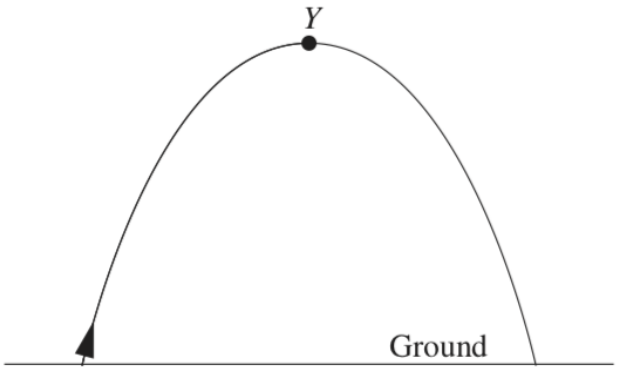
New Syllabus NESA Questions:

1)

An object is projected upwards from the ground, and follows a path as represented in the diagram.



Which of the following describes the projectile's horizontal and vertical acceleration at point Y?

A. Both the horizontal and vertical acceleration are zero.

B. Both the horizontal and vertical acceleration are $9.8\ \text{m s}^{-2}$.

C. The horizontal acceleration is $9.8\ \text{m s}^{-2}$ and the vertical acceleration is zero.

D. The horizontal acceleration is zero and the vertical acceleration is $9.8\ \text{m s}^{-2}$.

2)

Some students were testing the hypothesis that launching a projectile at an angle of 45° will give the maximum horizontal range.

Which experimental setup will best test the hypothesis?

A.

Launch speed ($m\ s^{-1}$)	*Launch angle* (degrees)
1	45
2	45
3	45
4	45
5	45

B.

Launch speed ($m\ s^{-1}$)	*Launch angle* (degrees)
5	43
5	44
5	45
5	46
5	47

C.

Launch speed ($m\ s^{-1}$)	*Launch angle* (degrees)
3	25
3	35
3	45
3	55
3	65

D.

Launch speed ($m\ s^{-1}$)	*Launch angle* (degrees)
2	43
4	44
6	45
8	46
10	47

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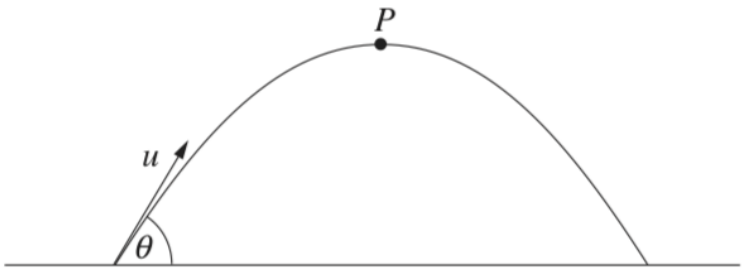
3)

A ball is launched at speed u and angle θ from the horizontal as shown. P is the highest point reached by the ball.



Ignoring air resistance, what is the speed of the ball at point P?

A. Zero

B. u

C. $u \cos\theta$

D. $u \sin\theta$

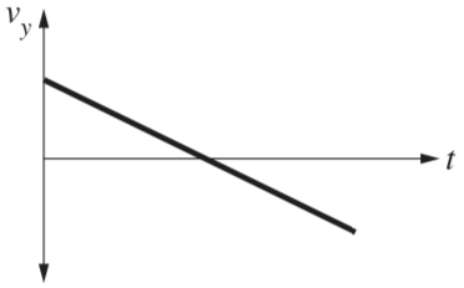
4)

The horizontal and vertical components of the velocity of a projectile are respectively v_x and v_y.

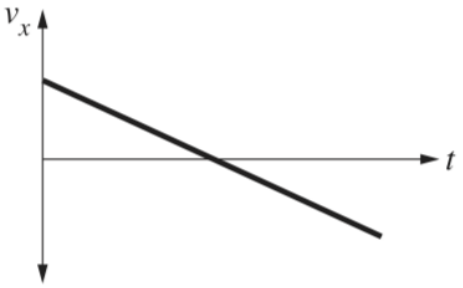
Which pair of graphs best represents the velocity of the projectile?

A.

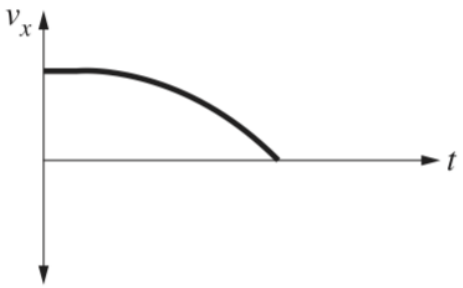
B.

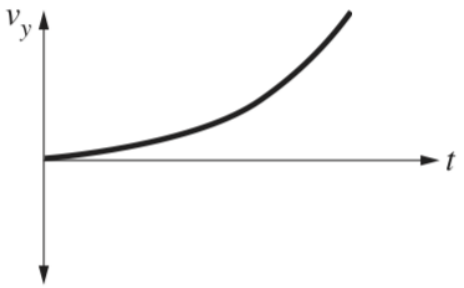


C.



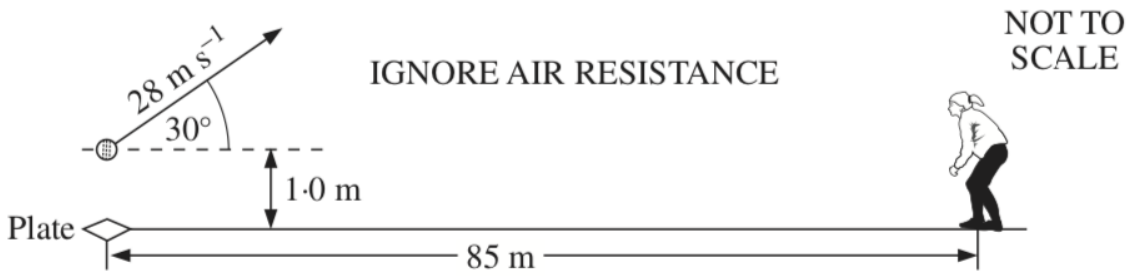
D.





5)

A baseball is hit with a velocity of 28 m s^{-1} at an angle of 30° to the horizontal at an initial height of 1.0 m above the plate. Ignore air resistance in your calculations.



(a) How long does it take the ball to return to the initial height above the ground? **3**

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

$0 = 14t - 4.9t^2$

$0 = t(14 - 4.9t)$

$\therefore 4.9t = 14$

$t = 2.86$ s (2 d.p)

(b) The ball is hit directly towards a stationary outfielder who is 85 m from the plate. At the instant the ball is hit, the outfielder begins to run towards the plate with constant acceleration. **4**

What is the magnitude of her acceleration if she catches the ball when it is 0.50 m above the ground? $a = -9.8 ms^{-2}$ $u = 14 ms^{-1}$

find time

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

left $s = -0.5$

$-0.5 = 14t - 4.9t^2$

$4.9t^2 - 14t + 0.5 = 0$

$t = 2.89$ only (used exact for calculations)

find x-distance

distance $= 2.89 \times 28\cos 30 = 70.078...$

So needs to travel $70.078 - 55.092 = 14.92$ m in 2.89 s

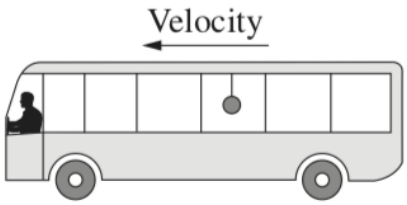
$s = ut + \frac{1}{2}at^2$

$\frac{2 \times 14.92}{2.89^2} = 3.57 ms^{-2}$ left

Past HSC Questions:

2018:

19 A mass was hanging from the roof of a bus that was travelling forward on a horizontal road at a constant velocity.



The string holding the mass was cut. At the same instant, the bus driver applied the brakes, causing the bus to slow down at a rate of 3 m s^{-2}.

To an observer outside the bus, the mass follows a parabolic trajectory.

Which statement correctly describes the resulting motion of the mass observed from within the frame of reference of the moving bus?

A. The mass travelled in a straight line vertically downwards.

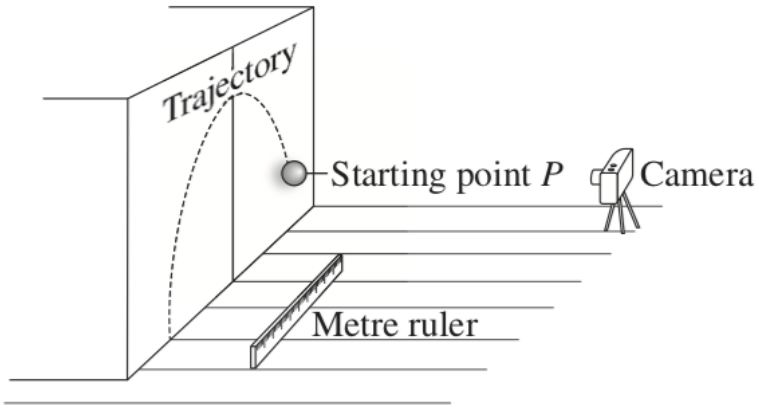
B. The mass travelled in a straight line downwards and towards the front of the bus.

