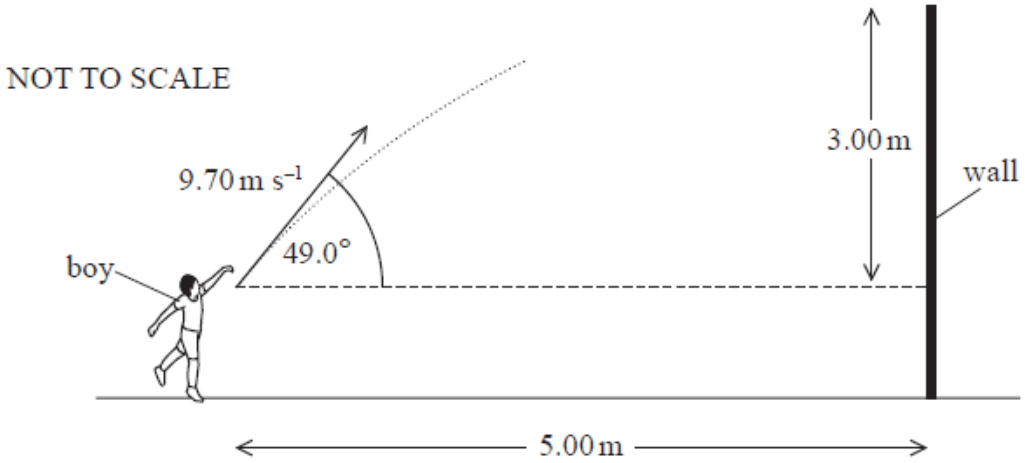
Questions

Q1.

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.

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

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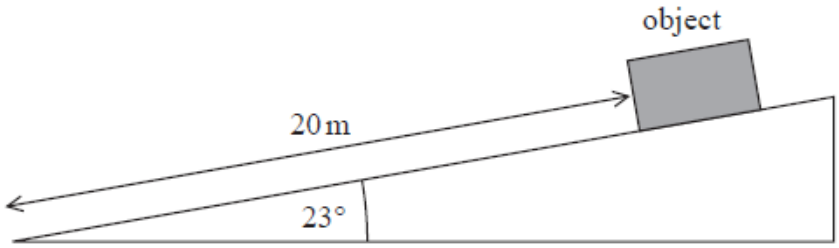
(Total for question = 7 marks)

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 ☒.

An object accelerates from rest down a frictionless slope. The object moves a distance of 20 m. The slope is at an angle of 23° to the horizontal, as shown.



Which of the following gives the final speed of the object in m s^{-1}?

☒ **A** $\sqrt{2 \times 9.81 \times 20 \times \cos 23°}$

☒ **B** $\sqrt{0.5 \times 9.81 \times 20 \times \cos 23°}$

☒ **C** $\sqrt{2 \times 9.81 \times 20 \times \sin 23°}$

☒ **D** $\sqrt{0.5 \times 9.81 \times 20 \times \sin 23°}$

(Total for question = 1 mark)

Q3.

The photograph shows an area of land where golfers can practise their golf shots. Distances are marked out along the land in front of where the golfer stands, to measure the distance travelled by the ball.

Two levels are available. If the lower level is used, the ball lands at the same height from which it was hit. If the higher level is used, this enables the ball to be hit further.

Source: www.golfnews.co.uk

(a) A ball is given an initial velocity of 33 m s^{-1} at an angle of 28° to the horizontal.

When hit from the lower level, this ball travels a horizontal distance of 92 m before landing. Use of the higher level increases the horizontal distance travelled before landing by 10 m.

Deduce whether an upper level at a height of 4.5 m would be sufficient to produce this increase. You should ignore air resistance.

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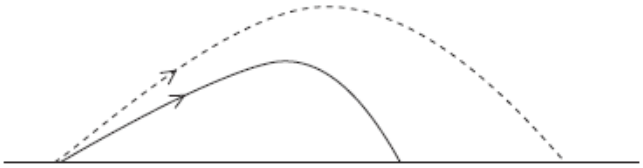
* (b) Your answer to part (a) did not consider the effect of air resistance.

