

Topic Test

Summer 2022

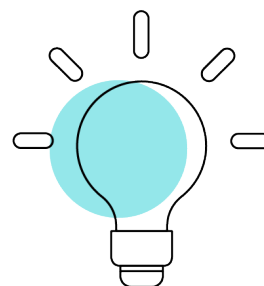
Pearson Edexcel GCE Mathematics (9MA0)

Paper 3 – Mechanics

Topic 2: Kinematics – Variable Acceleration

Contents

<u>General guidance to Topic Tests</u>	<u>3</u>
<u>Revise Revision Guide content coverage</u>	<u>4</u>
<u>Questions</u>	<u>5</u>
<u>Mark Scheme</u>	<u>16</u>



Mark Scheme

Question T2_Q1

Question		Scheme	Marks	AO
1(a)		Differentiate $\mathbf{v}$	M1	1.1a
		$(\mathbf{a} =) 6\mathbf{i} - \frac{15}{2}t^{\frac{1}{2}}\mathbf{j}$	A1	1.1b
		$= 6\mathbf{i} - 15\mathbf{j} \text{ (m s}^{-2}\text{)}$	A1	1.1b
			(3)	
1(b)		Integrate $\mathbf{v}$	M1	1.1a
		$(\mathbf{r} =)(\mathbf{r}_0) + 3t^2\mathbf{i} - 2t^{\frac{5}{2}}\mathbf{j}$	A1	1.1b
		$= (-20\mathbf{i} + 20\mathbf{j}) + (48\mathbf{i} - 64\mathbf{j}) = 28\mathbf{i} - 44\mathbf{j} \text{ (m)}$	A1	2.2a
			(3)	
			(6)	
Marks		Notes		
		N.B. Accept column vectors throughout and condone missing brackets in working but they must be there in final answers		
1a	M1	Use of $\mathbf{a} = \frac{d\mathbf{v}}{dt}$ with attempt to differentiate (both powers decreasing by 1) M0 if $\mathbf{i}$'s and $\mathbf{j}$'s omitted and they don't recover		
	A1	Correct differentiation in any form		
	A1	Correct and simplified. Ignore subsequent working (ISW) if they go on and find the magnitude.		
1b	M1	Use of $\mathbf{r} = \int \mathbf{v} dt$ with attempt to integrate (both powers increasing by 1) M0 if $\mathbf{i}$'s and $\mathbf{j}$'s omitted and they don't recover		
	A1	Correct integration in any form. Condone $\mathbf{r}_0$ not present		
	A1	Correct and simplified.		

Question T2_Q2

Question	Scheme		Marks	AOs
3(i)(a)	Integrate a wrt t to obtain velocity		M1	3.4
	$\mathbf{v} = (t - 2t^2)\mathbf{i} + \left(3t - \frac{1}{3}t^3\right)\mathbf{j} (+\mathbf{C})$		A1	1.1b
	$8\mathbf{i} - \frac{28}{3}\mathbf{j} \text{ (m s}^{-1}\text{)}$		A1	1.1b
			(3)	
3(i)(b)	Equate i component of v to zero		M1	3.1a
	$t - 2t^2 + 36 = 0$		A1ft	1.1b
	$t = 4.5$ (ignore an incorrect second solution)		A1	1.1b
			(3)	
3(ii)	Differentiate r wrt to t to obtain velocity		M1	3.4
	$\mathbf{v} = (2t - 1)\mathbf{i} + 3\mathbf{j}$		A1	1.1b
	Use magnitude to give an equation in t only		M1	2.1
	$(2t - 1)^2 + 3^2 = 5^2$		A1	1.1b
	Solve problem by solving this equation for t		M1	3.1a
	$t = 2.5$		A1	1.1b
			(6)	
(12 marks)				
Notes: Accept column vectors throughout				
3(i)(a)	M1	At least 3 terms with powers increasing by 1 (but M0 if clearly just multiplying by t)		
	A1	Correct expression		
	A1	Accept $8\mathbf{i} - 9.3\mathbf{j}$ or better. Isw if speed found.		
3(i)(b)	M1	Must have an equation in t only (Must have integrated to find a velocity vector)		
	A1ft	Correct equation follow through on their v but must be a 3 term quadratic		
	A1	cao		
3(ii)	M1	At least 2 terms with powers decreasing by 1 (but M0 if clearly just dividing by t)		
	A1	Correct expression		
	M1	Use magnitude to give an equation in t only, must have differentiated to find a velocity (M0 if they use $\sqrt{x^2 - y^2}$)		

Question T2_Q3

Question	Scheme	Marks	AOs
	Allow column vectors throughout this question		
5(a)	Differentiate $\mathbf{v}$ wrt t	M1	3.1a
	$\frac{3}{2}t^{-\frac{1}{2}}\mathbf{i} - 2\mathbf{j}$ isw	A1	1.1b
		(2)	
5(b)	$3t^{\frac{1}{2}} = 2t$	M1	2.1
	Solve for t	DM1	1.1b
	$t = \frac{9}{4}$	A1	1.1b
		(3)	
5(c)	Integrate $\mathbf{v}$ wrt t	M1	3.1a
	$\mathbf{r} = 2t^{\frac{3}{2}}\mathbf{i} - t^2\mathbf{j} (+C)$	A1	1.1b
	$t = 1, \mathbf{r} = -\mathbf{j} \Rightarrow \mathbf{C} = -2\mathbf{i}$ so $\mathbf{r} = 2t^{\frac{3}{2}}\mathbf{i} - t^2\mathbf{j} - 2\mathbf{i}$	A1	2.2a
		(3)	
5(d)	$\sqrt{(3t^{\frac{1}{2}})^2 + (2t)^2} = 10$ or $(3t^{\frac{1}{2}})^2 + (2t)^2 = 10^2$	M1	2.1
	$9t + 4t^2 = 100$	M(A)1	1.1b
	$t = 4$	A1	1.1b
	$\mathbf{r} = 14\mathbf{i} - 16\mathbf{j}$	M1	1.1b
	$\sqrt{14^2 + (-16)^2}$	M1	3.1a
	$\sqrt{452} \ (2\sqrt{113}) \text{ (m)}$	A1	1.1b
		(6)	
(14 marks)			
Notes:			
5a	M1	Both powers decreasing by 1 (M0 if vector(s) disappear but allow recovery)	
	A1	cao	
5b	M1	Complete method, using $\mathbf{v}$, to obtain an equation in t only, allow a sign error	
	DM1	Dependent on M1, solve for t	