

Projectile Motion Worksheet

Module 5: Advanced Mechanics

Instructions

Complete all questions. Show all working for calculation questions. Use $g = 9.8 \text{ m/s}^2$ unless otherwise specified.

Equipment needed: Scientific calculator, ruler

Part A: Fundamental Calculations (15 marks)

Question 1 (3 marks)

A ball is thrown horizontally at 12 m/s from a cliff 80 m high.

- (a) Calculate the time for the ball to hit the ground. (1 mark)

i Working Space

$$y = \frac{1}{2}gt^2 \text{ (since } u_y = 0\text{)}$$

- (b) Calculate the horizontal distance from the base of the cliff. (1 mark)
- (c) Calculate the speed of the ball just before it hits the ground. (1 mark)
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Question 2 (4 marks)

A projectile is launched at 40 m/s at an angle of 30° above the horizontal.

- (a) Calculate the initial horizontal velocity component. (1 mark)
- (b) Calculate the initial vertical velocity component. (1 mark)
- (c) Calculate the maximum height reached. (2 marks)
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Question 3 (4 marks)

A stone is thrown upward at 25 m/s at 53° to the horizontal from ground level.

- (a) Calculate the time of flight. (2 marks)
 - (b) Calculate the horizontal range. (2 marks)
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Question 4 (4 marks)

A ball is kicked at 20 m/s at 45° above the horizontal from a cliff 50 m above the sea.

- (a) Calculate the time for the ball to hit the water. (3 marks)
 - (b) How far from the base of the cliff does the ball land? (1 mark)
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Part B: Analysis Questions (15 marks)**Question 5 (3 marks)**

Explain why the horizontal and vertical components of projectile motion can be analysed independently.

Question 6 (4 marks)

Two projectiles are launched simultaneously from the same point. Projectile A is launched at 30° and Projectile B at 60° , both with the same initial speed.

- (a) Which projectile has the greater range? Explain. (2 marks)
 - (b) Which projectile reaches a greater maximum height? Justify your answer. (2 marks)
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Question 7 (4 marks)

A football is kicked at 25 m/s at an angle of 40° above the horizontal.

- (a) At what time(s) is the football at a height of 10 m? (3 marks)
 - (b) What is the horizontal displacement at each of these times? (1 mark)
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Question 8 (4 marks)

A rescue package is dropped from a helicopter flying horizontally at 30 m/s at a height of 150 m.

- (a) Where should the helicopter be (relative to the target) when the package is released? (2 marks)
 - (b) What is the velocity of the package (magnitude and direction) when it reaches the ground? (2 marks)
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Part C: Extended Response (10 marks)**Question 9 (5 marks)**

A golf ball is hit with an initial speed of 50 m/s at 35° above the horizontal. A tree 80 m away has a height of 15 m.

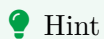
- (a) Calculate the time for the ball to travel 80 m horizontally. (2 marks)
 - (b) Determine the height of the ball when it reaches the tree. (2 marks)
 - (c) Will the ball clear the tree? Justify your answer. (1 mark)
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Question 10 (5 marks)

A basketball player shoots from 6.0 m horizontally from the basket. The ball is released at a height of 2.0 m and must enter the basket at a height of 3.0 m.

If the ball is thrown at an angle of 50° above the horizontal:

- (a) Calculate the initial speed required. (4 marks)
- (b) Calculate the time of flight. (1 mark)



Hint

Set up simultaneous equations using the horizontal and vertical displacement equations.

Answers

i Part A Answers

Q1: (a) $t = 4.04$ s (b) $x = 48.5$ m (c) $v = 42.4$ m/s at 73° below horizontal

Q2: (a) $u_x = 34.6$ m/s (b) $u_y = 20$ m/s (c) $H = 20.4$ m

Q3: (a) $T = 4.08$ s (b) $R = 61.3$ m

Q4: (a) $t = 4.6$ s (b) $x = 65$ m

i Part B Answers

Q5: Gravity only acts vertically, so horizontal motion is unaffected. Horizontal velocity remains constant while vertical motion undergoes constant acceleration.

Q6: (a) Same range - complementary angles give equal range with same initial speed (b) 60° gives greater height - larger vertical component ($u_y = u \sin 60^\circ > u \sin 30^\circ$)

Q7: (a) $t = 0.70$ s and $t = 2.58$ s (b) $x = 13.4$ m and $x = 49.4$ m

Q8: (a) 166 m before target (b) $v = 61.8$ m/s at 61° below horizontal

i Part C Answers

Q9: (a) $t = 1.95$ s (b) $y = 37.1$ m (c) Yes, 37.1 m $>$ 15 m

Q10: (a) $v = 9.5$ m/s (b) $t = 0.98$ s