The trajectories of the motion of the golf ball with air resistance and without air resistance are shown.



Explain the differences between the two paths.

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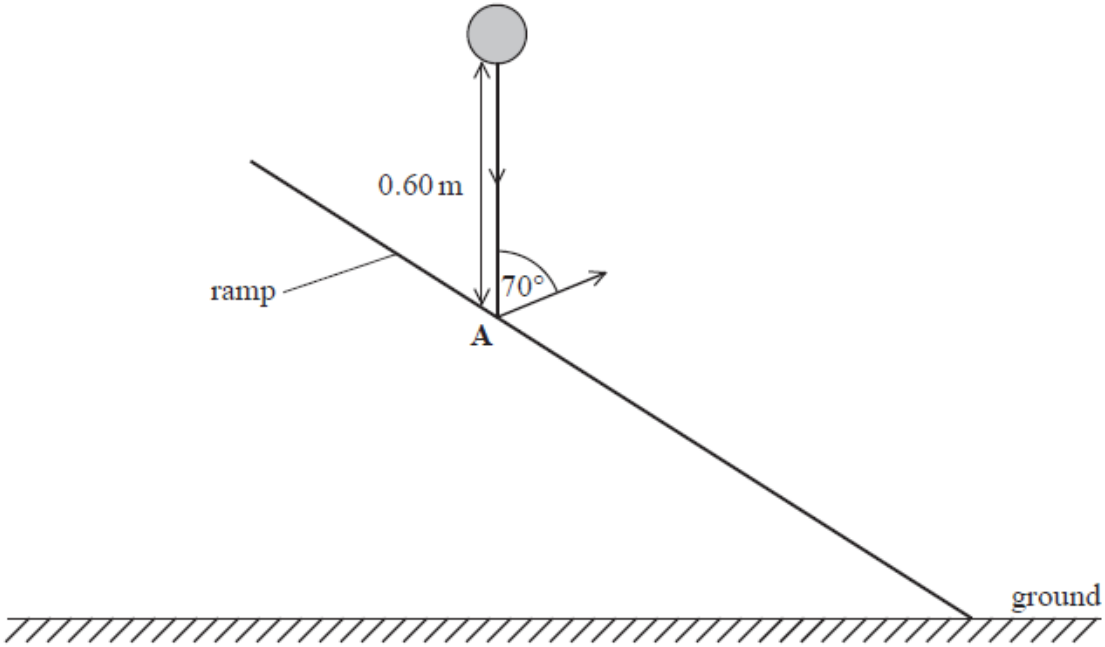
(Total for question = 11 marks)

Q4.

A ball falls through a vertical height of 0.60 m before bouncing at point A on a ramp, as shown.



(a) Show that the velocity of the ball immediately before the bounce is about 3 m s^{-1}.

(2)

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(b) Kinetic energy is conserved as the ball bounces off the ramp. The ball bounces at an angle of 70° to the vertical.

State expressions for the horizontal and vertical components of velocity of the ball immediately after the bounce.

