Constant Acceleration - Answers

June 2017 Mathematics Advanced Paper 1: Mechanics 1

1.

Question Number	Scheme	Marks
6(a)	$s = vt - \frac{1}{2}at^2$ $40 = 10 \times 5 - \frac{1}{2}a5^2$ $a = 0.8$	M1 A2 A1 (4)
(b)	Finding u $(=6)$ $s = ut + \frac{1}{2}at^2$ $(A \text{ to } M)$ $20 = 6t + \frac{1}{2}0.8t^2$ $t = \frac{-15 \pm \sqrt{225+200}}{2}$ $= 2.8$ or 2.81 or better	M1 M1 A1 **DM1** A1 (5)
	Alternative : Finding v $(=\sqrt{68})$ $s = vt - \frac{1}{2}at^2$ $(A \text{ to } M)$ $20 = \sqrt{68}t - \frac{1}{2}0.8t^2$ $t = \frac{\sqrt{68} \pm \sqrt{68-32}}{0.8}$ $= 2.8$ or 2.81 or better	M1 M1 A1 **DM1** A1 (5)
	Alternative : $s = vt_1 - \frac{1}{2}at_1^2$ $(M \text{ to } B)$ $20 = 10t_1 - \frac{1}{2}0.8t_1^2$ $t_1 = \frac{10 \pm \sqrt{100-32}}{0.8}$ $= 2.192$ $t = 5 - t_1 = 2.8$ or 2.81 or better	M2 A1 **DM1** A1 (5) **9**

	Notes	
6(a)	First M1 for a complete method to produce a value for a. They may use two (or more equations) and solve for a.(see possible equations) A2 if all correct, A1A0 for one error Third A1 for 0.8 ($m\ s^{-2}$) Possible equations: $40 = 5u + \frac{1}{2}a.5^2$ $10^2 = u^2 + 2a.40$ $10 = u + 5a$ $40 = \frac{(u+10)}{2}.5$	
6(b)	First M1 for attempt to find a value for u (This may have been done in part (a) but MUST be used in (b)) Second M1 for a complete method (may involve 2 or more *suvat* equations) for finding an equation in t *only* First A1 for a correct equation Third M1, **dependent** on previous M, for solving their equation for t Second A1 for 2.8 (s) or better or $\frac{5(2\sqrt{17}-6)}{4}$; $\frac{40}{6+2\sqrt{17}}$	

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2.

Question Number	Scheme	Marks
7(a)		B1 (shape) B1 (V) (2)
(b) **(i) (ii)**	$\frac{V}{t_1} = \frac{1}{2} \Rightarrow t_1 = 2V$ s; $t_2 = 4V$ s	M1 A1; A1
(iii)	$t_3 = 300 - 2V - 4V = 300 - 6V$ s	M1 A1 (5)

(c)	$6300 = \frac{V(300+300-6V)}{2}$ or $\frac{1}{2}2V.V + (300-6V).V + \frac{1}{2}4V.V$ $V^2 - 100V + 2100 = 0$ $(V-30)(V-70) = 0$ $V = 30$ or 70 $V = 30\ (<50)$	M1 **A1 ft** A1 M1 A1 A1 (6) **13**
	Notes	
7(a)	B1 for a trapezium with line starting and finishing on the *t*-axis B1 for V correctly marked	
(b)	First M1 for a correct method First A1 for $V/0.5$ oe Second A1 for $V/0.25$ oe Second M1 for (300 – sum of previous answers) Allow 5 instead of 300. Third A1 for $300 - 6V$ oe	
(c)	First M1 for using the area under the curve (distance travelled) to form an equation in V only. (Allow use of 6.3 but must see ½ used at least once in their expression.) First A1 **ft on their answers in (b)** for a correct equation so must have used 6300 not 6.3 Second A1 for correct equation in form $aV^2 + bV + c = 0$ Second M1 for solving a 3 term quadratic. (Can be implied by correct answers) Second A1 for either 30 or 70	

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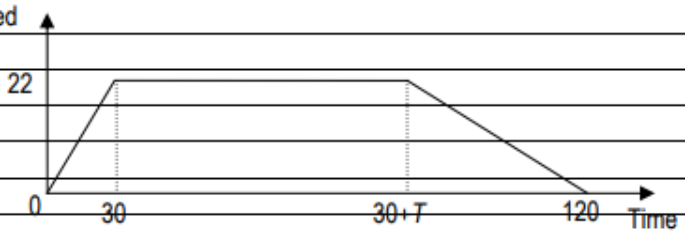
3.

