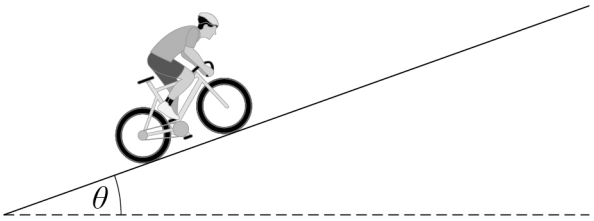
Do not write outside the box

0 7 . 1 **Figure 8** shows a cyclist going up a hill.

Figure 8



not to scale

The angle θ of the slope of the hill is constant.
The total mass m of the cyclist and bicycle is $65\ \text{kg}$.

Write an expression for the component of the total weight parallel to the slope.

[1 mark]

0 7 . 2 The useful power output of the cyclist is $310\ \text{W}$.
The cyclist has a steady speed of $1.63\ \text{m s}^{-1}$.

Assume that air resistance is negligible at this speed.

Calculate θ.

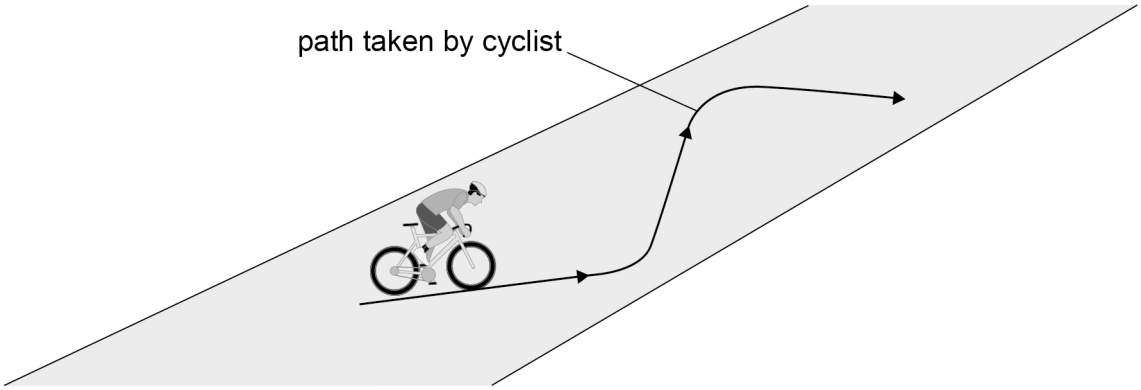
[2 marks]

$\theta =$ _____ °

Do not write outside the box

Figure 9 shows an alternative 'zig-zag' path taken by the cyclist up the same hill. She maintains a steady speed of $1.63\ \text{m s}^{-1}$.

Figure 9



0 7 . 3 Discuss how her useful power output when taking the path in **Figure 9** compares with her useful power output in Question **07.2**.

[3 marks]

