

Projectiles and relative motion in a plane

AP Physics 1 (algebra-based) · Test answers (mark scheme)

The answers give the expected method and the mark allocation. Award marks for correct reasoning even if an earlier arithmetic slip carries through to the final value.

Level: AP Physics 1 (algebra-based) · **Curriculum:** AP P1 Unit 1

Question 1 Acceleration at the top (1 mark)

It is **9.81 m/s² downward**, the same as everywhere else on the path.

Marking: 1 mark, needs both magnitude and direction.

Question 2 Horizontal velocity (1 mark)

No horizontal force acts (air resistance ignored), so $a_x = 0$ and **v_x is constant**.

Marking: 1 mark for no horizontal force or zero horizontal acceleration.

Question 3 Cliff throw (5 marks)

a. $20 = \frac{1}{2} \times 9.81 \times t^2$, so $t = \sqrt{(40 \div 9.81)} = \mathbf{2.02 \text{ s}}$.

b. $x = 15 \times 2.02 = \mathbf{30 \text{ m}}$.

c. $v_y = 9.81 \times 2.02 = 19.8 \text{ m/s}$; speed = $\sqrt{(15^2 + 19.8^2)} = \mathbf{25 \text{ m/s}}$.

Marking: (a) 1 for the equation, 1 for the answer; (b) 1; (c) 1 for v_y , 1 for the speed.

Question 4 Components (2 marks)

a. $24 \cos 35^\circ = \mathbf{19.7 \text{ m/s}}$.

b. $24 \sin 35^\circ = \mathbf{13.8 \text{ m/s}}$.

Marking: 1 mark each, correct trigonometric function and value.

Question 5 Boat on a river (3 marks)

a. $t = 100 \div 4.0 = \mathbf{25 \text{ s}}$.

b. Drift = $3.0 \times 25 = \mathbf{75 \text{ m}}$.

c. $v = \sqrt{(4.0^2 + 3.0^2)} = \mathbf{5.0 \text{ m/s}}$.

Marking: 1 mark for each part.

Question 6 Kicked ball (4 marks)

a. $v_{y0} = 22 \sin 45^\circ = 15.56 \text{ m/s}$; $T = 2 \times 15.56 \div 9.81 = \mathbf{3.2 \text{ s}}$.

b. $v_x = 15.56 \text{ m/s}$; $R = 15.56 \times 3.172 = \mathbf{49 \text{ m}}$.

Marking: (a) 1 for v_{y0} , 1 for T ; (b) 1 for v_x , 1 for R .

Question 7 Explain the landing (2 marks)

The vertical motion is identical for both balls: each starts with zero vertical velocity and accelerates downward at 9.81 m/s^2 over the same height. Horizontal velocity has no effect on the vertical motion, so the fall time is the same.

Marking: 1 for equal vertical conditions, 1 for independence of the two motions.

Question 8 Equal ranges (2 marks)

The ranges are **equal**. $R = v^2 \sin 2\theta \div g$, and $\sin 60^\circ = \sin 120^\circ$, so the 30° and 60° launches (complementary angles) give the same range.

Marking: 1 for equal, 1 for the reason.