Uniform Acceleration/ SUVAT Equations

Question Paper 1

Level	International A Level
Subject	Physics
Exam Board	Edexcel
Topic	Mechanics
Sub Topic	Uniform Acceleration / SUVAT Equations
Booklet	Question Paper 1

Time Allowed: **64 minutes**

Score: **/53**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 A stone dropped into a well takes 1.5 seconds to reach the water.

Ignoring the effects of air resistance, what distance did the stone fall through?

☒ **A** 7 m

☒ **B** 11 m

☒ **C** 14 m

☒ **D** 22 m

(Total for Question 1 = 1 mark)

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2 A girl dropped a stone into an empty well. She heard the sound of the stone hitting the bottom of the well after 4 seconds.

The depth of the well is about

☒ **A** 20 m

☒ **B** 40 m

☒ **C** 80 m

☒ **D** 160 m

(Total for Question 2 = 1 mark)

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3 A marble is dropped from the roof of a building and takes 3.2 s to reach the ground.

The approximate height of the building is

☒ **A** 16 m

☒ **B** 31 m

☒ **C** 50 m

☒ **D** 100 m

(Total for Question 3 = 1 mark)

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4 A ball is thrown vertically upwards with a velocity of +3.0 m s^{-1}.

At the maximum height, the acceleration of the ball is

☒ **A** 0 m s^{-2}

☒ **B** – 3.0 m s^{-2}

☒ **C** + 9.8 m s^{-2}

☒ **D** – 9.8 m s^{-2}

(Total for Question 4 = 1 mark)

5 During the 17th century, the physicist Galileo carried out a series of experiments to investigate how gravity affected acceleration.

There were no accurate methods to measure short times, so Galileo used an object on a smooth inclined plane to increase the time taken for the object's motion.

(a) An object is released from rest and slides a distance s down a smooth inclined plane, as shown in diagram 1. This will take longer than releasing the object from rest and allowing it to fall freely through the same distance s, as shown in diagram 2.

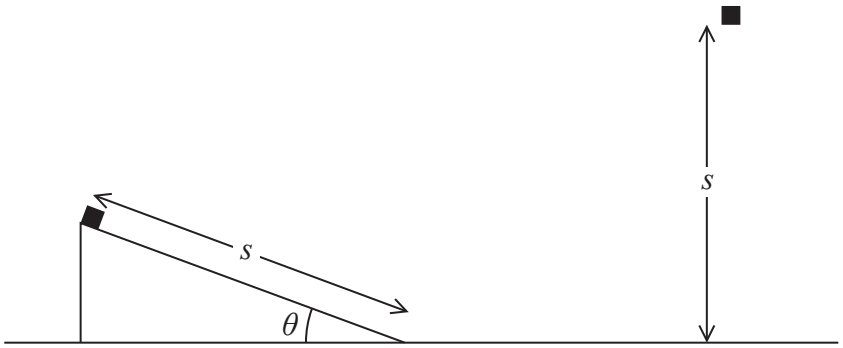


Diagram 1 Diagram 2

(i) Assuming that the frictional forces between the plane and the object are negligible, explain why the object in diagram 1 takes longer to travel distance s than the object in diagram 2.

(3)

(ii) Calculate the acceleration of the object in diagram 1 when $\theta = 35°$.

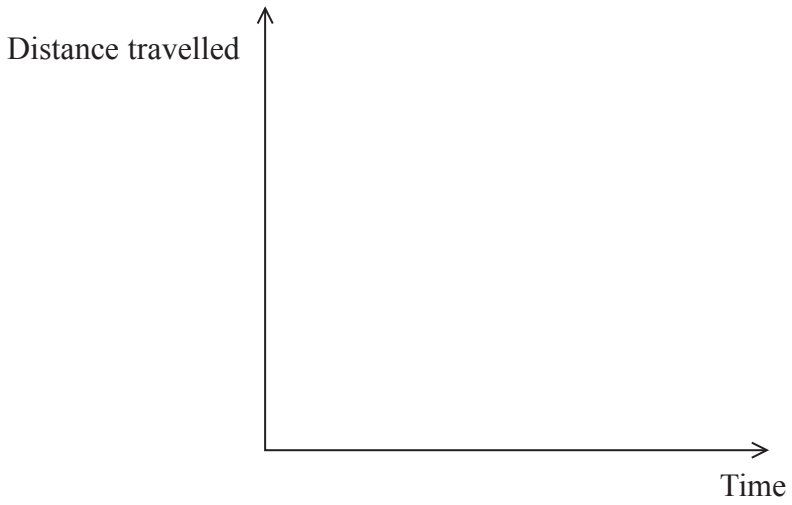
(2)

Acceleration = ...

