2.1 Motion

Question Paper

Course	DP IB Physics
Section	2. Mechanics
Topic	2.1 Motion
Difficulty	Easy

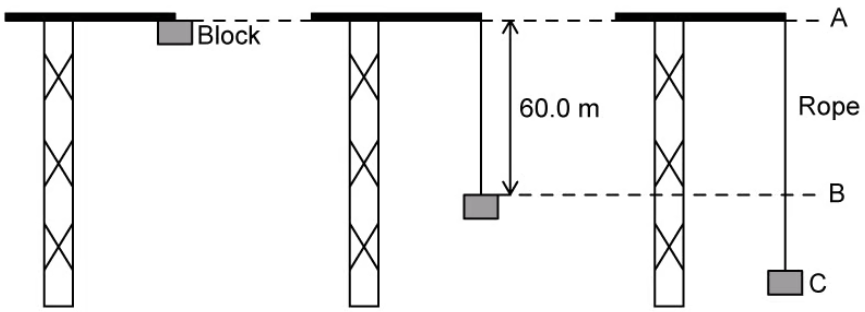
Time allowed: 60

Score: /47

Percentage: /100

Question 1a

One end of an elastic climbing rope is fixed to the top of a crane. The other end of the rope is connected to a block which is initially at position A. The block is released from rest. The mass of the rope is negligible.



The full length of the rope is 60.0 m. From position A to B, the block falls freely.

(a)

(i)
State the block's acceleration between position A and B.

[1]

(ii)
Describe how the velocity of the block changes between position A and B.

[1]

[2 marks]

Question 1b

(b)
Calculate the speed of the block at position B.

[2]

[2 marks]

Question 1c

(c)
At position B the rope starts to extend. Position C is the point at which the rope is fully extended. Describe the motion of the block between position B and C.

[2]

[2 marks]

Question 1d

Between position B and C the resultant force on the block changes, because the tension in the rope increases as the rope extends.

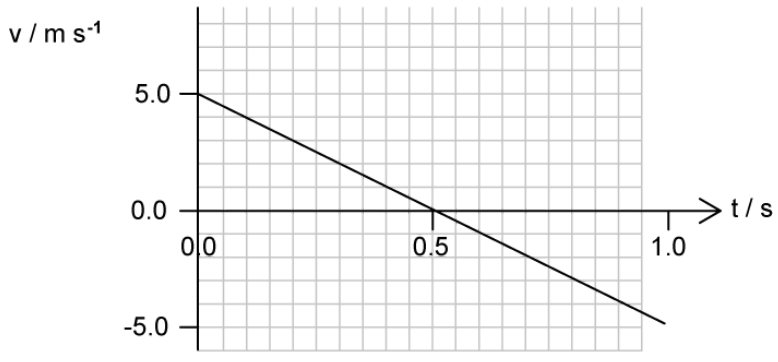
(d)
State and explain whether a SUVAT equation can be used to determine the distance the block falls between position B and C.

[2]

[2 marks]

Question 2a

An experimenter throws a small object upwards. The graph shows the variation of velocity v with time t of the object.



(a)
Explain why the gradient of the graph between $t = 0.0$ s and $t = 0.5$ s is roughly 10 m s^{-2}.

[2]

[2 marks]

Question 2b

(b)
Use the graph to calculate the displacement of the object between $t = 0$ s and $t = 0.5$ s.

[3]

[3 marks]

Question 2c

(c)
State and explain the motion of the object at $t = 0.5$ s.

[2]

[2 marks]

Question 2d

The experimenter states that the velocity-time graph shows the object travels the same distance upwards and it does downwards.

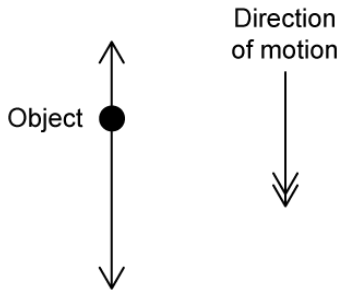
(d)
Explain how the velocity-time graph shows the distance travelled by the object is the same upwards as it is downwards.

[2]

[2 marks]

Question 3a

Examination questions on projectile motion often involves objects moving vertically through the atmosphere.



