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2002

XVIII

1583

Time allowed

Score

Percentage

/

%

Maths

**AQA
AS & A LEVEL**

Mark Scheme

Kinematics

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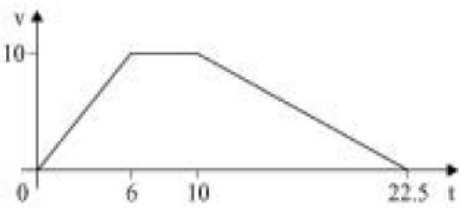
2(a)	$\mathbf{v} = 4\mathbf{i} + (-3\mathbf{i} + 12\mathbf{j})t$	M1 A1	2	use of $\mathbf{v} = \mathbf{u} + \mathbf{a}t$
(b)	$t = 0.5, \mathbf{v} = 2.5\mathbf{i} + 6\mathbf{j}$ Speed = $\sqrt{(2.5^2 + 6^2)}$ Speed = 6.5 m s^{-1}	B1✓ M1 A1✓	3	✓ 2 terms and t subs 2 terms ✓ 2 terms
Total			5	

3(a)(i)	$s = ut + \frac{1}{2}at^2$ $25 = 0 + 4.9t^2$ $t = 2.26 \text{ sec} \quad (2.236)(\text{if } g = 10)$ (2.259)	M1 A1	2	full method
(ii)	$v^2 = u^2 + 2as$ $v^2 = 0 + 2 \times 9.8 \times 25$ $v = 22.1 \text{ m s}^{-1} \quad (21.913)$ (22.14)	M1 A1	2	
(b)	(Time longer) air resistance slows down motion, links with motion, no contradictions	M1 A1	2	(or Time less) package large so less distance to travel
Total			6	



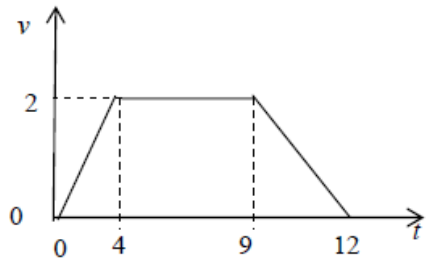
6(a)(i)		B1 B1 B1	3	3 straight lines correct end points sensible scales + labelled v/t
(ii)	$s = \frac{1}{2} \times 10 \times 4 + \frac{1}{2} \times (4 + 12) \times 10 + \frac{1}{2} (12 + 16) \times 10$ $s = 240 \text{ metres}$	M1 m1 A1	4	area attempt full method equation correct Or equation attempted full method all correct
(iii)	Average speed = $\frac{240}{30}$ = 8 ms^{-1}	A1✓ M1	2	✓ one slip ✓ distance
(iv)	Greatest acceleration = 2 nd stage = $\frac{12 - 4}{10}$ = 0.8 ms^{-2}	M1 A1	2	cao
(b)(i)	Less area below curve < area below line/velocity lower	B1 B1	2	no additional incorrect statements
(ii)	Change in velocity more gradual oe	B1	1	
Total			14	

1(a)	$s = 0 + \frac{1}{2} \times 9.8 \times 4^2$ $s = 78.4 \text{ metres}$	M1 A1 A1	3	Full method Correct subs, accept ± 9.8 CAO (need positive)
(b)	Average speed = $\frac{78.4}{4}$ = 19.6 ms^{-1}	M1 A1F	2	Also accept full method with use of velocities at $t = 0$ and 4, or at $t = 2$ FT distance
(c)	Only force acting is weight	B1	1	Acc resistance forces negligible or ignored, (not friction, or air friction)
Total			6	

3(a)	$v = u + at$ $0 = 10 + (-0.8) \times t$ $t = 12.5 \text{ sec}$	M1		Full method with u, v used correctly Accept ± 0.8
		A1	2	CAO (correct subs and answer)
(b)		B1 B1 B1		} each line, straight and correct end points SC: B1 for 3 lines giving correct shape but no values shown SC: first error in labelling times loses B1, repeated errors no further penalty axes labelled v, t
		B1	4	
(c)	$\text{distance} = \frac{1}{2} \times 10 \times (4 + 22.5)$ $= 132.5 \text{ metres}$	M1 A1F A1F		Full correct method Correct subs, FT graph if final $t = 12.5$ FT one slip, AWRT 133
(d)	Acceleration unlikely to: change so abruptly or be constant or velocity unlikely to be constant	B1	1	
Total			10	

