WORKED EXAMPLES

EXAMPLE 1

A car starting from rest accelerates uniformly over 8 s to a velocity of 16 m s^{-1}. It then maintains a constant velocity for the next 20 s. It finally decelerates uniformly to rest for 4 s. Draw a velocity-time curve to represent the motion of the car. Use the graph to find

(i) the acceleration and distance travelled by the car in the first 8 s,
(ii) the distance travelled by the car over the next 20 s,
(iii) the deceleration and distance travelled by the car over the last 4 s,
(iv) the average velocity of the car for its entire journey.

EXAMPLE 2

A car travels from A to B. It starts from rest at A and accelerates at 2 m s^{-2} until it reaches a speed of 30 m s^{-1}. It then travels at this speed for 600 m and then decelerates at 2.5 m s^{-2} to come to rest at B. Find

(i) the total time for the journey,
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EXAMPLE 3

A particle P with speed 140 m s^{-1} begins to decelerate uniformly at a certain instant while another particle Q starts from rest 6 s later and accelerates uniformly. When the second particle Q has travelled 125 m, both particles have a speed of 25 m s^{-1}.

(i) Show the motion of both on the same speed-time curve.
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EXAMPLE 4

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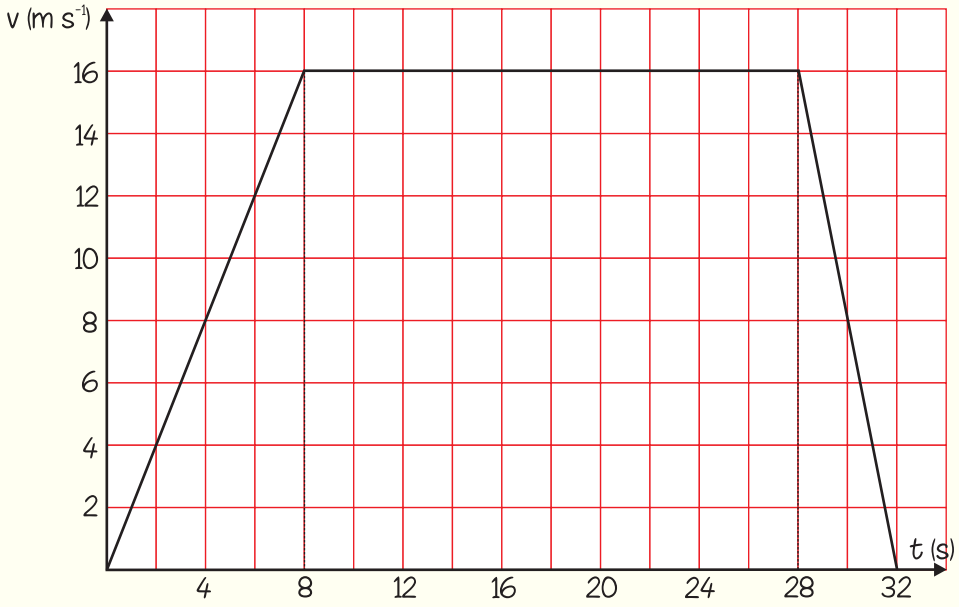
SOLUTION



VELOCITY TIME CURVES
Acceleration = Slope of curve
Distance = Area under curve

CONT....

