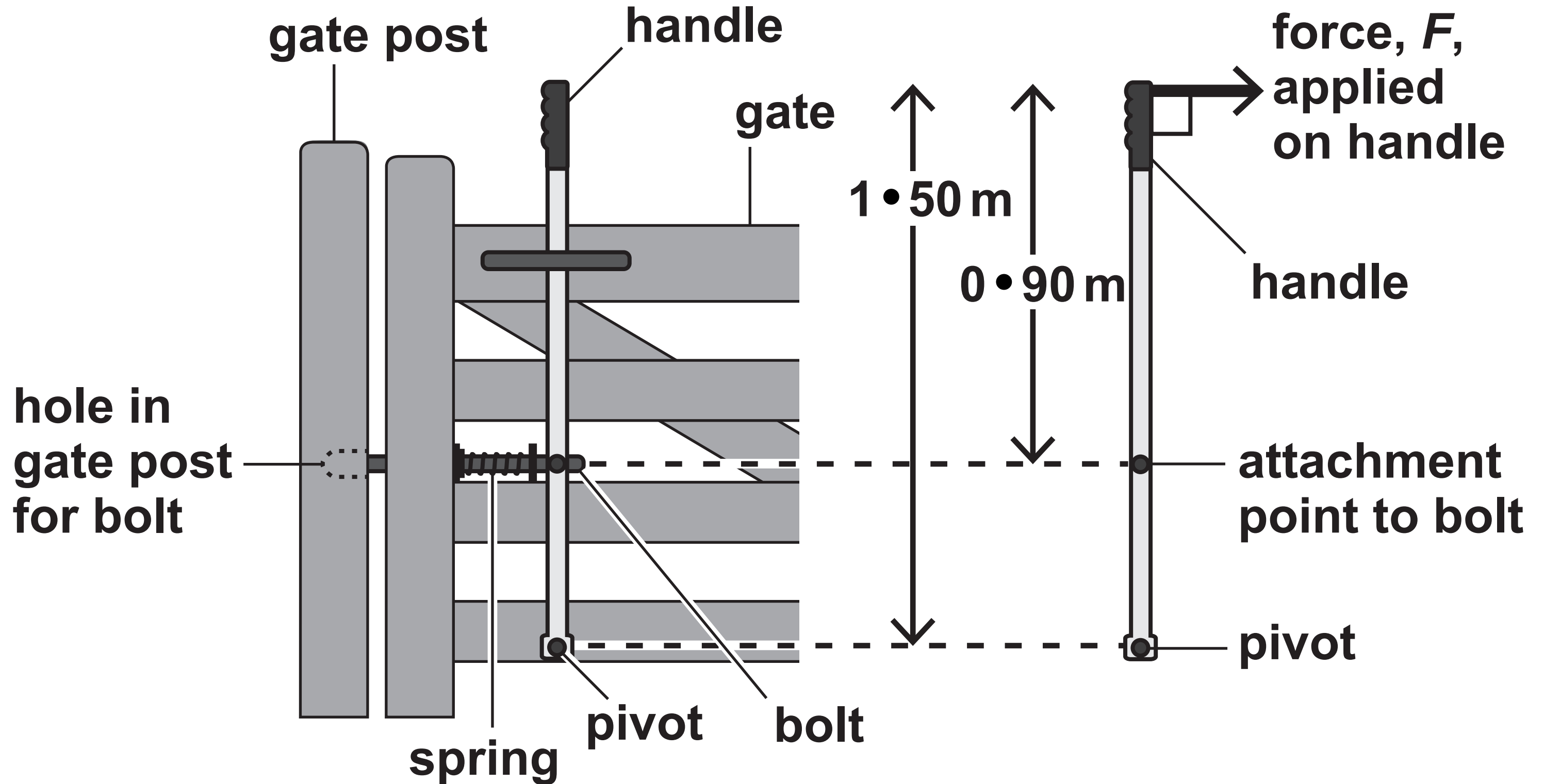
Centre Number: _____

Candidate