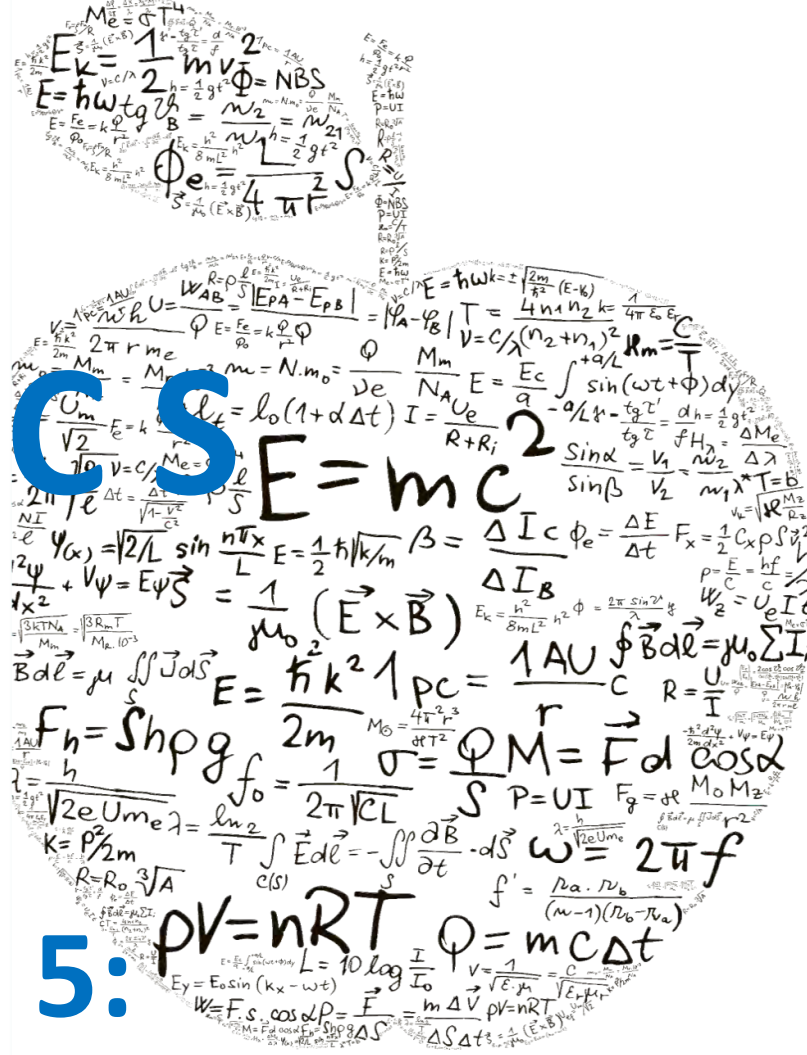


NAME:

# HSC PHYSICS



# MODULE 5: ADVANCED MECHANICS

## FOCUS 1: PROJECTILE MOTION – SUPPLEMENTARY

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# Supplementary Question Sets:

<input type="checkbox"/> S5.1.1 – Projectile Motion	Pages
○ Part A – Fundamental	3-4
<input type="checkbox"/> S5.1.2 – Projectile Motion Problems	
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This booklet of supplementary questions was created to aid you in your consolidation of concepts covered in class.

The questions in these booklets are divided into sections based on the essential concepts to be mastered and perceived level of difficulty:

- **1-SIGMA** – These are basic questions, fundamental to our understanding of the material from our class booklet – these question types **SHOULD** be able to be completed with no guidance. They are essentially the easier questions and the approaches to these questions and any definitions should be memorised. **These are typical band 3/4 questions.**
- **2-SIGMA** – These questions are more difficult than the 1-SIGMA questions and rely on an understanding of the concepts taught in the class booklet. These questions may take a while longer to complete than the 1-SIGMA questions, but if you are aiming for a Band 6, you **SHOULD** be able to do these questions with limited guidance. **These are typical Band 5 – Low Band 6 questions.**
- **3-SIGMA** – These questions are either the most difficult questions or questions where the most careless mistakes are made. Some of these questions will challenge even the brightest physics students. **These are typical (and not so typical) Band 6+ questions.**

