

Questions

Q1.

A student used a falling sphere to determine the acceleration of free fall.

A camera produced images of the sphere at constant time intervals as it fell.

The positions of the sphere in the first two images are shown. Image 1 shows the sphere's position at the instant it was released.

☒	Image 1
☒	Image 2
☐	P
☐	Q
☐	R
☐	S

Which of the positions P, Q, R or S will the sphere be at in Image 3?

(1)

☒ **A** P

☒ **B** Q

☒ **C** R

☒ **D** S

(Total for question = 1 mark)

Q2.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer

with a cross ☒.

A student determined the acceleration of free fall g .

She measured the time t for a ball bearing to fall from rest through a distance s .
She repeated this for a range of values of s .

Which row of the table shows the graph that would give a gradient equivalent to g ?

	<i>y</i> -axis	<i>x</i> -axis
☒ A	s	$2t^2$
☒ B	$2s$	t^2
☒ C	s	$2t$
☒ D	$2s$	t

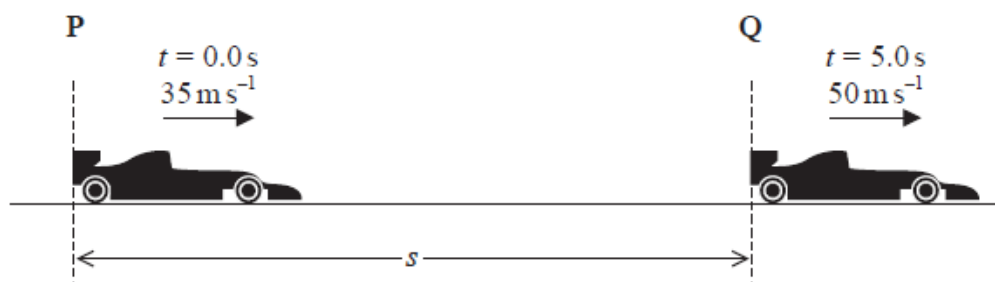
(Total for question = 1 mark)

Q3.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A racing car passes point P at a speed of 35 m s^{-1} .

The car accelerates uniformly and after 5.0 s passes point Q at a speed of 50 m s^{-1} , as shown.



Which of the following expressions gives the distance s , in metres, between the two points?

- ☐ A $\frac{50^2 - 35^2}{2 \times 5}$
- ☐ B $(35 \times 5) + (0.5 \times 9.81 \times 5^2)$
- ☐ C $0.5 \times (35 + 50) \times 5$
- ☐ D $35 + (9.81 \times 5)$

(Total for question = 1 mark)

Q4.

A car is moving towards a stop sign at a speed of 25 m s^{-1} . The driver applies the brakes 20 m before the sign and decelerates uniformly to rest just before the sign.

Which of the following gives the magnitude of the car's deceleration in m s^{-2} ?

- ☐ A $\frac{25}{40}$
- ☐ B $\frac{25}{20}$
- ☐ C $\frac{25^2}{40}$
- ☐ D $\frac{25^2}{20}$

(Total for question = 1 mark)

Q5.

A ball is thrown vertically upwards.

Which row of the table correctly describes the magnitude of the initial acceleration of the ball and the magnitude of the acceleration when it is at its maximum height?

	Initial acceleration	Acceleration at maximum height
☐ A	0	9.81 ms^{-2}
☐ B	9.81 ms^{-2}	0
☐ C	9.81 ms^{-2}	9.81 ms^{-2}
☐ D	0	0

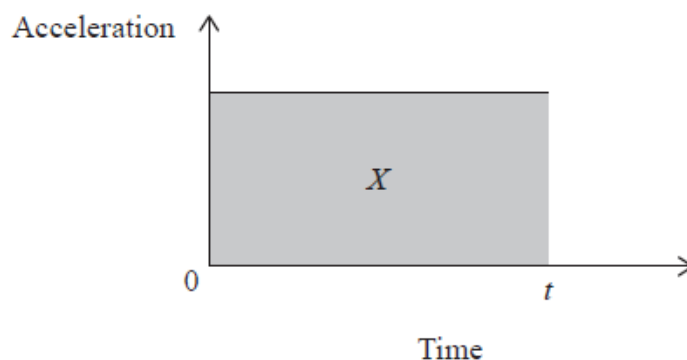
(Total for question = 1 mark)

Q6.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☐ and then mark your new answer with a cross ☐.

An object moves from rest with uniform acceleration for time t .

The acceleration-time graph for the object is shown. X is the area under the graph between time 0 and time t .



Which of the following expressions gives the distance moved by the object?

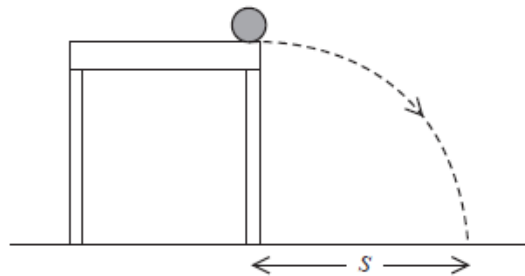
- ☐ A X
- ☐ B $\frac{X}{2}$
- ☐ C Xt
- ☐ D $\frac{Xt}{2}$

(Total for question = 1 mark)

Q7.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

A ball rolls off a table with a horizontal velocity of 1.2 m s^{-1} . The ball takes 0.9 s to reach the ground and lands a distance s from the table as shown.