C. The mass travelled in a parabolic path downwards and towards the back of the bus.

D. The mass travelled in a parabolic path downwards and towards the front of the bus.

Question 27 (6 marks)

(a) The diagram shows a camera and a ruler set up to obtain data about a projectile's motion along the trajectory shown. The entire trajectory is visible through the camera. **3**

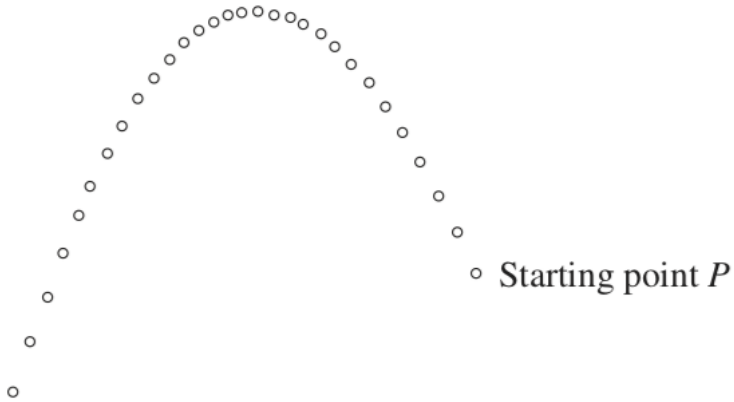


Identify ONE of the errors in this set-up and describe the effect of this error on the results.

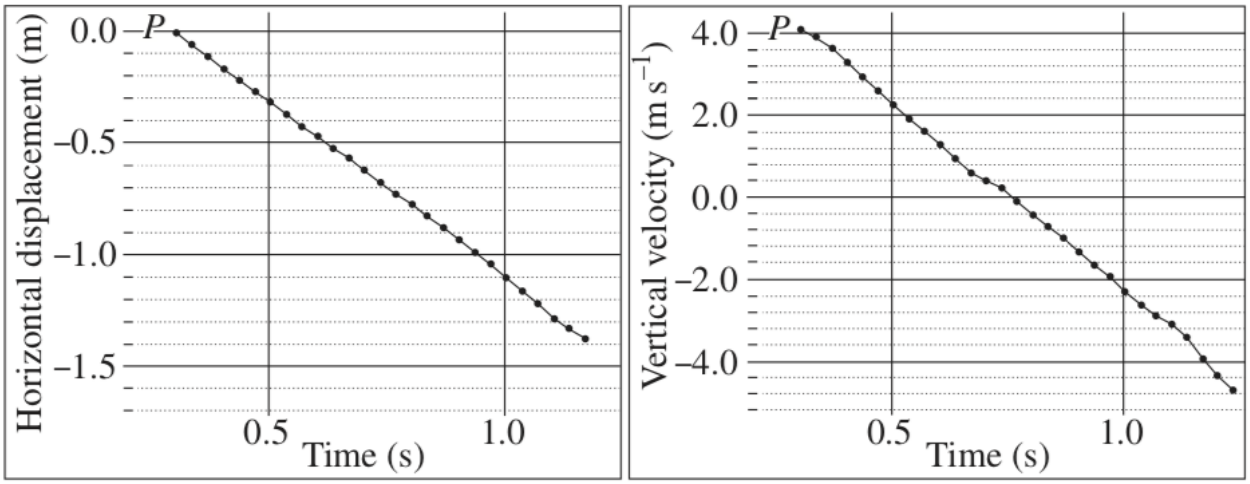
Parallax error

(b) An experiment was set up based on the method described in part (a), but conducted so that the data obtained were valid. **3**

The image shows the trajectory of the ball.



The graphs show data from this experiment.



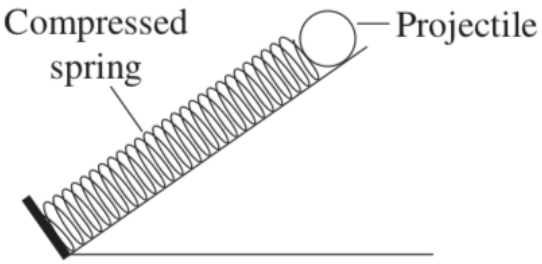
Using the graphs, describe the velocity and acceleration of the ball quantitatively and qualitatively.

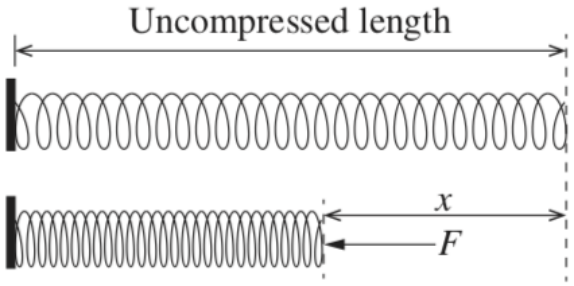
The ball's trajectory has a constant horizontal velocity of $\frac{-1.1-0}{1} = -1.1\ m\,s^{-1}$, so $1.1\ m\,s^{-1}$ to the right. ~~The~~ As such, there is ~~an~~ no ~~a~~ horizontal acceleration for the ball. The linear vertical velocity ~~she~~ ~~Aem~~ shows a constant linear acceleration of $\frac{-2.4-2.2}{1-0.5} = -9.2\ m\,s^{-2}$

2017:

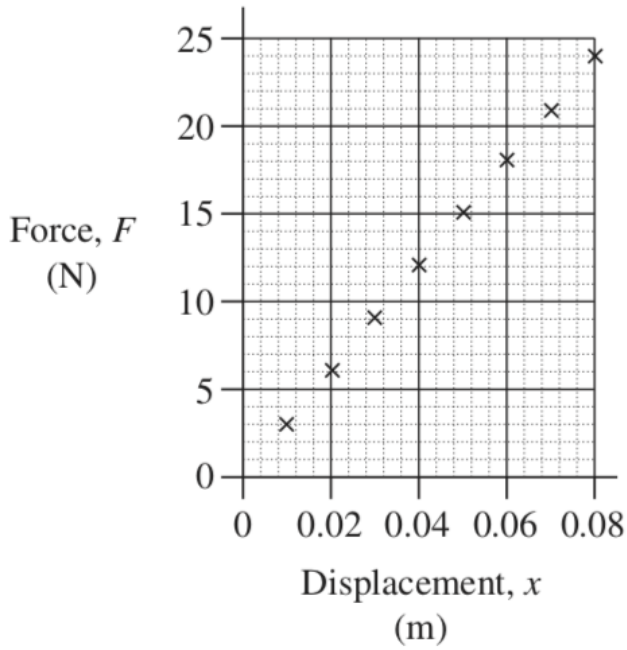
Question 29 (7 marks)

A spring is used to construct a device to launch a projectile. The force (F) required to compress the spring is measured as a function of the displacement (x) by which the spring is compressed.





The potential energy stored in the compressed spring can be calculated from $E_p = \frac{1}{2}kx^2$, where k is the gradient of the force–displacement graph shown.



$k = \frac{24 - 0}{0.08 - 0}$

$= 300$

$\therefore E_p = 150x^2$

(a) A projectile of mass 0.04 kg is launched using this device with the spring compressed by 0.08 m. Calculate the launch velocity. **4**

$m = 0.04\ kg \qquad x = 0.08\ m$

$PE_{init} = KE = 150x^2 = 150 \times 0.08^2 = 0.96\ J$

A point ball leaves spring

$PE_{init} = KE$

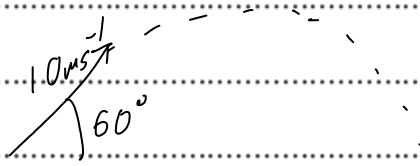
$KE = \frac{1}{2}mv^2$

$0.96 = \frac{1}{2} \times 0.04 \times v^2$

$v = \sqrt{\frac{2 \times 0.96}{0.04}} = 4\sqrt{3} = 6.928...$

$= 6.93\ ms^{-1}$

(b) Calculate the range of a projectile launched by this device from ground level at an angle of 60° to the horizontal with a velocity of 10 m s^{-1}. **3**