# S5.1.1 – Projectile Motion

1. Define the term 'projectile'.

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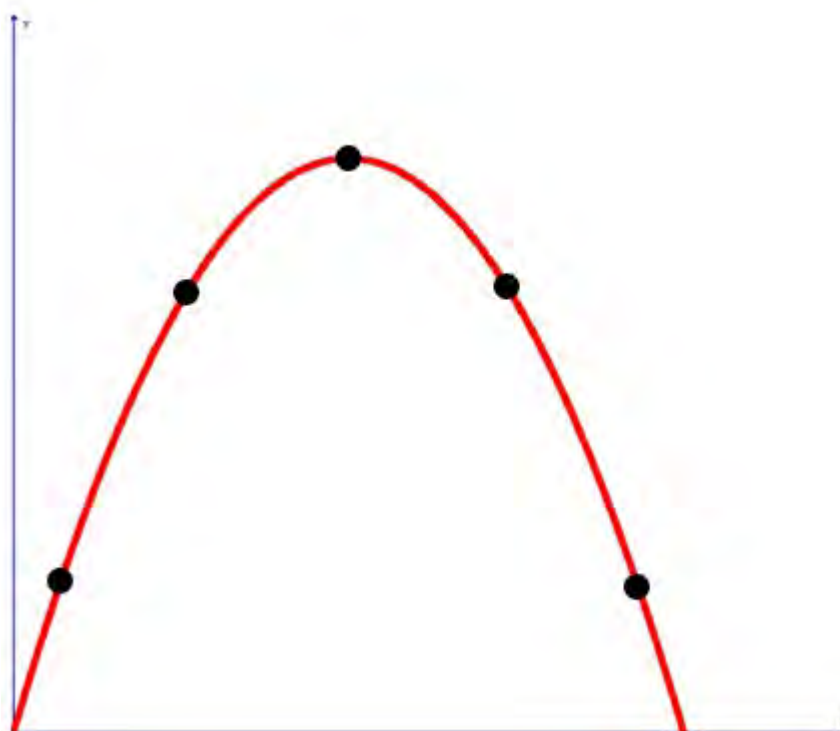
2. Identify any force(s) acting on an object when it is undergoing projectile motion.

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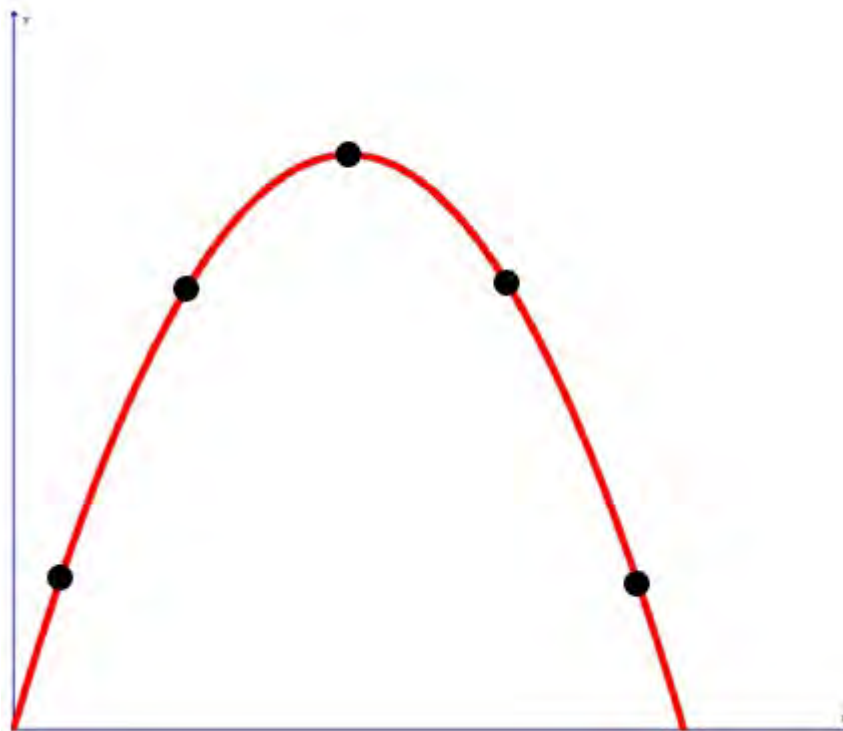
3. Describe the force(s) identified in (2).