Which of the following expressions could be used to determine the value of s in metres?

- ☒ **A** $\frac{1.2^2}{2 \times 9.81}$
- ☐ **B** 1.2×0.9
- ☐ **C** $\frac{1}{2} \times 9.81 \times 0.9^2$
- ☐ **D** $(1.2 \times 0.9) + (\frac{1}{2} \times 9.81 \times 0.9^2)$

(Total for question = 1 mark)

Q8.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

A ball bearing falls vertically from rest through a distance of 50 cm in a time of 0.32 s .

Which expression gives the acceleration of the ball bearing in m s^{-2} ?

- ☒ **A** $1 \div 0.32^2$

- ☐ **B** $0.5 \div 0.32$
- ☐ **C** $100 \div 0.32^2$
- ☐ **D** $50 \div 0.32$

(Total for question = 1 mark)

Q9.

Answer the question with a cross in the box you think is correct (☐). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☐).

An apple falls freely from rest until it reaches the ground.

The apple falls a distance s in a time t .

Which of the following gives the relationship between s and t ?

- ☐ **A** $s \propto t^{-1}$
- ☐ **B** $s \propto \sqrt{t}$
- ☐ **C** $s \propto t$
- ☐ **D** $s \propto t^2$

(Total for question = 1 mark)

Q10.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

Quantities in physics are classified as either vectors or scalars.

Which of the following units could **only** be used for a scalar quantity?

- ☐ **A** m s^{-1}

- ☐ **B** m s^{-2}
- ☐ **C** kg m s^{-2}
- ☐ **D** kg m^{-3}

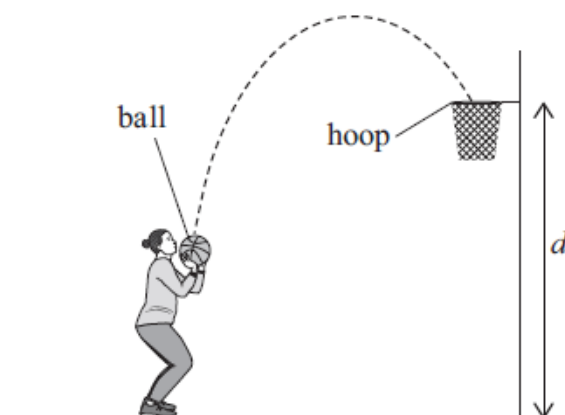
(Total for question = 1 mark)

Q11.

In a game of basketball, points are scored by throwing a ball so that it falls through a hoop.

The rules state that the distance d between the hoop and the floor should be 3.0 m.

A basketball player throws the ball so that it falls through the hoop, as shown.



The ball was thrown from a height of 1.7 m above the floor.

The initial vertical component of the velocity of the ball was 5.1 m s^{-1} .

As the ball entered the hoop, the vertical component of the velocity of the ball was 2.1 m s^{-1} .

Deduce whether d was 3.0 m.

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 3 marks)

Q12.

A student used two different methods to investigate the acceleration of a freely falling object.

(a) In the first method, the student dropped a ball from rest at a known height. He used a stopwatch to measure the time taken for the ball to reach the ground. He repeated this several times. He then calculated the mean acceleration of the ball.

Explain why there was a large uncertainty in the calculated value of acceleration.

(2)

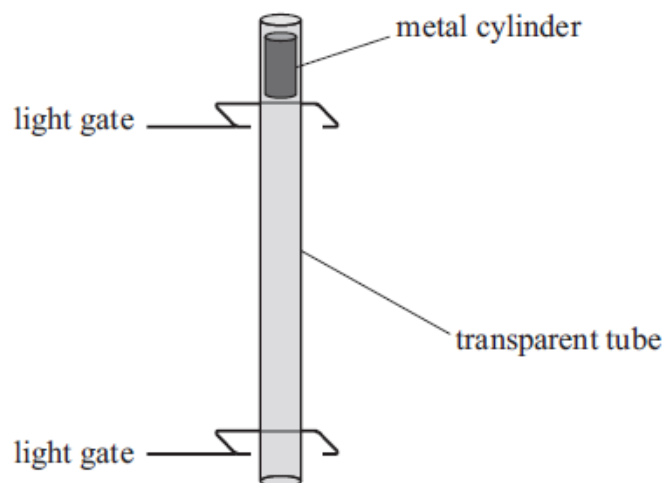
.....

.....

.....

.....

(b) In the second method, the student positioned light gates near the top and bottom of a transparent vertical tube. He dropped a metal cylinder into the tube, as shown.



The time taken for the metal cylinder to pass through each light gate was recorded by a data logger.

The student measured the distance between the light gates.

(i) Give one other measurement needed to determine the acceleration of the metal cylinder.

(1)

.....
(ii) The speed of the metal cylinder through the first light gate was 1.39 ms^{-1} .

The speed of the metal cylinder through the second light gate was 2.96 ms^{-1} .