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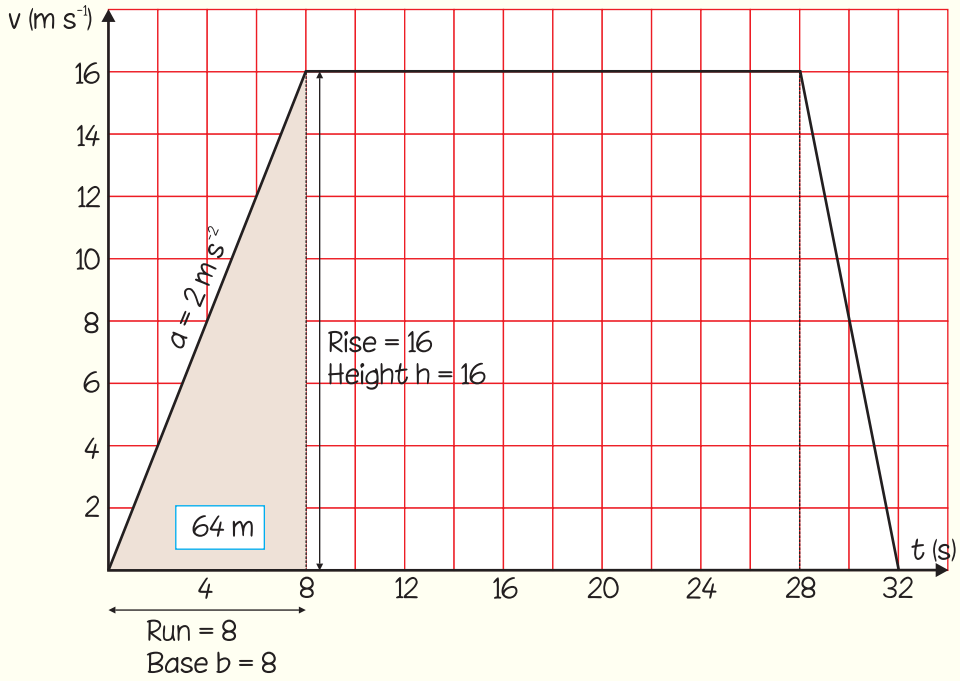

Area of a triangle = $\frac{1}{2}bh$

VELOCITY TIME CURVES

Acceleration a = Slope of curve

Distance s = Area under curve

MATHEMATICAL CALCULATIONS

(i) $a = \dfrac{\text{Rise}}{\text{Run}} = \dfrac{16\ \text{m s}^{-1}}{8\ \text{s}} = 2\ \text{m s}^{-1}$

$s = \frac{1}{2}bh = \frac{1}{2}(8)(16) = 64\ \text{m}$

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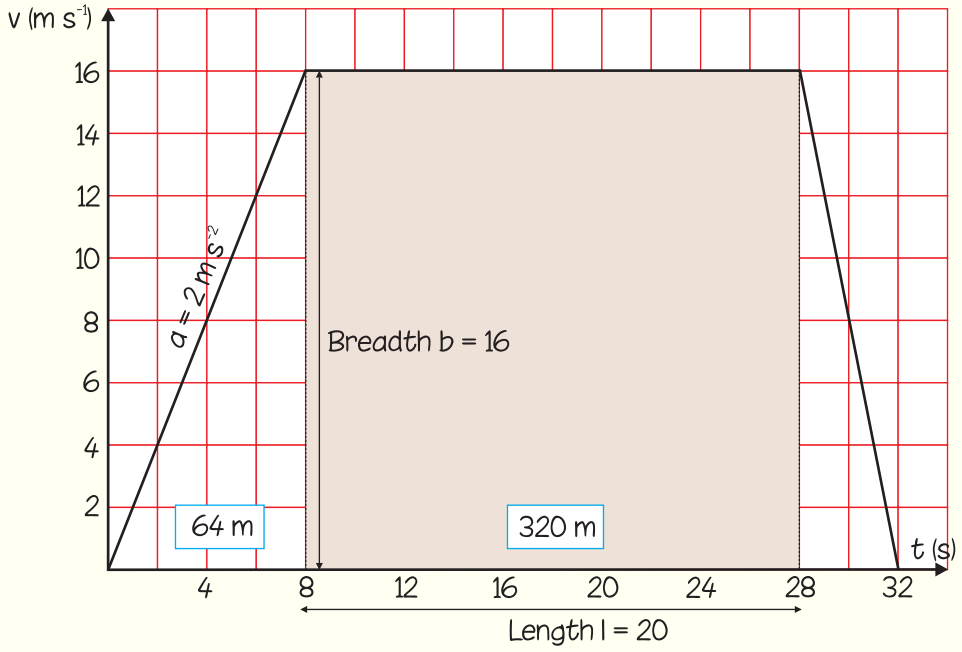