6(a)	$\mathbf{d} = 3\mathbf{i} - 6\mathbf{j}$ $3\mathbf{i} - 6\mathbf{j} = (\mathbf{i} - 2\mathbf{j})t$ $t = 3$	B1 M1 A1		Accept $\pm \mathbf{d}$ or displacements of 3, 6 shown on a diagram Or equivalent method for t Accept ratio of vectors leading directly to ± 3 CAO
(b)(i)	$\mathbf{r} = (\mathbf{i} - 2\mathbf{j}) \times 4 + \frac{1}{2} \times 2\mathbf{j} \times 16$ $+6\mathbf{i} - 4\mathbf{j}$ $= 10\mathbf{i} + 4\mathbf{j}$	M1 A1 M1 A1F		Full method for vector expression giving change in position For correct subs (gives $4\mathbf{i} + 8\mathbf{j}$) FT slip provided obtain vector expression ($\mathbf{u} = 0$ gives $6\mathbf{i} + 12\mathbf{j}$)
(ii)	$A(3,2) \quad C(10,4)$ $\mathbf{d} = 7\mathbf{i} + 2\mathbf{j}$ $ \mathbf{d} = \sqrt{7^2 + 2^2}$ $AC = \sqrt{53} = 7.28$	M1 A1F		Attempt to find vector \overline{AC} or \overline{CA} (using candidate's C) FT \mathbf{d} provided two non-zero components Accept $\sqrt{53}$
Total			9	



<p>2(a)</p>		<p>B1 B1 B1 B1</p>	<p>4</p>	<p>Starts and finishes at rest Correct shape Correct values on t-axis Correct values on v-axis Condone omission of the origin</p>
<p>(b)</p>	$s = \frac{1}{2}(5+12) \times 2$ <p>or $s = \frac{1}{2} \times 2 \times 4 + 5 \times 2 + \frac{1}{2} \times 2 \times 3 = 17$ $= 17$</p>	<p>M1</p>	<p>2</p>	<p>Use of the area under the graph (or equivalent) to find s</p> <p>Correct distance SC When 21 used instead of 12 allow full marks for $s = 26$</p>
<p>(c)</p>	$\max a = \frac{2}{4} = 0.5$ $300 \times 0.5 = T - 300 \times 9.8$ $T = 2940 + 150 = 3090$	<p>B1 M1 A1 A1</p>	<p>4</p>	<p>Maximum acceleration</p> <p>Three term equation of motion using their a Correct equation using $a = 0.5$</p> <p>Correct tension</p>
			<p>10</p>	

<p>5(a)</p>	$v = \sqrt{0.3^2 + 0.1^2} = \sqrt{0.1} = 0.316 \text{ ms}^{-1}$	<p>M1A1</p>	<p>2</p>	<p>Use of Pythagoras to find v. Correct v</p>
<p>(b)</p>	$\alpha = \tan^{-1}\left(\frac{0.3}{0.1}\right) = 71.6^\circ$	<p>M1A1 A1</p>	<p>3</p>	<p>Use of trigonometry with reasonable choice of sides to find α. Correct expression Correct angle CAO</p>
<p>(i)</p>	$t = \frac{15}{0.3} = 50\text{s}$	<p>M1 A1</p>	<p>2</p>	<p>Use of s/v to find t with s and t consistent Correct t</p>
<p>(ii)</p>	$s = 50 \times \sqrt{0.1} = 15.8\text{m}$	<p>M1A1</p>	<p>2</p>	<p>Use of their t in $t \times v$ to find s or the use of trigonometry. Correct distance CAO</p>
<p>Total</p>			<p>9</p>	



8(a)	$75\mathbf{i} = (5\mathbf{i} - 2\mathbf{j}) \times 10 + \frac{1}{2}\mathbf{a} \times 10^2$ $\mathbf{a} = \frac{75\mathbf{i} - 50\mathbf{i} + 20\mathbf{j}}{50} = 0.5\mathbf{i} + 0.4\mathbf{j}$	M1 A1 A1	3	Equation to find \mathbf{a} from $\mathbf{r} = \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$ Correct expression AG Correct \mathbf{a} from correct working
(b)	$\mathbf{r} = (5\mathbf{i} - 2\mathbf{j}) \times 8 + \frac{1}{2}(0.5\mathbf{i} + 0.4\mathbf{j}) \times 8^2$ $= 56\mathbf{i} - 3.2\mathbf{j}$	M1 A1 A1	3	Expression for \mathbf{r} using $t = 8$ with no extra terms Correct expressions Correct position vector
(c)	$\mathbf{v} = (5 + 0.5t)\mathbf{i} + (0.4t - 2)\mathbf{j}$ $0.4t - 2 = 0$ $t = \frac{2}{0.4} = 5$ $\mathbf{r} = (5\mathbf{i} - 2\mathbf{j}) \times 5 + \frac{1}{2}(0.5\mathbf{i} + 0.4\mathbf{j}) \times 5^2$ $= 31.25\mathbf{i} - 5\mathbf{j}$ $= 31.3\mathbf{i} - 5\mathbf{j}$	M1A1 dM1 A1 dM1 A1	6	Expression for \mathbf{v} . Correct expression \mathbf{j} component equal to zero Correct t Expression for \mathbf{r} using t from \mathbf{j} component equal to zero Correct position vector
Total			12	