The distance between the light gates was 355 mm.

Calculate the acceleration of the metal cylinder.

(2)

.....
.....
.....
.....

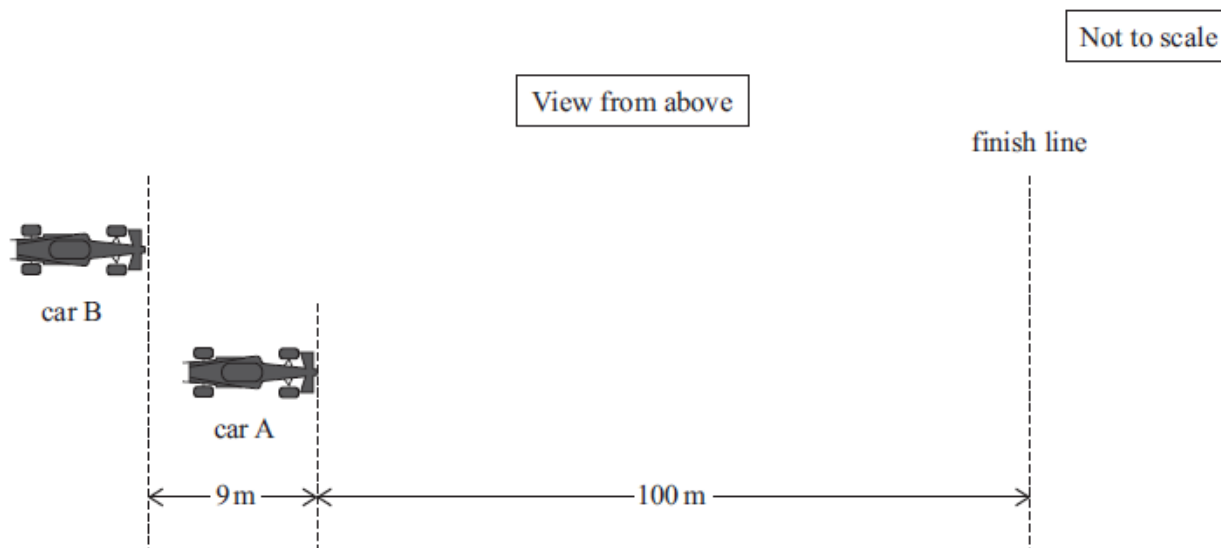
Acceleration = ...

(Total for question = 5 marks)

Q13.

Two cars, A and B, are racing along a track.

Car A has a constant velocity of 93 m s^{-1} . At a particular instant, car A is 9 m ahead of car B, as shown.



At this instant, car B has a velocity of 93 m s^{-1} . Car B is accelerating with a constant acceleration of 14 m s^{-2} .

(a) Show that car A and car B are side by side after a time of about 1.1 s.

(3)

.....

.....

.....

.....

.....

.....

(b) At the instant shown, car A is 100 m from the finish line.

Deduce whether car A reaches the finish line before car B.

(3)

.....

.....

.....

.....

.....

.....

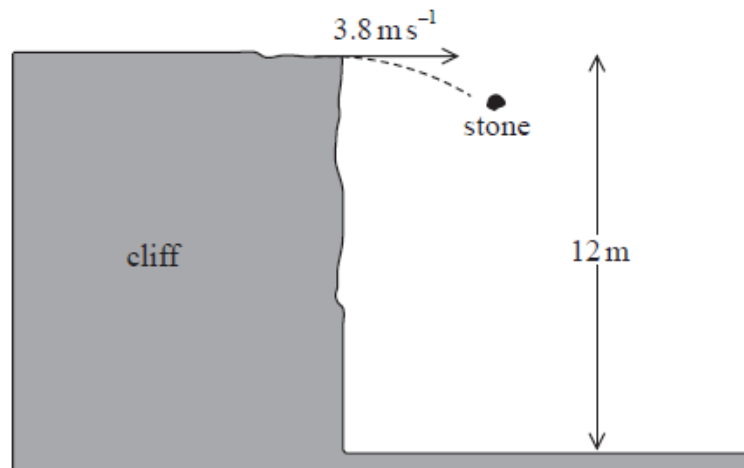
(Total for question = 6 marks)

Q14.

A stone is projected horizontally from a cliff.

The initial horizontal velocity of the stone is 3.8 m s^{-1} .

The initial height of the stone is 12 m, as shown.



Calculate the horizontal distance from the bottom of the cliff to where the stone hits the ground.

.....

.....

.....

.....

.....

.....

.....

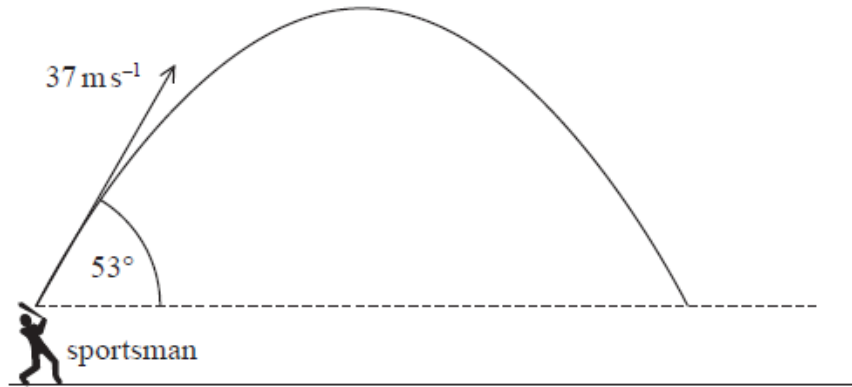
Horizontal distance = ...