Area of a rectangle = $l \times b$

VELOCITY TIME CURVES

Acceleration a = Slope of curve

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MATHEMATICAL CALCULATIONS

(i) $a = \dfrac{\text{Rise}}{\text{Run}} = \dfrac{16\ \text{m s}^{-1}}{8\ \text{s}} = 2\ \text{m s}^{-1}$

$s = \frac{1}{2}bh = \frac{1}{2}(8)(16) = 64\ \text{m}$

(ii) $s = l \times b = (20)(16) = 320\ \text{m}$

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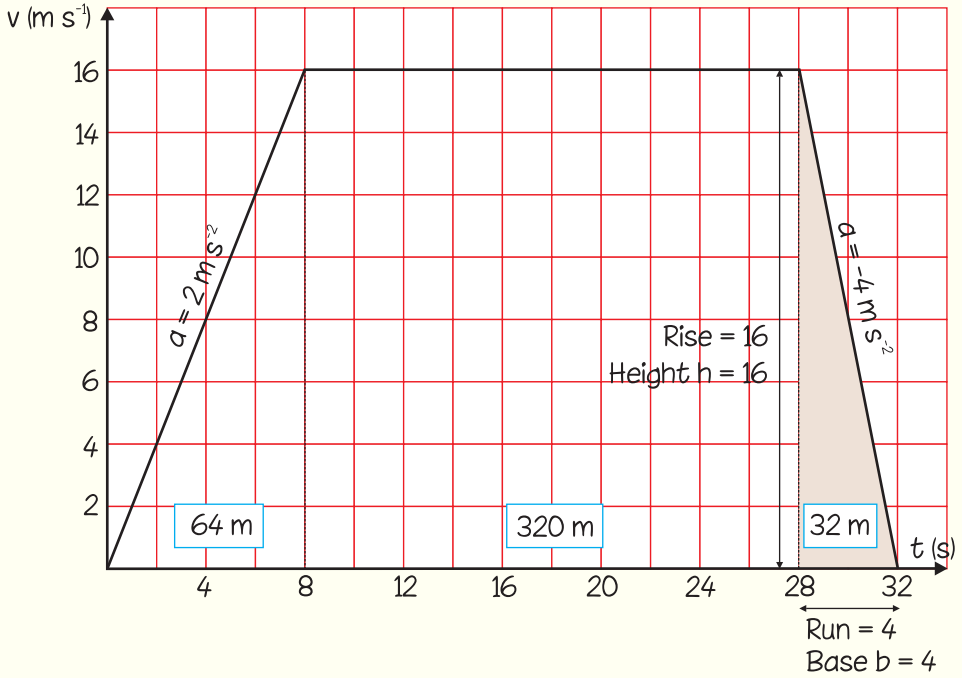

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Acceleration a = Slope of curve

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MATHEMATICAL CALCULATIONS

(i) $a = \dfrac{\text{Rise}}{\text{Run}} = \dfrac{16 \text{ m s}^{-1}}{8 \text{ s}} = 2 \text{ m s}^{-1}$

$s = \frac{1}{2}bh = \frac{1}{2}(8)(16) = 64 \text{ m}$

(ii) $s = l \times b = (20)(16) = 320 \text{ m}$

(iii) $a = \dfrac{\text{Rise}}{\text{Run}} = -\dfrac{16 \text{ m s}^{-1}}{4 \text{ s}} = -4 \text{ m s}^{-1}$