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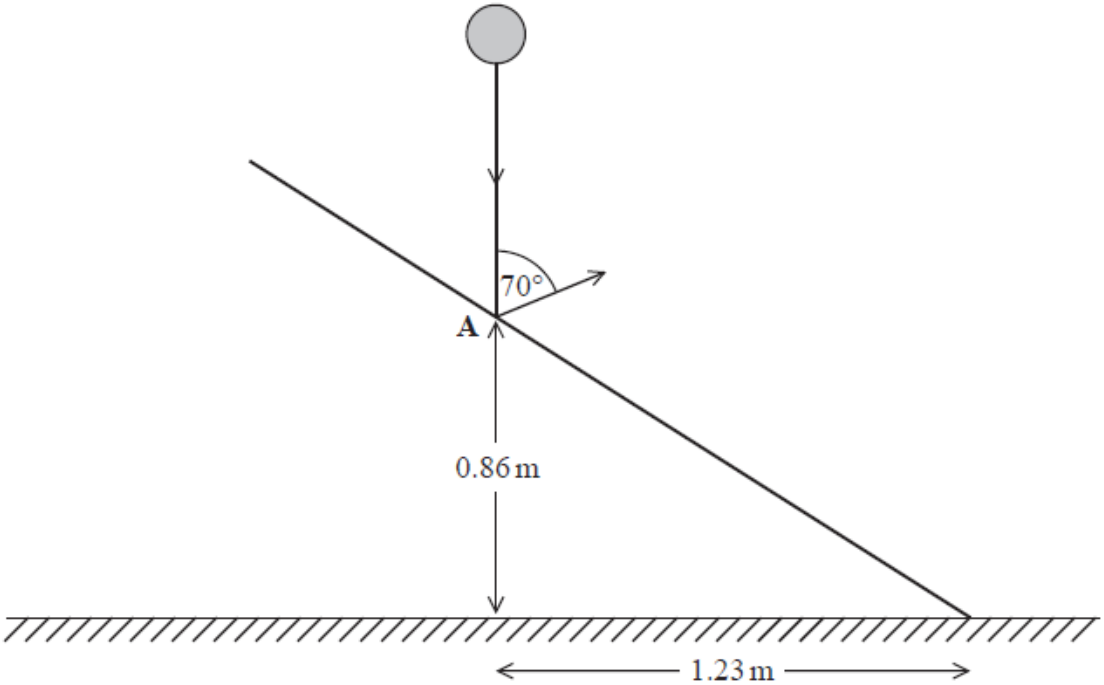
Horizontal component = ...

Vertical component = ...

(c) Point A is 0.86 m vertically above the ground and 1.23 m horizontally from the end of the ramp as shown.



Deduce whether the ball will bounce a second time on the ramp.

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(Total for question = 8 marks)

Q5.

A firework is launched into the air and explodes once it reaches a maximum height.

(a) The firework is designed to explode at a maximum height of 350 m.

(i) Show that the vertical component of the velocity at launch is about 80 m s^{-1}.

(2)

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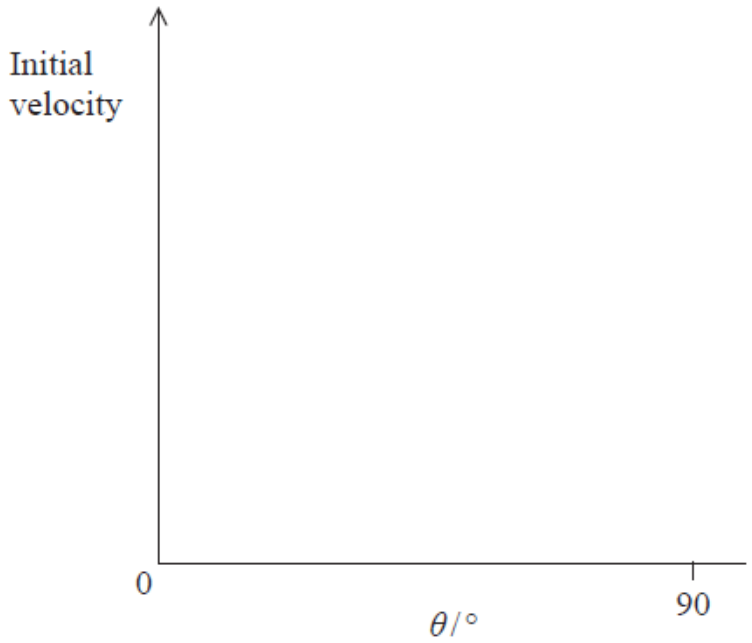
(ii) The vertical component of the velocity at launch depends on both the initial velocity of the firework and θ, the angle between the initial velocity and the horizontal.