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

$0 = 10 \sin 60° t - 4.9t^2$

$0 = 5t - 4.9t^2$

$0 = t(5 - 4.9t)$

$t = 1.020408...$

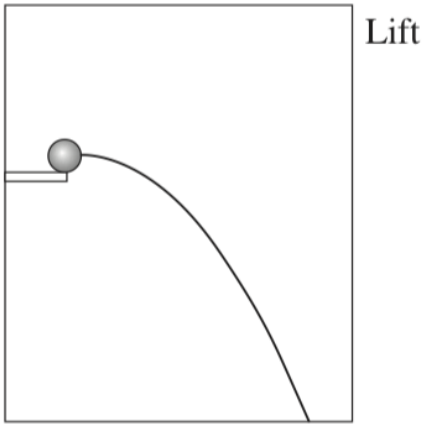
range $= 1.02041... \times 10 \cos 60$

$= 5.1020...$

So 5.1 m ✗ 8.8 m

2016:

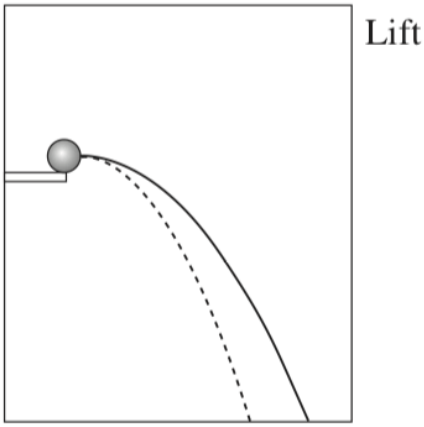
17 A projectile was launched horizontally inside a lift in a building. The diagram shows the path of the projectile when the lift was stationary.



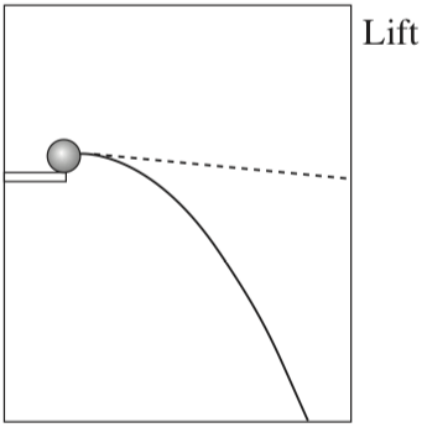
The projectile was launched again with the same velocity. At this time, the lift was slowing down as it approached the top floor of the building.

Which diagram correctly shows the new path of the projectile (dotted line) relative to the path created in the stationary lift (solid line)?

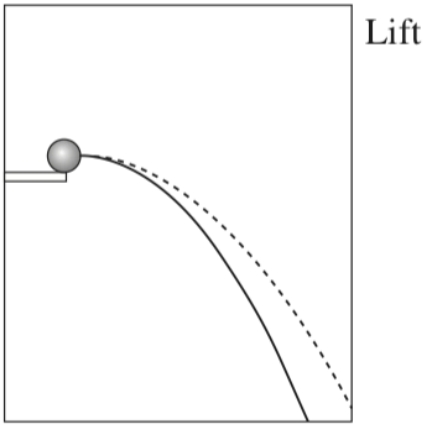
(A)



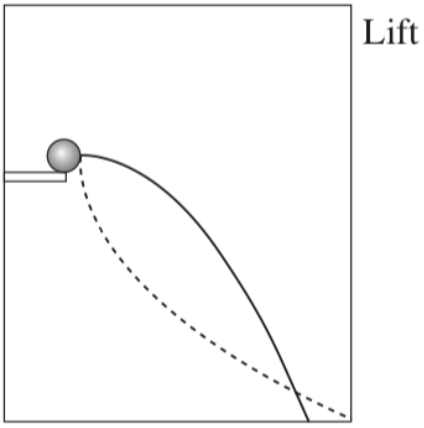
(B)



(C)



(D)

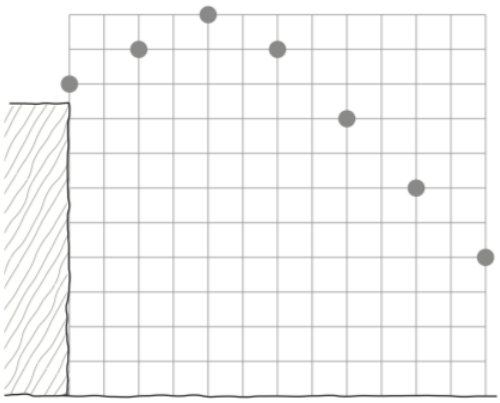


2015:

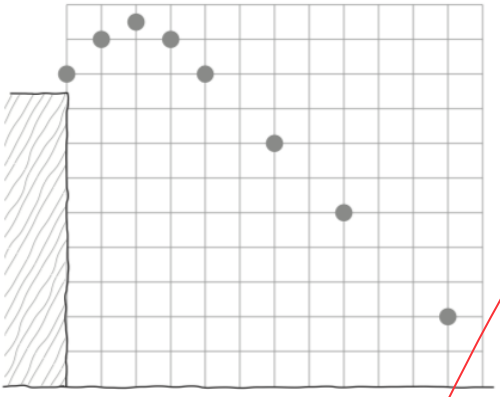
4 A projectile is launched from a cliff top. The dots show the position of the projectile at equal time intervals.

Assuming negligible air resistance, which diagram best shows the path of the projectile?

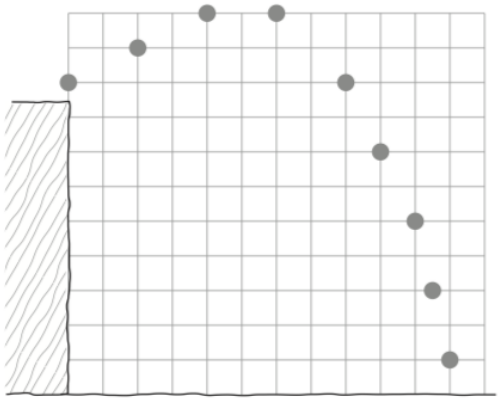
(A)



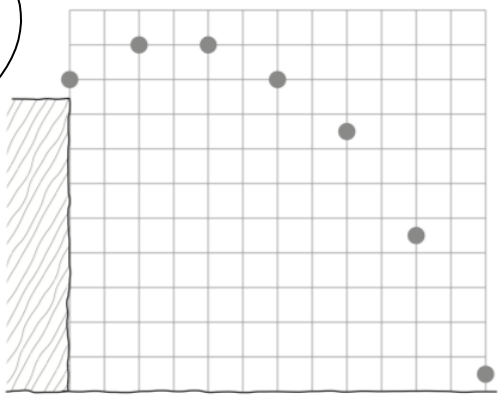
(B)



(C)



(D)



20 A projectile was launched from the ground. It had a range of 70 metres and was in the air for 3.5 seconds.

At what angle to the horizontal was it launched?

(A) 30°

(B) 40°

(C) 50°

(D) 60°

$s = ut - 4.9t^2$

$17.15 = V\sin\theta$

$t = 3.5$

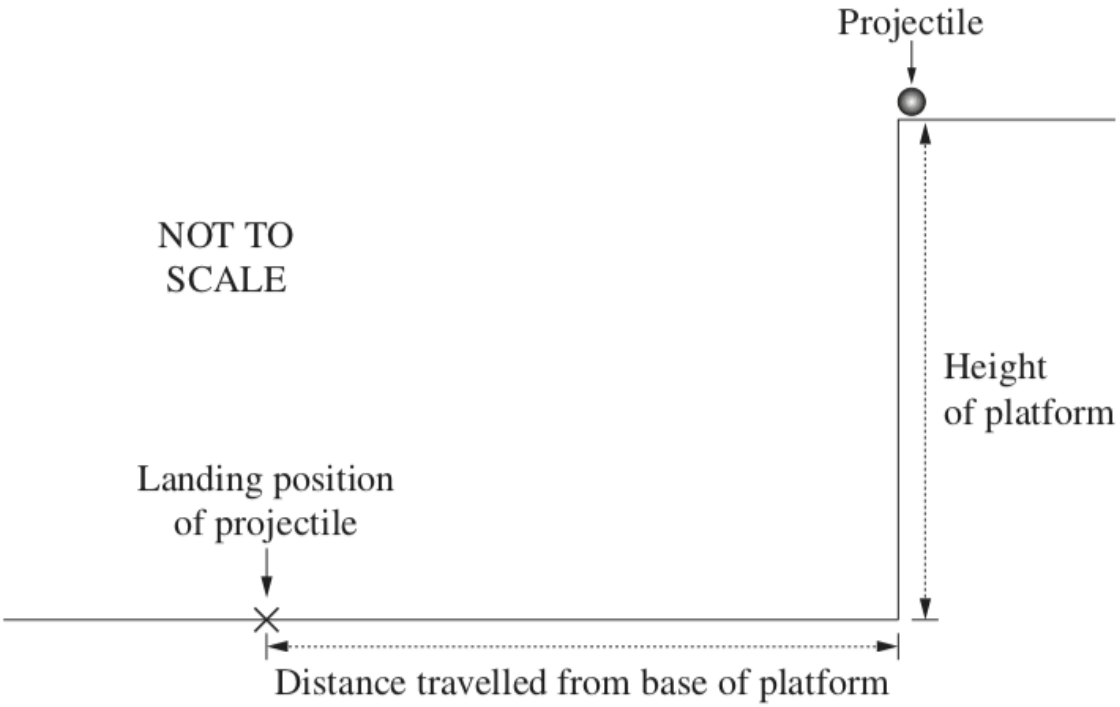
70m

$s_x = ut$

$V\cos\theta = \frac{70}{3.5}$

Question 21 (4 marks)

A projectile is fired horizontally from a platform.