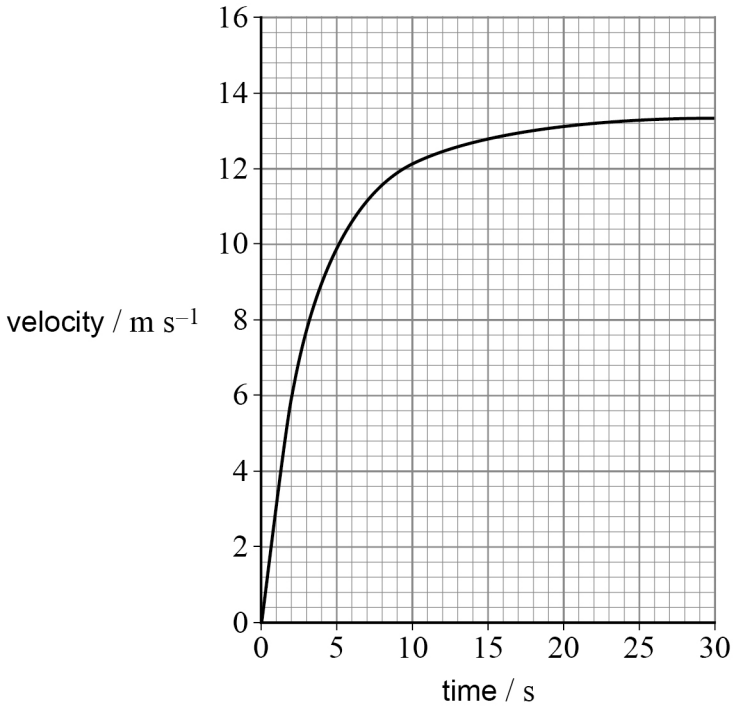
Question 7 continues on the next page

Do not write outside the box

The cyclist reaches the top of the hill. She then travels back down the hill in a straight line. The bicycle rolls freely without the cyclist pushing the pedals or applying the brakes.

Figure 10 shows the variation of her velocity with time as she goes down the hill.

Figure 10



0 7 . 4 Determine the acceleration of the cyclist 10.0 s after she begins to go down the hill.

[3 marks]

acceleration = _____ m s^{-2}

Do not write outside the box

0 7 . 5 Energy transfers occur as the cyclist travels down the hill.

Outline how these energy transfers explain the shape of the graph in **Figure 10**.

[4 marks]

13

Turn over for the next question

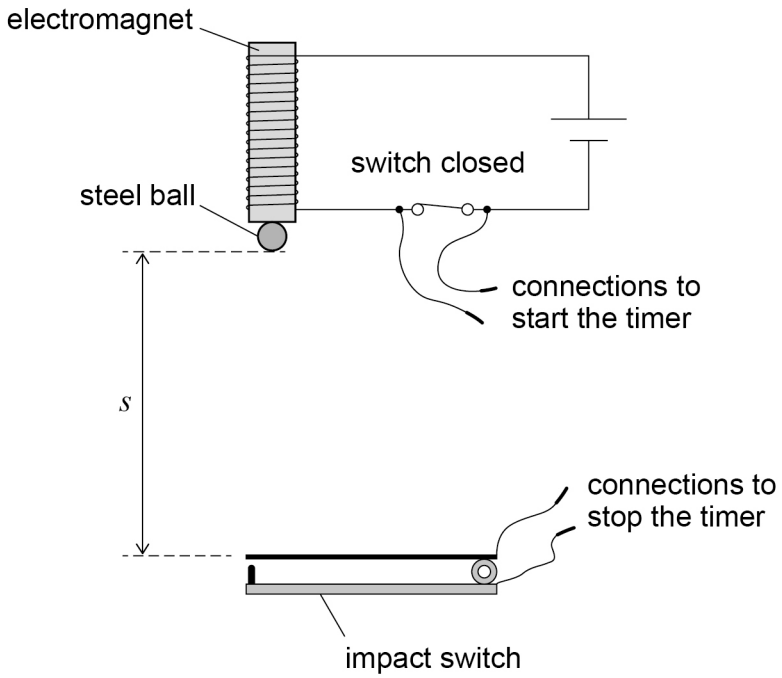
Do not write outside the box

Section A

Answer **all** questions in this section.

0 1 **Figure 1** shows apparatus used to determine the acceleration g due to gravity by a free-fall method.

Figure 1



When the switch is opened a timer starts and a steel ball is released from rest.
The ball falls vertically onto an impact switch and this stops the timer.
The timer displays the time t for the ball to fall through the vertical distance s shown in **Figure 1**.

