Year 12 Physics Assessment Task

I.D. Number: _____

Practical and Processes

Teacher: ☐ Coombes ☐ Pitt ☐ Robson

TOTAL MARKS _____/ 40

Task Weighting: 15%

Time Allowed: 45 minutes

- Attempt all questions.
- Show all working
- Question 1 relates to pendulum motion.
- Questions 2 – 4 relate to projectile motion.

Pendulum Motion

Question 1.

(a) On the projector screen is a movie of an oscillating pendulum of unknown length. Determine the period of this pendulum. Ensure that you show all relevant working and calculations. You have been provided with a stopwatch for this task. [3M]

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(b) Calculate the length of the pendulum using the following formula and assuming that the acceleration due to gravity is 9.8ms^{-2}. [2M]

$$T = 2\pi\sqrt{\frac{l}{g}}$$

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(c) A group of students conducted the pendulum experiment on the surface of the Earth and obtained values as follows. The average periods calculated below were obtained through extensive repetition and can be considered as reliable.

Average Period (s)	Length (m)	Acceleration due to gravity (m s^{-2})
0.93	0.2	9.2
1.31	0.4	9.2
1.61	0.6	9.2
1.87	0.8	9.1
2.07	1.0	9.3

Propose one possible reason why the values for the acceleration due to gravity in the table are less than the expected value of 9.8 m s^{-2}. Justify your answer with reference to the following equation.

[2M]

$$T = 2\pi\sqrt{\frac{l}{g}}$$

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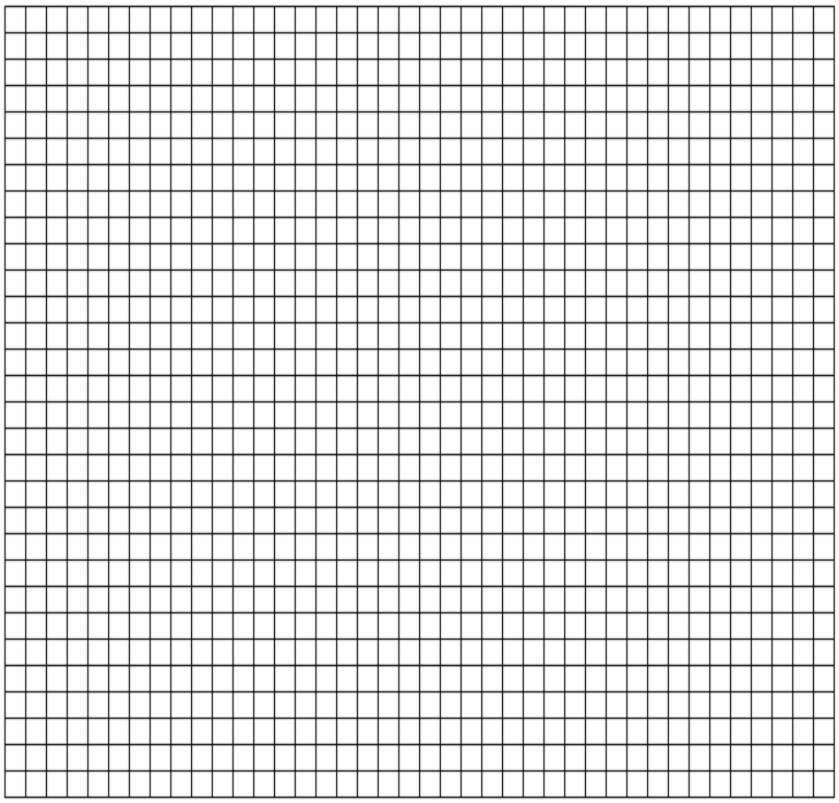
(d) A group of student carried out an experiment to determine the acceleration due to gravity using a pendulum on planet X. The following values were obtained.