(b) Galileo released a metal ball from rest so that it could roll down a smooth inclined plane. The time t taken to roll a distance s was measured. He repeated the experiment, each time recording the time taken to travel a different fraction of the distance s.

(i) On the axes below, sketch the distance-time graph that would be expected from these readings.

(2)



(ii) Write an expression for the time taken, in terms of t, for the ball to roll a distance $\frac{s}{2}$ from the top of the plane.

(1)

Time taken = ...

(c) Galileo repeated his measurements many times and obtained similar results on each occasion. He did not have a stopwatch and had to measure times using his pulse. A human pulse is about one beat per second.

Comment on Galileo's method.

(2)

(d) Today, the acceleration of free fall can be found accurately by dropping a metal ball vertically and using ICT to collect data.

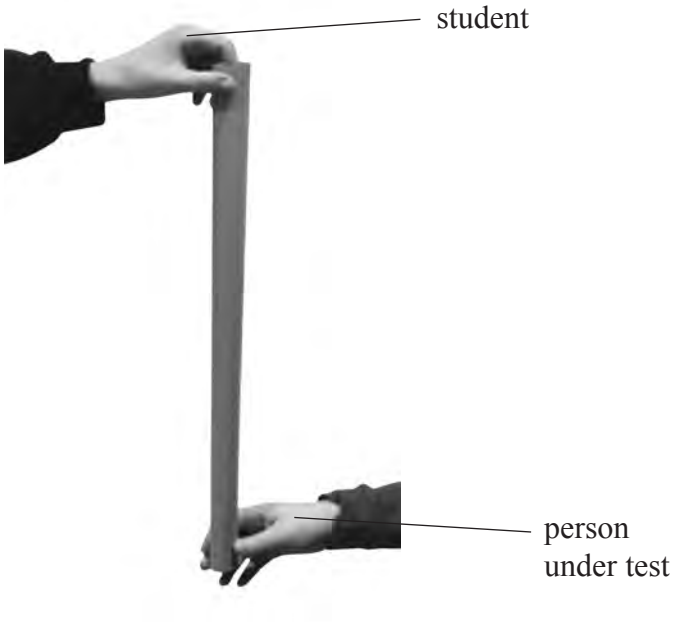
Suggest the apparatus required to take the measurements needed to calculate a value for the acceleration of free fall.

(2)

(Total for Question 5 = 12 marks)

6 The reaction time of a person can add approximately 0.2 s to a measured time. A student decided to make a basic device to measure a person's reaction time. The only equipment the student used was a strip of card 50 cm long, a ruler and a calculator.

