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ANSWER BOOK

Drag and terminal speed

Mechanics · Year 12

AQA 3.4.1.4 · CIE 3.2 · OCR A 3.2.2

9 questions · 27 marks

NAVY EDITION

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SECTION A · Warm-up

A1 Drag (air resistance) acts opposite to the motion; friction acts opposite to the direction of sliding; lift (where present) acts perpendicular to the motion. [2]

A2 The constant maximum speed reached by a falling object when the resultant force on it is zero, so the drag (plus any upthrust) balances its weight and it stops accelerating. [2]

A3 Drag increases as speed increases; at the speeds studied it rises roughly with the square of the speed. [2]

SECTION B · Standard

B1 Drag = 750 N, acting upwards. At terminal speed the resultant force is zero, so the upward drag exactly balances the downward weight. [3]

B2 At terminal speed: weight = upthrust + drag, so drag = 0.30 − 0.05 = 0.25 N. The three forces balance, giving zero resultant force and therefore zero acceleration. [4]

B3 The curve starts steep (acceleration ≈ g) and its gradient decreases as drag grows with speed, levelling off to a horizontal line at the terminal speed where acceleration is zero. [4]

SECTION C · Stretch

C1 Opening the parachute sharply increases the drag, so drag now exceeds weight and the resultant force acts upwards: the parachutist decelerates. As speed falls, drag falls, until drag again equals weight at a new, lower terminal speed. [4]

C2 Drag $\propto v^2$, so doubling the speed multiplies drag by 4: $D = 20 \times (10/5.0)^2 = 80$ N. [3]

C3 Terminal speed is reached when drag equals weight. A heavier skydiver has a larger weight, so a larger drag, and hence a higher speed, is needed to balance it; with the same shape they must fall faster to generate that drag. [3]