Length (m)	0.2	0.4	0.6	0.8	1.0
Period (s)	1.26	1.80	2.16	2.52	2.81

Use the graph paper below and any relevant calculations to determine the acceleration due to gravity on planet X. {Marks will be deducted if less than half of the area of the graph paper is used.} [5M]



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Projectile Motion

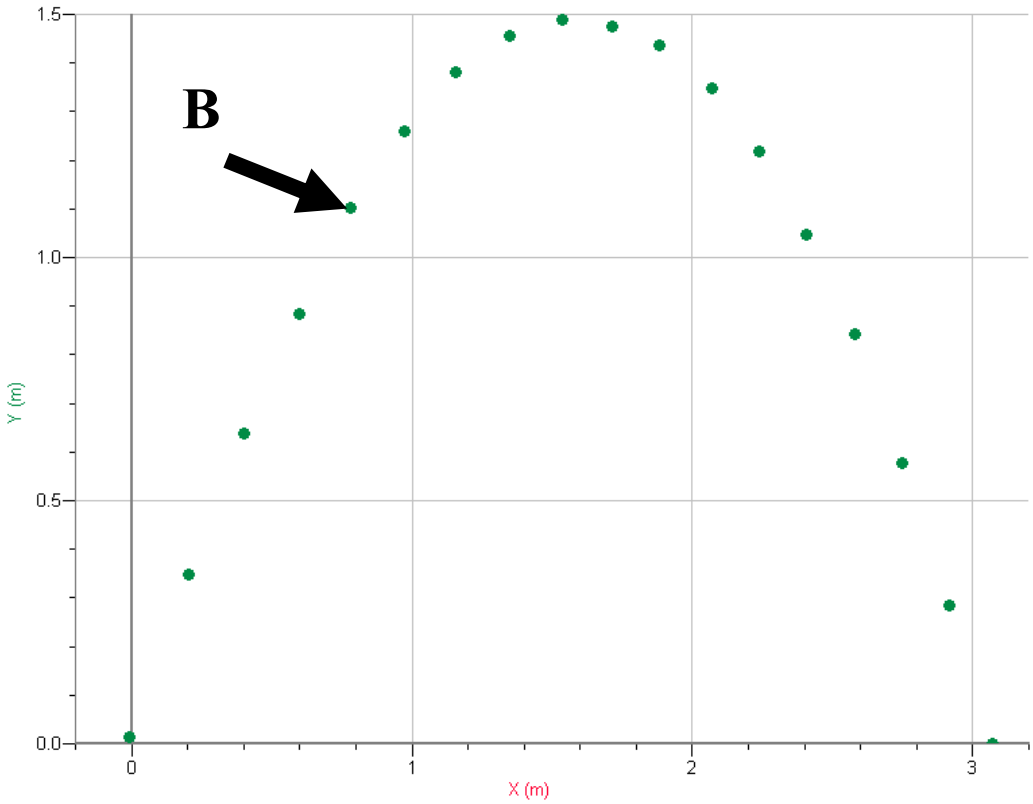
Equations required for the following questions

$$v = u + at \qquad \Delta x = u_x t$$

$$v_y^2 = u_y^2 + 2a_y\Delta y \qquad \Delta y = u_y t + \frac{1}{2}a_y t^2$$

Question 2.

The following graph shows the position of a ball over time. Images of the position of the ball are displayed at regular time intervals.



(a) Ignoring air resistance identify any forces acting on the ball at point B in the graph. [1M]

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(b) Identify the maximum height of the projectile. [1M]

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(c) Use an equation from the list above to calculate the time taken to reach the maximum height. [2M]

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(d) Considering the number of time intervals to reach this maximum height determine, the time elapsed between each image on the graph. [2M]

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(e) Identify the range of the projectile. [1M]

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(f) Calculate the horizontal velocity of the projectile. [2M]

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(g) Determine the initial velocity of the projectile (including the direction). [4M]

