Variable acceleration As level Edexcel Machanics Maths Past Papers Answers

01.

Question	Scheme		Marks	AOs
a	Finds third angle of triangle and uses or states $$\frac{x}{\sin 60°} = \frac{30}{\sin "50°"}$$	Finds third angle of triangle and uses or states $$\frac{y}{\sin 70°} = \frac{30}{\sin "50°"}$$	M1	2.1
	So $x = \frac{30\sin 60°}{\sin 50°}$ $(=33.9)$	So $y = \frac{30\sin 70°}{\sin 50°}$ $(=36.8)$	A1	1.1b
	Area $= \frac{1}{2} \times 30 \times x \times \sin 70°$ or $\frac{1}{2} \times 30 \times y \times \sin 60$		M1	3.1a
	$= 478$ m^2		A1ft	1.1b
			(4)	
(b)	Plausible reason e.g. Because the angles and the side length are not given to four significant figures Or e.g. The lawn may not be flat		B1	3.2b
			(1)	
			(5 marks)	

Notes

(a) M1: Uses sine rule with their third angle to find one of the unknown side lengths

A1: finds expression for, or value of either side length

M1: Completes method to find area of triangle

A1ft: Obtains a correct answer for their value of x or their value of y.

(b) B1: As information given in the question may not be accurate to 4sf or the lawn may not be flat so modelling by a plane figure may not be accurate.

02.

Question	Scheme	Marks	AOs
(a)	Multiply out and differentiate *wrt* to time (or use of product rule i.e. must have two terms with correct structure)	M1	1.1a
	$v = 2t^3 - 3t^2 + t$	A1	1.1b
	$2t^3 - 3t^2 + t = 0$ and solve: $t(2t-1)(t-1) = 0$	DM1	1.1b
	$t = 0$ or $t = \dfrac{1}{2}$ or $t = 1$; any two	A1	1.1b
	All three	A1	1.1b
		(5)	
(b)	Find *x* when $t = 0, \dfrac{1}{2}, 1$ and 2: $\left(0, \dfrac{1}{32}, 0, 2\right)$	M1	2.1
	Distance $= \dfrac{1}{32} + \dfrac{1}{32} + 2$	M1	2.1
	$2\dfrac{1}{16}$ (m) oe or 2.06 or better	A1	1.1b
		(3)	
(c)	$x = \dfrac{1}{2}t^2(t-1)^2$	M1	3.1a
	$\dfrac{1}{2}$ perfect square so $x \geq 0$ i.e. never negative	A1 cso	2.4
		(2)	
		(10 marks)	

Notes:

(a)

M1: Must have 3 terms and at least two powers going down by 1

A1: A correct expression

DM1: Dependent on first M, for equating to zero and attempting to solve a cubic

A1: Any two of the three values (Two correct answers can imply a correct method)

A1: The third value

(b)

M1: For attempting to find the values of *x* (at least two) at their *t* values found in (a) or at *t* =2

  or equivalent e.g. they may integrate their *v* and sub in at least two of their *t* values

M1: Using a correct strategy to combine their distances (must have at least 3 distances)

A1: $2\dfrac{1}{16}$ (m) oe or 2.06 or better

(c)

M1: Identify strategy to solve the problem such as:

    (i)   writing x as $\dfrac{1}{2}$ × perfect square

    (ii)   or using x values identified in (b).

    (iii)   or using calculus i.e. identifying min points on x–t graph.

    (iv)   or using x-t graph.

A1 cso : Fully correct explanation to show that $x \geq 0$ i.e. never negative

03.