The object shown moves vertically downwards through the atmosphere.

(a)
Identify the two forces acting on the object and label them on the diagram.

[2]

[2 marks]

Question 3b

Often, a simplifying condition is assumed so that, in these cases, only a single force acts on objects as they move through the atmosphere.

(b)

(i)
State the simplifying condition that is normally assumed.

[1]

(ii)
Identify the force that is ignored under this simplifying condition.

[1]

[2 marks]

Question 3c

Terminal velocity is only attained if both forces act on the object.

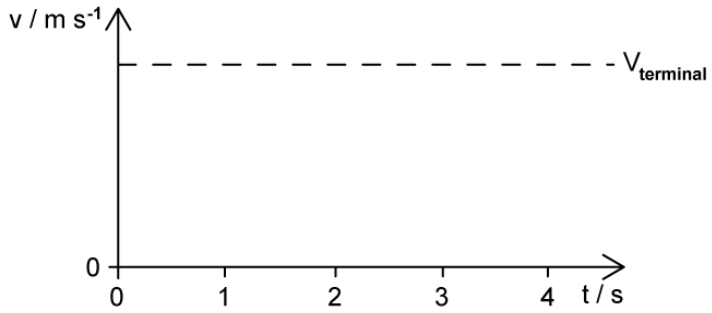
(c)
State and explain the magnitude of the resultant force on the object if it moves at its terminal velocity.

[2]

[2 marks]

Question 3d

(d)
Sketch a graph on the axes provided to show an object that is released from rest at $t = 0$ s and falls vertically through the atmosphere, attaining terminal velocity, $v_{terminal}$ after $t = 4$ s.



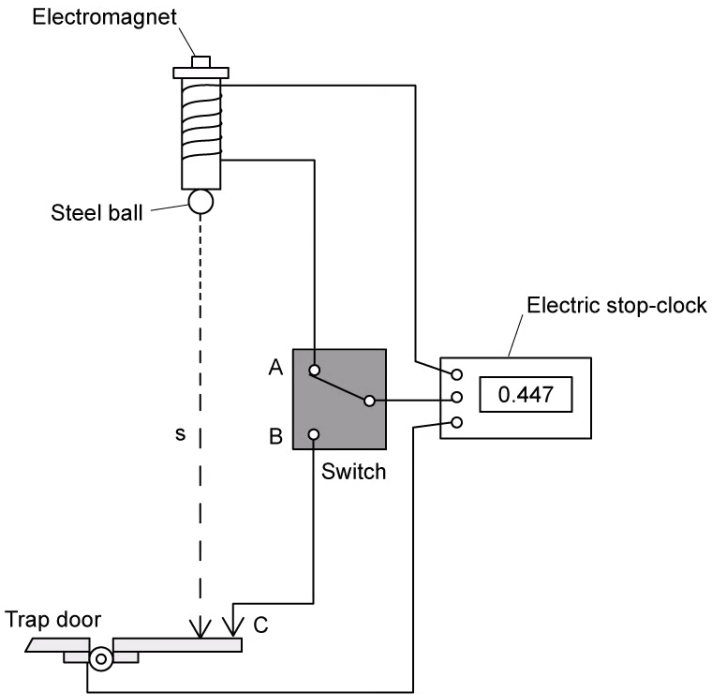
The line corresponding to $v_{terminal}$ is included as guidance.

[3]

[3 marks]

Question 4a

An experiment designed to measure the acceleration due to gravity is set up as shown.



The two-way switch is connected at A to an electromagnet and at B to a trap door, via an electric stop-clock. The stop-clock starts the instant the switch moves from A to B, and stops when the trap door is opened by a falling steel ball, which breaks the circuit.

(a)
State the resolution of the electric stop-clock.

[2]

[2 marks]

Question 4b

The distance travelled *s* acts as the independent variable in this experiment.

(b)

(i)
State what is meant by the independent variable.

[1]

(ii)
Identify the dependent variable in this experiment.

[1]

[2 marks]

Question 4c

Use the equation of motion for the steel ball,

$$s = ut + \frac{1}{2}at^2$$

to help answer the following questions:

(c)

(i)
State the value of the initial velocity, *u*.