$s = \frac{1}{2}bh = \frac{1}{2}(4)(16) = 32 \text{ m}$

Area of a triangle = $\frac{1}{2}bh$

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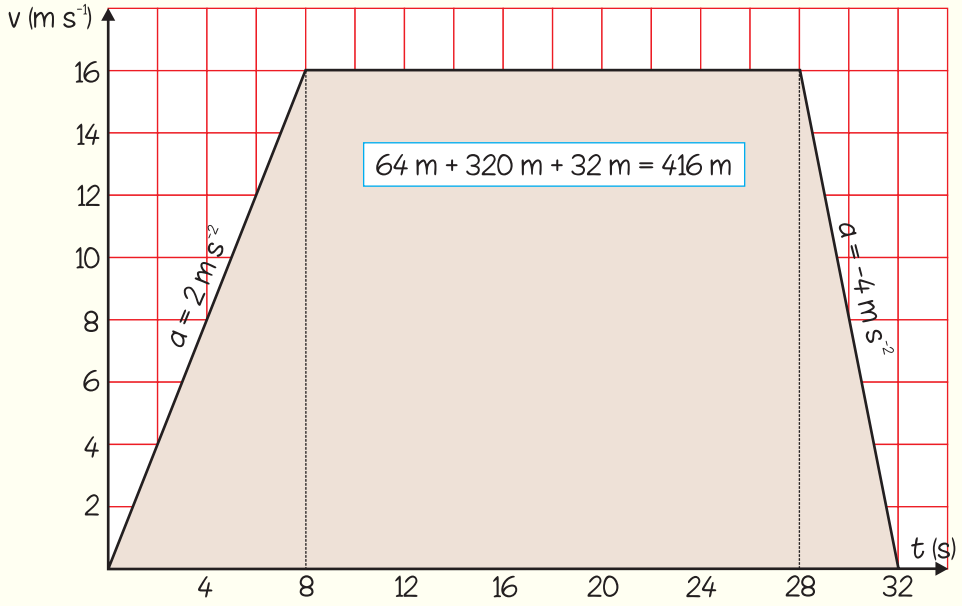

$$\text{Average Velocity} = \frac{\text{Total Distance}}{\text{Total Time}}$$

MATHEMATICAL CALCULATIONS

(iv) Average velocity $= \dfrac{416\text{ m}}{32\text{ s}} = 13\text{ m s}^{-1}$

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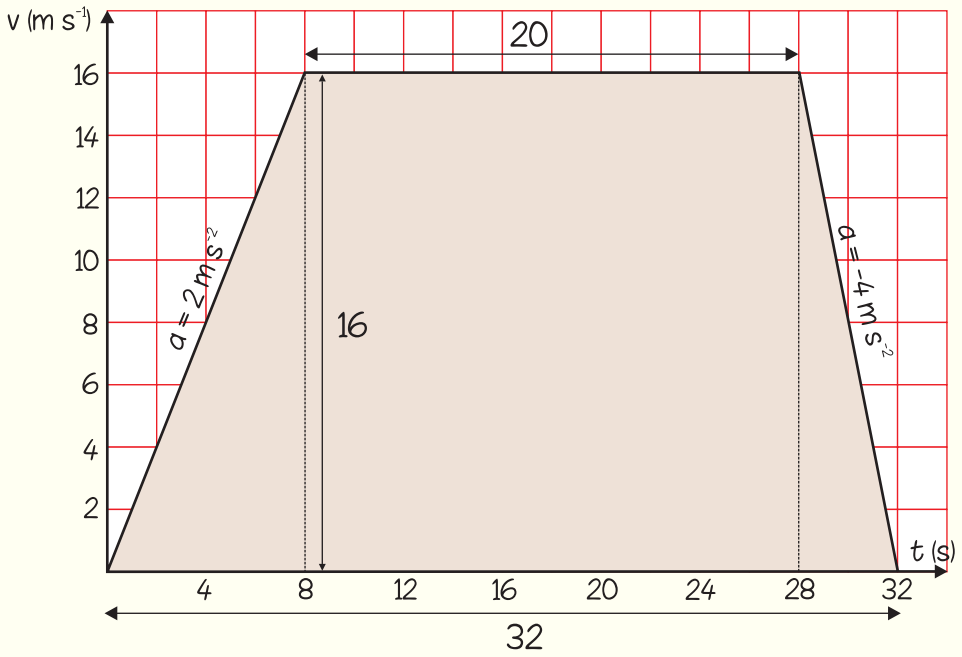
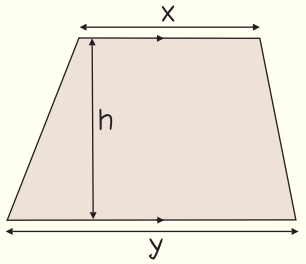