(Total for question = 3 marks)

Q15.

A sportsman hits a ball with a bat.

The ball leaves the bat at a speed of 37 m s^{-1} at an angle of 53° to the horizontal, as shown.



Calculate the horizontal distance travelled by the ball before returning to the height it was hit from.

.....

.....

.....

.....

.....

.....

.....

.....

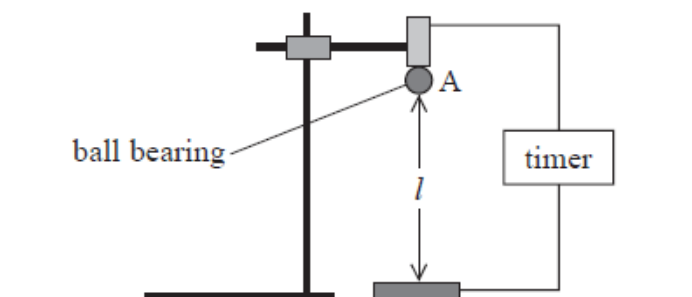
Horizontal distance = ...

(Total for question = 4 marks)

Q16.

A student carried out an experiment to measure the acceleration of free-fall g .

A ball bearing was released from position A. The time t for the ball bearing to fall a distance l was measured. This was repeated for decreasing values of l .



Explain how the measurements obtained can be used to determine a value for g in m s^{-2} . Your answer should include a sketch on the axes below of the graph that the student would expect to obtain.

(5)



.....

.....

.....

.....

.....

.....

.....

.....

.....

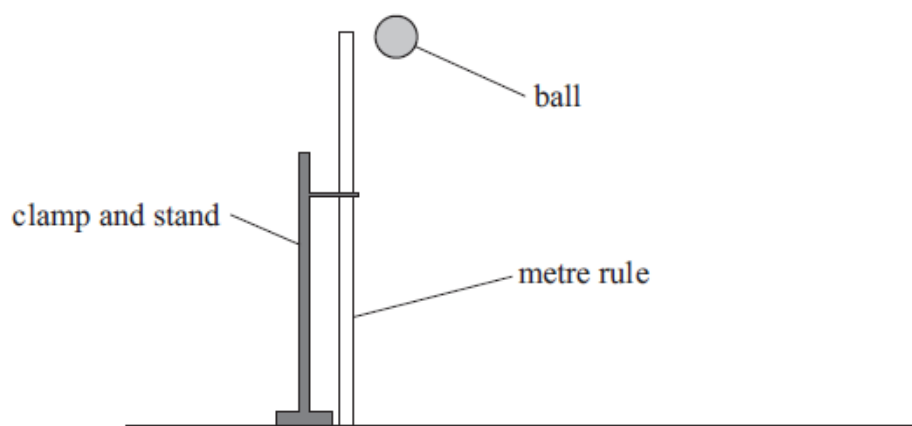
.....

(Total for question = 5 marks)

Q17.

A student clamped a metre rule so that it was vertical. She dropped a ball from rest near the top

of the metre rule, as shown.



A strobe emits flashes of light. The time interval between flashes is constant.

The student photographed the falling ball using strobe lighting. The ball can be seen at different heights in the photograph, as shown.



(Source: © sciencephotos/Alamy Stock Photo)

For each flash of light, the student determined the distance fallen by the ball.

(a) She took one photograph using a strobe app on a mobile phone.

She took a second photograph using a laboratory strobe.

The time interval between flashes was the same for the strobe app and for the laboratory strobe. Each flash of light from the laboratory strobe has a smaller duration than each flash from the mobile phone.

Explain how the smaller duration of each flash from the laboratory strobe affected the uncertainty in the measurement of the distance fallen.

(2)

.....

.....

.....

.....

(b) The student recorded the distances s fallen by the ball and corresponding values of the time

t .

(i) Explain why a graph of s against t^2 gives a straight line.

(2)