Question	Scheme	Marks	AOs	Notes
3(a)	$v = 12 + 4t - t^2 = 0$ and solving	M1	3.1a	Equating v to 0 and solving the quadratic If no evidence of solving, and at least one answer wrong, M0
	$t = 6$ (or -2)	A1	1.1b	6 but allow -2 as well at this stage
	Differentiate v wrt t	M1	1.1a	For differentiation (both powers decreasing by 1)
	$(a = \dfrac{dv}{dt} =) \ 4 - 2t$	A1	1.1b	Cao; only need RHS
	When $t = 6$, $a = -8$; Magnitude is 8 (m s^{-2})	A1	1.1b	Substitute in $t = 6$ and get 8 (m s^{-2}) as the answer . Must be **positive**. (A0 if two answers given)
		(5)		
(b)	Integrate v wrt t	M1	3.1a	For integration (at least two powers increasing by 1)
	$(s =)12t + 2t^2 - \dfrac{1}{3}t^3 (+C)$	A1	1.1b	Correct expression (ignore C) only need RHS Must be used in part (b)
	$t = 3 \implies$ distance $= 45$ (m)	A1	1.1b	Correct distance. Ignore units
		(3)		
		(8 marks)		

04.

Question	Scheme	Marks	AOs
a	$v = 3t - 2t^2 + 14$ and differentiate	M1	3.1a
	$a = \dfrac{dv}{dt} = 3 - 4t$ or $(7 - 2t) - 2(t + 2)$ using product rule	A1	1.1b
	$3 - 4t = 0$ and solve for t	M1	1.1b
	$t = \dfrac{3}{4}$ oe	A1	1.1b
		(4)	
b	Solve problem using $v = 0$ to find a value of t $\left(t = \dfrac{7}{2}\right)$	M1	3.1a
	$v = 3t - 2t^2 + 14$ and integrate	M1	1.1b
	$s = \dfrac{3t^2}{2} - \dfrac{2t^3}{3} + 14t$	A1	1.1b
	Substitute $t = \dfrac{7}{2}$ into their s expression (M0 if using *suvat*)	M1	1.1b
	$s = \dfrac{931}{24} = 38\dfrac{19}{24} = 38.79166..(m)$ Accept 39 or better	A1	1.1b
		(5)	
		(9 marks)	

Notes:

(a)	M1	Multiply out and attempt to differentiate, with at least one power decreasing	
	A1	Correct expression	
	M1	Equate their a to 0 and solve for t	
	A1	cao	
(b)	M1	Uses $v = 0$ to obtain a value of t	
	M1	Attempt to integrate, with at least one power increasing	
	A1	Correct expression	
	M1	Substitute in their value of t, which must have come from using $v = 0$, into their s (must have integrated)	
	A1	39 or better	

05.

Question	Scheme	Marks	AOs
a	Differentiate v w.r.t. t	M1	3.1a
	$a = \dfrac{dv}{dt} = 10 - 2t$ isw	A1	1.1b
		(2)	
b	Solve problem using $v = 0$ when $t = 6$	M1	3.1a
	$0 = 10t - t^2 - 24$	A1	1.1b
	Solve quadratic oe to find other value of t	M1	1.1b
	$t = 4$	A1	1.1b
		(4)	
c	Integrate v or $-v$ w.r.t. t	M1	3.1a
	$5t^2 - \dfrac{1}{3}t^3 - 24t$	A1	1.1b
	Total distance $= -\left[5t^2 - \dfrac{1}{3}t^3 - 24t\right]_0^4 + \left[5t^2 - \dfrac{1}{3}t^3 - 24t\right]_4^6$	M1	2.1
	$\dfrac{116}{3}$ (m)	A1	1.1b
		(4)	
		(10 marks)	

Notes:

a	M1	Differentiate, with both powers decreasing by 1
	A1	Correct expression
b	M1	Put $t = 6$ **OR** use $(t-6)(t-x) = t^2 - 10t + k$ oe
	A1	Correct expression (unsimplified) for v **OR** $v = (t-6)(t-4)$
	M1	Put $v = 0$ to give quadratic in t and solve for other value of t
	A1	$t = 4$
c	M1	Integrate, with at least two powers increasing by 1 (allow if only two terms integrated)
	A1	Correct expression
	M1	Complete method to find the total distance
	A1	Accept 39(m) or better

06.