Number: 2 _____

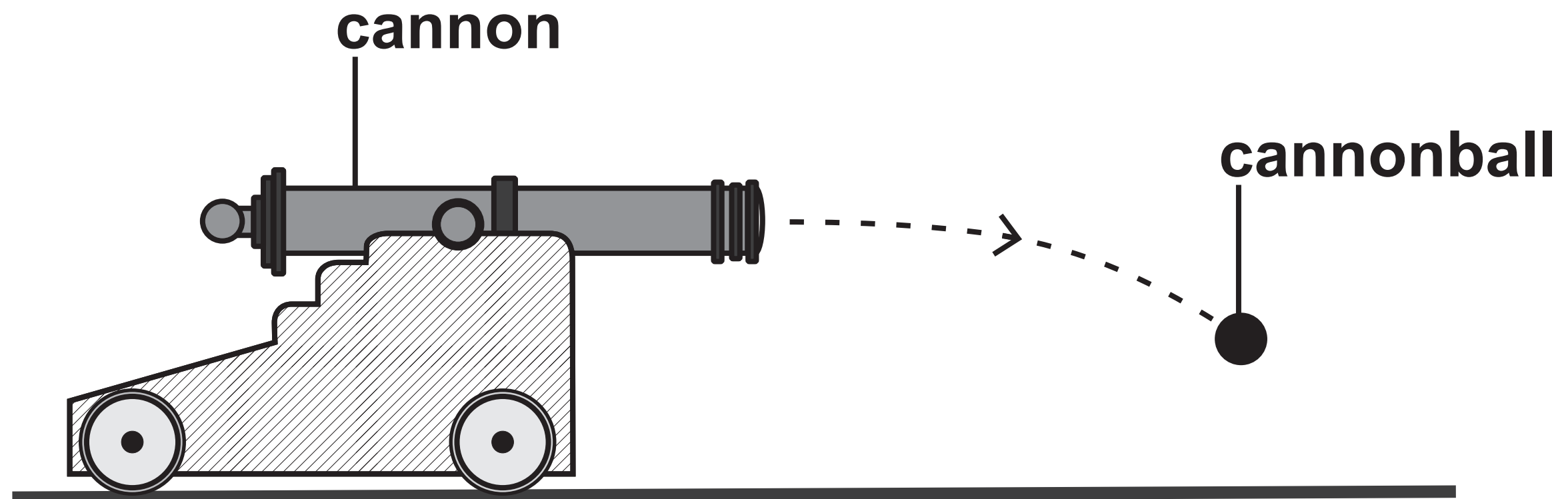
Question 1 (b)