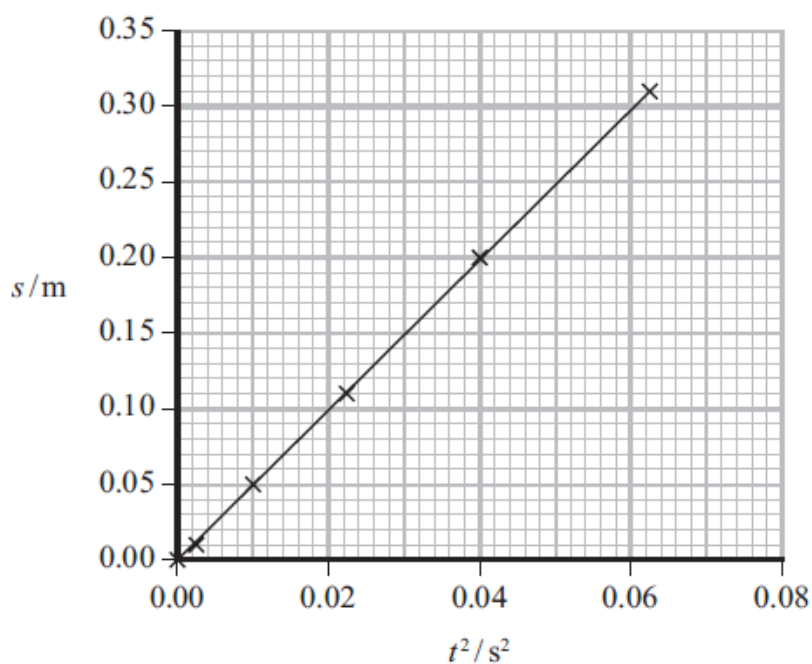
.....

.....

.....

.....

(ii) The student plotted a graph of s against t^2 , as shown.



Determine the acceleration of free fall, g , using the student's graph.

(2)

.....

.....

.....

.....

$g =$

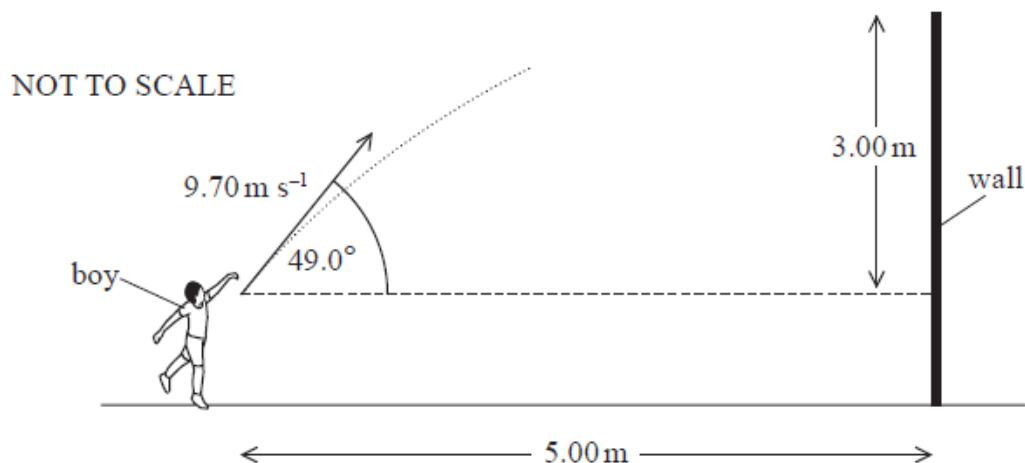
(Total for question = 6 marks)

Q18.

A boy was throwing a ball towards a wall. The wall was 5.00 m from the boy. The top of the wall was 3.00 m above the point where the boy released the ball.

The boy tried to throw the ball over the wall but sometimes the ball hit the wall.

In one attempt, the boy threw the ball with an initial velocity of 9.70 m s^{-1} at an angle to the horizontal of 49.0° , as shown.



(a) Show that the ball travelled the distance to the wall in about 0.8 s.

(3)

.....

.....

.....

.....

.....

.....

(b) Deduce whether or not the ball went over the wall for this attempt.

(4)

.....

.....

.....

.....

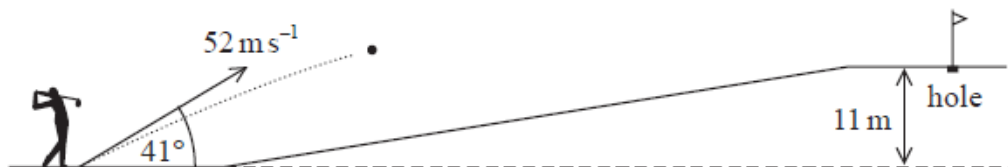
.....

.....

(Total for question = 7 marks)

Q19.

A golfer hit a golf ball into the air at a speed of 52 m s^{-1} and an angle of 41° to the horizontal, as shown.



The ball landed on the ground near a hole. The ground was 11 m higher than the starting point of the ball.

(a) Show that the vertical component of the ball's initial velocity was about 30 m s^{-1} .

(2)

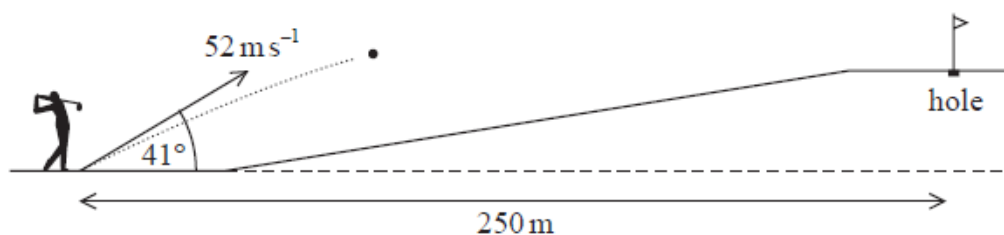
(b) Show that the time taken by the ball to reach the ground was about 7 s . You should ignore the effects of air resistance.