FINDING THE AREA UNDER THE CURVE IN ONE GO:

A **trapezium** is a four sided shape where two of the sides are parallel. The area of a trapezium is half the sum of the parallel sides by the perpendicular distance between them.

$$\text{Area} = \tfrac{1}{2}(x+y)h$$



MATHEMATICAL CALCULATIONS

$$s = \tfrac{1}{2}(20+32)(16) = 416 \text{ m}$$

(iv) Average velocity $= \dfrac{416 \text{ m}}{32 \text{ s}} = 13 \text{ m s}^{-1}$

EXAMPLE 2

A car travels from A to B. It starts from rest at A and accelerates at 2 m s^{-2} until it reaches a speed of 30 m s^{-1}. It then travels at this speed for 600 m and then decelerates at 2.5 m s^{-2} to come to rest at B. Find

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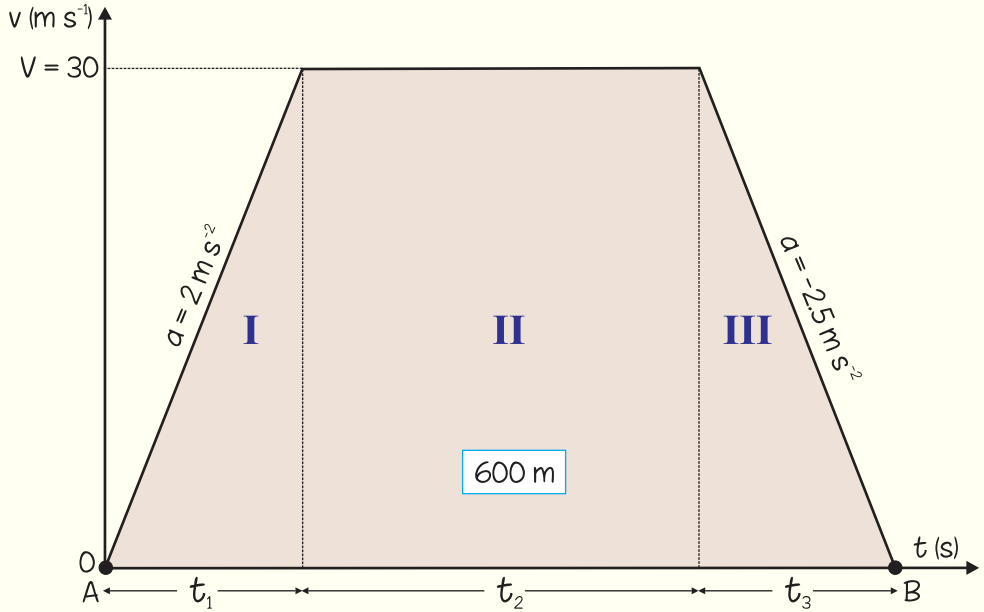

VELOCITY TIME CURVES
Acceleration a = Slope of curve
Distance s = Area under curve

MATHEMATICAL CALCULATIONS

(i) **I** : $a = \frac{V}{t_1} \Rightarrow 2 = \frac{30}{t_1}$

$$t_1 = \frac{30}{2} = 15 \text{ s}$$

II : $s = V \times t_2 \Rightarrow 600 = 30t_2$

$$t_2 = 20 \text{ s}$$

III : $a = \frac{V}{t_3} \Rightarrow 2.5 = \frac{30}{t_3}$

$$t_3 = \frac{30}{2.5} = 12 \text{ s}$$

Total time T = 15 s + 20 s + 12 s = 47 s

Cont.....