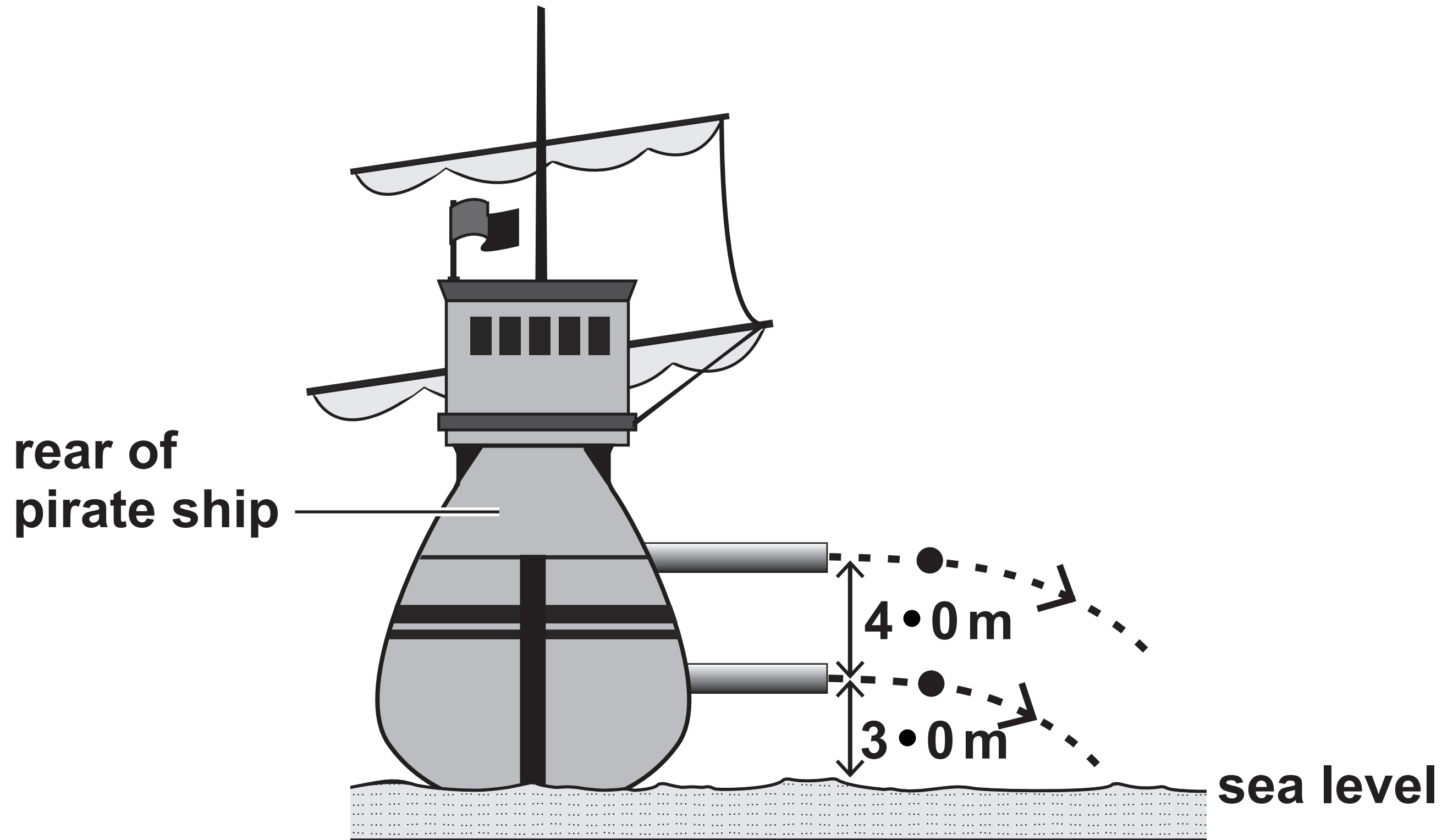
Question 2



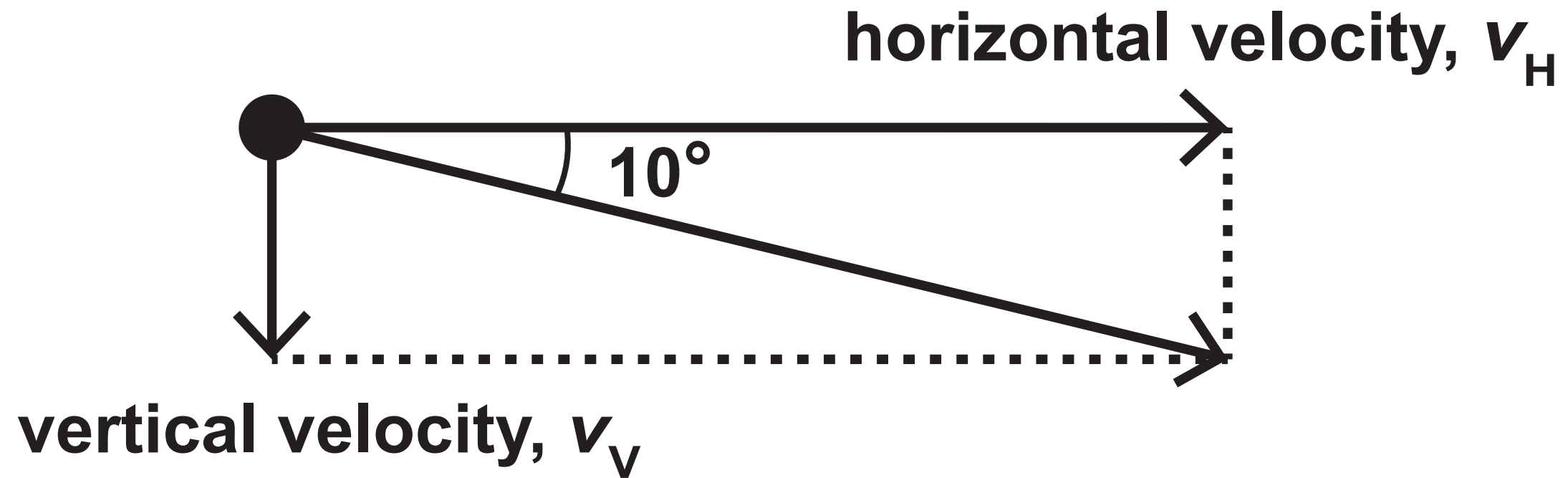
Question 3 (a)