1(a)	$v = 0 + 1.5 \times 9.8$ $= 14.7 \text{ ms}^{-1}$	M1 A1	2	Use of constant acceleration equation to find v AG Correct v from correct working $1.5 \times 9.8 = 14.7$ is not enough on its own
(b)	$h = \frac{1}{2} \times 9.8 \times 1.5^2$ $= 11.0 \text{ m (to 3 sf)}$	M1 A1	2	Use of constant acceleration equation with $a = 9.8$ to find h Correct h Allow 11 m; ignore negative signs
(c)	$5^2 = 0^2 + 2 \times 9.8s$ $s = \frac{25}{19.6} = 1.28 \text{ m (to 3 sf)}$ <p>OR</p> $t = \frac{5}{9.8} = 0.510$ $s = \frac{1}{2}(0 + 5) \frac{5}{9.8} = 1.28 \text{ m}$ <p>OR</p> $s = 0 + \frac{1}{2} \times 9.8 \times \left(\frac{5}{9.8}\right)^2 = 1.28 \text{ m}$	M1 A1 A1	3	Use of constant acceleration equation with $u = 0$ to find s Correct equation Correct s Accept 1.27
Total			7	



5(a)	$V = 150 \tan 30^\circ$	M1	2	Using trigonometry (usually tan or sine rule) to find V AG Correct answer from correct working (Division by 2 only acceptable if $\sin 30^\circ$ or $\cos 60^\circ$ seen)
	$= 86.6 \text{ ms}^{-1}$	A1		
	OR			
	$\frac{V}{\sin 30^\circ} = \frac{150}{\sin 60^\circ}$ AG			
	$V = 86.6 \text{ ms}^{-1}$			
(b)	$\frac{150}{v} = \cos 30^\circ$	M1	3	Using trigonometry or Pythagoras to find v Correct expression
	$v = \frac{150}{\cos 30^\circ} = 173 \text{ ms}^{-1}$ (to 3sf)	A1		
		A1	Correct answer	
Total			5	

8(a)	$\mathbf{u} = 5\mathbf{i}$ or $\begin{bmatrix} 5 \\ 0 \end{bmatrix}$	B1	1	Correct velocity
(b)	$\mathbf{v} = 5\mathbf{i} + (-0.2\mathbf{i} + 0.25\mathbf{j})t$	M1	2	Use of constant acceleration equation, with \mathbf{u} and \mathbf{a} not zero Correct velocity M1A0 for using $5\mathbf{j}$ or just 5
		A1		
	OR			
	$\mathbf{v} = \begin{bmatrix} 5 - 0.2t \\ 0.25t \end{bmatrix}$			
(c)	$5 - 0.2t = 0$	M1	3	Easterly component zero Correct equation
		A1		
	$t = \frac{5}{0.2} = 25$ seconds	A1		Correct t
(d)	$\mathbf{r} = 5\mathbf{i} \times 25 + \frac{1}{2}(-0.2\mathbf{i} + 0.25\mathbf{j}) \times 25^2$	M1	6	Use of constant acceleration equation with t from part (c) Correct expression based on t from part (c) Correct simplification CAO Using tan to find the angle Correct expression based on t from part (c), with correct two values (either way) Correct angle Accept 38.6° or 039°
		A1F		
		A1		
		dM1		
		A1F		
	$= 62.5\mathbf{i} + 78.125\mathbf{j}$			
	$\theta = \tan^{-1}\left(\frac{62.5}{78.125}\right)$			
	$= 038.7^\circ$	A1		
	OR			
	$\mathbf{r} = \frac{1}{2}(5\mathbf{i} + 6.25\mathbf{j}) \times 25$	(M1)		
		(A1F)		
		(A1)		
	$\theta = \tan^{-1}\left(\frac{5}{6.25}\right) = 038.7^\circ$	(dM1)		
		(A1F)		
		(A1)		
Total			12	