# 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]