(3)

.....

.....

(c) The hole is a horizontal distance of 250 m from the starting point of the ball, as shown.



Deduce whether the ball landed within 5.0 m of the hole. You should ignore the effects of air resistance.

(3)

.....

.....

.....

.....

.....

.....

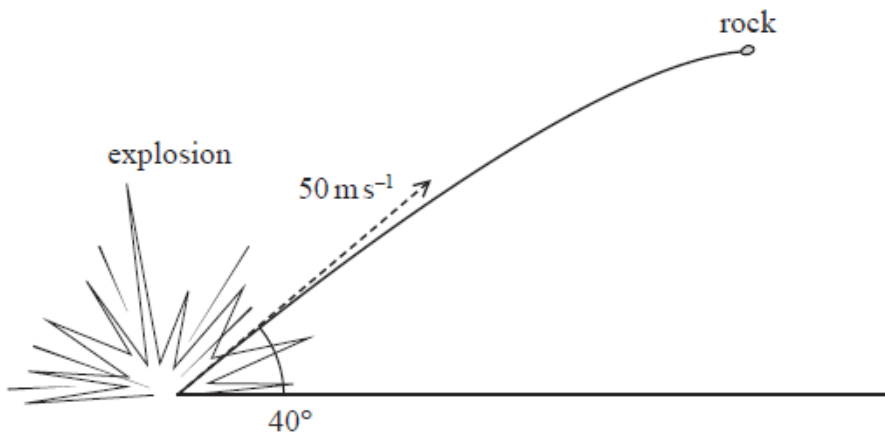
.....

.....

(Total for question = 8 marks)

Q20.

An explosion projects a rock into the air with a speed of 50 m s^{-1} at an angle to the horizontal of 40° .



(a) Show that the rock would reach its maximum height about 3 s after the explosion.

(3)

.....

.....

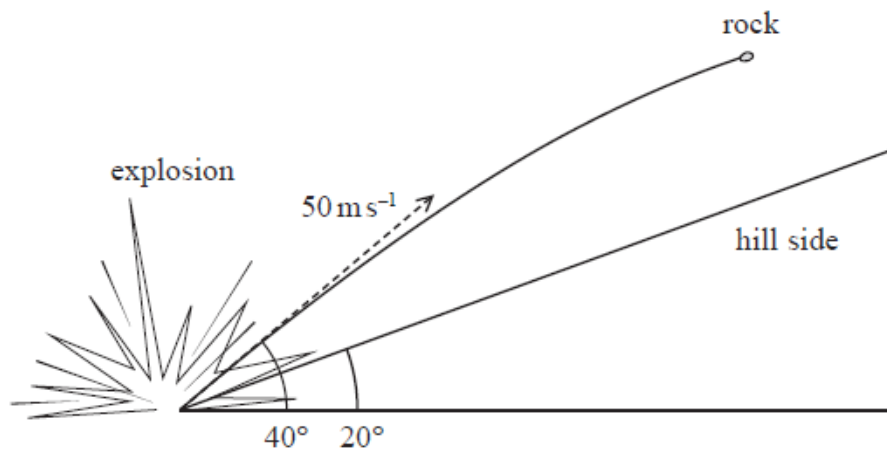
.....

.....

.....

.....

(b) The rock moves in the direction of a hill. The side of the hill is at 20° to the horizontal, as shown.



After a certain distance, the rock lands on the side of the hill.

Deduce whether the rock hits the ground before it reaches its maximum possible height.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

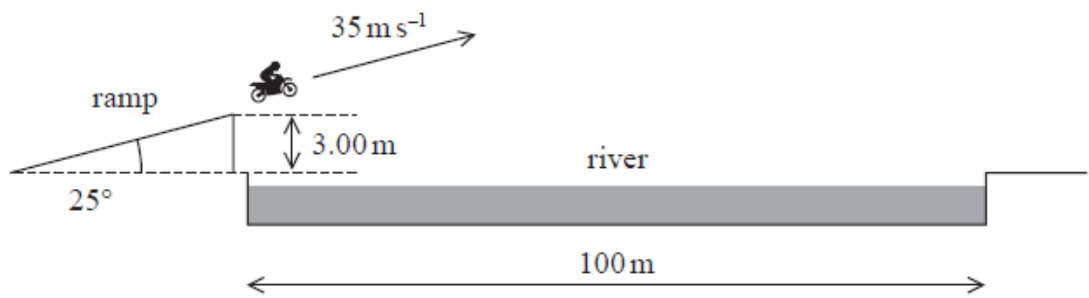
.....

.....

(Total for question = 9 marks)

Q21.

A stunt motorcyclist wants to jump across a river to land on the other side. The diagram shows the motorcyclist driving off a ramp at the edge of a river.



The ramp is at an angle of 25° to the horizontal and the height at the end of the ramp is 3.0 m . The width of the river is 100 m . The initial velocity of the motorcyclist is 35 m s^{-1} .

(a) Calculate the horizontal and vertical components of the motorcycle's initial velocity as it leaves the ramp.

(2)

.....

.....