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4. Draw in the vertical and horizontal components of the ball's velocity at the 5 points in time shown on the diagram below.



5. Draw in the acceleration vectors at the 5 points in time shown on the diagram below.

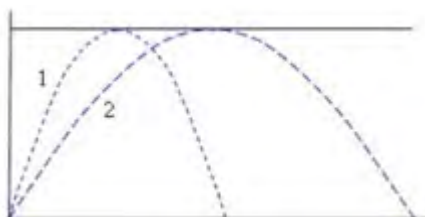


6. Identify the condition(s) for all projectiles at maximum height.

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7. Two objects are fired in the air such that they have the same height as shown below.



Mark the following statements as either true or false.

- |  |       |
|--|-------|
| (A) Both projectiles have the same time of flight.       | T / F |
| (B) Both projectiles hit the ground with the same speed. | T / F |
| (C) Both projectiles have the same initial velocity.     | T / F |
| (D) Projectile 2 has a greater $U_y$ than Projectile 1.  | T / F |
| (E) Projectile 2 has a greater $U_x$ than Projectile 1.  | T / F |
| (F) Projectile 2 has a greater $U$ than Projectile 1.    | T / F |

# S5.1.2 – Projectile Motion Problems

## Type 1 Projectiles:

1. A box is dropped from a plane moving horizontally at  $200 \text{ ms}^{-1}$  from a height of 1500m.

Find:

- (a) The time taken for the box to hit the ground.

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- (b) The velocity of the box after 7.5 seconds.

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- (c) The height of the box after 6.0 seconds.

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- (d) The height of the box when it reaches a speed of  $240 \text{ ms}^{-1}$ .

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2. A box is dropped from a small plane moving at  $120 \text{ ms}^{-1}$ . The box hits the ground after 11.1 s.  
Find:

(a) The height from which the box was dropped.

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(b) The velocity of the box when it had fallen half-way.

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(c) The time at which the box was 200m off the ground.

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(d) The final velocity of the box.

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3. A ball is thrown horizontally from the top of a cliff. The ball strikes the ground 8 seconds later at an angle of  $25^\circ$  to the vertical.

Find:

(a) The speed at which the ball was thrown.

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(b) The velocity at which the ball strikes the ground.

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(c) The height of the cliff.

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A second ball was thrown with a different horizontal speed. After 4s, the angle it created was  $60^\circ$  to the vertical.

(d) Compare the initial speed of the second ball to the first ball.

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(e) Find the range of the second ball.

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4. A rifle is fired horizontally at the centre of a target which is 400m away. If the bullet strikes the target 40cm below the horizontal, determine:

(a) The time of flight of the bullet.

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(b) The muzzle velocity of the bullet.

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(c) The speed at which the bullet strikes the target.

