InkMaths

ANSWER BOOK

Kinematics with constant acceleration

Mechanics · Year 12-13

6 questions · 20 marks

NAVY EDITION

SECTION A · Warm-up

A1 Displacement s, initial velocity u, final velocity v, acceleration a, time t. The s-free equation is $v = u + at$. Each of the four equations omits one quantity; choosing by the missing letter is the routine. [2]

A2 $v = u + at = 0 + 12 = 12$ m s^{-1}, and $s = ut + \frac{1}{2}at^2 = \frac{1}{2} \times 2 \times 36 = 36$ m. From rest, the distance is the average speed, 6 m s^{-1}, times the time, which agrees. [3]

SECTION B · Standard

B1 Time is not involved at first, so use $v^2 = u^2 + 2as$: $0 = 900 + 300a$, giving $a = -3$ m s^{-2}, a deceleration of 3 m s^{-2}. Then $v = u + at$ gives $0 = 30 - 3t$, so $t = 10$ s. The negative sign is the physics: the acceleration opposes the motion. [4]

B2 Depth: $s = \frac{1}{2}gt^2 = \frac{1}{2} \times 9.8 \times 6.25 = 30.6$ m. Impact speed: $v = gt = 24.5$ m s^{-1}. 'Dropped' supplies $u = 0$ silently; reading the starting conditions out of the words is half of every kinematics question. [4]

B3 At the top $v = 0$, so $v^2 = u^2 + 2as$ gives $0 = 196 - 19.6s$ and $s = 10$ m. Time to the top is $14/9.8 = 1.43$ s, and by symmetry the whole flight takes twice that: 2.86 s. Taking up as positive makes $a = -9.8$ throughout; the signs then run themselves. [4]

SECTION C · Stretch

C1 $5 = 14t - 4.9t^2$ rearranges to $4.9t^2 - 14t + 5 = 0$, giving $t = 0.418$ s and $t = 2.44$ s. Two roots, two visits: the ball passes 5 m on the way up and again on the way down, and the quadratic knows about both. [3]