Horizontal component = ...

Vertical component = ...

(b) Deduce whether the rider lands on the other side of the river.

The effects of air resistance can be ignored.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) Explain how air resistance would affect the jump.

(3)

.....

.....

.....

.....

.....

.....

(Total for question = 9 marks)

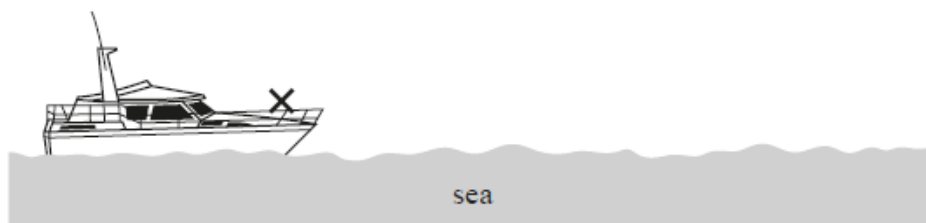
A distress flare may be launched from a boat, to signal for help.

(a) A flare was launched from a stationary boat at an angle of 30° to the horizontal.

(i) The flare was launched to the right from the launch position marked $\times$ on the boat in the diagram below.

Complete the diagram to show the path taken by the flare before it hit the sea.

(1)



(ii) The maximum height of the flare above the launch position was 42 m.

Show that the flare was launched at a speed of about 60 m s^{-1} .

(3)

.....

.....

.....

.....

.....

.....

(iii) The flare was visible from a maximum distance of 8 km. A rescue boat was 8.2 km from the boat in distress.

Determine whether the flare travelled a sufficient distance to be visible from the rescue boat. You should assume that the flare was launched in the direction of the rescue boat.

(4)

.....

.....

.....

.....

.....

.....

.....
.....
.....
.....
(b) State one assumption you made in (a)(iii).

(1)

.....
.....
(Total for question = 9 marks)

Q23.

In the sport of shot put, a person launches a heavy ball called a 'shot' into the air.

The photograph shows a person about to launch a shot.



(Source: © Lim Weixiang - Zeitgeist Photos/Getty Images)

(a) The shot is very dense and has a large mass.

Explain why the equations of motion can be used to give an accurate prediction for the path of the shot.

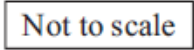
(2)

.....

.....

.....

.....



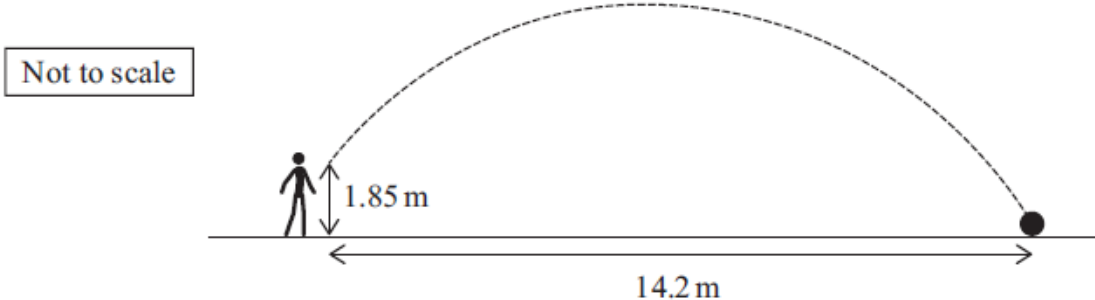
(b) The shot was released from a height of 1.85 m above the ground. The shot travelled horizontal distance of 14.2 m before landing on the ground, as shown.

The diagram shows a person standing on a horizontal ground line. A dashed parabolic curve starts at a point 1.85 m above the ground and ends at a point on the ground, 14.2 m horizontally from the start. A box labeled 'Not to scale' is in the upper left of the diagram area.

The shot moved through the air for a time of 1.61 s.

(i) Show that the horizontal speed of the shot was about 8.8 ms^{-1} .

(b) The shot was released from a height of 1.85 m above the ground. The shot travelled horizontal distance of 14.2 m before landing on the ground, as shown.



The diagram shows a person standing on a horizontal ground line. A dashed parabolic curve starts at a point 1.85 m above the ground and ends at a point on the ground. A horizontal double-headed arrow below the ground line indicates a distance of 14.2 m between the vertical projection of the release point and the landing point. A box labeled 'Not to scale' is in the upper left of the diagram area.

The shot moved through the air for a time of 1.61 s.

(i) Show that the horizontal speed of the shot was about 8.8 ms^{-1} .

(b) The shot was released from a height of 1.85 m above the ground. The shot travelled horizontal distance of 14.2 m before landing on the ground, as shown.

The diagram shows a person standing on a horizontal ground line. A dashed parabolic curve starts at a point 1.85 m above the ground and ends at a point on the ground, 14.2 m horizontally from the start. A box labeled 'Not to scale' is in the upper left of the diagram area.

The shot moved through the air for a time of 1.61 s.

(i) Show that the horizontal speed of the shot was about 8.8 ms^{-1} .

(ii) Determine the velocity of the shot at the point it was released.

(ii) Determine the velocity of the shot at the point it was released.