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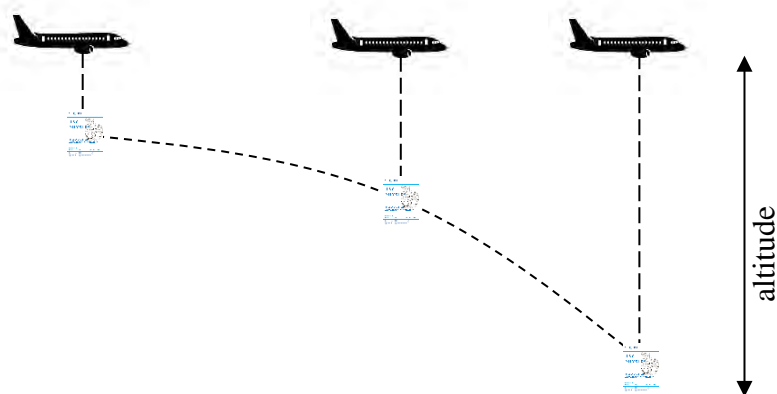
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5. An emergency plane drops a package of hard projectile motion questions to students from other tuition institutions who do not receive enough challenging material.

The plane is travelling at  $150\text{kmh}^{-1}$  and keeping a constant altitude above the surface below.



The person dropping the package measures the time of fall to be  $\sqrt[3]{42^2}$  seconds.

(a) Calculate the final vertical velocity at impact.

**118 ms<sup>-1</sup>**

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(b) Calculate the planes altitude.

**715 m**

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(c) Calculate the overall velocity after it has fallen halfway.

**93.5 ms<sup>-1</sup> @ 26° to vertical**

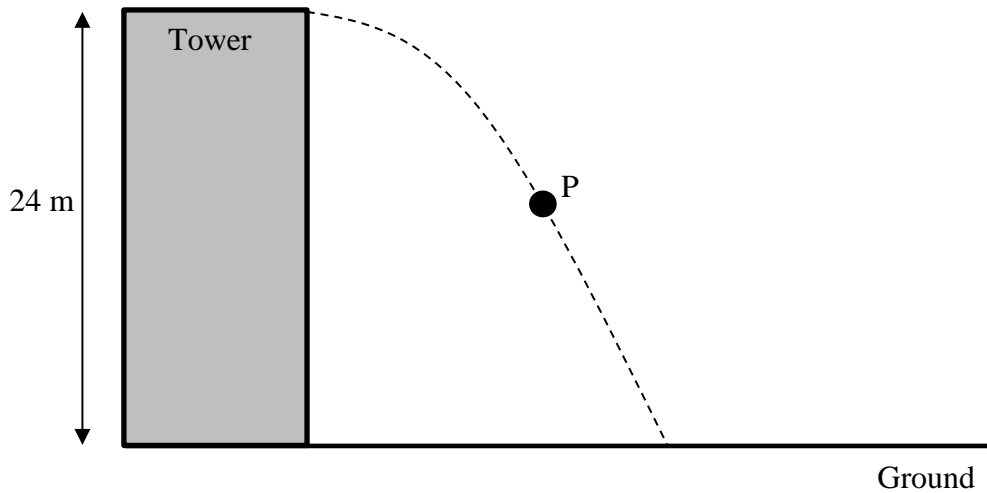
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12. The diagram below shows the path of a ball thrown horizontally from the top of a tower of height 24 m which is surrounded by level ground.



(a) Using two labelled arrows, show on the diagram above the direction of the velocity,  $v$ , and the acceleration,  $a$ , of the ball when it is at point **P**, which is half the distance to the ground.

(b) (i) Calculate the time taken from when the ball is thrown to when it first hits the ground. Assume air resistance is negligible.

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(ii) If the velocity vector at **P** creates an angle of  $40^\circ$  relative to the vertical, calculate the speed at which the ball is thrown.

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21. Two projectile launchers are beside one another on level ground. Both launchers are directed at an angle,  $\theta$ , relative to the ground. Projectile A is launched with an initial speed,  $v$ , and projectile B is launched with an initial speed,  $2v$ . Quantitatively compare the ranges of the two projectiles.