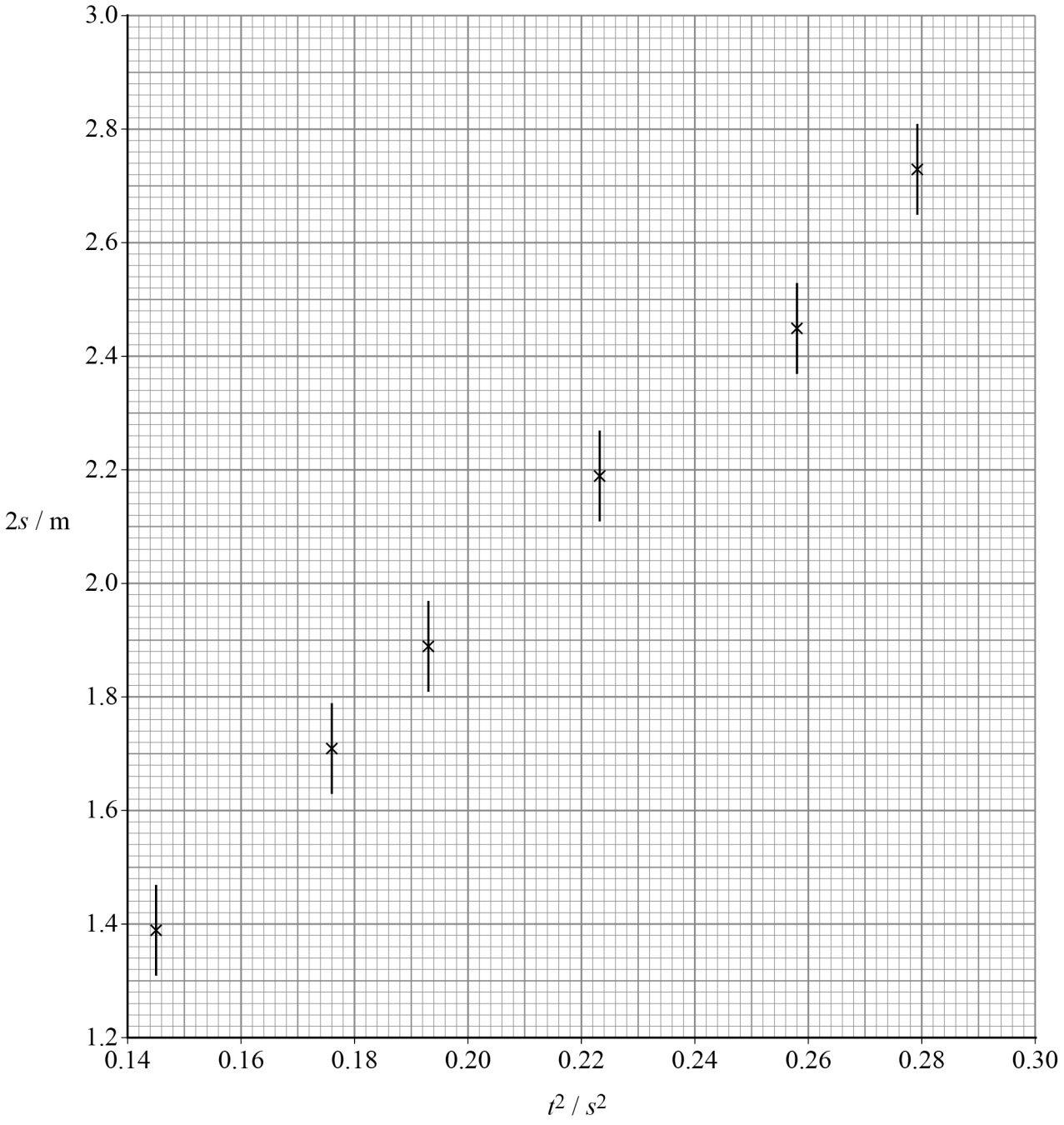
Question 1 continues on the next page

Do not write outside the box

A student obtains values of t for different values of s.

The student plots the graph of $2s$ against t^2 shown in **Figure 2**.

Figure 2



Do not write outside the box

0 1 . 1 The student has used an absolute uncertainty in s to draw the vertical error bars in **Figure 2**.

Deduce the student's absolute uncertainty in s.

[1 mark]

absolute uncertainty in s = _____ m

0 1 . 2 Determine

- the maximum gradient G_{max} of a straight line that passes through all the error bars
- the minimum gradient G_{min} of a straight line that passes through all the error bars.

[3 marks]

G_{max} = _____

G_{min} = _____

Question 1 continues on the next page

Do not write outside the box

0 1 . 3 It can be shown that $2s = gt^2$.