Sketch a graph showing how the initial velocity required for the firework to reach the maximum height of 350 m varies with θ for the firework.

(4)

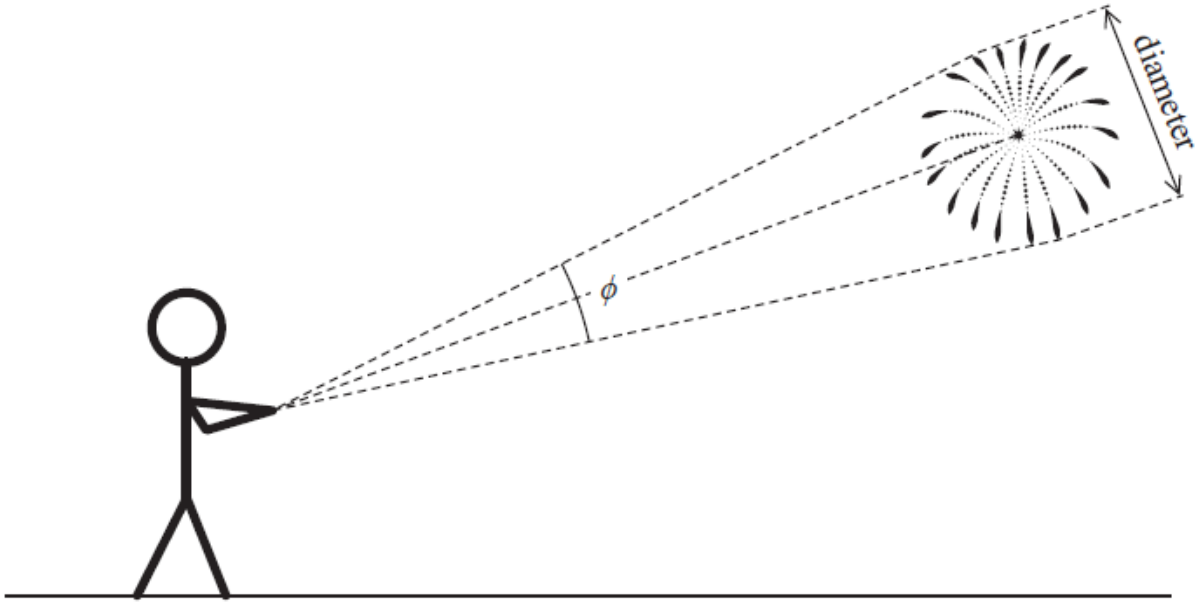


(b) A student wanted to estimate the maximum diameter of the firework after exploding.

The student estimated:

- the time taken between seeing the firework explode and hearing the firework explode

- the angle ϕ from the top to the bottom of the firework



Describe how the student could determine the maximum diameter of the exploded firework using the estimated data.

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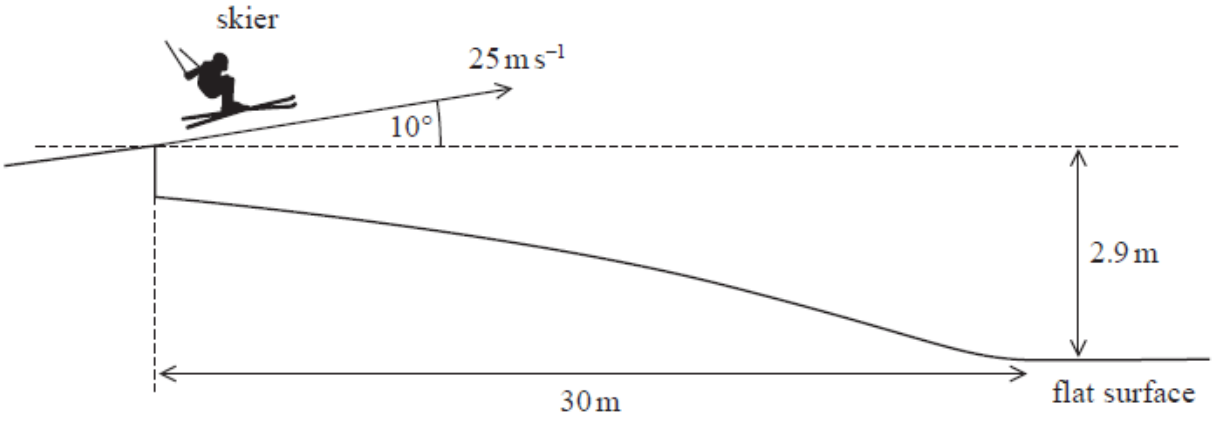
(Total for question = 8 marks)