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22. A projectile of mass 2.75kg is fired from a cannon at  $30^\circ$  relative to the horizontal. The cannon applies 125N of force for 7.00 seconds. What is the range of the projectile? **8950m**

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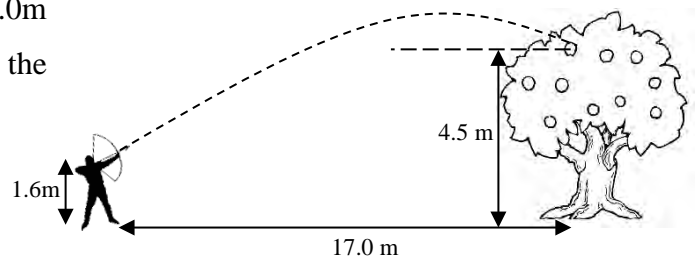
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23. An archer fires an arrow from 1.6 m above the ground to strike an apple on an apple tree, which is 17.0m away and 4.5m from the ground. If the arrow hits the apple after its maximum height, determine:

(a) The initial velocity of the arrow.



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(b) The time it takes to hit the apple.

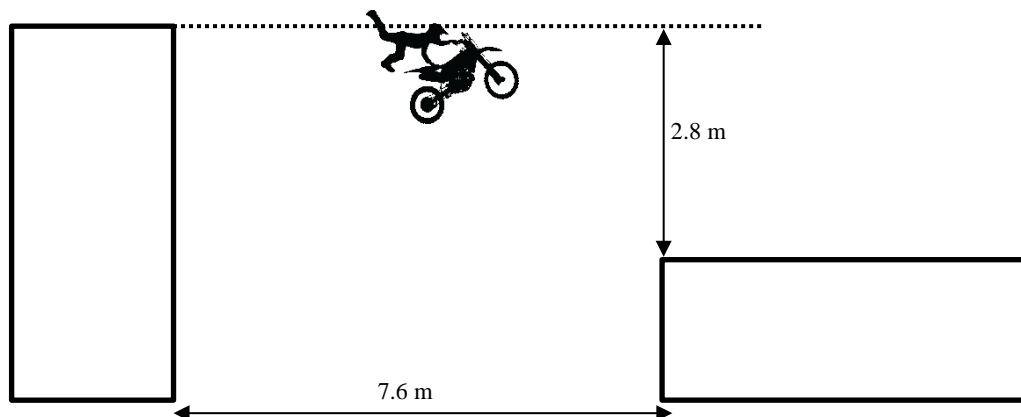
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24. A stunt motorcyclist attempts to jump a river which is 7.6m wide. The bank from which he will take-off is 2.8m higher than the bank on which he will land, as shown below.



Calculate the minimum horizontal speed he must achieve before take-off to avoid landing in the river.