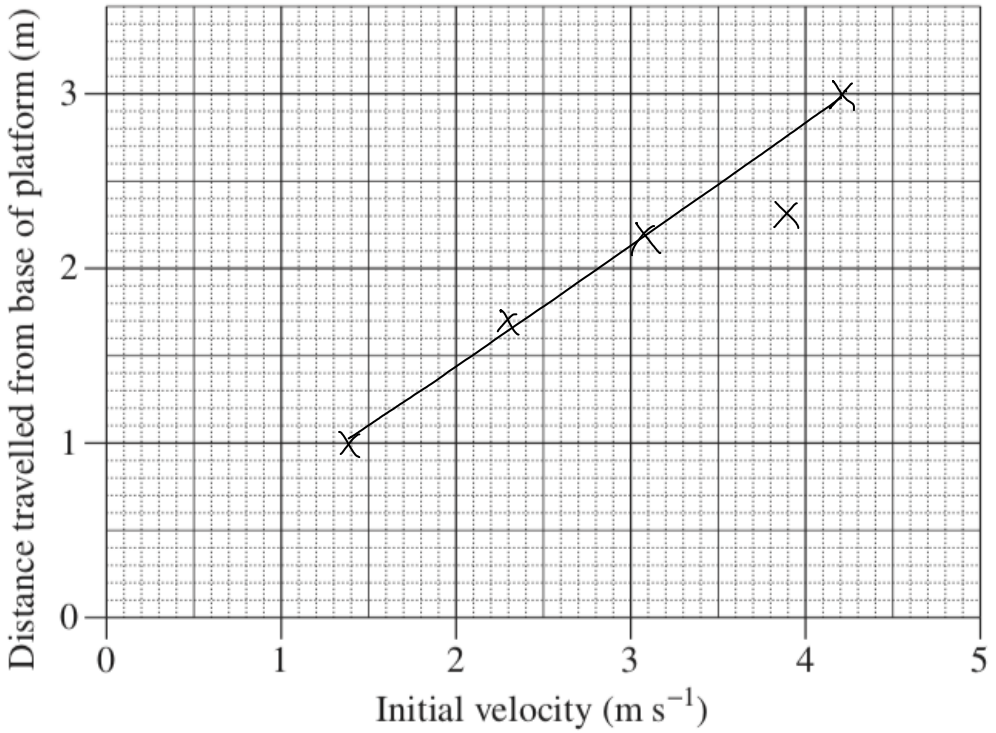


Measurements of the distance travelled by the projectile from the base of the platform are made for a range of initial velocities.

Initial velocity of projectile (m s^{-1})	*Distance travelled from base of platform* (m)
1.4	1.0
2.3	1.7
3.1	2.2
3.9	2.3
4.2	3.0

avg :

(a) Graph the data on the grid provided and draw the line of best fit. **2**



(b) Calculate the height of the platform. **2**

2.4678

= 2.5 m

2014:

20 A ball is launched horizontally from a cliff with an initial velocity of u m s^{-1}. After two seconds, the ball's velocity is in the direction 45° from the horizontal.

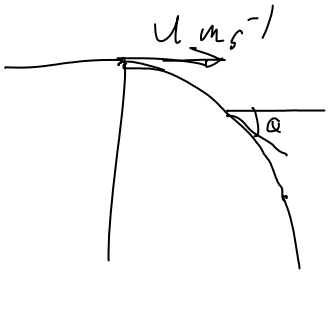
What is the magnitude of the velocity in m s^{-1} at two seconds?

(A) u

(B) $1.5u$

(C) 19.6

(D) 27.7



$V_y = u_y + at$

$V_y = -19.6$ ms^{-1}

$V \sin\theta = -19.6$

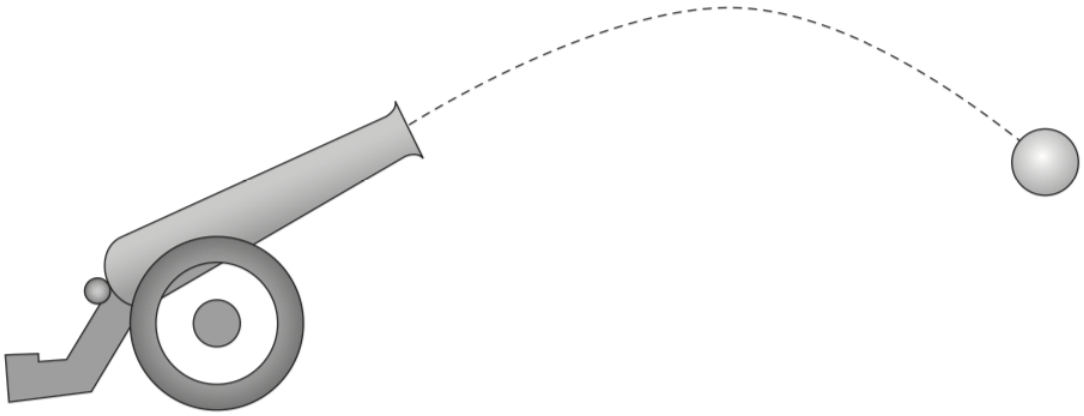
2013:

4 Students performed an investigation to determine the initial velocity of a projectile.

Which row correctly identifies a hazard of this investigation and a related precaution?

	Hazard	*Safety precaution*
(A)	flying projectile	wearing safety glasses
(B)	range of projectile	measuring the range with a tape measure
(C)	enclosed shoes	limiting the range of the projectile
(D)	safety glasses	flying projectile

6 This diagram shows the path of a cannonball, fired from a cannon.



Which set of vectors represents the horizontal and vertical components of the cannonball's velocity along the path?

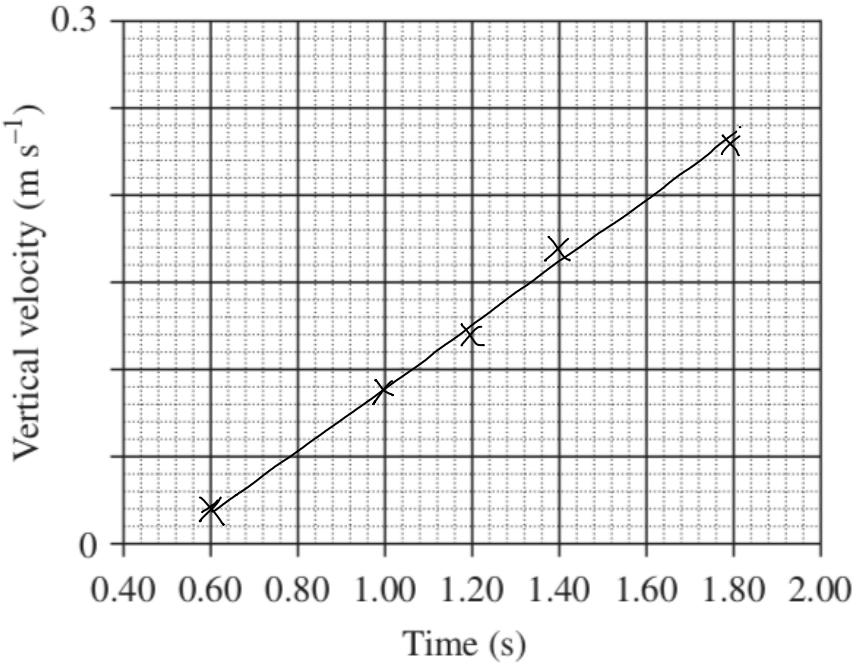
	Horizontal	*Vertical*
(A)	→ → → →	↓ ↓ ↓ ↓
(B)	→ → → →	↑ ↑ ↓ ↓
(C)	→ → → →	↑ ↑ ↓ ↓
(D)	→ → → →	↓ ↓ ↓ ↓

Question 22 (3 marks)

This set of data was obtained from a motion investigation to determine the acceleration due to gravity on a planet other than Earth. **3**

Time (s)	Vertical velocity ($m\ s^{-1}$)
0.60	0.02
1.00	0.09
1.20	0.12
1.40	0.17
1.80	0.23

Plot the data from the table, and then calculate the acceleration.



