1. June/2023/Paper_9709/41/No.2

A particle P of mass 0.4 kg is projected vertically upwards from horizontal ground with speed 10 m s^{-1}.

(a) Find the greatest height above the ground reached by P. [2]

When P reaches the ground again, it bounces vertically upwards. At the first instant that it hits the ground, P loses 7.2 J of energy.

(b) Find the time between the first and second instants at which P hits the ground. [4]

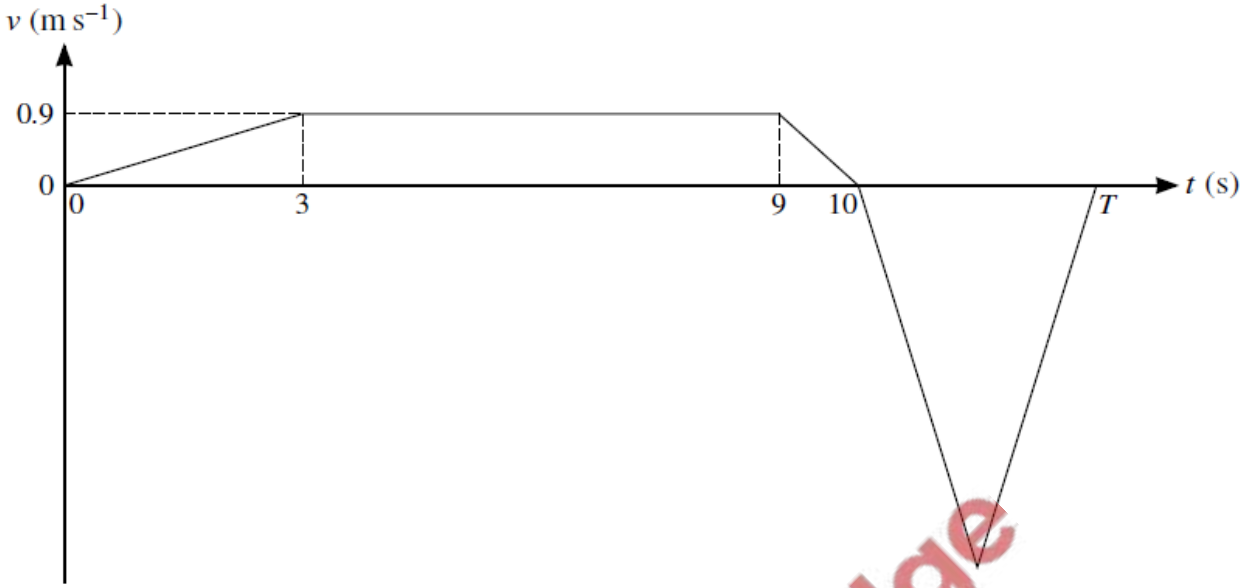
2. June/2023/Paper_9709/41/No.3

A particle moves in a straight line starting from rest. The displacement s m of the particle from a fixed point O on the line at time t s is given by

$$s = t^{\frac{5}{2}} - \frac{15}{4}t^{\frac{3}{2}} + 6.$$

Find the value of s when the particle is again at rest. [4]

3. June/2023/Paper_9709/41/No.4



The velocity of a particle at time t s after leaving a fixed point O is v m s^{-1}. The diagram shows a velocity-time graph which models the motion of the particle. The graph consists of 5 straight line segments. The particle accelerates to a speed of 0.9 m s^{-1} in a period of 3 s, then travels at constant speed for 6 s, and then comes instantaneously to rest 1 s later. The particle then moves back and returns to rest at O at time T s.

(a) Find the distance travelled by the particle in the first 10 s of its motion. [2]

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(b) Given that $T = 12$, find the minimum velocity of the particle. [2]

(c) Given instead that the greatest speed of the particle is $3\,\text{m s}^{-1}$, find the value of T and hence find the average speed of the particle for the whole of the motion. [4]

4. June/2023/Paper_9709/42/No.6

A particle P starts at rest and moves in a straight line from a point O. At time t s after leaving O, the velocity of P, v m s^{-1}, is given by $v = bt + ct^{\frac{3}{2}}$, where b and c are constants. P has velocity 8 m s^{-1} when $t = 4$ and has velocity 13.5 m s^{-1} when $t = 9$.

(a) Show that $b = 3$ and $c = -0.5$. [1]

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(b) Find the acceleration of P when $t = 1$. [2]

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(c) Find the positive value of t when P is at instantaneous rest and find the distance of P from O at this instant. [5]

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(d) Find the speed of P at the instant it returns to O. [3]

5. June/2023/Paper_9709/43/No.5

A particle starts from rest from a point O and moves in a straight line. The acceleration of the particle at time t s after leaving O is $a\,\text{m s}^{-2}$, where $a = kt^{\frac{1}{2}}$ for $0 \leqslant t \leqslant 9$ and where k is a constant. The velocity of the particle at $t = 9$ is $1.8\,\text{m s}^{-1}$.

(a) Show that $k = 0.1$. [3]

For $t > 9$, the velocity $v\,\text{m s}^{-1}$ of the particle is given by $v = 0.2(t - 9)^2 + 1.8$.

(b) Show that the distance travelled in the first 9 seconds is one tenth of the distance travelled between $t = 9$ and $t = 18$. [4]

(c) Find the greatest acceleration of the particle during the first 10 seconds of its motion. [3]

6. June/2023/Paper_9709/43/No.6

An elevator is pulled vertically upwards by a cable. The elevator accelerates at $0.4\,m\,s^{-2}$ for 5 s, then travels at constant speed for 25 s. The elevator then decelerates at $0.2\,m\,s^{-2}$ until it comes to rest.

(a) Find the greatest speed of the elevator and hence draw a velocity-time graph for the motion of the elevator. [3]

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(b) Find the total distance travelled by the elevator. [2]

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The mass of the elevator is 1200 kg and there is a crate of mass m kg resting on the floor of the elevator.

(c) Given that the tension in the cable when the elevator is decelerating is 12 250 N, find the value of m. [3]

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(d) Find the greatest magnitude of the force exerted on the crate by the floor of the elevator, and state its direction. [3]

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