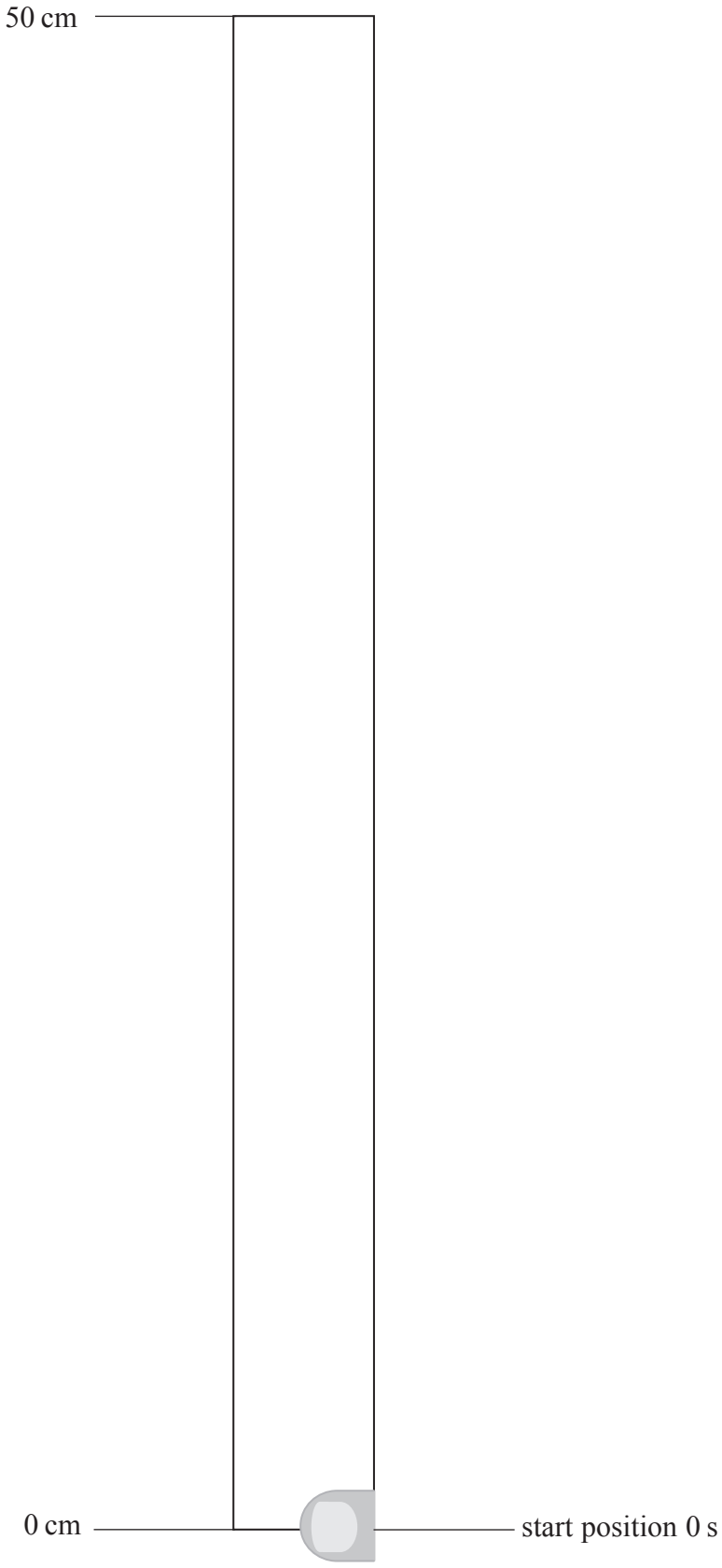
To use the timer the student holds the card vertically so that it will fall between the fingers and thumb of the person under test as shown.
The person under test holds their hand in the position shown, but not touching the card.



The student releases the strip and the person under test grabs it as quickly as possible, marking the position on the card at which it is caught.

Mark on the scale diagram on the opposite page the positions at which the card will be caught for reaction times of 0.10 s and 0.30 s. Show all working out in the space below.

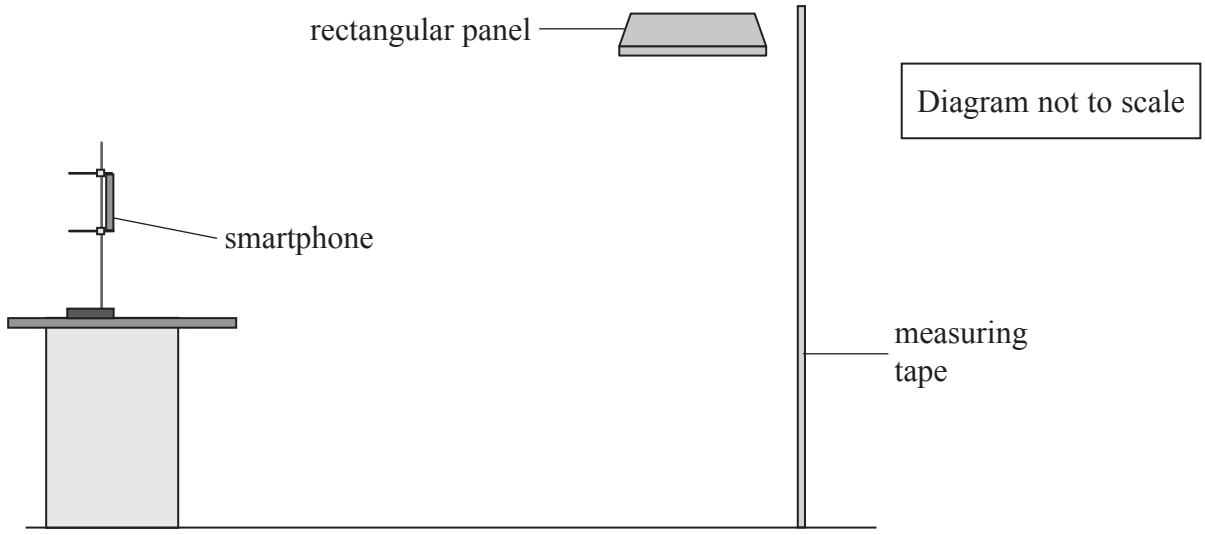
(4)



