Pearson Edexcel A Level Mathematics 9MA0

Mechanics – Further Kinematics

Time allowed: 45 **minutes**

School: www.CasperYC.club

Name:

Teacher:

Question	Points	Score
1	9	
2	6	
3	12	
4	11	
5	12	
Total:	50	

How I can achieve better:

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Last updated: January 11, 2026

1. The position of a particle is $\mathbf{r}$ metres. Initially $\mathbf{r} = \mathbf{i}$.

   The velocity of the particle at time t seconds is v m/s where $\mathbf{v} = t\mathbf{i} + 3t^2\mathbf{j}$.

   (a) Find $\mathbf{r}$ in terms of t. [3]

   (b) Find the acceleration of the particle when $t = 4$. [4]

   (c) Find the position of the particle when it is 1 m from the x-axis. [2]

   Total: 9

2. The position, $\mathbf{r}$, of a planet orbiting a star at time t is given by $\mathbf{r} = \begin{pmatrix} \cos(2t) \\ \sin(2t) \end{pmatrix}$.

   (a) Find the velocity $\mathbf{v}$ and acceleration $\mathbf{a}$ of the planet in terms of t. [3]

   (b) Show that $\mathbf{a} = -4\mathbf{r}$. [1]

   (c) Sketch the trajectory of the particle and draw arrows showing its velocity and acceleration when $t = 0$. [2]

Total: 6

3. A ball falling vertically through viscous fluid is subject to a drag force of magnitude kv N, where v m/s is the speed of the ball at time t seconds. The mass of the ball is 1 kg.

   (a) Draw a force diagram showing the forces on the ball. [2]

   (b) Find an expression for v when the ball is in equilibrium. [2]

   (c) Explain why $\dfrac{\mathrm{d}v}{\mathrm{d}t} = g - kv$ [3]

   (d) Show, by substitution, that [3]

   $$v = \frac{g}{k}\left(1 - \mathrm{e}^{-kt}\right)$$

   satisfies this equation in part (c).

   (e) Explain why this solution agrees with your answer to part (b). [1]

   (f) Describe one limitation of this model. [1]

Total: 12

4. A car travels along a long, straight road for one hour, starting from rest.

   After t hours, its acceleration is a km/h^2, where $a = 180 - 360t$.

   (a) Find the speed of the car, in km/h in terms of t. [2]

   The speed limit is 40 km/h.

   (b) Find the range of times during which the car is breaking the speed limit. [4]

   Give your answer in minutes.

   (c) Find the average speed of the car over the whole journey. [5]

Total: 11

5. At time t seconds, a 2 kg particle experiences a force $\mathbf{F}$ N, where

$$\mathbf{F} = \begin{pmatrix} 8 \\ 4 \end{pmatrix} t + \begin{pmatrix} 6 \\ -12 \end{pmatrix} t^2.$$

(a) Find the acceleration of the particle at time t seconds. [3]

The particle is initially at rest at the origin.

(b) Find the position of the particle at time t seconds. [6]

(c) Find the particle's velocity when $t = 1$. [3]

Total: 12