1.2 Equations of motion and projectiles (full A.1)

Name: _____ Class: _____ Date: _____ **Total: 28 marks**

KEY WORDS uniformly accelerated motion • terminal speed

Objective

Practise the full guide A.1 toolkit beyond the focus lesson: the four equations of uniformly accelerated motion, choosing the right equation, and projectile motion resolved into components, with the qualitative effects of fluid resistance. Original practice; not an official IB paper.

1 Key knowledge and worked examples

■ Choose the equation by what you know

$$s = \frac{u+v}{2}t \qquad v = u + at \qquad s = ut + \tfrac{1}{2}at^2 \qquad v^2 = u^2 + 2as$$

No time in the problem? Use $v^2 = u^2 + 2as$. No final velocity? Use $s = ut + \frac{1}{2}at^2$. Always state the positive direction first.

■ Projectiles: two independent motions

Horizontal: constant velocity, $x = u_x t$. Vertical: free fall, u_y, $a = -g$. Connect the two motions only through t. Fluid resistance (qualitative): shorter range, steeper descent, terminal speed.

Worked check. A ball rolls off a 0.80 m table at 3.0 m/s: $t = \sqrt{2 \times 0.80/9.8} = 0.404$ s; lands $3.0 \times 0.404 = 1.21$ m away.

2 Practice

2.1 A car accelerates uniformly from 5.0 m/s to 25 m/s over 120 m. Calculate the acceleration. [3]

2.2 A stone is thrown up at 12 m/s. Calculate its maximum height ($g = 9.8\ m/s^2$). [2]

2.3 State the four equations of uniformly accelerated motion. [4]

2.4 A projectile is launched at 20 m/s, 40° above the horizontal. Calculate the horizontal and vertical components of the launch velocity. [2]

2.5 State two qualitative effects of fluid resistance on a projectile's flight. [2]

3 Exam-style questions

3.1 A ball is kicked from level ground at 16 m/s, 30° above the horizontal ($g = 9.8\ m/s^2$). Calculate the time of flight, the maximum height and the range, stating the independence assumption you used. [6]

3.2 A stone is thrown horizontally at 6.0 m/s from a cliff and lands in the sea 4.5 s later. Calculate the cliff height and the stone's speed on impact. [5]

3.3 The same kick as 3.1 is now performed into a strong headwind. Without calculation, describe how the time of flight, trajectory shape and range change, and explain what a falling skydiver's terminal speed tells you about the forces on them. [4]