Q6.

A skier moving at 25 m s^{-1} skis off a ramp. The ramp is angled upwards at 10° to the horizontal, as shown.

There is a flat surface that starts 30 m from the ramp. The flat surface is 2.9 m below the ramp.



(a) Deduce whether the skier reaches the flat surface before landing. You may ignore any effects of air resistance.

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(b) Another skier travels along the horizontal surface with an initial speed of 23 m s^{-1} . She comes to rest after travelling a distance of 43 m.

Calculate the average force required to bring the skier to rest.

mass of skier = 63 kg

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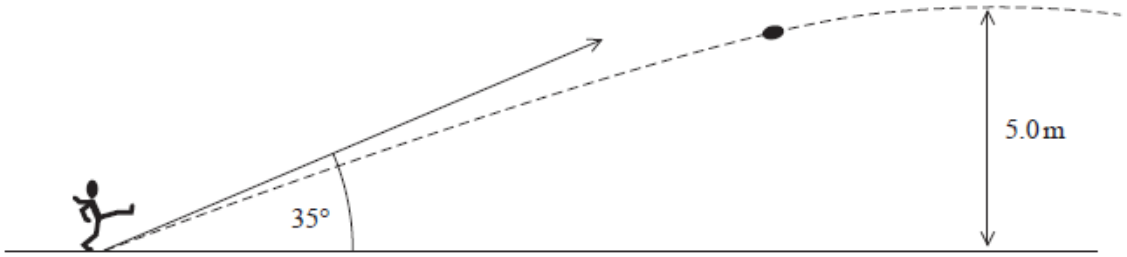
Average force = ...

(Total for question = 8 marks)

Q7.

A rugby player kicks a ball off the ground at an angle of 35.0° to the horizontal as shown. The ball reaches a maximum height of 5.0 m before returning to the ground.



(a) Show that the initial speed of the ball is about 17 m s^{-1}.

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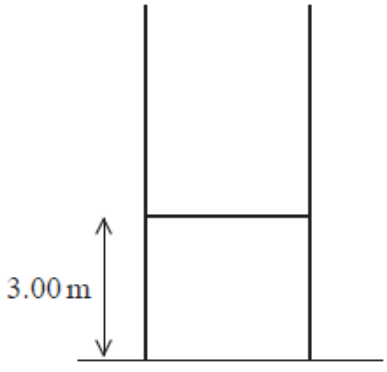
(b) After travelling a horizontal distance of 22.0 m the ball reaches the goal.



To score, the ball must be more than 3.00 m above the ground when it reaches the goal.

Deduce whether an initial speed of 17.0 m s^{-1} is sufficient to score.

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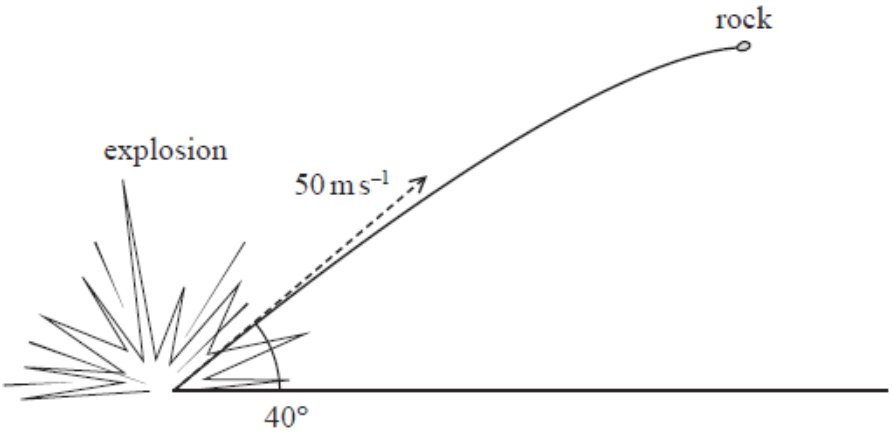
(Total for question = 8 marks)

