Write your name here

Surname	Other Names

AS/A Level Mathematics

Kinematics with Calculus

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

• Use **black** ink or ball-point pen.
• If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
• **Fill in the boxes** at the top of this page with your name.
• Answer **all** questions and ensure that your answers to parts of questions are clearly labelled..
• Answer the questions in the spaces provided
– there may be more space than you need.
• You should show sufficient working to make your methods clear.
Answers without working may not gain full credit.
• Answers should be given to three significant figures unless otherwise stated.

Information

• The marks for **each** question are shown in brackets
– use this as a guide as to how much time to spend on each question.

Advice

• Read each question carefully before you start to answer it.
• Try to answer every question.
• Check your answers if you have time at the end.

1 After t seconds, a particle P has position vector

$$\mathbf{r} = [(3t^3 - t + 3)\mathbf{i} + (2t^2 + 2t - 1)\,\mathbf{j}] \text{ m}$$

(a) Find an expression for the velocity of P in terms of t **(2)**

(b) Find an expression for the acceleration of P in terms of t **(2)**

(Total for question 1 is 4 marks)

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2 After t seconds, a particle P has position vector

$$\mathbf{r} = [(t^2 + 5t - 2)\mathbf{i} + (t^3 + 2t^2)\,\mathbf{j}] \text{ m}$$

(a) Find the displacement of P when $t = 2$ **(2)**

(b) Find the velocity of P when $t = 3$ **(3)**

(Total for question 2 is 5 marks)

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3 After t seconds, a particle has position vector

$$\mathbf{r} = [(3t^2 - 4)\mathbf{i} + (2t^2 + 12t)\,\mathbf{j}] \text{ m}$$

(a) Find the time at which the particle is travelling on a bearing of 045° **(4)**

(b) Find the magnitude of the acceleration of the particle. **(4)**

(Total for question 3 is 8 marks)

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4 A particle P has acceleration $[(3t^2 - 4)\mathbf{i} + (2t^2 + 4t)\,\mathbf{j}]$ ms^{-2} where t is the time in seconds.

When $t = 3$ the velocity of the particle is $(10\mathbf{i} + 20\mathbf{j})$ ms^{-1}

(a) Find an expression for the velocity of P in terms of t **(4)**

Initially the particle is at the point with position vector $(2\mathbf{i} - 5\mathbf{j})$

(b) Find an expression for the displacement of P in terms of t **(4)**

(Total for question 4 is 8 marks)

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5 A particle P has acceleration $[(3t - 3)\mathbf{i} + (2t - 4)\mathbf{j}]$ ms^{-2} where t is the time in seconds.

Initially P has velocity $(-4\mathbf{i} + 4\mathbf{j})$ ms^{-1}

(a) Find an expression for the velocity of P in terms of t **(3)**

(b) Find the velocities at the two times P is moving parallel to the vector $(2\mathbf{i} + \mathbf{j})$ **(5)**

(Total for question 5 is 8 marks)