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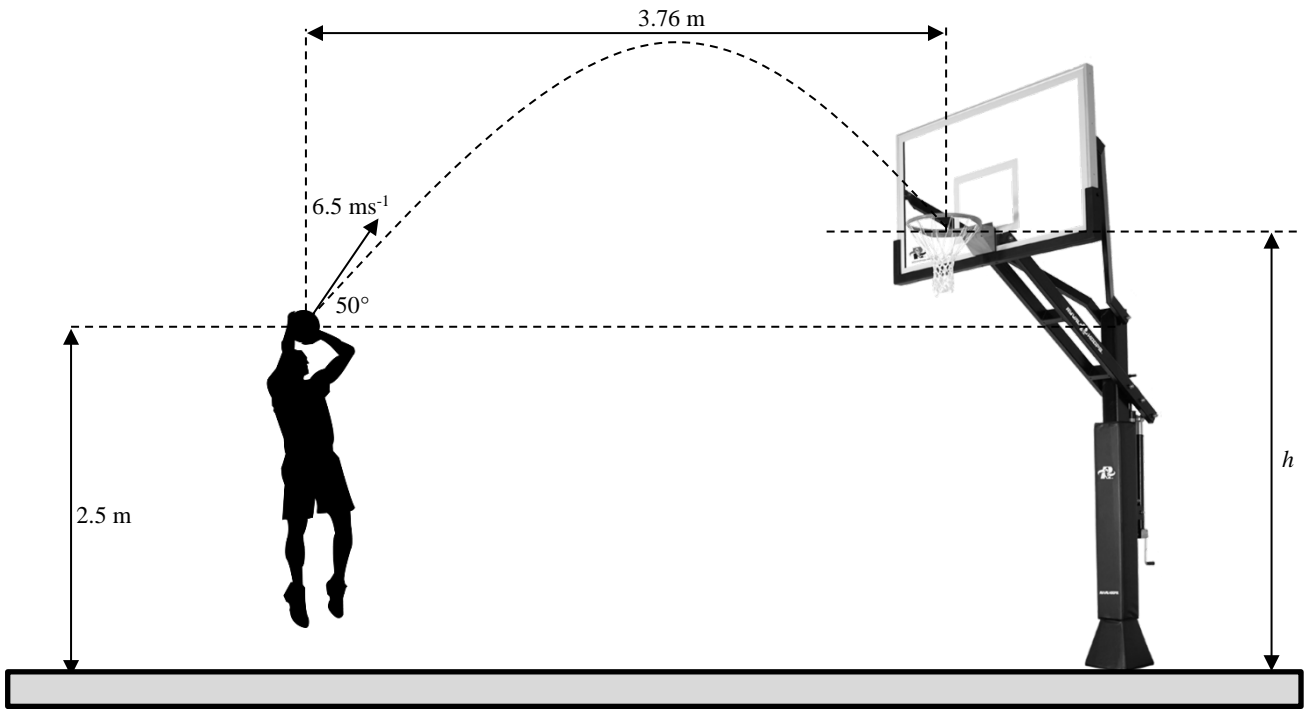
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29. A basketball player shoots a jumpshot with an initial velocity of  $6.5\text{ms}^{-1}$  at an angle of  $50^\circ$  to the horizontal. The ball is  $2.5\text{m}$  above the ground when released. The ball travels a horizontal distance of  $3.76\text{m}$  to reach the top of the basket.



Find:

(a) The time taken for the ball to reach the basket. **0.90 s**

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(b) The height,  $h$ , of the basket. **3.0 m**

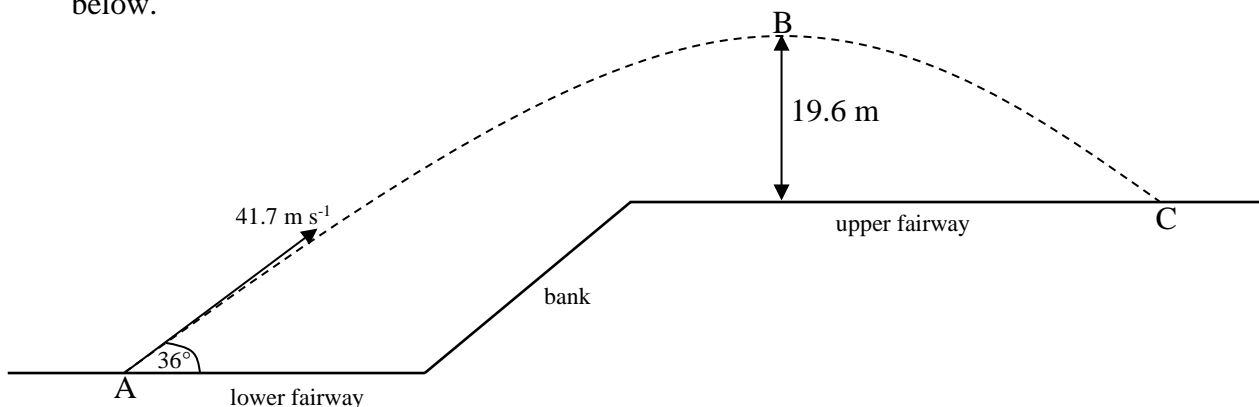
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30. The fairway on a golf course is in two horizontal parts separated by a steep bank as shown below.