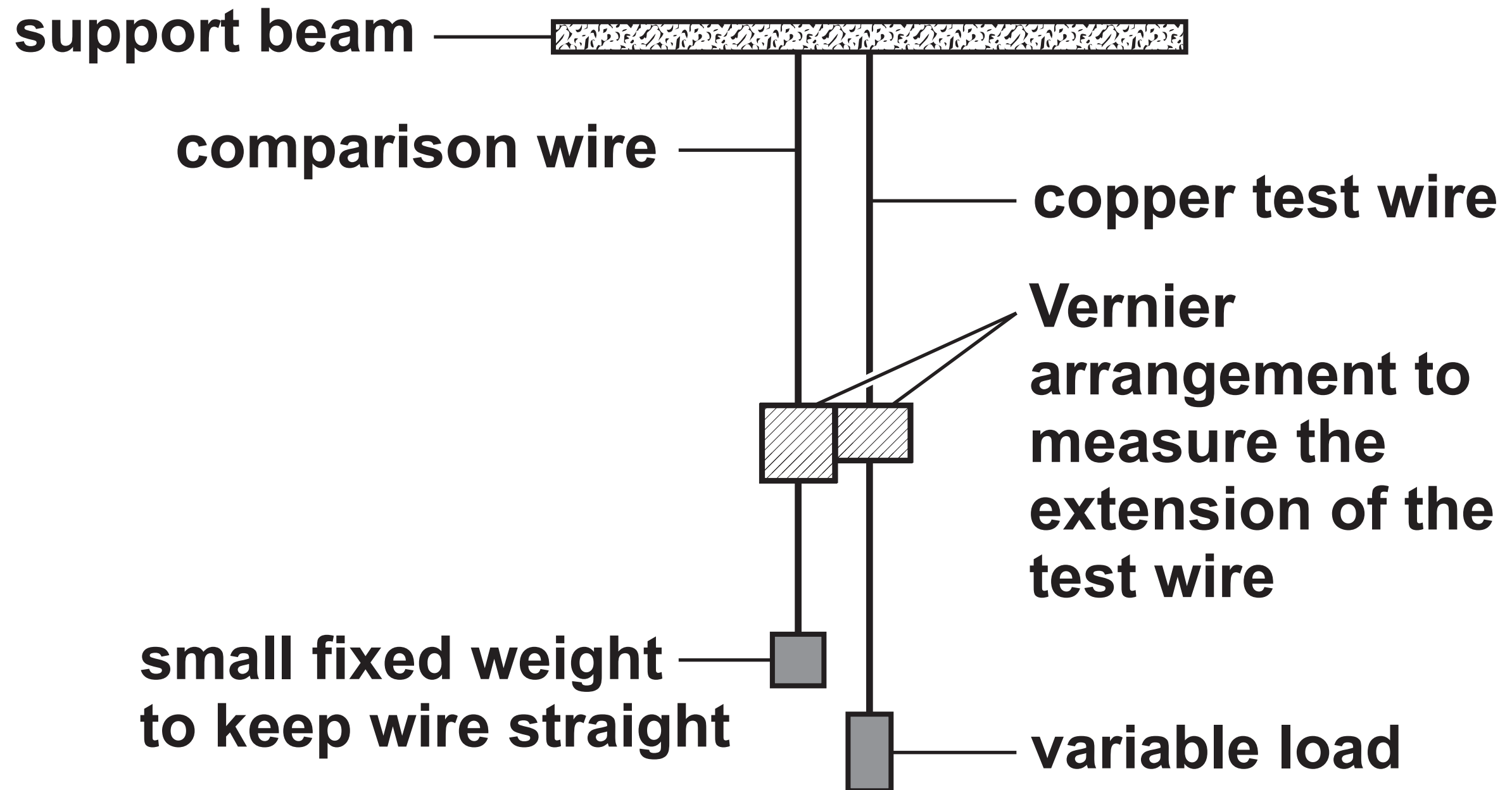
Question 3 (b)