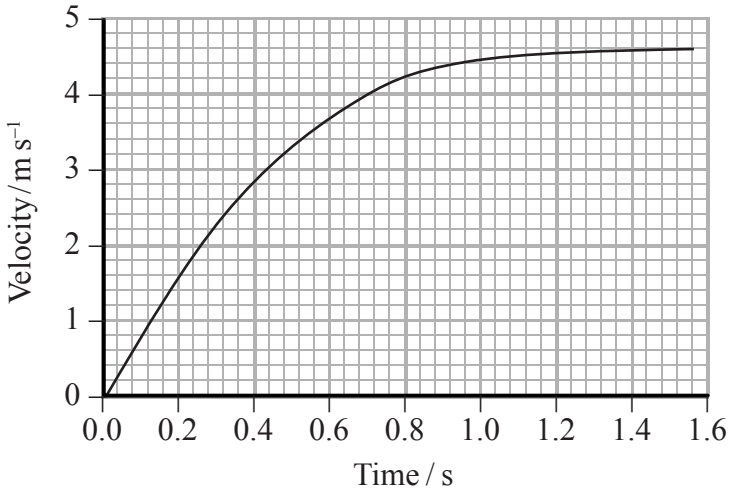
(Total for Question 6 = 4 marks)

7 A student investigated the motion of a small rectangular panel. The panel was held above the floor next to a measuring tape.

The panel was released and, using a video camera on a smartphone, its motion as it fell to the floor was recorded. Using the position of the panel at regular time intervals the velocity of the panel was obtained.



The velocity-time graph shows the motion of the panel until it reaches the floor.



(a) Show that the panel was dropped from a height of approximately 5 m.

(3)

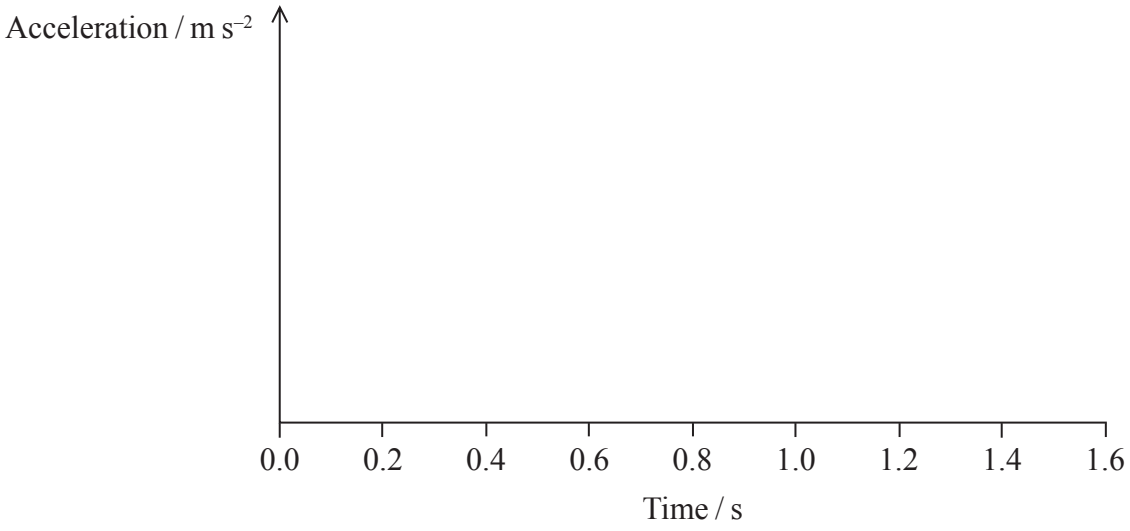
(b) (i) Use the graph to calculate the maximum acceleration of the panel.

(3)

Maximum acceleration = ...

(ii) Without further calculation sketch an acceleration-time graph for the panel on the axes below.

(4)

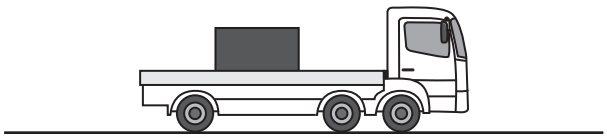


(c) Explain how the student can check the reliability of these results.

(2)

(Total for Question 7 = 12 marks)

8 (a) A lorry gradually accelerates from rest. There is a box of mass 200 kg on the back of the lorry. The box is not tied to the lorry.



(i) The lorry accelerates from rest to a speed of 15 m s^{-1} over a distance of 39 m.

Show that the acceleration of the lorry is about 3 m s^{-2}.

(2)

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(ii) The maximum frictional force between the lorry and the box is 630 N.

Explain why this limits the maximum acceleration that the lorry can have without the box falling off. Your answer should include a calculation.