Question		Scheme	Marks	AOs
a		Differentiate s wrt t	M1	3.1a
		$(v =)\ t^2 - 5t + 6$	A1	1.1b
		Equate their v to 0 and solve	M1	1.1b
		$t = 2$ or 3	A1	1.1b
		$(a =)\ 2t - 5$	B1ft	2.1
		$a = 1$ and -1 (m s^{-2}) isw (A0 if extras)	A1	1.1b
			(6)	
(b)		Attempt to find values of s for $t = 2, 3$ and 4 oe	DM1	1.1b
		Correct values are $\left(s_2 = \dfrac{14}{3}, s_3 = \dfrac{9}{2} \text{ and } s_4 = \dfrac{16}{3} \right)$		
		Could be implied by correct values for: s_2, $(s_3 - s_2)$ and $(s_4 - s_3)$ which are $\dfrac{14}{3}$, $(-\dfrac{1}{6})$ and $\dfrac{5}{6}$		
		Total distance travelled $= s_2 + (s_2 - s_3) + s_4 - s_3$ OR $s_2 - (s_3 - s_2) + s_4 - s_3$ OR $\left[\dfrac{1}{3}t^3 - \dfrac{5}{2}t^2 + 6t \right]_0^2 - \left[\dfrac{1}{3}t^3 - \dfrac{5}{2}t^2 + 6t \right]_2^3 + \left[\dfrac{1}{3}t^3 - \dfrac{5}{2}t^2 + 6t \right]_3^4$ OR $\dfrac{14}{3} - (-\dfrac{1}{6}) + \dfrac{5}{6}$ OR $s_2 + 2(s_2 - s_3) + s_4 - s_2$ $(= 2s_2 - 2s_3 + s_4)$ oe	M1	2.1
		$5\frac{2}{3}$ oe (m) Accept 5.7 or better	A1	1.1b
			(3)	
			(9 marks)	

Notes:

a	M1	Differentiate, with at least 2 powers decreasing by 1
	A1	Correct expression
	M1	Must have attempted to differentiate s to find v and be solving a 3 term quadratic
	A1	Both values needed
	B1ft	Follow their v (must be differentiating)

	A1	cao
b	**DM 1**	This mark is dependent on the 2nd M1 in part (a) and their t values are between 0 and 4. Clear attempt to find all three s values (may integrate their v incorrectly) **N.B.** No penalty for extra values.
	M1	Complete method using their s values Do NOT condone sign errors.
	A1	Any equivalent fraction, 5.7 or better.
		S.C. Correct answer, with no working, scores all 3 marks, since $\int_{0}^{4}\left|t^2 - 5t + 6\right| \, dt$ entered on a calculator will give $\dfrac{17}{3}$

07.

Question	Scheme	Marks	AOs
a	$15 - 3^2 - 2 \times 3 = 0$ *	B1*	1.1b
		(1)	
b	Differentiate v wrt t	M1	2.1
	$-2t - 2$	A1	1.1b
	$8\,(\text{m s}^{-2})$	A1	1.1b
		(3)	
c	Integrate v w.r.t. t	M1	1.1b
	$15t - \dfrac{1}{3}t^3 - t^2$	A1	1.1b
	Total distance $= \left[15t - \dfrac{1}{3}t^3 - t^2 \right]_0^3 - \left[15t - \dfrac{1}{3}t^3 - t^2 \right]_3^4$ OR $s_3 + (s_3 - s_4)$ where s_3 means the value of their integral when $t = 3$. **N.B.** Allow the negative of this.	M1	3.1a
	$\dfrac{94}{3}$ (m)	A1	1.1b
		(4)	

(8 marks)

Notes:

a	B1*	Correct expression, correctly evaluated to give 0 OR $0 = 15 - t^2 - 2t$ $t = 3$
b	M1	Differentiate v, with at least two powers decreasing by 1
	A1	Correct expression
	A1	cao (must be positive)
		N.B. If they give 8 as their answer, without any working, this can score all 3 marks.
c	M1	Integrate v, with at least two powers increasing by 1 (allow if only two terms integrated).
	A1	Correct expression. Ignore (+ C)
	M1	Complete method to find the total distance or displacement
	A1	Accept 31(m) or better, must be positive
		N.B. If the indefinite integral ($15t - \dfrac{1}{3}t^3 - t^2$) is never seen, they score nothing, even if the correct answer appears, as this indicates they have used a calculator to do the whole question.