[1]

(ii)
Show that the equation of motion for the steel ball becomes:

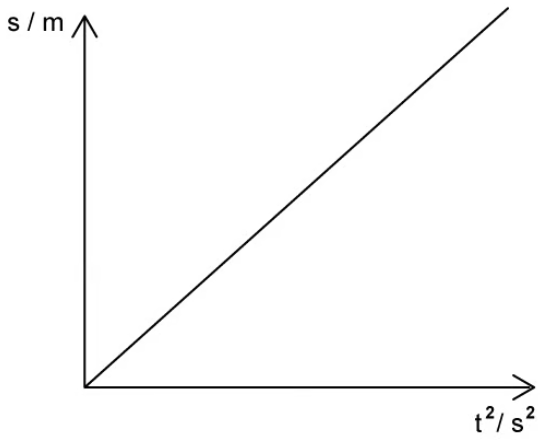
$$s = \frac{1}{2}at^2$$

[1]

[2 marks]

Question 4d

The time taken *t* for the steel ball to descend different distances s is measured. The graph shows the variation of the distance s with the square of time, t^2.



(d)

(i)
Explain why the equation of motion can be written as:

$$s = \frac{1}{2}gt^2$$

[1]

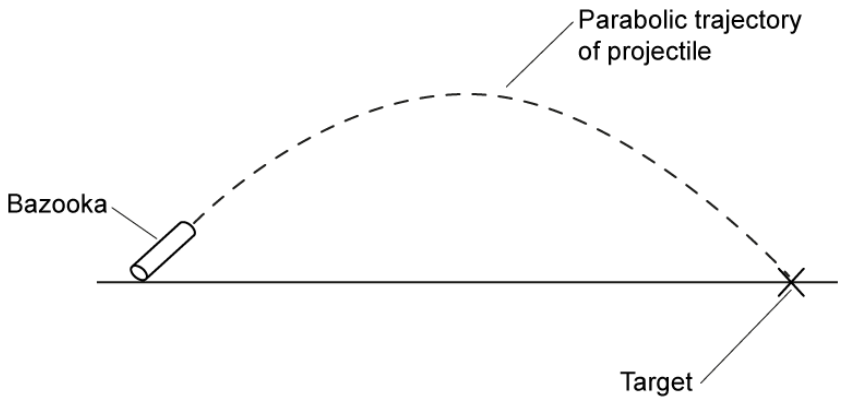
(ii)
By comparing the equation to the graph, state the value of the gradient.

[2]

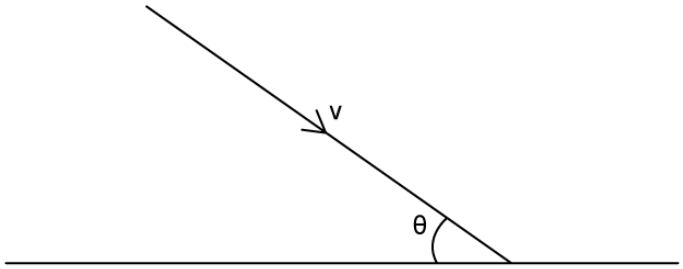
[3 marks]

Question 5a

Projectiles follow parabolic trajectories. One such trajectory is shown for a projectile fired from a bazooka.



The projectile lands on its target with a final velocity *v* that can be represented as shown.



(a)

(i)
Draw and label the direction of the horizontal and vertical components of the final velocity *v* on the diagram.

[2]

(ii)
Write the magnitude of each component in terms of the angle to the horizontal, θ.

[2]

[4 marks]

Question 5b

The initial horizontal velocity given to the projectile is 3.5 m s^{-1}. Air resistance can be ignored.

(b)

(i)
State the final horizontal velocity of the projectile.

[1]

(ii)
Explain your answer to part (i).

[1]

[2 marks]

Question 5c

The final vertical velocity of the projectile is 3.8 m s^{-1}.

(c)
Calculate the magnitude of the final velocity, *v*.

[3]

[3 marks]

Question 5d

The horizontal distance between the bazooka and the target is 27 m.

(d)
Calculate the time taken for the projectile to reach the target.

[3]

[3 marks]