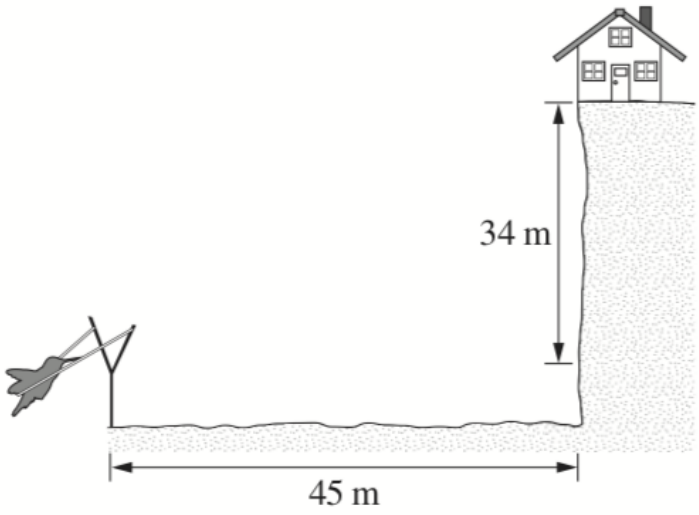
acceleration = gradient = $\frac{0.23-0.02}{1.8-0.6}$ = 0.175

So 0.175 $m\,s^{-2}$ towards the center of this planet.

2012:

Question 27 (4 marks)

A toy bird is launched at 60° to the horizontal, from a point 45 m away from the base of a cliff. **4**



NOT TO SCALE

Calculate the magnitude of the required launch velocity such that the toy bird strikes the base of the wooden building at the top of the cliff, 34 m above the launch height.

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2010:

2 Which of the following best describes Galileo's analysis of projectile motion?

(A) A projectile launched with a great enough velocity would escape Earth's gravity.

(B) A projectile would travel in a straight line until it ran out of momentum, then it would fall.

(C) A projectile launched from the equator towards the east with a great enough velocity would orbit Earth.

(D) A projectile would travel in a parabolic path because it has constant horizontal velocity and constant vertical acceleration.

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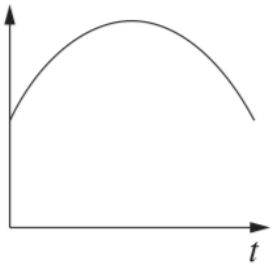
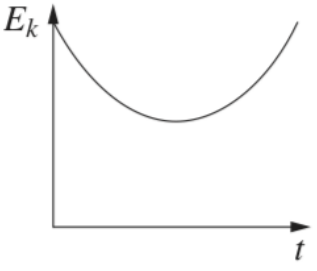
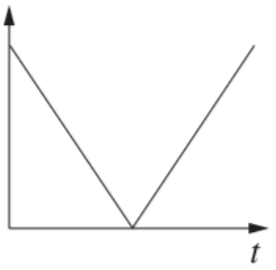
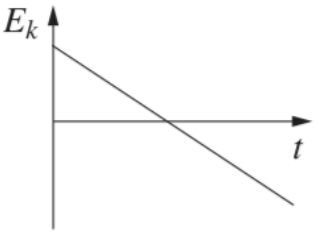
4 A ball was thrown upward at an angle of 45°. It landed at the same height as thrown.

Which graph best represents the kinetic energy of the ball during its time of flight?

(A) 

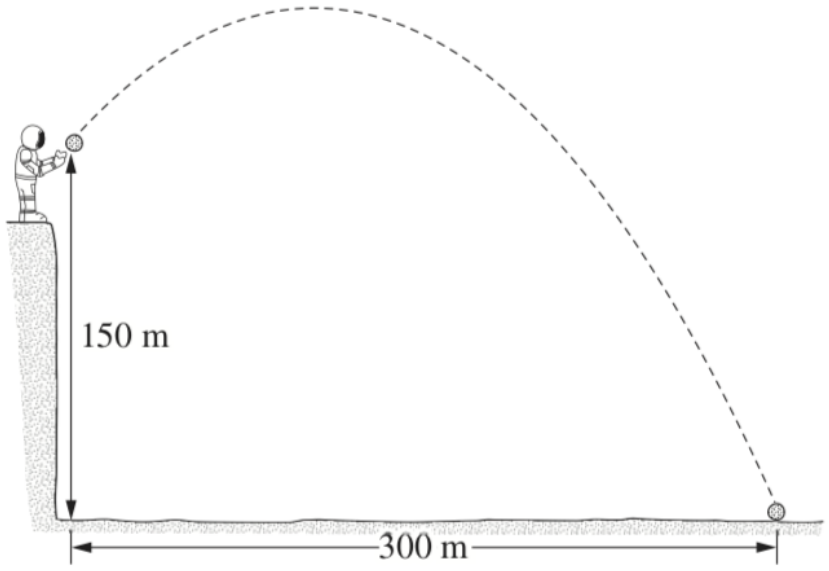
(B) 

(C) 

(D) 

Question 22 (5 marks)

An astronaut on the Moon throws a stone from the top of a cliff. The stone hits the ground below 21.0 seconds later. The acceleration due to gravity on the moon is 1.6 ms^{-2}.



(a) Calculate the horizontal component of the stone's initial velocity. Show your working. **1**

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(b) Calculate the vertical component of the stone's initial velocity. Show your working. **2**

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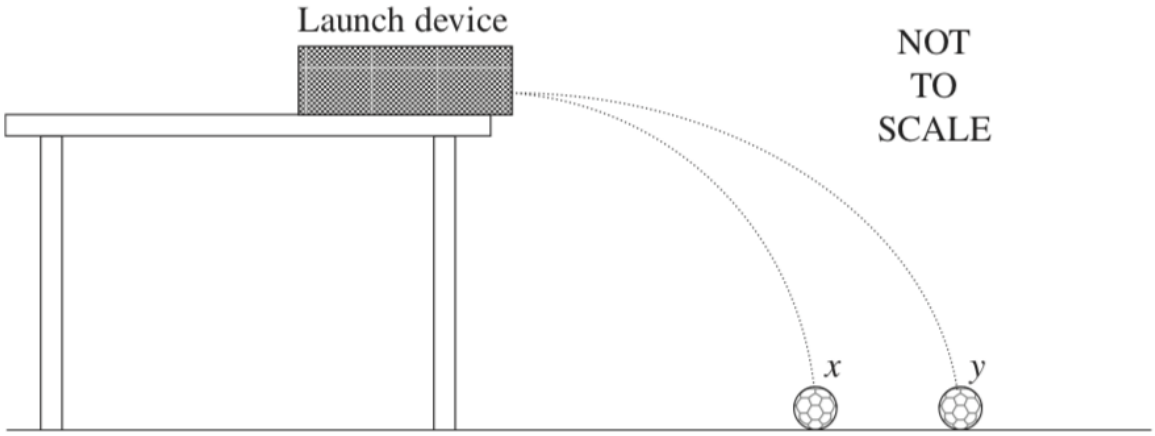
(c) On the diagram, sketch the path that the stone would follow if the acceleration due to gravity was higher. The initial velocity is the same. **2**

2009:

4 A device launches two identical balls (x and y) simultaneously in a horizontal direction from the same height. The results are shown.



Which statement correctly describes what happens?

(A) x hits the ground before y as it is closer to the launch site.

(B) y hits the ground before x as it has a higher launch velocity.

(C) x and y hit the ground simultaneously with the same velocity.

(D) x and y hit the ground simultaneously with different velocities.

2008:

3 An aeroplane is flying horizontally over level ground. It has an altitude of 490 m and a velocity of 100 m s^{-1}. As the aeroplane passes directly above a cross marked on the ground, an object is released from the aeroplane.

How far away from the cross will this object land?

(A) 490 m

(B) 1000 m

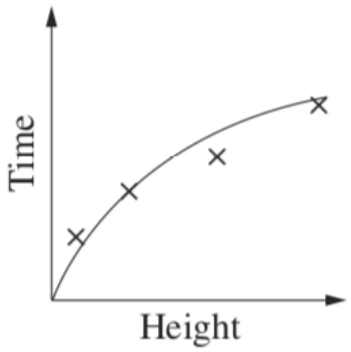
(C) 10 000 m

(D) 49 000 m

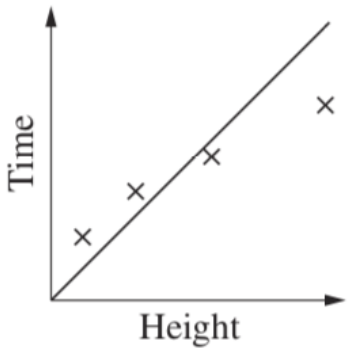
4 An investigation was performed to determine the acceleration due to gravity. A ball was dropped from various heights and the time it took to reach the ground from each height was measured. The results were graphed with the independent variable on the horizontal axis.