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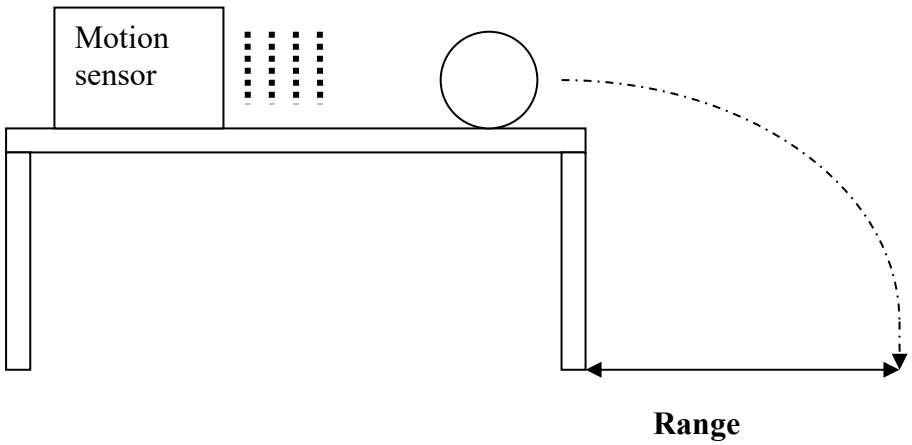
Question 3

A group of students carried out an experiment by rolling a ball horizontally off a table of unknown height. They wanted to determine the relationship between the initial horizontal velocity and the range of the projectile. The equipment used was as follows.



The ball was pushed by a student a number of times to produce differing initial velocities. The motion sensor was used to measure the initial velocity each time. Students observed where the ball landed each time and measured the range with a ruler. The following results were collected.

Velocity (m s^{-1})	1.2	2.0	3.1	3.7	4.2
Range (m)	0.54	0.90	1.52	1.66	1.90

(a) A line of best fit graph of the values above has been plotted below. [2M]
Identify the dependent variable and justify your choice.

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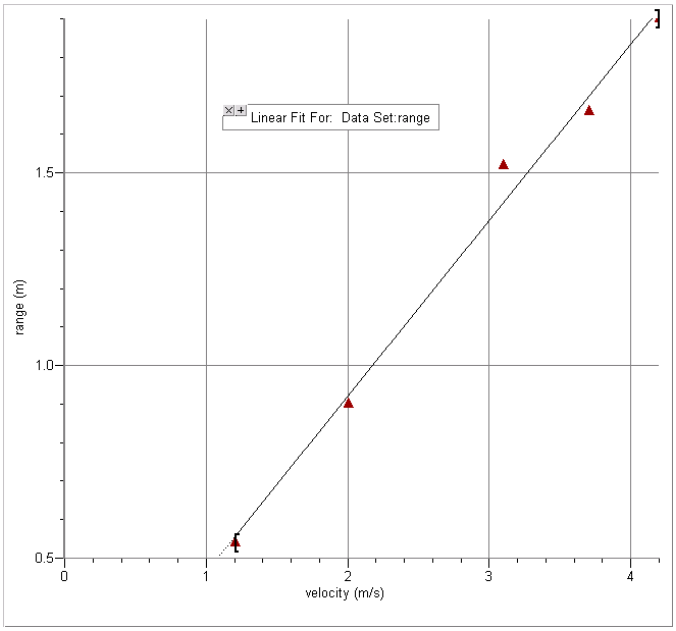

(b) Identify the relationship between the initial velocity and the range. [1M]

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(c) Calculate the gradient of the line of best fit. [2M]

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(d) With reference to your graph and the equations of motion identify what the gradient represents. [1M]

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(e) Using any relevant information calculate the height of the table. [2M]

