

Equations of motion for constant acceleration

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

Marks are given for correct equations, correct substitutions and correct answers 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, IB A.1

Question 1 Choosing equations (2 marks)

- a. $v = u + at$.
- b. $s = \frac{1}{2}(u + v)t$.

Marking: 1 mark for each correct equation.

Question 2 Cyclist (3 marks)

- a. $v = u + at = 2.0 + 0.80 \times 10 = \mathbf{10 \text{ m/s}}$.
- b. $s = ut + \frac{1}{2}at^2 = 2.0 \times 10 + 0.5 \times 0.80 \times 100 = 20 + 40 = \mathbf{60 \text{ m}}$.

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

Question 3 Canyon drop (3 marks)

- a. $s = \frac{1}{2}gt^2$, so $t = \sqrt{(2 \times 80 \div 9.81)} = \sqrt{16.31} = \mathbf{4.04 \text{ s}}$.
- b. $v = gt = 9.81 \times 4.04 = \mathbf{39.6 \text{ m/s}}$.

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

Question 4 Bus braking (3 marks)

- a. $a = (0 - 15) \div 5.0 = \mathbf{-3.0 \text{ m/s}^2}$.
- b. Distance = area under the line = $\frac{1}{2} \times 5.0 \times 15 = \mathbf{37.5 \text{ m}}$.

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

Question 5 Thrown ball (3 marks)

- a. $v^2 = u^2 + 2as$ with $v = 0$: $s = 144 \div (2 \times 9.81) = \mathbf{7.34 \text{ m}}$.
- b. Time up = $12 \div 9.81 = 1.223 \text{ s}$, so total = $\mathbf{2.45 \text{ s}}$.

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

Question 6 Top of the flight (2 marks)

The velocity is **zero** but the acceleration is still **9.81 m/s² downwards**. Because the acceleration is not zero, the velocity keeps changing and the ball starts to fall.

Marking: 1 mark for both values; 1 mark for the explanation.

Question 7 Limits of the equations (2 marks)

The equations need **constant acceleration**. As the parachutist speeds up, air resistance increases, so the resultant force and the acceleration change continuously.

Marking: 1 mark for constant acceleration needed; 1 mark for air resistance changing the acceleration.

Question 8 Van overtaking (2 marks)

$v^2 = u^2 + 2as$: $a = (625 - 25) \div 200 = \mathbf{3.0 \text{ m/s}^2}$. $t = (25 - 5.0) \div 3.0 = \mathbf{6.7 \text{ s}}$.

Marking: 1 mark for the acceleration; 1 mark for the time.