Q8.

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.

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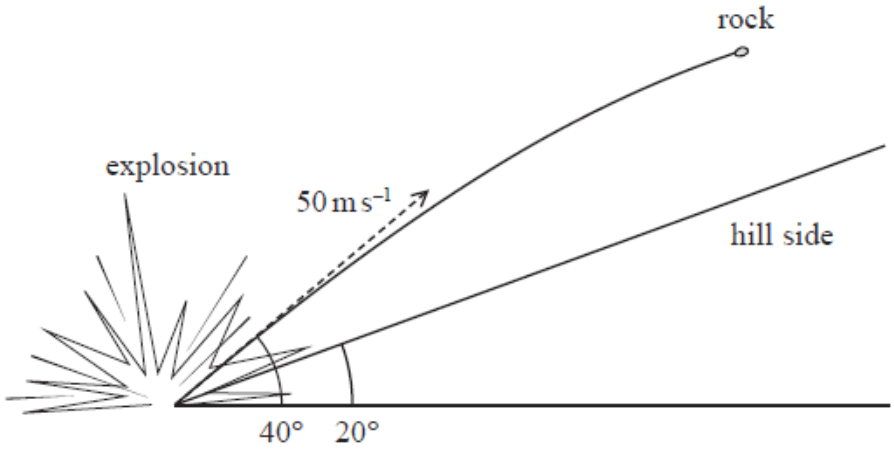
(b) The rock moves in the direction of a hill. The side of the hill is at 20° to the horizontal, as shown.



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.

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(Total for question = 9 marks)

Q9.

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 × 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}.

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(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.

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

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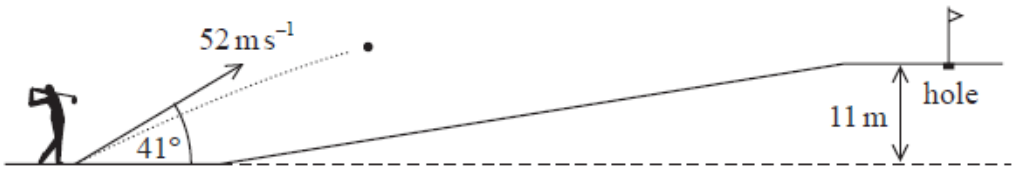
(Total for question = 9 marks)

Q10.

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}.

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(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.

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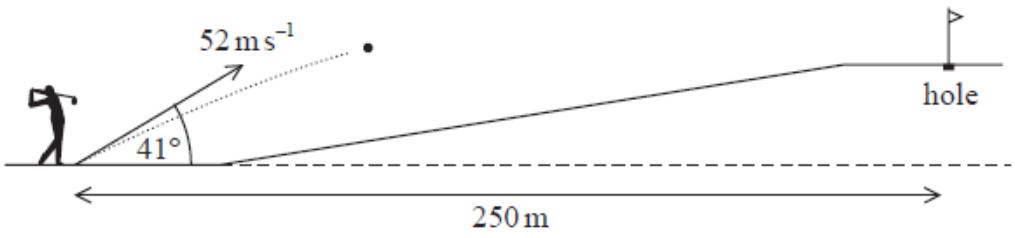
(c) The hole is a horizontal distance of 250 m from the starting point of the ball, as shown.