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A car travels from A to B. It starts from rest at A and accelerates at 2 m s^{-2} until it reaches a speed of 30 m s^{-1}. It then travels at this speed for 600 m and then decelerates at 2.5 m s^{-2} to come to rest at B. Find

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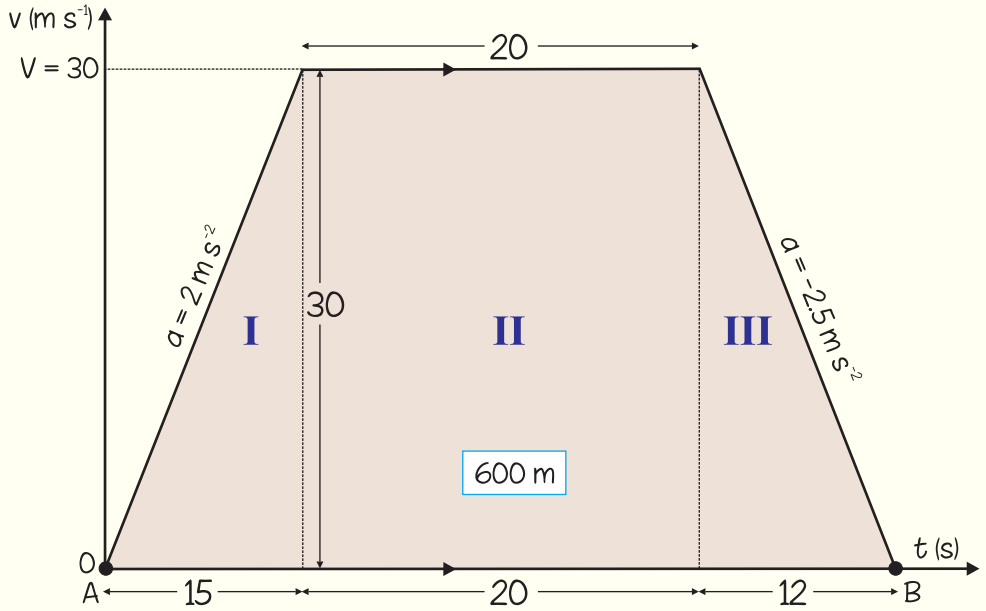

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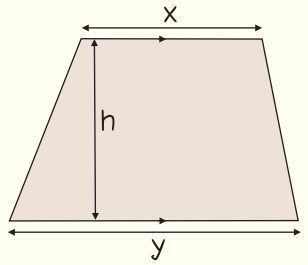

$$\text{Average Velocity} = \frac{\text{Total Distance}}{\text{Total Time}}$$

MATHEMATICAL CALCULATIONS

(ii) $S = \frac{1}{2}(20+47)30 = 1005$ m

(iii) Average velocity $= \dfrac{1005 \text{ m}}{47 \text{ s}} = 21.4 \text{ m s}^{-1}$

EXAMPLE 3

A particle P with speed 140 m s^{-1} begins to decelerate uniformly at a certain instant while another particle Q starts from rest 6 s later and accelerates uniformly. When the second particle Q has travelled 125 m, both particles have a speed of 25 m s^{-1}.

(i) Show the motion of both on the same speed-time curve.