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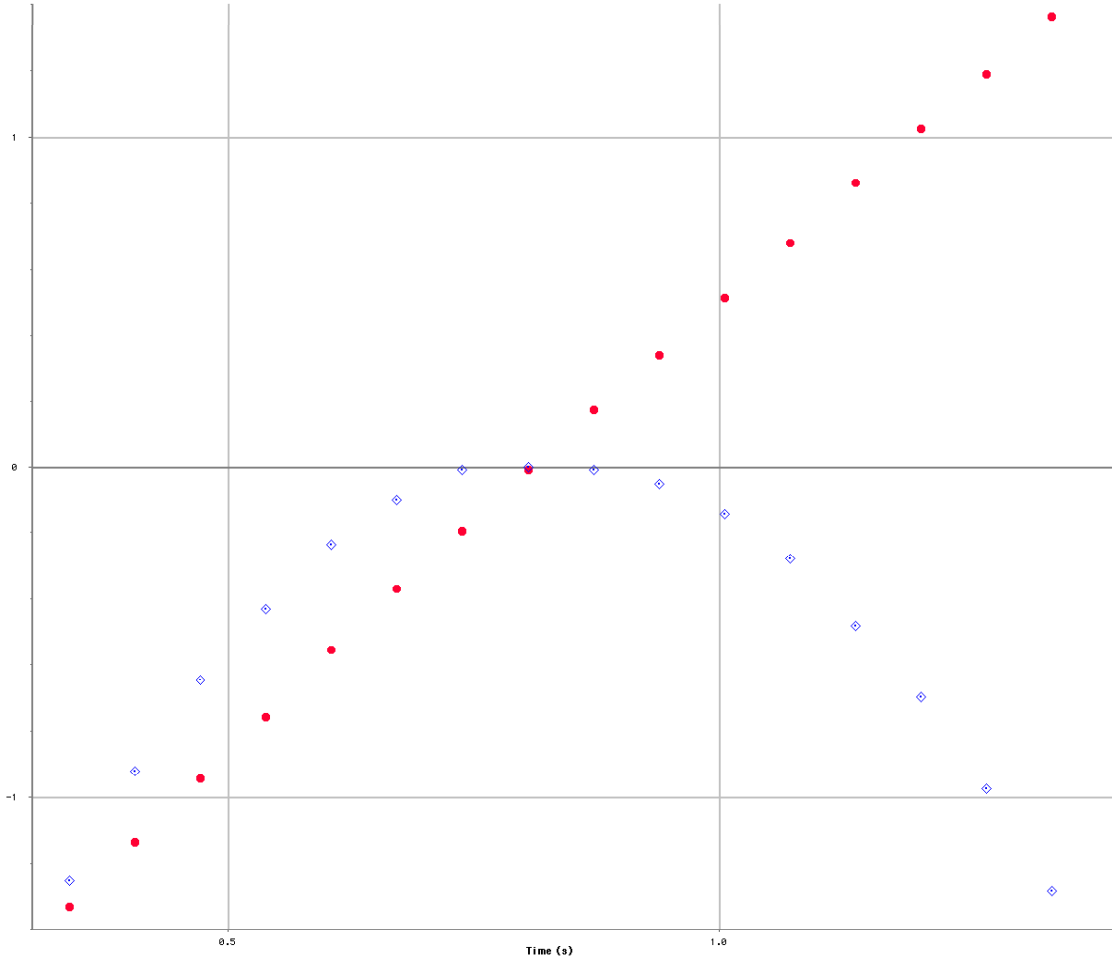
Question 4

Shaun graphed two variables relating to the motion of a projectile against time, however he forgot to label the vertical axis of the graph with the two variables. He used solid circles for one of the variables and open diamonds for the other variable.



He remembered that the two variables he graphed would have been one of the following four possibilities.

(i) horizontal and vertical velocity
(ii) horizontal and vertical displacement
(iii) horizontal and vertical acceleration
(iv) vertical velocity and vertical acceleration

(a) Identify the two variables that have been graphed and justify your choice. [3M]

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(b) Draw a line of best fit for each variable graphed. [1M]

(c) The two graphs intersect at between 0.5 s and 1.0 s. Qualitatively describe the motion of the projectile at the time at which the two graphs intersect. [3 M]

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1 a)

Criteria	Marks
Correctly determines the period of the pendulum to be between 1 and 1.15 s by - measuring the time for multiple periods (eg time for 10 oscillations) repeating this process at least twice - correctly calculating an average time for the above data - dividing the average time by the number of oscillations	3
Correctly determines the period of the pendulum to be between 1 and 1.15 s using the method above but does not repeat the measurement of time for multiple periods OR Obtains a period outside of the range above using the method outlined OR Uses the method above correctly but performs an incorrect calculation at one or more stage in the process	2
Method shows repetition but period is obtained from a single swing	1

