# Kinematics of motion in a straight line 2

Q1.

A particle travels in a straight line from $A$ to $B$ in 20 s. Its acceleration $t$ seconds after leaving $A$ is $a$ m s$^{-2}$, where $a = \frac{3}{160}t^2 - \frac{1}{800}t^3$. It is given that the particle comes to rest at $B$.

**(i)** Show that the initial speed of the particle is zero. [4]

**(ii)** Find the maximum speed of the particle. [2]

**(iii)** Find the distance $AB$. [4]

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Q2.

A particle $P$ starts from a point $O$ and moves along a straight line. $P$'s velocity $t$ s after leaving $O$ is $v$ m s$^{-1}$, where

$$v = 0.16t^{\frac{3}{2}} - 0.016t^2.$$

$P$ comes to rest instantaneously at the point $A$.

**(i)** Verify that the value of $t$ when $P$ is at $A$ is 100. [1]

**(ii)** Find the maximum speed of $P$ in the interval $0 < t < 100$. [4]

**(iii)** Find the distance $OA$. [3]

**(iv)** Find the value of $t$ when $P$ passes through $O$ on returning from $A$. [2]

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Q3.

A car travels along a straight road with constant acceleration $a$ m s$^{-2}$. It passes through points $A$, $B$ and $C$; the time taken from $A$ to $B$ and from $B$ to $C$ is 5 s in each case. The speed of the car at $A$ is $u$ m s$^{-1}$ and the distances $AB$ and $BC$ are 55 m and 65 m respectively. Find the values of $a$ and $u$. [6]

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Q4.

A particle $P$ is projected vertically upwards, from a point $O$, with a velocity of 8 m s$^{-1}$. The point $A$ is the highest point reached by $P$. Find

**(i)** the speed of $P$ when it is at the mid-point of $OA$, [4]

**(ii)** the time taken for $P$ to reach the mid-point of $OA$ while moving upwards. [2]

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Q5.

The top of a cliff is 40 metres above the level of the sea. A man in a boat, close to the bottom of the cliff, is in difficulty and fires a distress signal vertically upwards from sea level. Find

**(i)** the speed of projection of the signal given that it reaches a height of 5 m above the top of the cliff, [2]

**(ii)** the length of time for which the signal is above the level of the top of the cliff. [2]

The man fires another distress signal vertically upwards from sea level. This signal is above the level of the top of the cliff for $\sqrt{(17)}$ s.

**(iii)** Find the speed of projection of the second signal. [3]

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Q6.

A particle $P$ moves in a straight line. It starts from rest at a point $O$ and moves towards a point $A$ on the line. During the first 8 seconds $P$'s speed increases to $8\,\mathrm{m\,s^{-1}}$ with constant acceleration. During the next 12 seconds $P$'s speed decreases to $2\,\mathrm{m\,s^{-1}}$ with constant deceleration. $P$ then moves with constant acceleration for 6 seconds, reaching $A$ with speed $6.5\,\mathrm{m\,s^{-1}}$.

**(i)** Sketch the velocity-time graph for $P$'s motion. [2]

The displacement of $P$ from $O$, at time $t$ seconds after $P$ leaves $O$, is $s$ metres.

**(ii)** Shade the region of the velocity-time graph representing $s$ for a value of $t$ where $20 \leqslant t \leqslant 26$. [1]

**(iii)** Show that, for $20 \leqslant t \leqslant 26$,

$$s = 0.375t^2 - 13t + 202.$$ [6]

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Q7.

A particle $P$ is projected vertically upwards from a point on the ground with speed $17\,\mathrm{m\,s^{-1}}$. Another particle $Q$ is projected vertically upwards from the same point with speed $7\,\mathrm{m\,s^{-1}}$. Particle $Q$ is projected $T$ seconds later than particle $P$.

**(i)** Given that the particles reach the ground at the same instant, find the value of $T$. [2]

**(ii)** At a certain instant when both $P$ and $Q$ are in motion, $P$ is 5 m higher than $Q$. Find the magnitude and direction of the velocity of each of the particles at this instant. [6]

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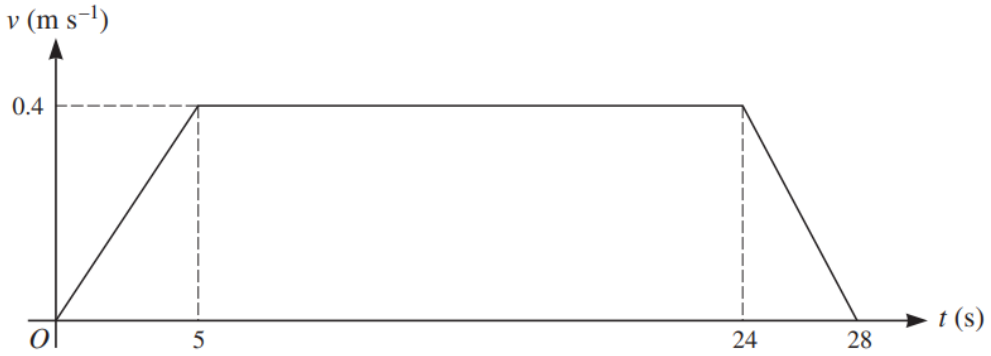
Q8.




An elevator is pulled vertically upwards by a cable. The velocity-time graph for the motion is shown above. Find

**(i)** the distance travelled by the elevator, [2]

**(ii)** the acceleration during the first stage and the deceleration during the third stage. [2]

The mass of the elevator is 800 kg and there is a box of mass 100 kg on the floor of the elevator.

**(iii)** Find the tension in the cable in each of the three stages of the motion. [3]

**(iv)** Find the greatest and least values of the magnitude of the force exerted on the box by the floor of the elevator. [3]

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Q9.

A car travels in a straight line from $A$ to $B$, a distance of 12 km, taking 552 seconds. The car starts from rest at $A$ and accelerates for $T_1$ s at 0.3 m s$^{-2}$, reaching a speed of $V$ m s$^{-1}$. The car then continues to move at $V$ m s$^{-1}$ for $T_2$ s. It then decelerates for $T_3$ s at 1 m s$^{-2}$, coming to rest at $B$.

**(i)** Sketch the velocity-time graph for the motion and express $T_1$ and $T_3$ in terms of $V$. [3]

**(ii)** Express the total distance travelled in terms of $V$ and show that $13V^2 - 3312V + 72\,000 = 0$. Hence find the value of $V$. [5]

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