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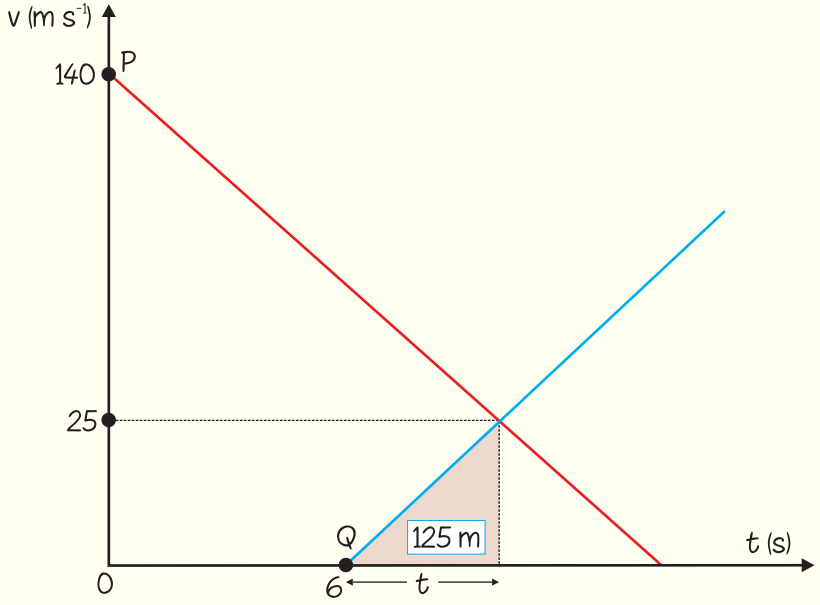

VELOCITY TIME CURVES

Acceleration a = Slope of curve

Distance s = Area under curve

MATHEMATICAL CALCULATIONS

(ii) Particle Q:

$$s = \tfrac{1}{2}bh \Rightarrow 125 = \tfrac{1}{2}t(25)$$

$$t = 10 \text{ s}$$

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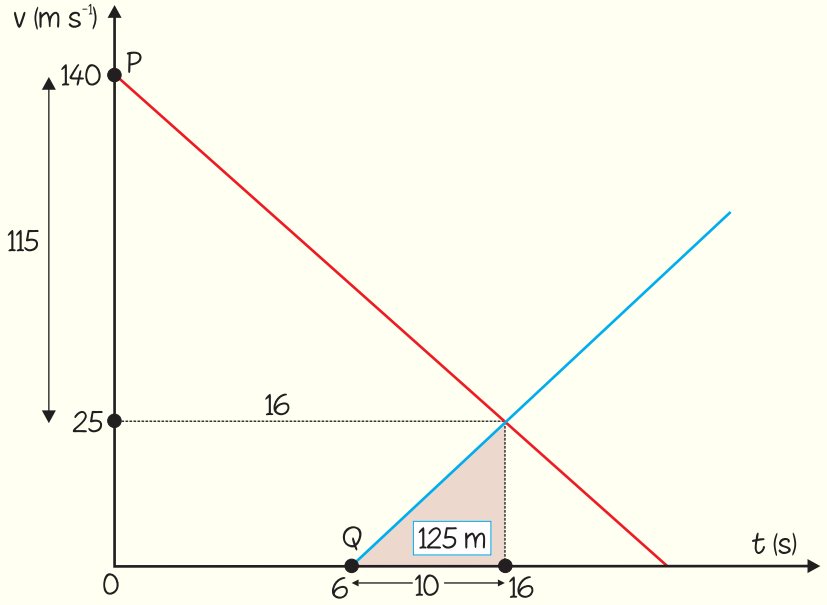

VELOCITY TIME CURVES

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MATHEMATICAL CALCULATIONS

(ii) Particle P:

$$a = \frac{\text{Rise}}{\text{Run}} = -\frac{115}{16} \text{ m s}^{-2}$$

$u = 140 \text{ m s}^{-1}$

$a = -\frac{115}{16} \text{ m s}^{-2}$

$v = 0 \text{ m s}^{-1}$

$t = ?$

$v = u + at$

$0 = 140 + (-\frac{115}{16})t$

$\frac{115}{16}t = 140$

$t = 19.5 \text{ s}$