Exercise walk-through

Kinematics of motion in a straight line ▪ 4.2

eXercise

You must be able to

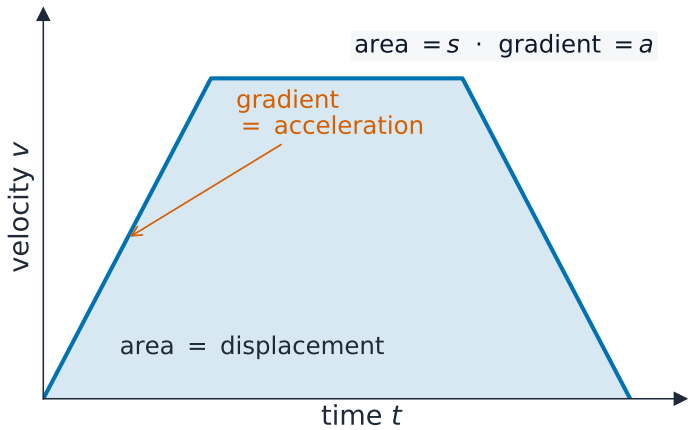
- read displacement (area) and acceleration (gradient) from a v–t graph
- use $v = u + at$, $s = ut + \frac{1}{2}at^2$, $v^2 = u^2 + 2as$
- differentiate/integrate between s, v, a for variable acceleration

Method — Graph & suvat

Car from rest, $a = 2.5$ **m s**$^{-2}$ **for** 4 **s:** $v = 2.5 \times 4 = 10$ m s^{-1}; $s = \frac{1}{2}(2.5)(16) = 20$ m.

Variable: if $s = t^3 - 3t^2$ then $v = \dfrac{ds}{dt} = 3t^2 - 6t$, $a = \dfrac{dv}{dt} = 6t - 6$.

Method — Graph & suvat



A velocity-time graph rising, flat, then falling, with the area shaded

Practice 2.1 ▪ 2 marks

A particle accelerates from 4 m s^{-1} at 3 m s^{-2} for 5 s. Find its final velocity.

Solution 2.1

Method: Graph & suvat

Worked steps

$v = u + at = 4 + 3(5) = 19$ m s^{-1} M1 A1.

Practice 2.2 ▪ 2 marks

A v–t graph is a straight line from $(0, 2)$ to $(6, 14)$. Find the acceleration.

Solution 2.2

Method: Graph & suvat

Worked steps

$$\text{gradient} = \frac{14-2}{6-0} = 2 \text{ m s}^{-2}$$ M1 A1.

Exam-style 3.1 ▪ 1 mark

A stone is dropped from rest. After 3 s its speed is ($g = 10$):

A 10 m s^{-1}

B 20 m s^{-1}

C 30 m s^{-1}

D 45 m s^{-1}

Solution 3.1

A $10\ \text{m s}^{-1}$

B $20\ \text{m s}^{-1}$

C $30\ \text{m s}^{-1}$ ✓

D $45\ \text{m s}^{-1}$

Worked steps

C. $v = u + gt = 0 + 10(3) = 30\ \text{m s}^{-1}$.

Exam-style 3.2 ▪ 3 marks

A car travelling at 30 m s^{-1} brakes with constant deceleration and stops in 75 m.
(a) Find the deceleration.
(b) Find the time taken to stop.

Solution 3.2

Method: Graph & suvat

Worked steps

(a) $v^2 = u^2 + 2as$: $0 = 30^2 + 2a(75)$ M1; $a = -\dfrac{900}{150} = -6$, so deceleration 6 m s^{-2} M1 A1.

(b) $v = u + at$: $0 = 30 - 6t \Rightarrow t = 5$ s M1 A1.

Exam-style 3.3 ▪ 2 marks

A particle moves so that its velocity is $v = 12t - 3t^2$ m s^{-1} at time t s.
(a) Find the time when the particle is instantaneously at rest (other than $t = 0$).
(b) Find the distance travelled in the first 4 seconds.

Solution 3.3

Method: Graph & suvat

Worked steps

(a) $v = 0$: $12t - 3t^2 = 0 \Rightarrow 3t(4 - t) = 0 \Rightarrow t = 4$ s M1 A1.

(b) $v \geqslant 0$ for $0 \leqslant t \leqslant 4$, so distance $= \displaystyle\int_0^4 (12t - 3t^2)\,dt = [6t^2 - t^3]_0^4$ M1 M1;

$= 96 - 64 = 32$ m M1 A1.