Which graph best represents the relationship between the variables?

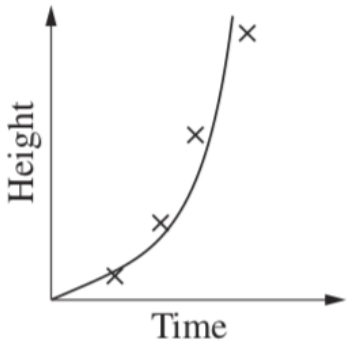
(A)



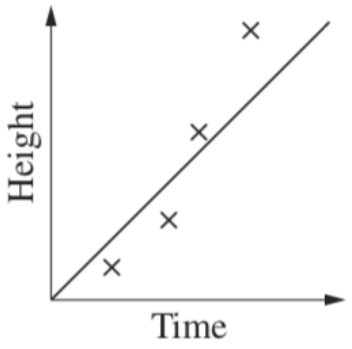
(B)



(C)



(D)

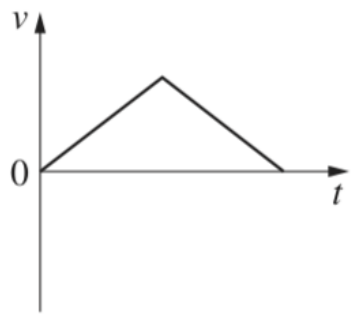


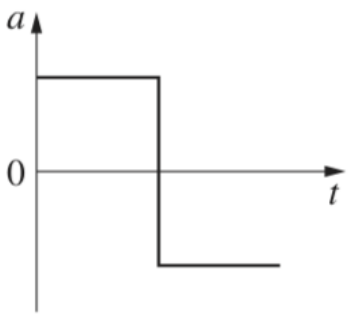
2007:

5 A cannon ball is fired vertically upward from a stationary boat.

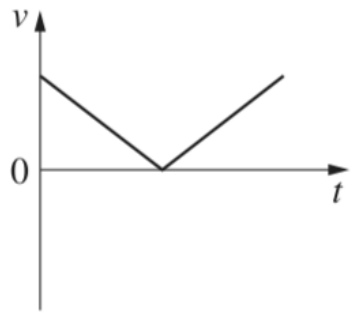
Which pair of graphs best describes the velocity, v, and acceleration, a, of the cannon ball as functions of time, t? Ignore air resistance.

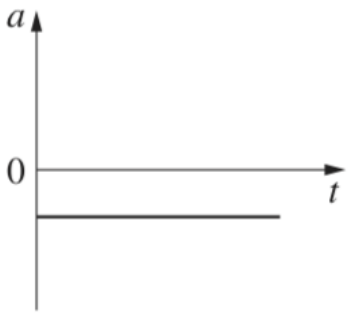
(A)



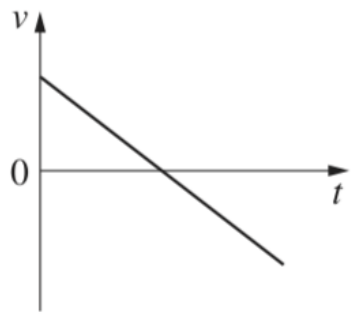


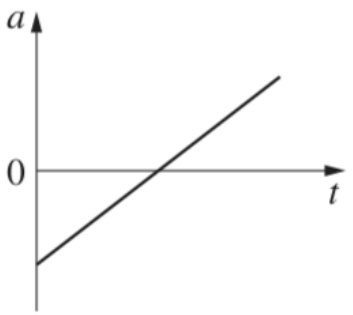
(B)



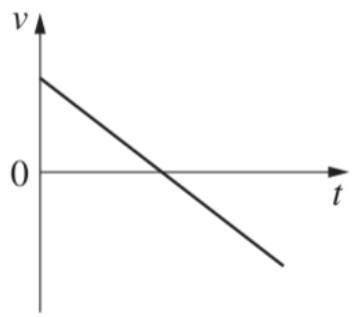


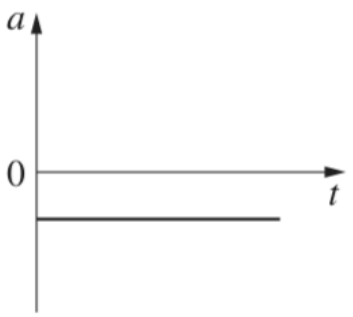
(C)





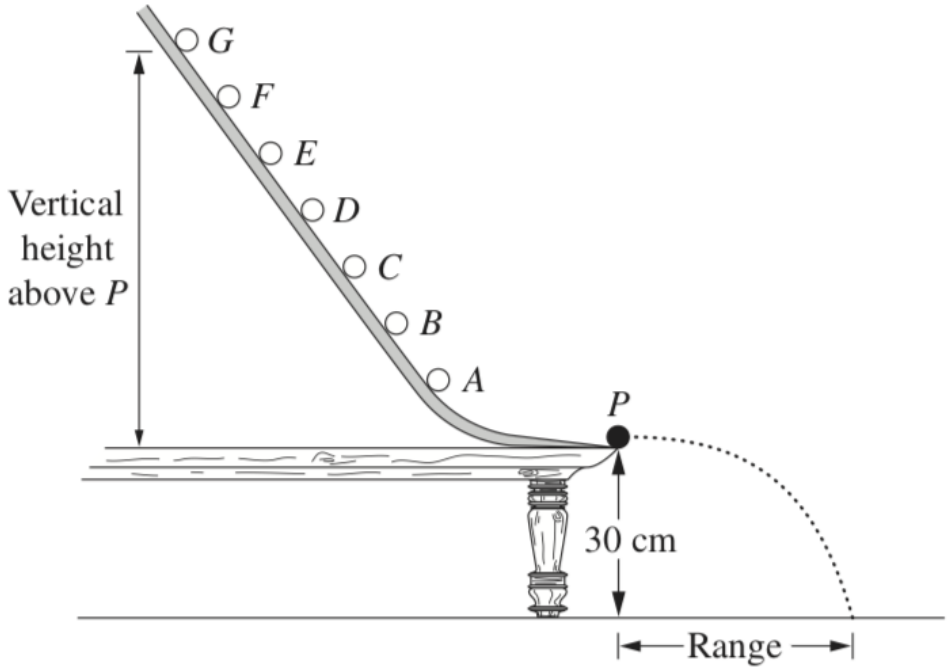
(D)





Question 16 (5 marks)

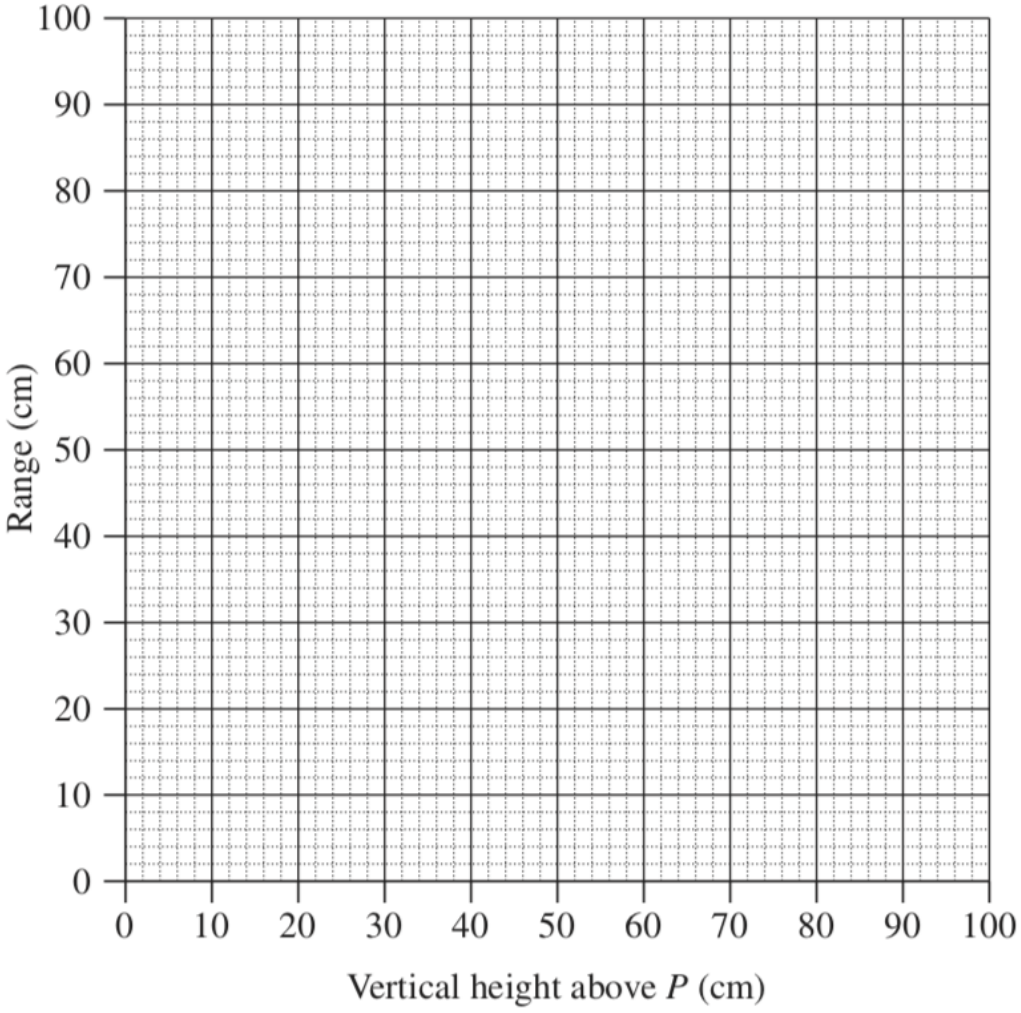
A group of students conducted an investigation in which ball bearings were released from various points on a ramp. The ball bearings rolled down the ramp to the edge of a table at point *P* as shown. Their ranges were measured.