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

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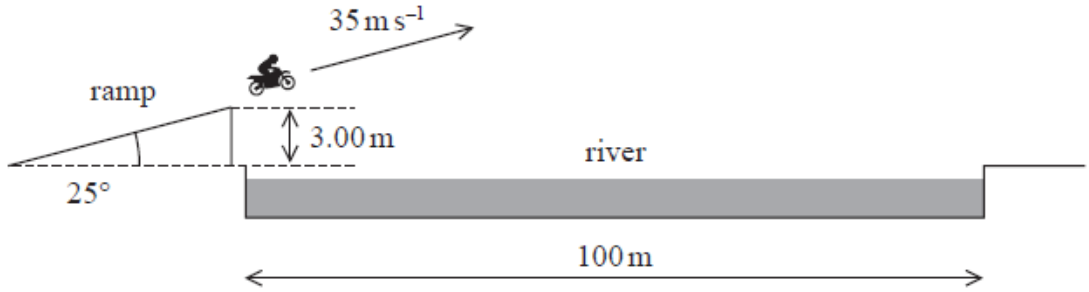
(Total for question = 8 marks)

Q11.

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)

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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.

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

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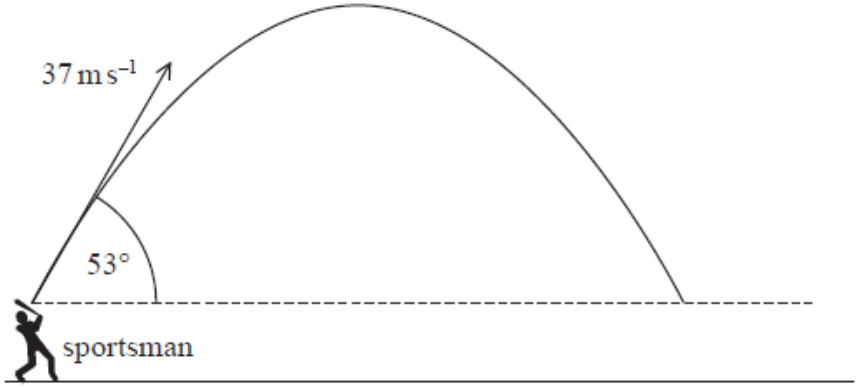
(Total for question = 9 marks)

Q12.

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.

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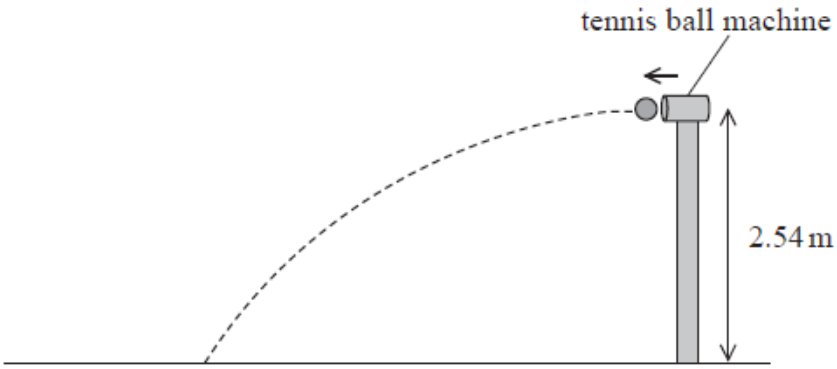
Horizontal distance = ...

(Total for question = 4 marks)

Q13.

Tennis players can practise using a tennis ball machine. The machine projects tennis balls horizontally from a height of 2.54 m, as shown.



(a) (i) Show that the time taken for a ball to reach the ground is about 0.7 s.

(2)

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(ii) The ball lands on the ground at a horizontal distance of 17.89 m from the machine.

Calculate the velocity of the ball as it is projected from the machine.

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Velocity = ...

(b) The initial velocity of the ball, as it is projected from the machine, can be increased.

Explain how increasing the initial velocity would affect the angle at which the ball hits the ground.

(3)

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(Total for question = 7 marks)