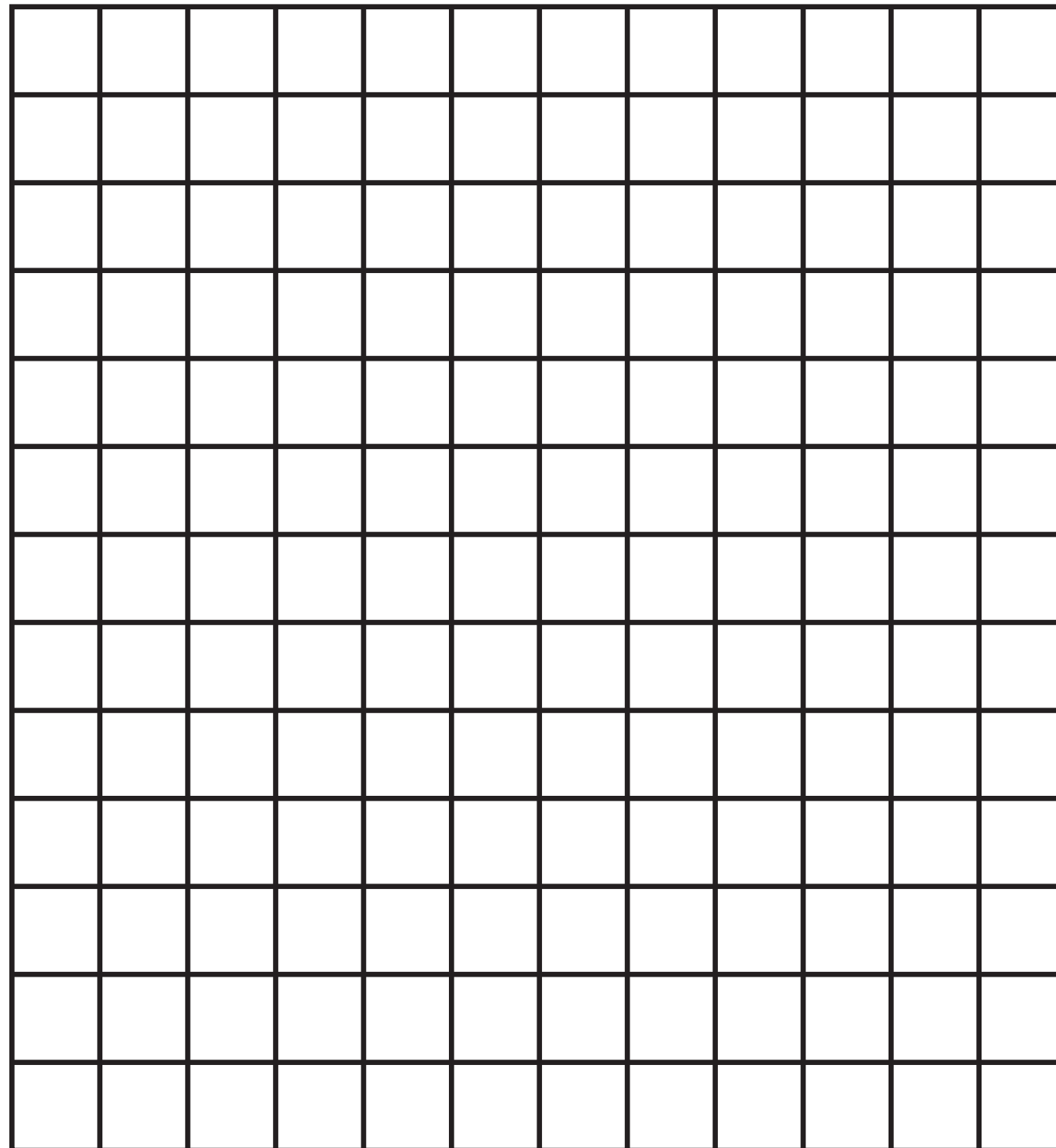
Question 3 (b) (iii)



Question 4 (a)



Question 4 (b) (i)



