

Topic X4 Mechanics (Pre-TT A) [51]

Based on chapters 19-20

1.

A man travels 360 m along a straight road. He walks for the first 120 m at 1.5 m s^{-1} , runs the next 180 m at 4.5 m s^{-1} , and then walks the final 60 m at 1.5 m s^{-1} . The man's displacement from his starting point after t seconds is x metres.

- (i) Sketch the (t, x) graph for the journey, showing the values of t for which $x = 120, 300$ and 360 . [5]

A woman jogs the same 360 m route at constant speed, starting at the same instant as the man and finishing at the same instant as the man.

- (ii) Draw a dotted line on your (t, x) graph to represent the woman's journey. [1]
(iii) Calculate the value of t at which the man overtakes the woman. [5]

(Total 11 marks)

2.

A swimmer C swims with velocity $v \text{ m s}^{-1}$ in a swimming pool. At time t s after starting, $v = 0.006t^2 - 0.18t + k$, where k is a constant. C swims from one end of the pool to the other in 28.4 s.

- (i) Find the acceleration of C in terms of t . [2]
(ii) Given that the minimum speed of C is 0.65 m s^{-1} , show that $k = 2$. [5]
(iii) Express the distance travelled by C in terms of t , and calculate the length of the pool. [5]

(Total 12 marks)

3.

A man drives a car on a horizontal straight road. At $t = 0$, where the time t is in seconds, the car runs out of petrol. At this instant the car is moving at 12 m s^{-1} . The car decelerates uniformly, coming to rest when $t = 8$. The man then walks back along the road at 0.7 m s^{-1} until he reaches a petrol station a distance of 420 m from his car. After his arrival at the petrol station it takes him 250 s to obtain a can of petrol. He is then given a lift back to his car on a motorcycle. The motorcycle starts from rest and accelerates uniformly until its speed is 20 m s^{-1} ; it then decelerates uniformly, coming to rest at the stationary car at time $t = T$.

- (i) Sketch the shape of the (t, v) graph for the man for $0 \leq t \leq T$. [Your sketch need not be drawn to scale; numerical values need not be shown.] [5]
(ii) Find the deceleration of the car for $0 < t < 8$. [2]
(iii) Find the value of T . [4]

(Total 11 marks)

4.

A car is moving along a straight horizontal road with constant acceleration. There are three points A , B and C , in that order, on the road, where $AB = 22$ m and $BC = 104$ m. The car takes 2 s to travel from A to B and 4 s to travel from B to C .

Find

- (i) the acceleration of the car,
- (ii) the speed of the car at the instant it passes A .

(7)

(Total 7 marks)

5.

Two particles A and B are projected vertically upwards from horizontal ground at the same instant. The speeds of projection of A and B are 7 m s^{-1} and 10.5 m s^{-1} respectively.

- (i) Write down expressions for the heights above the ground of A and B at time t seconds after projection. [1]
- (ii) Hence find a simplified expression for the difference in the heights of A and B at time t seconds after projection. [1]
- (iii) Find the difference in the heights of A and B when A is at its maximum height. [3]

At the instant when B is 3.5 m above A , find

- (iv) whether A is moving upwards or downwards, [3]
- (v) the height of A above the ground. [2]

(Total 10 marks)