A golf ball at point A is given an initial velocity of  $41.7 \text{ ms}^{-1}$  at  $36^\circ$  to the horizontal. The ball reaches a maximum vertical height at point P above the upper fairway. Point B is  $19.6\text{m}$  above the upper fairway as shown. The ball hits the ground at point C.

Find:

(a) The time taken to travel from point A to point C. **4.5 s**

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(b) The range of the golf ball. **152 m**

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(c) The vertical distance between the lower and upper fairways. **11.05m**

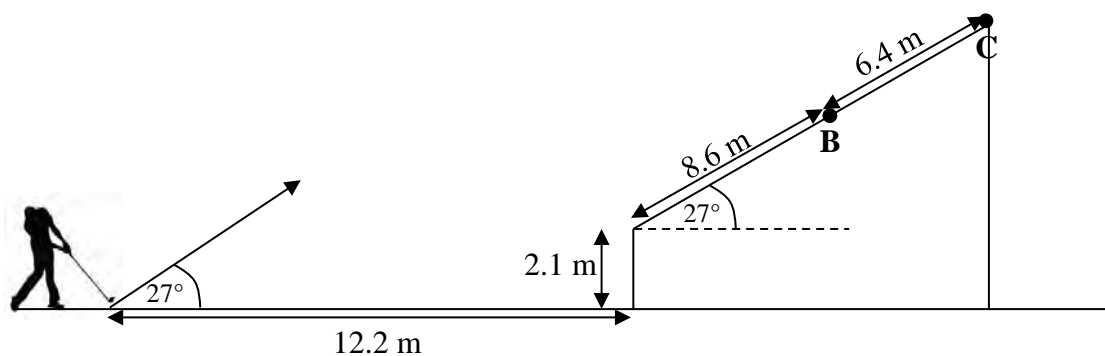
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8. A golf-ball is chipped onto a hill with a velocity  $v_0$ .



(a) Find the value of  $v_0$  if it reaches the point on the hill marked with B.

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(b) If the ball is chipped at the same speed, find the angle(s) at which the ball can strike point C.

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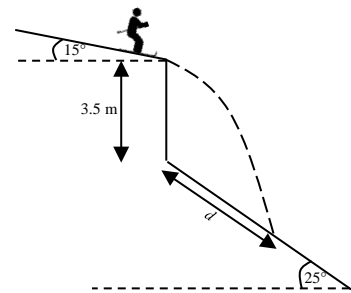
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11. A skier is travelling down a  $15^\circ$  slope which abruptly ends and the skier then leaves the  $25^\circ$  slope at a speed of  $18 \text{ ms}^{-1}$ .



(a) Find the time taken for the skier to strike the slope beneath it.

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(b) Determine the distance,  $d$ .

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15. Jimmy stood at the top of a 246m high cliff, throwing pebbles into the lake below. If he threw a pebble that reached a peak height of 45m above the cliff top and landed in the water 193m away from the base of the cliff, what was the initial speed of the pebble? **35ms<sup>-1</sup>**

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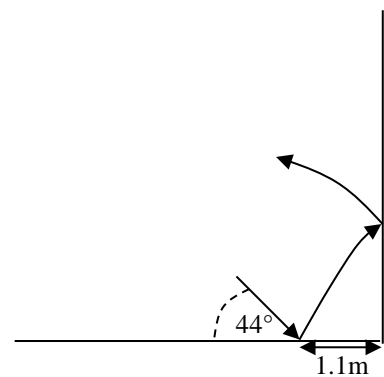
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16. Lodi and Dodi were playing wall ball at school. Lodi hit the ball so that it hit the ground at 10 ms<sup>-1</sup> at an angle of 44° to the ground 1.1m from the wall. Assuming the ball underwent perfect reflection from the ground and the wall, how far from the wall does the ball land? **9.15m**



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