1 b)

Criteria	Marks
Substitutes appropriate values into the formula to obtain a correct length value including units(0.25 m – 0.33 m for above period range)	2
Substitutes appropriate values into the formula to obtain a correct length value but omits units or units incorrect	1.5
Substitutes appropriately but does not calculate a correct value	1

1 c)

Criteria	Marks
Correctly proposes that the length values have not been measured to the centre of mass and explicitly links the effect of this to the calculation of g using the equation (if length is shorter, g will be less since g is proportional to l/T^2)	2
Correctly proposes that the length values have not been measured to the centre of mass but does not explicitly link the effect of this to the calculation of g using the equation OR proposes that another factor (eg. lower density of earth at location or altitude at which the experiment was performed) that causes a consistently lower value of g	1.5

1 d)

Criteria	Marks
Graph of T^2 v l plotted with axes correctly labelled, points plotted appropriately and a reasonable straight line of best fit and Gradient calculated using points on the line OR a point chosen on the line A calculation performed which clearly establishes the link between the gradient and the formula $T = 2\pi\sqrt{\frac{l}{g}}$ showing substitution and a correct final value for g OR Substitutes the point on the line of best fit into the formula and correctly calculates a final value of g	5
Above steps completed but graph poorly drawn (omits one or two of the identified criteria) OR a mathematical error made when processing the data (gradient or formula calculations)	4
Draws an appropriate graph and makes an attempt to establish a link between the graph and the calculation of g.	3
Correct graph drawn appropriately OR draws a graph of the data in the table (T v l) and performs a calculation of g using one or more data points.	2
A calculation performed using one of the data points substituted correctly into the equation to obtain a reasonable value of g OR draws a reasonable graph of the data in the table	1

2 a)

Criteria	Marks
Names the force of gravity	1

2 b)

Criteria	Marks
States the height as 1.5 m (lose half mark if no units)	1

2 c)

Criteria	Marks
Applies the equation $\Delta y = u_y t + \frac{1}{2}a_y t^2$ to calculate the correct answer of 0.56 s OR Uses $v_y^2 = u_y^2 + 2a_y\Delta y$ to calculate $u_y = 5.42$ m s^{-1} and the applies $v_y = u_y + a_y t^2$ to determine the time (0.56 s).	2
Substitutes correctly into the equation but makes an error in the calculation OR Uses $v_y^2 = u_y^2 + 2a_y\Delta y$ to calculate $u_y = 5.42$ m s^{-1} which is an intermediate step in applying $v_y = u_y + a_y t^2$ as an alternative approach to solving the problem.	1

2 d)

Criteria	Marks
Divides the time from part (c) by 8 to get 0.07 s	2
Identifies that there are 8 time intervals (not 9)	1

2 e)

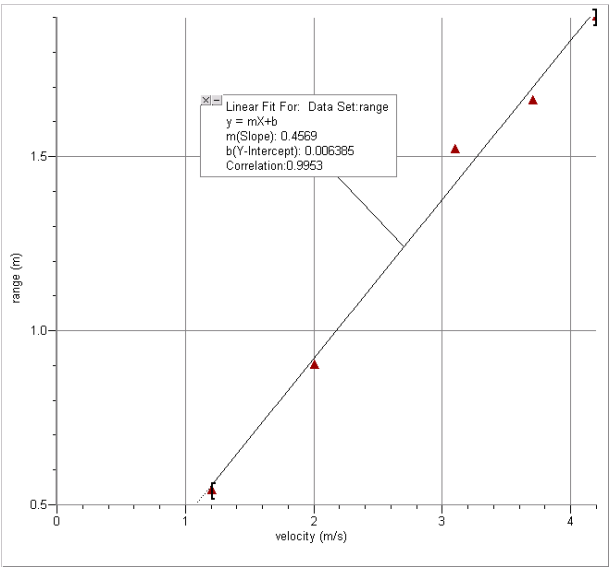
Criteria	Marks
States the range of the projectile as being between 3.05 metres and 3.1 metres (it is definitely greater than 3 m)	1

