InkMaths

ANSWER BOOK

Projectiles

Mechanics · Year 12-13

5 questions · 20 marks

NAVY EDITION

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SECTION A · Warm-up

A1 The horizontal component is constant, since no horizontal force acts; the vertical component changes at g downwards, exactly like free fall. The two motions run independently, sharing nothing but the clock. [2]

A2 Vertically, from rest: $44.1 = \tfrac{1}{2} \times 9.8 \times t^2$, so $t^2 = 9$ and $t = 3$ s. Horizontally: $12 \times 3 = 36$ m. The vertical clock decides the landing; the horizontal motion just spends whatever time it is given. [4]

SECTION B · Standard

B1 Components: up $24.5 \sin 30° = 12.25$ m s^{-1}, across $24.5 \cos 30° = 21.2$ m s^{-1}. Vertically, returning to the ground: $0 = 12.25t - 4.9t^2$, so $t = 12.25/4.9 = 2.5$ s. Range: $21.2 \times 2.5 = 53.0$ m. Resolve once, then run two one-dimensional problems that share t. [5]

B2 At the top the vertical velocity is zero: $0 = 12.25^2 - 2 \times 9.8 \times s$, so $s = 150.0625/19.6 = 7.66$ m. Only the vertical component enters: the ball never stops moving, but its climb does. [4]

SECTION C · Stretch

C1 The components at $t = 0.5$: horizontal still 21.2 m s^{-1}, vertical $12.25 - 4.9 = 7.35$ m s^{-1} upwards. Speed: $\sqrt{(21.2^2 + 7.35^2)} = 22.5$ m s^{-1}, at $\tan^{-1}(7.35/21.2) = 19.1°$ above the horizontal. Velocity questions end with Pythagoras and an angle: the components are working parts, not the answer. [5]