Determine a value for g using G_{max} and G_{min}.

[2 marks]

$g =$ _____ m s^{-2}

0 1 . 4 Determine the percentage uncertainty in your value for g.

[2 marks]

percentage uncertainty = _____ %

Do not write outside the box

A fault develops in the apparatus.
When the switch is opened there is now a $30\ \text{ms}$ delay before the ball is released.

0 1 . 5 State the type of error produced by this fault.

[1 mark]

0 1 . 6 A graph of $2s$ against t^2 is produced using results from the faulty apparatus.

Describe how this graph is different from the graph in **Figure 2**.

[1 mark]

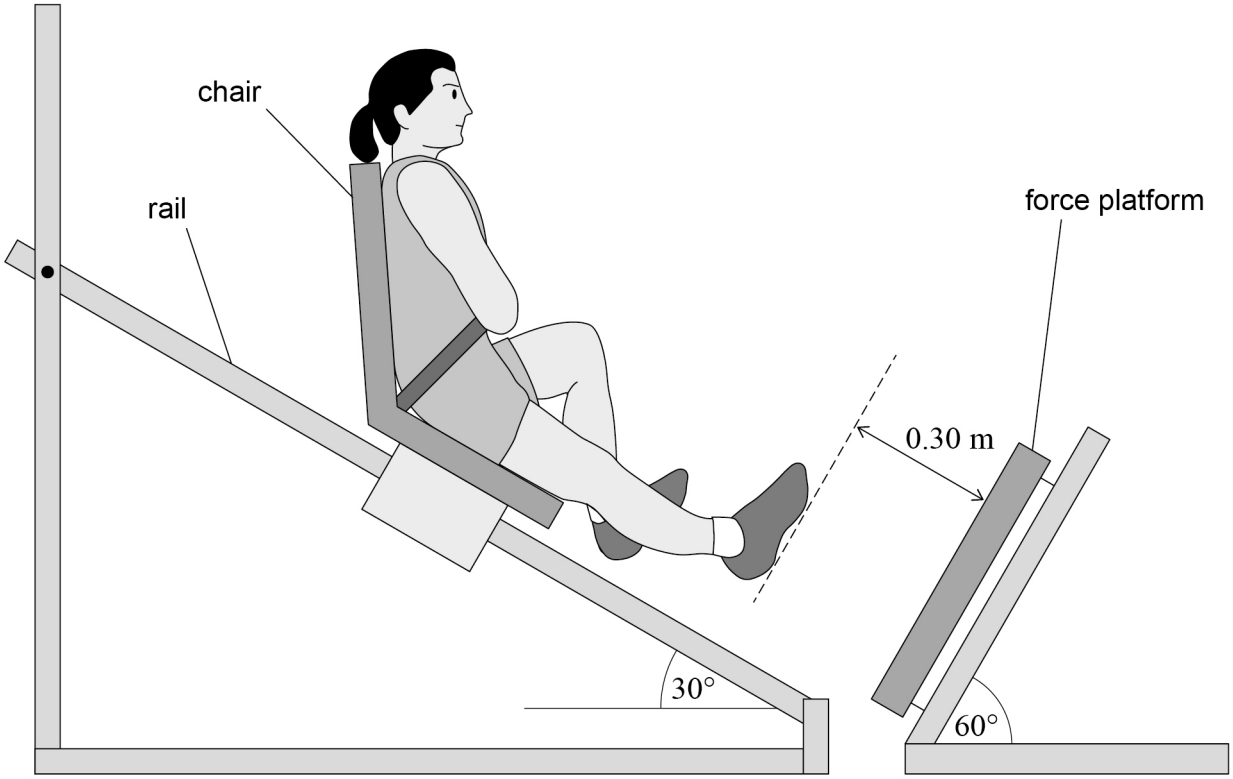
10

Turn over for the next question

Do not write outside the box

0 4 **Figure 6** shows apparatus used to measure the force exerted by an athlete during a single-leg jump.