2 f)

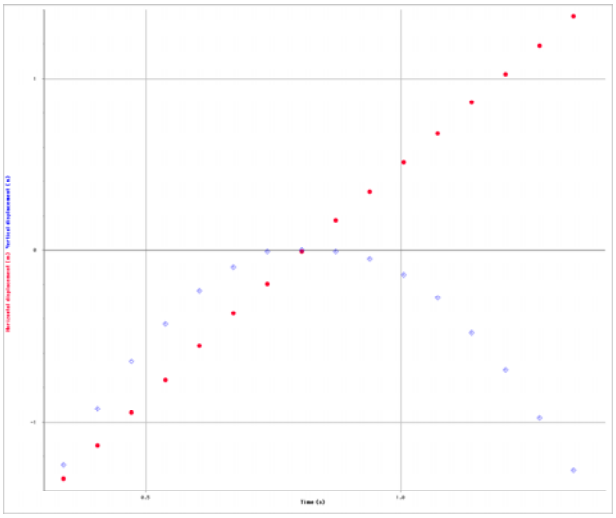
Criteria	Marks
Calculates the horizontal velocity by dividing the horizontal distance travelled by the corresponding time to get a value of 2.61 m s^{-1}. The best approach is to divide the distance (3.1 m) by the time taken to travel that distance (17 time intervals x 0.07 s). A less valid method is to double the answer to part (c) to determine the time – this was accepted but the method is not as good as there are 8 time intervals going up and 9 going down.	2
Correct substitution but incorrect answer	1

2 g)

Criteria	Marks
Uses a vector diagram and Pythagoras' relationship to determine the resultant of the horizontal velocity (from part f) and the vertical velocity calculated from $v_y^2 = u_y^2 + 2a_y\Delta y$ to calculate $u_y = 5.42$ m s^{-1} and calculates the angle.	4
Uses a vector diagram and Pythagoras' relationship to determine the resultant of the horizontal velocity (from part f) and the vertical velocity calculated from $u_y = 5.42$ m s^{-1} ONLY	3
Shows that a vector diagram is needed to determine the magnitude of the final velocity but incorrectly substitutes one of the velocities AND determines a correct angle based on this.	2
Shows that a vector diagram is needed to determine the magnitude of the final velocity but incorrectly substitutes one of the velocities OR shows the correct method calculating the angle based on two velocity components.	1



Here is the graph with the correct labels on the axes.



3 (a)

Criteria	Marks
Answer identifies range as the independent variable and justifies this by stating that it depends on the initial velocity of the projectile	2
Answer identifies the range as the independent variable	1

(b)

Criteria	Marks
States that the range is proportional to the initial velocity	1

(c)

Criteria	Marks
Calculates the gradient and has the correct units (s)	2
Has the correct method for calculating the gradient (but may have an incorrect substation, no units shown)	1

(d)

Criteria	Marks
Indicates ONLY that the gradient represents the time taken to reach the floor.	1

(e)

Criteria	Marks
Applies the equation of motion ($\Delta y = \frac{1}{2} at^2$) and the time taken to reach the floor to calculate the correct answer.	2
Has one correct step or appropriately used piece of data	1

4(a)

Criteria	Marks
Identifies the variables as the horizontal displacement [straight line] and vertical displacement [curve] for one mark and justifies each for one mark. E.g. straight line represents the horizontal displacement because gravity has no effect on the motion in that direction.	3
Identifies the variables as the horizontal displacement [straight line] and vertical displacement [curve] OR identifies one variable and provides a logical reason for the choice	2
Identifies one of the variables and correctly associates it with a graph	1

4(b)

Criteria	Marks
Draws a curved line and a straight line that has points evenly distributed on each side of the line.	1

4(c)

Criteria	Marks
States three correct facts about the projectile's motion: e.g. the projectile is moving horizontally (or the vertical velocity is zero), it is at the peak of its trajectory and its vertical acceleration is 9.8 m s^{-2} downward	3
Makes two correct statements about the motion	2
Makes one correct statement about the motion	1