(3)

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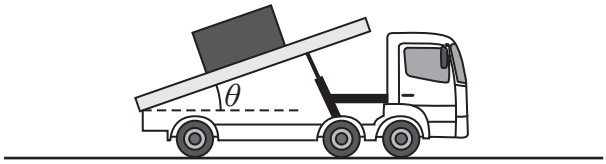
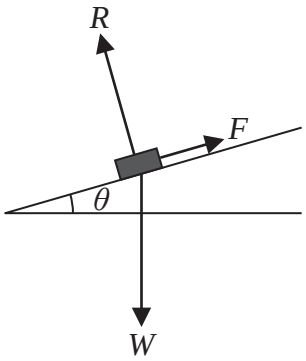
(b) Once the lorry has reached its destination, the back of the lorry is tilted at an angle θ to the horizontal.



Three forces act on the box: the weight W, the normal contact force R and the frictional force F.



(i) State expressions for the components of the weight of the box parallel to the back of the lorry and perpendicular to the back of the lorry.

(2)

$W_{parallel}$ = ...

$W_{perpendicular}$ = ...

(ii) The angle θ is increased until the box is just about to slide.

Given that $F = 0.32R$, calculate the value of θ at which the box is just about to slide.

(4)

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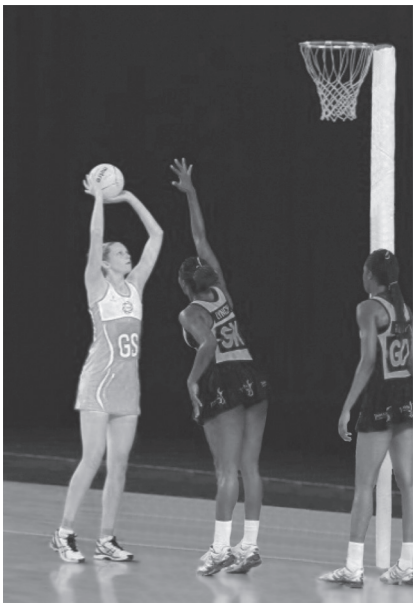
θ = ...

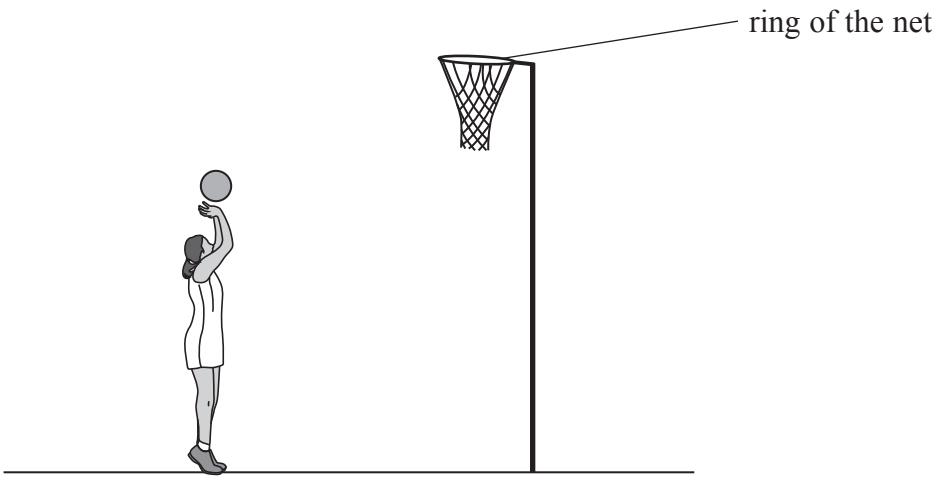
(Total for Question 8 = 11 marks)

9 In a game of netball, a goal is scored when the ball passes through the ring at the top of the net.



(a) On the diagram below draw the path the ball should take if a goal is to be scored.

(1)



(b) A student is given the following information for a particular attempt at a goal.

initial velocity of ball on release = 4.5 m s^{-1}
release angle of ball = 60° from the horizontal
horizontal distance from centre of ball to centre of ring = 1.5 m

(i) Show that the time taken to travel the horizontal distance of 1.5 m is about 0.7 s.

(3)

(ii) Calculate the vertical displacement of the ball when it has travelled a horizontal distance of 1.5 m and hence comment on whether a goal will be scored.

vertical distance of ring from release point = 0.70 m

(4)

Vertical displacement = ...

Comment .....

(iii) Explain how air resistance would have affected the calculation in (b)(i).

(2)

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(Total for Question 9 = 10 marks)