

12Ma Mechanics Mini Test 01

Vectors and Kinematics (Graphs)

Question 1

$OACB$ is a parallelogram. O is the origin, A has coordinates $(5, 6)$ and B has position vector $\mathbf{b} = -2\mathbf{i} - 7\mathbf{j}$.

(a) Find the coordinates of point C .

$$\textcircled{a} \quad \vec{OA} + \vec{AC} = \vec{OC}$$

$$\vec{AC} = \vec{OB} = \begin{pmatrix} -2 \\ -7 \end{pmatrix}$$

[3]

$$\vec{OA} = \begin{pmatrix} 5 \\ 6 \end{pmatrix}$$

[3]

$$\vec{OC} = \vec{OA} + \vec{AC}$$

[2]

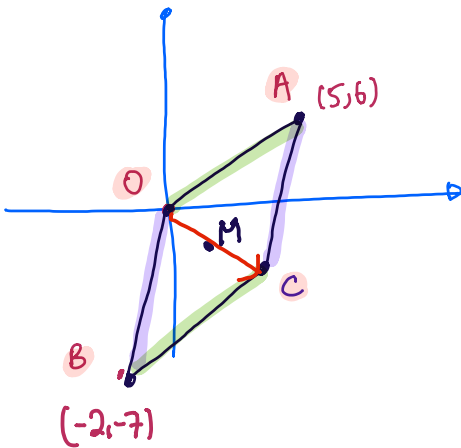
$$\vec{OC} = \begin{pmatrix} 5 \\ 6 \end{pmatrix} + \begin{pmatrix} -2 \\ -7 \end{pmatrix}$$

$$\vec{OC} = \begin{pmatrix} 3 \\ -1 \end{pmatrix}$$

M is the midpoint of \overline{AB} .

(b) Prove that $\vec{OM} = \vec{MC}$.

(c) Find the exact distance $|\vec{MC}|$.



$$\textcircled{b} \quad \vec{AB} = \vec{AO} + \vec{OB}$$

$$= \begin{pmatrix} -5 \\ -6 \end{pmatrix} + \begin{pmatrix} -2 \\ -7 \end{pmatrix} = \begin{pmatrix} -7 \\ -13 \end{pmatrix}$$

$$\vec{OM} = \vec{OA} + \frac{1}{2}\vec{AB}$$

$$= \vec{OA} + \vec{AM} = \begin{pmatrix} 5 \\ 6 \end{pmatrix} + \frac{1}{2}\begin{pmatrix} -7 \\ -13 \end{pmatrix}$$

$$\vec{OM} = \begin{pmatrix} 1.5 \\ -0.5 \end{pmatrix}$$

$$\vec{MC} = \vec{MO} + \vec{OC}$$

$$= \begin{pmatrix} -1.5 \\ 0.5 \end{pmatrix} + \begin{pmatrix} 3 \\ -1 \end{pmatrix}$$

$$= \begin{pmatrix} 1.5 \\ -0.5 \end{pmatrix}$$

$$\vec{OM} = \vec{MC} \text{ as required.}$$

\textcircled{c}

$$\sqrt{1.5^2 + (-0.5)^2} = \frac{\sqrt{10}}{2}$$

Question 2

A car and a motorcycle are at rest adjacent to one another at a set of traffic lights on a long straight stretch of road. They set off simultaneously at time $t = 0$. The car accelerates uniformly at 6 ms^{-2} until it reaches a speed of 30 ms^{-1} which it then maintains. The motorcycle accelerates uniformly for 9 seconds until it reaches 36 ms^{-1} and then remains at this speed.

- (a) Find the acceleration of the motorcycle.

$$a = 4 \text{ ms}^{-2} //$$

[1]

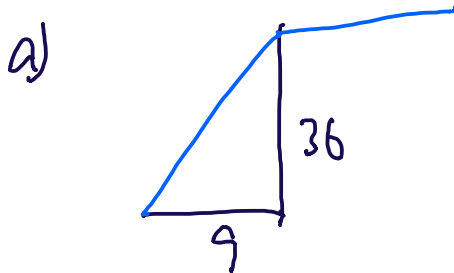
- (b) Draw on the same speed-time graphs to illustrate the movement of both vehicles.

[4]

- (c) Find the value of t when the car again draws level with the motorcycle.

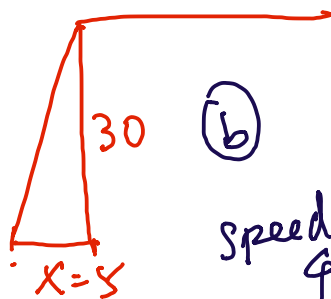
[7]

↳ distance travelled is the same



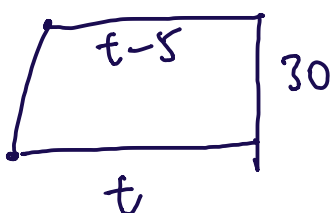
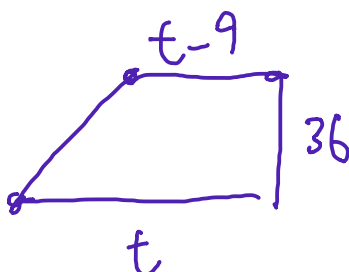
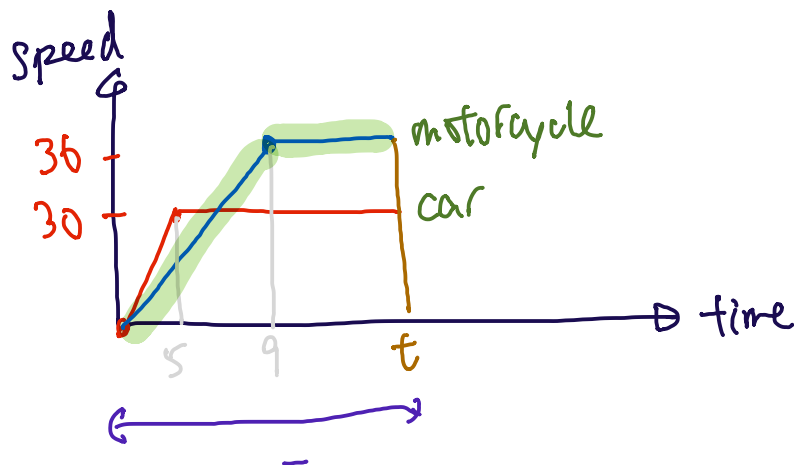
$$a = \frac{36}{9} = 4 \text{ ms}^{-2}$$

motorcycle



(b)

$$a = \frac{30}{x} = 6 \quad x = 5 \quad \text{car}$$



$$\left(\frac{t-9+t}{2} \right) (36) = \left(\frac{t-5+t}{2} \right) (30)$$

$$36(2t-9) = 30(2t-5)$$

$$72t - 324 = 60t - 150$$

$$12t = 174$$

$$t = 14.5 \text{ seconds}$$