

Solutions

2.1 (a) acceleration (b) displacement. *Distance needs the sizes of the areas; displacement uses their signs.*

2.2 (a) $a = \frac{\Delta v}{\Delta t} = \frac{2.0 \text{ m s}^{-1} - 0}{2.0 \text{ s}} = 1.0 \text{ m s}^{-2}$. (b) Areas: $t = 6\text{--}8 \text{ s}$: $\frac{1}{2} \times 2.0 \text{ s} \times 2.0 \text{ m s}^{-1} = +2.0 \text{ m}$; $t = 8\text{--}10 \text{ s}$: $\frac{1}{2} \times 2.0 \text{ s} \times (-2.0 \text{ m s}^{-1}) = -2.0 \text{ m}$; $t = 10\text{--}12 \text{ s}$: $2.0 \text{ s} \times (-2.0 \text{ m s}^{-1}) = -4.0 \text{ m}$. Displacement = $2.0 - 2.0 - 4.0 = -4.0 \text{ m}$. (c) Distance = $|+2.0| + |-2.0| + |-4.0|$ plus the $0\text{--}6 \text{ s}$ area $\frac{1}{2}(4.0 + 6.0) \text{ s} \times 2.0 \text{ m s}^{-1} = 10 \text{ m}$ and the $12\text{--}14 \text{ s}$ triangle $\frac{1}{2} \times 2.0 \text{ s} \times 2.0 \text{ m s}^{-1} = 2.0 \text{ m}$: total $10 + 2.0 + 2.0 + 4.0 + 2.0 = 20 \text{ m}$.

2.3 (a) $s = ut + \frac{1}{2}at^2 = 0 + \frac{1}{2} \times 9.81 \text{ m s}^{-2} \times (0.55 \text{ s})^2 = 1.5 \text{ m}$. (b) Reaction time makes t too long, so $g = 2s/t^2$ comes out too small; use light gates or video with a known frame rate instead.

2.4 No time is given, so $v^2 = u^2 + 2as$. $a = \frac{v^2 - u^2}{2s} = \frac{(20 \text{ m s}^{-1})^2 - (8.0 \text{ m s}^{-1})^2}{2 \times 96 \text{ m}} = \frac{336}{192} \text{ m s}^{-2} = 1.8 \text{ m s}^{-2}$.

3.1 B. Constant acceleration makes velocity change linearly (straight sloped velocity–time line) while displacement follows $s = ut + \frac{1}{2}at^2$ (curved). A is wrong because a straight displacement–time line means constant velocity; C and D mismatch the pair.

3.2 B. The area is a trapezium: $s = \frac{(u+v)}{2}t = \frac{3.0+9.0}{2} \text{ m s}^{-1} \times 4.0 \text{ s} = 24 \text{ m}$. A uses only u ; C multiplies $v \times t$; D doubles correctly counted halves.

3.3 (a) Plot t^2 on the x -axis; $s = \frac{1}{2}gt^2$, so the gradient equals $g/2$ and $g = 2 \times \text{gradient}$. (b) A fixed offset in the distance reading adds the same amount to every s ; it changes the vertical intercept but not the gradient, so $g = 2 \times \text{gradient}$ is unchanged.

3.4 $s = ut + \frac{1}{2}at^2$ with $u = 0$: $a = \frac{2s}{t^2} = \frac{2 \times 9.2 \text{ m}}{(1.4 \text{ s})^2} = 9.4 \text{ m s}^{-2}$. Compare: $\frac{9.4}{9.81} = 0.96 > 0.95$; since the calculated acceleration exceeds $0.95g$, air resistance **can** be ignored.