Figure 6



In **Figure 6**, the athlete is strapped into a chair and held at rest halfway along a rail. The chair is then released to slide down the rail. The athlete keeps her right leg extended until her right foot makes contact with a force platform.
Friction between the rail and the chair is negligible.

initial distance between right foot and platform = 0.30 m
angle between rail and floor = 30°
angle between platform and floor = 60°

0 4 . 1 Show that the athlete and chair accelerate towards the platform at approximately $5\ \text{m s}^{-2}$.

[1 mark]

Do not write outside the box

0 4 . 2 Calculate the speed of the athlete when her right foot makes initial contact with the platform.

[2 marks]

speed = _____ $m\ s^{-1}$

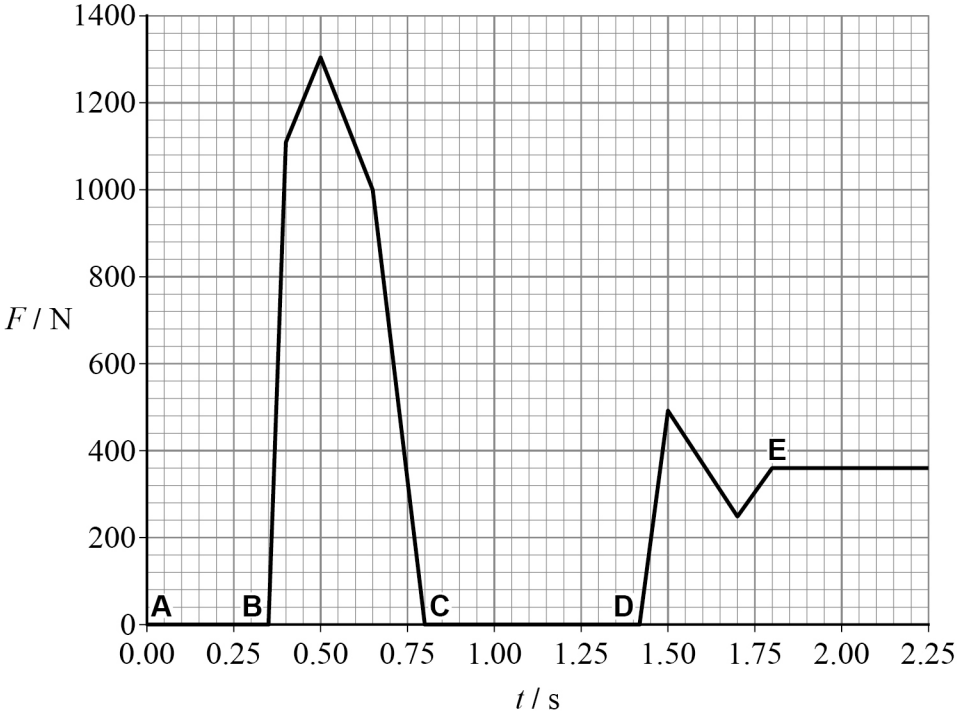
Question 4 continues on the next page

Do not write outside the box

After her right foot makes contact with the platform, she uses her right leg to stop moving and then push herself back up the rail. She slides down the rail again, lands on the platform with both feet and comes to rest.

Figure 7 shows the variation of force F on the platform with time t during the full motion.

Figure 7



The sequence below describes what happens at the five instances **A**, **B**, **C**, **D** and **E** shown in **Figure 7**.

A: athlete and chair are released at $t = 0.00$ s
B: right foot of athlete contacts the platform with leg fully extended
C: right foot loses contact with the platform
D: athlete lands on the platform with both feet
E: athlete and chair come to rest

0 4 . 3 Determine the impulse provided by the force platform between **B** and **C**.

[2 marks]

impulse = _____ N s

Do not write outside the box

0 4 . 4 Determine the distance travelled by the athlete between **C** and **D**.

[3 marks]

distance travelled = _____ m

0 4 . 5 Determine, using **Figure 7**, the combined mass of the athlete and chair.

[2 marks]

mass = _____ kg

10

END OF SECTION B