Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

2 Kinematics in one dimension

Exercise Test yourself, Question 1

Question:

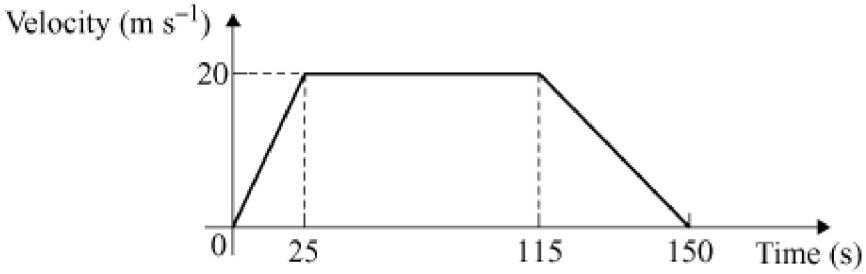
A car accelerates uniformly, along a straight road, from rest to 20 m s^{-1} in 25 seconds. It travels at this speed for 1.5 minutes and then slows down, stopping after a further 35 seconds.

(a) Draw a velocity-time graph and use it to find the total distance travelled by the car.

(b) Calculate the acceleration of the car on each stage of its journey.

Solution:

(a)



$$\text{Distance} = \left[\tfrac{1}{2} \times 25 \times 20\right] + [90 \times 20] + \left[\tfrac{1}{2} \times 35 \times 20\right]$$

$$= 2400 \text{ metres}$$

(b) $$\text{1st part acceleration} = \frac{20}{25}$$

$$= 0.8 \text{ m s}^{-2}$$

2nd part the speed is constant, $\therefore$ acceleration is zero.

$$\text{3rd part acceleration} = \frac{-20}{35}$$

$$= -\frac{4}{7} \text{ m s}^{-2}$$

i.e. a deceleration of $\frac{4}{7}$ m s^{-2}.

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Exercise Test yourself, Question 2

Question:

The velocity of a car increases from 5 m s^{-1} to 25 m s^{-1} as it travels a distance of 100 m. Assume that the acceleration of the car is constant and that the car moves along a straight line.

(a) Find the acceleration of the car.

(b) Find the speed of the car when it has travelled 50 m.

(c) Find the time it takes for the car to travel the 100 m.

Solution:

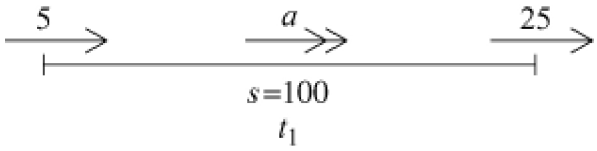
$v^2 = u^2 + 2as$

$25^2 = 5^2 + 2(a)(100)$

(a) $\therefore 25^2 - 5^2 = 200a$

$600 = 200a$

ie $a = 3$ m s^{-2}



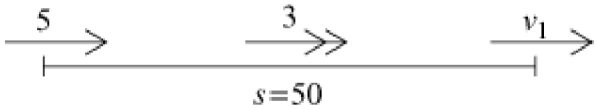
$v^2 = u^2 + 2as$

$v_1^2 = 5^2 + 2(3)(50)$

(b) $v_1^2 = 325$

$\therefore v_1 = \sqrt{325} = 18.027...$

$v_1 = 18.0$ m s^{-1} (3 s.f.)



$s = \frac{(u+v)}{2}t$

(c) $100 = \frac{(5+25)}{2} \times t_1$

$\therefore 100 = 15t_1$

$t_1 = \frac{100}{15} = 6\frac{2}{3}$ seconds

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Exercise Test yourself, Question 3

Question:

A stone is thrown vertically upwards from a height of 2 m above ground level. It reaches a maximum height of 5 m above ground level.

(a) Find the initial velocity of the stone.

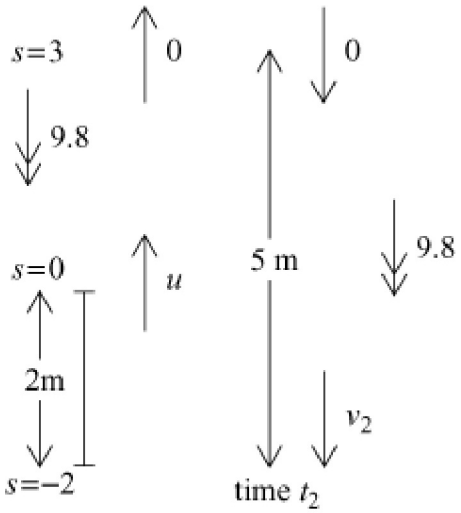
(b) Find the velocity of the stone when it hits the ground.

(c) How long is the stone in the air?

Solution:

(a)

$$\begin{aligned} v^2 &= u^2 + 2as \ , \ \uparrow \\ 0^2 &= u^2 + 2(-9.8)(3) \\ 58.8 &= u^2 \\ \therefore u &= \sqrt{58.8} \\ &= 7.6681... \\ u &= 7.67 \text{ m s}^{-1} \text{ (3 s.f.)} \end{aligned}$$



(b) In downward part of the motion

$$\begin{aligned} v^2 &= u^2 + 2as \ , \ \downarrow \\ v_2^2 &= 0^2 + 2(9.8)(5) \\ v_2^2 &= 98 \\ \therefore v_2 &= \sqrt{98} = 9.8994... \\ v_2 &= 9.90 \text{ m s}^{-1} \text{ (3 s.f.)} \end{aligned}$$

$s = ut + \frac{1}{2}at^2$, $\uparrow$ for whole motion

$-2 = \sqrt{58.8} \times t_2 + \frac{1}{2}(-9.8) \times t_2^2$

(c) $\therefore 4.9t_2^2 - \sqrt{58.8} \times t_2 - 2 = 0$

$t_2 = \frac{-(-\sqrt{58.8}) \pm \sqrt{(-\sqrt{58.8})^2 - 4(4.9)(-2)}}{2 \times 4.9}$

$t_2 = 1.7926...$ or $t = -0.22769$ but time can't be negative

$\therefore t_2 = 1.79$ seconds (3 s.f.)