The results are shown in the table.

Point of release	*Vertical height above P* (cm)	*Range* (cm)
A	10	32
B	20	44
C	30	58
D	40	66
E	50	76
F	60	82
G	70	87

(a) Plot the data from the table and draw a curve of best fit. **2**



(b) (i) Using your graph, predict the range of a ball bearing released from a height of 80 cm above point *P*. **1**

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(ii) Calculate the horizontal velocity of the ball bearing released from a height of 80 cm above point *P*. **2**

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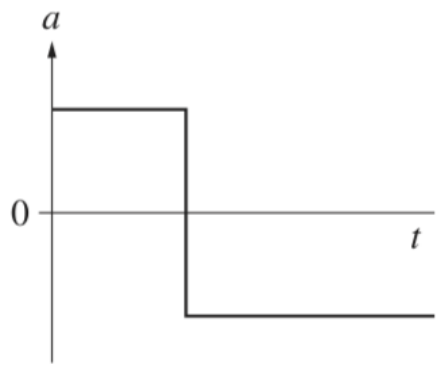
2006:

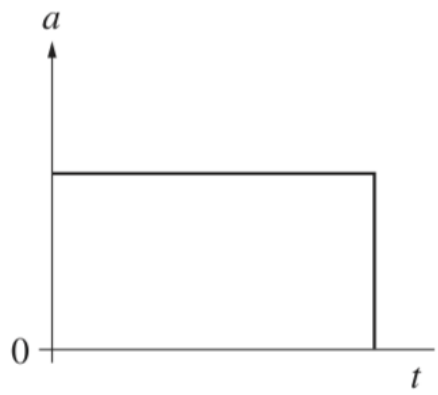
4 A stone is thrown horizontally from the top of a cliff and falls onto the beach below.

Which acceleration–time graph best describes the motion of the stone?

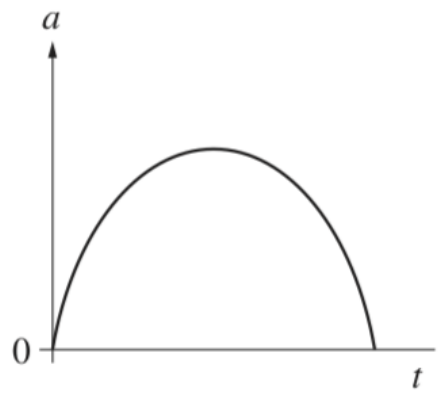
(A)



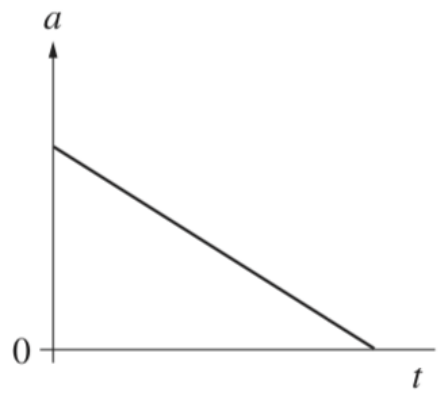
(B)



(C)

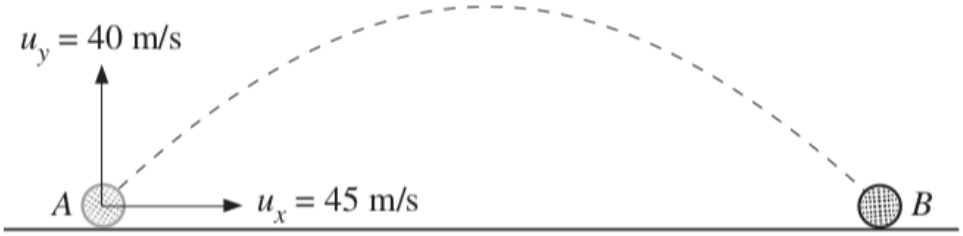


(D)



Question 16 (6 marks)

A projectile leaves the ground at point A with velocity components as shown in the diagram. It follows the path given by the dotted line and lands at point B.



(a) State the horizontal component of the projectile's velocity when it lands. **1**

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(b) Find the magnitude of the initial velocity of the projectile. **1**

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(c) Calculate the maximum height attained by the projectile. **2**

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(d) Calculate the range of the projectile, if it lands level with its starting position. **2**

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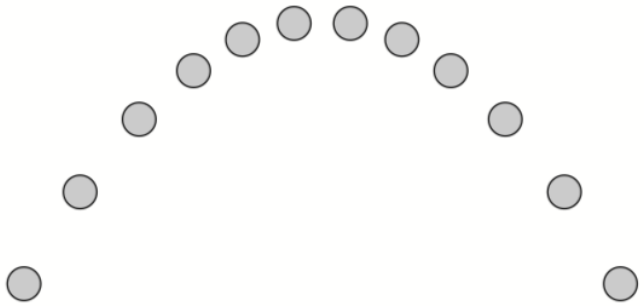
2005:

1 A ball thrown in the air traces a path as shown below.



Which of the following statements is true?

(A) The velocity of the ball keeps changing.

(B) The acceleration of the ball keeps changing.

(C) The velocity of the ball at the top of its motion is zero.

(D) The acceleration of the ball at the top of its motion is zero.

5 Napoleon attacked Moscow in 1812 with his cannon firing a shot at an elevation angle of 40°. Napoleon then decided to fire a second shot at the same speed but at an elevation angle of 50°.

Which of the following observations would Napoleon expect to be true about the second shot when compared with the first?

(A) Longer range

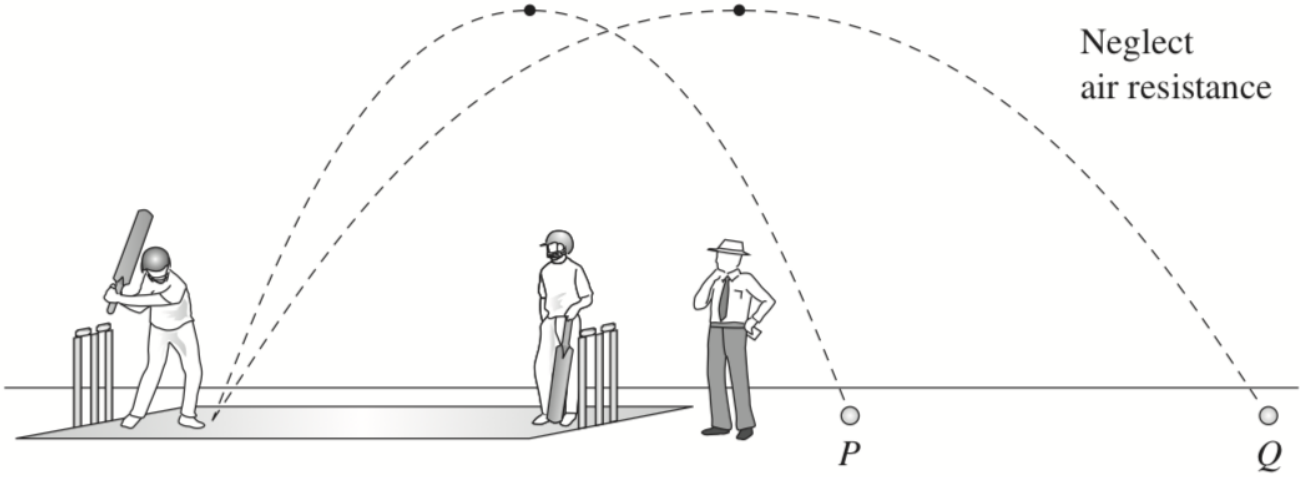
(B) Shorter range

(C) Longer time of flight

(D) Shorter time of flight

2004:

1 The picture shows a game of cricket.



The picture shows two consecutive shots by the batsman. Both balls reach the same maximum height above the ground but ball Q travels twice as far as ball P.

