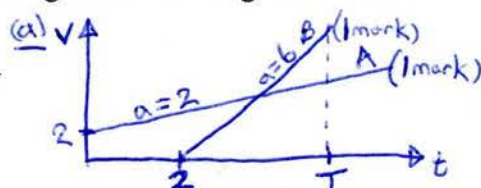


1. Two cyclists, A and B , are cycling along the same straight horizontal track.

The cyclists are modelled as particles and the motion of the cyclists is modelled as follows:

- At time $t = 0$, cyclist A passes through the point O with speed 2 m s^{-1}
- Cyclist A is moving in a straight line with constant acceleration 2 m s^{-2}
- At time $t = 2$ seconds, cyclist B starts from rest at O
- Cyclist B moves with constant acceleration 6 m s^{-2} along the same straight line and in the same direction as cyclist A
- At time $t = T$ seconds, B overtakes A at the point X

Using the model,



(a) sketch, on the **same** axes, for the interval from $t = 0$ to $t = T$ seconds,

- a velocity-time graph for the motion of A
- a velocity-time graph for the motion of B

(2)

(b) explain why the two graphs must cross before time $t = T$ seconds,

(b) At time T , both cyclists have travelled the same distance, so area under each graph is the same. When graphs cross, area under B is less than area under A (1 mark)

(c) find the time when A and B are moving at the same speed, (2)

(d) find the distance OX

(c) for A , $v = u + at$
 $v = 2 + 2t$
 for B , $v = u + at$
 $v = 0 + 6(t - 2)$

Handwritten note: "t for B = t for A - 2"

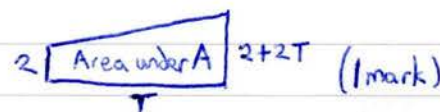
is the same. When graphs cross, area under B is less than area under A (1 mark)

(5)

(c) contd when velocities are the same, $2 + 2t = 6(t - 2)$ (1 mark)
 $\Rightarrow t = \frac{10}{4} = 2.5 \text{ s}$ (1 mark)

(d) A & B cross when distances are the same \Rightarrow areas are the same
 we need heights = velocities at time T for areas

velocity of A at time T , $V_{AT} = 2 + 2T$
 Area under $A = \frac{2 + (2 + 2T)}{2} \times T = 2T + T^2$



velocity of B at time T , $V_{BT} = 0 + 6(T - 2)$
 Area under $B = \frac{1}{2} \times (T - 2) \times 6(T - 2) = 3T^2 - 12T + 12$



For equal areas, $2T + T^2 = 3T^2 - 12T + 12 \Rightarrow 2T^2 - 14T + 12 = 0$ (1 mark)

$\Rightarrow T^2 - 7T + 6 = 0 \Rightarrow (T - 1)(T - 6) = 0 \Rightarrow T = 1, 6$, but only $T = 6$ is meaningful (1 mark)

Substituting $T = 6$ into Area under $A = 2(6) + 6^2 = 48 \text{ m}$ (2 marks) | ($T = 1$ leads to negative area)