

Independent horizontal and vertical motion of projectiles

Physics grades 11-12 (A Level · IB · Class 11-12) · Test answers (mark scheme)

Marks are given for correct method, substitution and answer with units. Follow-through marks apply when an earlier error is carried into a later part correctly. The marking notes show where each mark is earned.

Level: Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** A Level 3.4

Question 1 Horizontal launch (2 marks)

Horizontal acceleration is **zero**. Vertical acceleration is **9.81 m/s² downwards**.

Marking: 1 mark for each correct value with direction.

Question 2 Rolling off a platform (3 marks)

a. $t = \sqrt{2h \div g} = \sqrt{3.6 \div 9.81} = \mathbf{0.61 \text{ s}}$.

b. $x = 4.0 \times 0.606 = \mathbf{2.4 \text{ m}}$.

Marking: (a) 1 mark for the equation, 1 for the answer; (b) 1 mark.

Question 3 Components (2 marks)

Horizontal: $30 \cos 42^\circ = \mathbf{22.3 \text{ m/s}}$. Vertical: $30 \sin 42^\circ = \mathbf{20.1 \text{ m/s}}$.

Marking: 1 mark for each component.

Question 4 Full trajectory (4 marks)

a. $u_y = 24 \sin 38^\circ = 14.78 \text{ m/s}$; $T = 2 \times 14.78 \div 9.81 = \mathbf{3.01 \text{ s}}$.

b. $u_x = 24 \cos 38^\circ = 18.91 \text{ m/s}$; $R = 18.91 \times 3.012 = \mathbf{57.0 \text{ m}}$.

c. $H = 14.78^2 \div 19.62 = \mathbf{11.1 \text{ m}}$.

Marking: (a) 1 mark for u_y , 1 for T ; (b) 1 mark; (c) 1 mark.

Question 5 Equal ranges (3 marks)

$R = u^2 \sin 2\theta \div g$. For 30° : $\sin 60^\circ = 0.866$. For 60° : $\sin 120^\circ = 0.866$. Both give $R = 324 \times 0.866 \div 9.81 = \mathbf{28.6 \text{ m}}$.

Marking: 1 mark for using the range formula; 1 mark for showing both sines equal; 1 mark for the value.

Question 6 Air resistance (3 marks)

Any three: the range is **shorter**; the maximum height is **lower**; the descent is **steeper** than the climb; the landing speed is smaller than the launch speed; the best launch angle for range is below 45° .

Marking: 1 mark for each valid effect, maximum 3.

Question 7 Velocity at the top (2 marks)

At the top the vertical velocity is zero, but the horizontal velocity is **unchanged**, so the speed equals the horizontal component, which is the least value of the speed.

Marking: 1 mark for vertical component zero; 1 mark for the horizontal component constant and non-zero.

Question 8 Best angle (1 mark)

45° , because $\sin 2\theta = 1$.

Marking: 1 mark.