[illegible]

Magnitude of velocity = ...

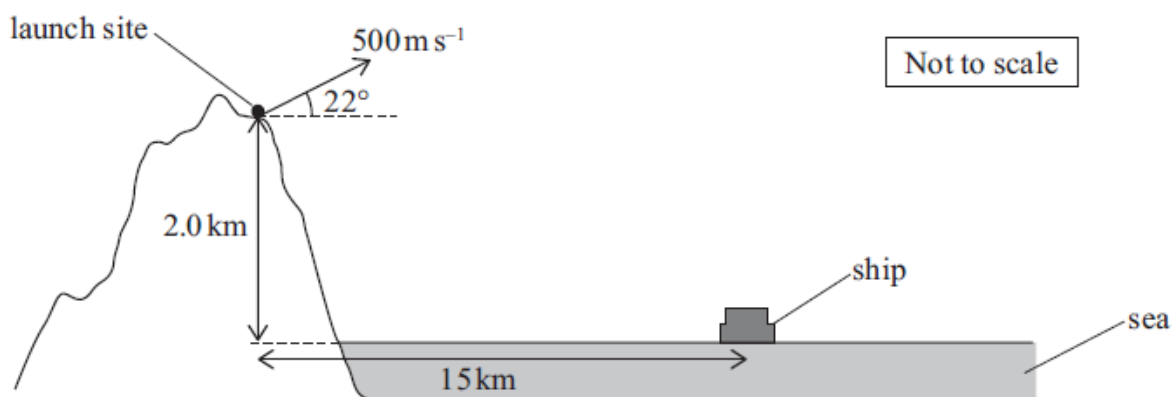
Angle to horizontal = ...

(Total for question = 9 marks)

Q24.

Scientists launched a projectile from a mountain. The launch site was 2.0 km above sea level. The projectile initially moved with a speed of 500 m s^{-1} at an angle of 22° to the horizontal.

A ship was a horizontal distance of 15 km from the launch site, as shown. The projectile passed over the ship.



(a) (i) Show that the projectile was vertically above the ship about 30 s after launch.

You should ignore the effects of air resistance.

(3)

.....

.....

.....

.....

.....

.....

(ii) Determine the height above sea level of the projectile as it passed over the ship.

You should ignore the effects of air resistance.

(4)

.....

.....

.....

.....

.....

.....

.....

Height above sea level = ...

(b) The scientists launched several more projectiles. Each projectile was launched at the same speed but at a different angle to the horizontal.

As the launch angle was increased, the horizontal distance travelled before landing in the sea increased to a maximum value and then decreased.

Explain why the horizontal distance travelled reached a maximum value.

You should consider the components of the initial velocity.

(4)

.....

.....

.....

.....

.....

.....

.....

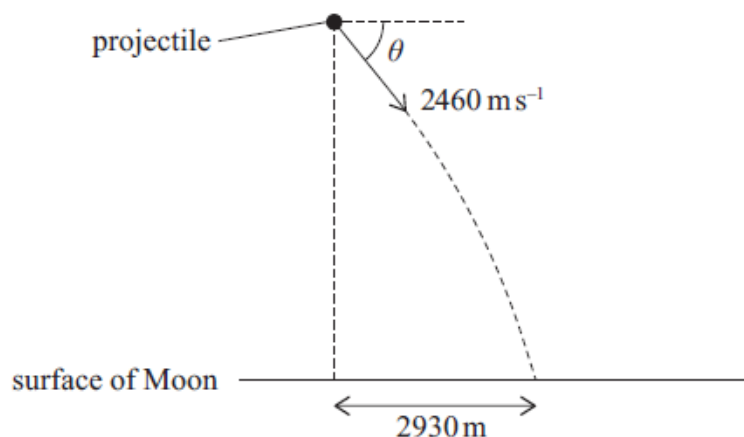
.....

(Total for question = 11 marks)

Q25.

In 2009, a satellite orbiting the Moon fired a projectile towards the surface of the Moon.

The horizontal distance travelled by the projectile was 2930 m, as shown.



The time taken for the projectile to reach the surface of the Moon was 7.50 s.

(i) Show that θ was about 81° .

(3)

(ii) Calculate the speed of the projectile as it reached the surface of the Moon.

Assume the acceleration due to gravity is constant and has a value of 1.63 m s^{-2} .

(4)

Speed = ...

(b) A satellite orbiting the Earth could fire a projectile towards the surface of the Earth with the same initial height and velocity as the projectile fired towards the Moon.

(i) A student used the equations of motion to predict the motion of this projectile.

Explain how the predicted horizontal distance travelled by this projectile would be different from the horizontal distance travelled by the projectile fired towards the Moon.

Assume the acceleration due to gravity is constant and has a value of 9.81 m s^{-2} .

You do not need to do any calculations.

(3)

.....

.....

.....

.....

.....

.....

(ii) The student used the equations of motion to calculate the speed of the projectile at the surface of the Earth. The student used a value of 9.81 m s^{-2} for the acceleration of the projectile.

Give two reasons why the student's value for the speed would **not** be accurate.

(2)

.....

.....

.....

.....

(Total for question = 12 marks)