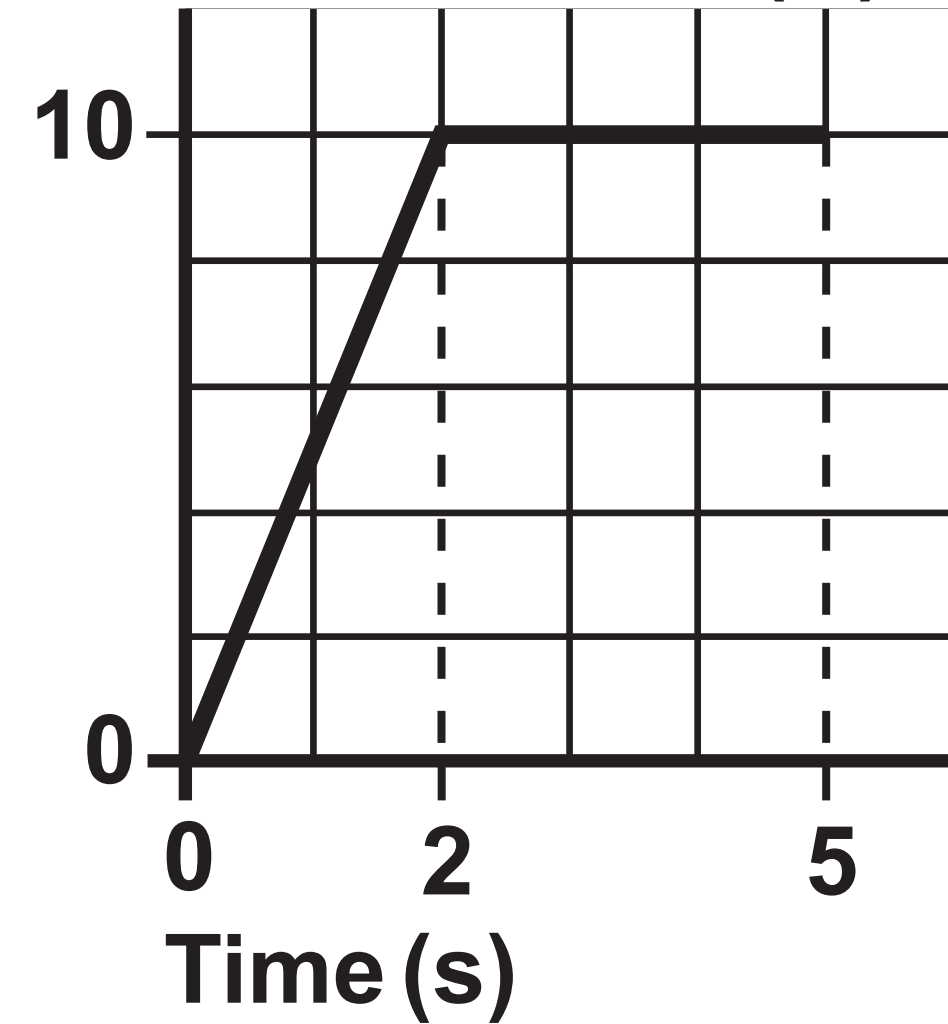
Question 5 (a)