Which of the following is DIFFERENT for balls P and Q?

(A) Time of flight

(B) Initial velocity

(C) Gravitational force

(D) Gravitational acceleration

Question 16 (4 marks)

A projectile is fired at a velocity of 50 m s^{-1} at an angle of 30° to the horizontal. **4**

Determine the range of the projectile.

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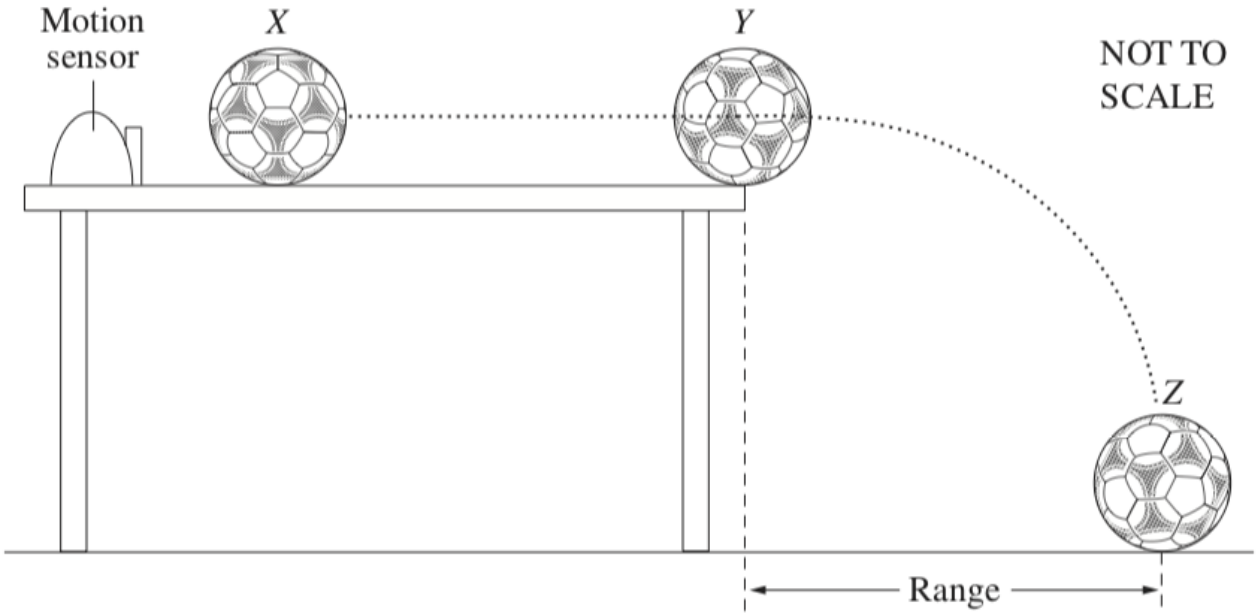
2003:

Question 16 (6 marks)

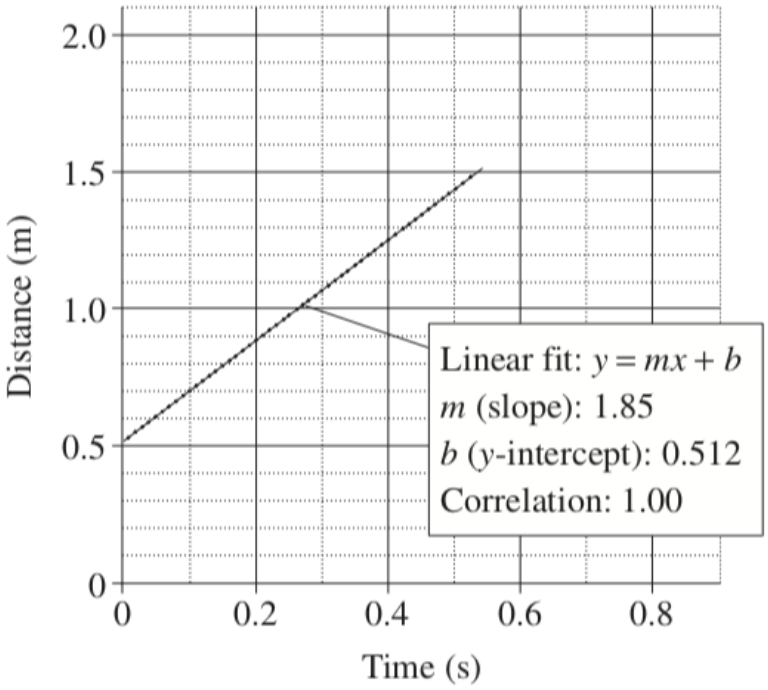
A student performed a first-hand investigation to examine projectile motion.

A ball resting on a horizontal table was given an initial push at *X*, resulting in the ball following the path *XYZ* as shown.



A data logger used the motion sensor to measure the horizontal distance to the ball. When the ball was at position *Y*, a distance of 1.50 m from the motion sensor, it left the edge of the table.

In the first trial, the range was 0.60 m. The graph below was obtained from the data logger.



(a) For this trial, determine the horizontal speed of the ball as it left the edge of the table. **1**

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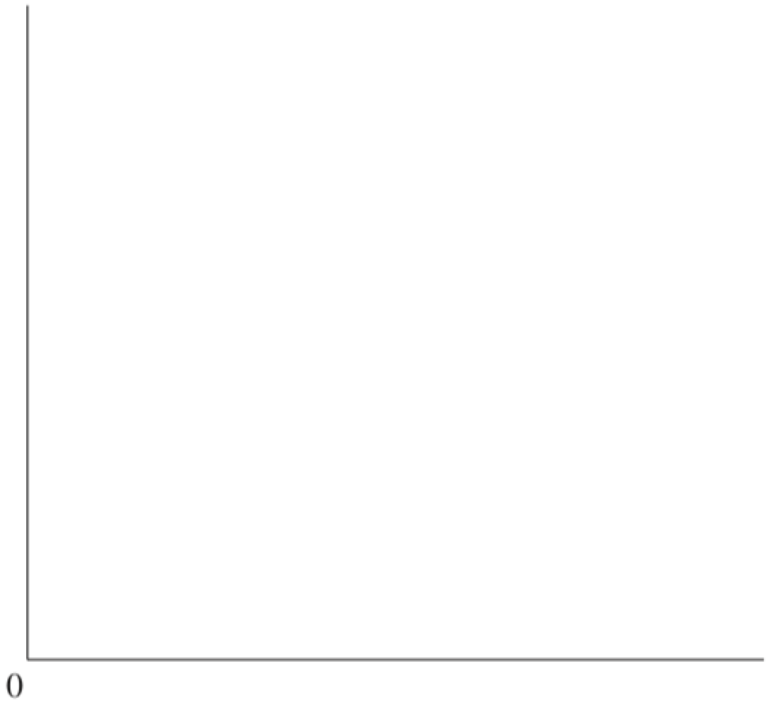
(b) The experiment was repeated with the ball leaving the table at different speeds. Graph the relationship between the range and the horizontal speed at Y. Identify on your graph the results from the first trial. **3**



(c) The apparatus described in this first-hand investigation was used to carry out an identical experiment on another planet where the acceleration due to gravity is less than that on Earth. **2**

The horizontal speed of the ball as it left the table on the planet was the same as in part (a). Compare the range of the ball on the planet to that on Earth. Explain your answer.

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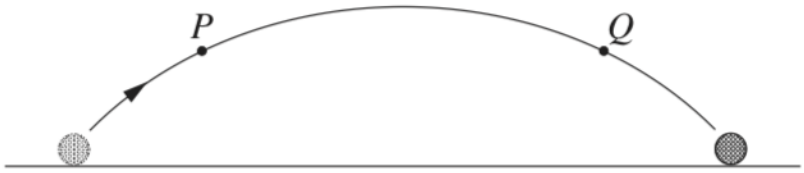
2002:

1 The diagram shows the trajectory of a golf ball.



Which set of arrows shows the direction of the acceleration of the ball at points *P* and *Q* respectively?

	At P	*At Q*
(A)	↑	↓
(B)	↓	↓
(C)	↗	↘
(D)	↙	↘

2001:

7 An astronaut is standing on Mars. The astronaut throws an object of mass 0.30 kg vertically upward at an initial speed of $9.0\,\text{m s}^{-1}$. It reaches a maximum height of 11 metres.

What is the magnitude of the acceleration of the object?

(A) $1.4\,\text{m s}^{-2}$

(B) $3.7\,\text{m s}^{-2}$

(C) $9.0\,\text{m s}^{-2}$

(D) $9.8\,\text{m s}^{-2}$