Photograph

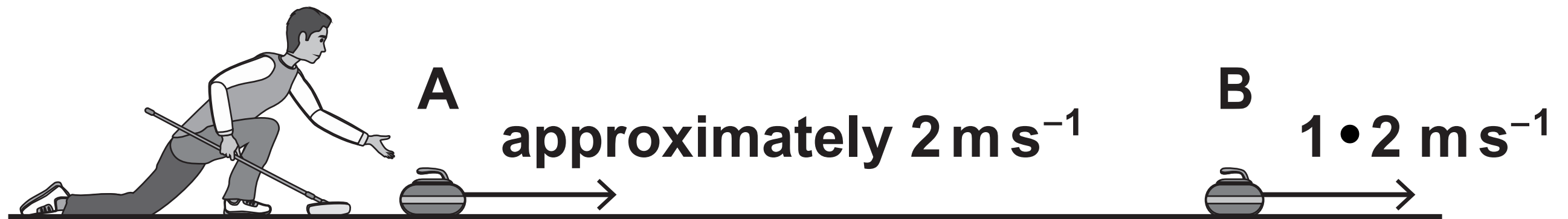


Graph

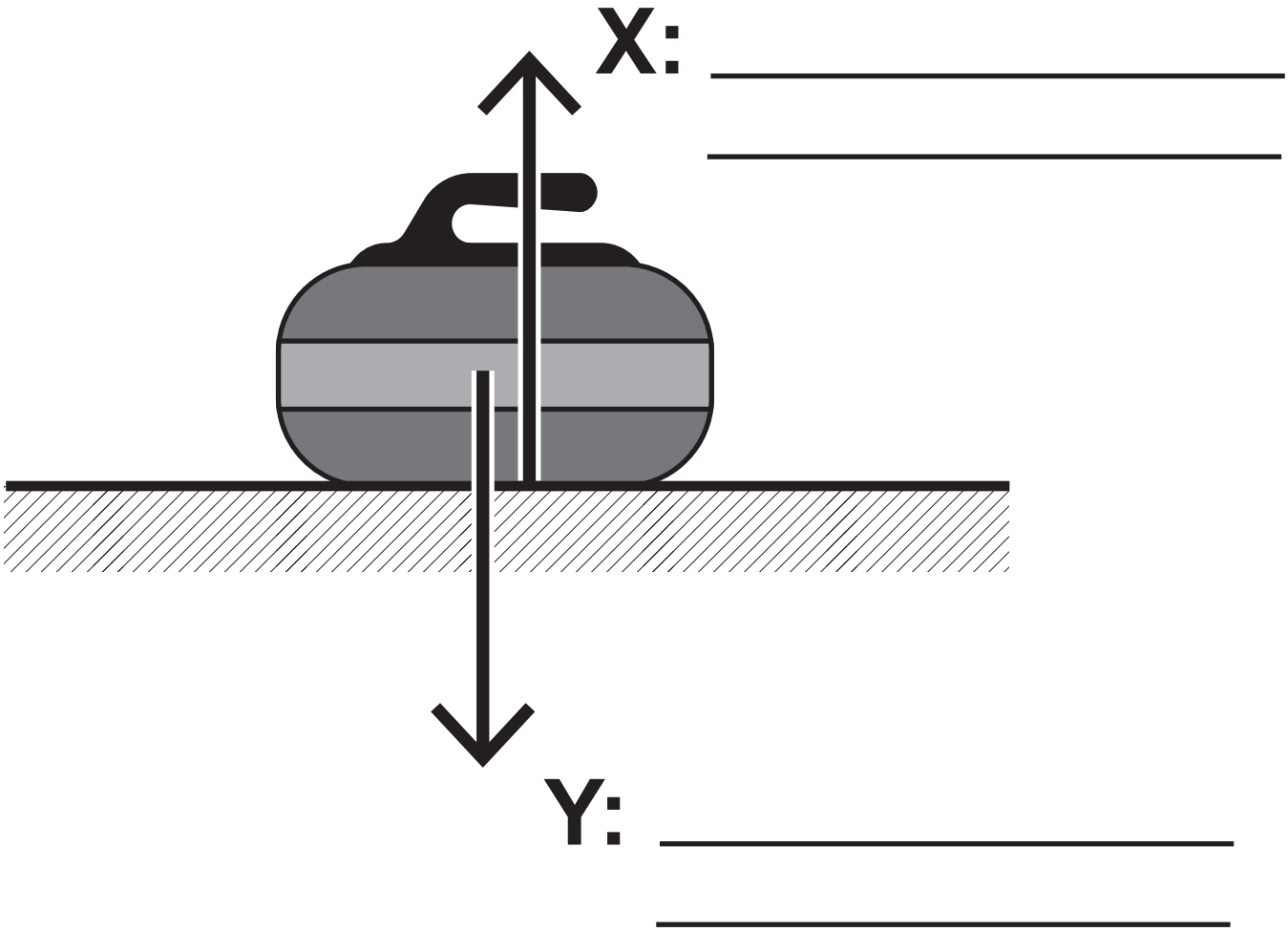
Resultant force (N)



Question 5 (b)



Question 5 (c)



Question 7 (b)

Key:

— luminosity

- - - radius

..... surface temperature

**Ratio with Sun in its
current state today**