Question Number	Scheme	Marks
4.		
(a)	$240 = \frac{1}{2}(u+34)10$	M1 A1
	$u = 14$	A1
		(3)
(b)	$34 = 14+10a \Rightarrow a = 2$	M1 A1
	$120 = 14t + \frac{1}{2}\times 2\times t^2$	M1 A1
	$t^2 + 14t - 120 = 0$	
	Solving, $t = -20$ or 6	**DM1**
	$t = 6$	A1
	OR	
	$34 = 14+10a \Rightarrow a = 2$	M1 A1
	$v^2 = 14^2 + 2\times 2\times 120 \Rightarrow v = 26$	
	AND $26 = 14+2t$	M1 A1
	$t = 6$	**DM1** A1
		(6)
		[9]

Notes for Question 4

Q4(a)	First M1 for a complete method to produce an equation in u only. First A1 for a correct equation. ($u^2 - 48u + 476 = 0$ oe is possible). Second A1 for $u = 14$.	
Q4(b)	**EITHER** First M1 for an equation in a only. (M0 if $v = 34$ when $s = 120$ is used) First A1 for $a = 2$. (This may have been found in part (a)) Second M1 for a 3-term quadratic equation in t only, allow sign errors (must have found a value of a. (M0 if $v = 34$ when $s = 120$ is used) Second A1 for a correct equaton. Third M1 dependent on previous M1 for solving for t. Third A1 for $t = 6$ **OR** First M1 for an equation in a only. First A1 for $a = 2$. (This may have been found in part (a)) Second M1 for a complete method to obtain an equation in t only, allow sign errors. (must have found a value of a) Second A1 for a correct equaton. Third M1 dependent on previous M1 for solving for t. Third A1 for $t = 6$	

4.

Question Number	Scheme	Marks
5.		
(a)	 Shape	B1
	Figures	B1
		(2)
(b)	$\frac{(120+T)22}{2}=2145$	M1 A1
	$T=75$	A1
		(3)
(c)	$\frac{(t+t-30)22}{2}=990$	M1 A1
	$t=60$	A1
	Answer $=60-10=50$	A1
		(4)
(d)	$990=0.5a50^2$	M1
	$a=0.79, 0.792, 99/125$ oe	A1
		(2)
		[11]

Notes for Question 5		
Q5(a)	First B1 for a trapezium starting at the origin and ending on the t-axis. Second B1 for the figures marked (allow missing 0 and a delineator oe for T) (allow if they have used $T=75$ correctly on their graph)	
Q5(b)	First M1 for producing an equation in their T *only* by equating the area of the trapezium to 2145, with the correct no. of terms. If using a single trapezium, we need to see evidence of using ½ the sum of the two parallel sides or if using triangle(s), need to see ½ base x height. Second A1 cao for a correct equation in T (This is not f.t. on their T) Third A1 for $T=75$. N.B. Use of a single *suvat* equation for the whole motion of the car e.g. $s=t(u+v)/2$ is M0	

Q5(c)	First M1 for producing an equation in t *only* (they may use $(t-30)$ oe as their variable) by equating the area of the trapezium to 990, with the correct no. of terms. If using a trapezium, we need to see evidence of using ½ the sum of the two parallel sides or if using triangle(s), need to see ½ base x height. First A1 for a correct equation. Second A1 for $t = 60$ (Allow 30 + 30). Third A1 for answer of 50. N.B. Use of a single *suvat* equation for the whole motion of the car e.g. $s = t(u+v)/2$ is M0. Use of the motion of the motorcycle is M0 (insufficient information). Use of $v = 22$ for the motorcycle is M0.	
Q5(d)	First M1 for an equation in a only. First A1 for $a = 0.79, 0.792, 99/125$ oe N.B. Use of $v = 22$ for the motorcycle is M0.	

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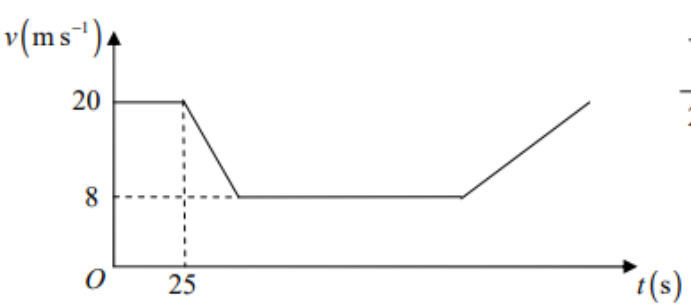
5.

Question Number	Scheme	Marks
4.	(a) 	B1 B1 B1 **(3)**
	(b) $v = u + at \Rightarrow 8 = 20 - 0.4t$ $t = 30$ (s)	M1 A1 **(2)**

	(c) $1960 = (25 \times 20) + (30 \times 8) + (\frac{1}{2} \times 30 \times 12) + (60 \times 8) + 8 \times t + \frac{1}{2} \times t \times 12$	M1A3 **ft** (2 ,1, 0)
	$1960 = 500 + 240 + 180 + 480 + 14t$	DM1 A1
	$T = 115 + 40$ $= 155$	DM1 A1
	N.B. SEE ALTERNATIVES	**(8)** **[13]**

Question 4(a)
First B1 for 1st section of graph
Second B1 for 2nd section
Third B1 for the figures 20, 8 and 25

Question 4(b)
M1 for a complete method to produce an equation in t only; allow $(20 - 8)/0.4$
A1 for 30 N.B.
Give A0 for $t = -30$, even if changed to 30, but then allow use of 30 in part (c), where full marks could then be scored.

Question 4(c)
First M1 (generous) for clear attempt to find whole area under *their* graph (must include at least one "1/2"), in terms of *a single unknown time (t say),* and equate it to 1960.
First A3, ft on their (b), for a correct equation.
Deduct 1 mark for each numerical error, or omission, in each of the 4 *sections of the area* corresponding to each stage of the motion. (they may 'slice' it, horizontally into 3 sections, or a combination of the two)
Second DM1, dependent on first M1, for simplifying to produce an equation with all their t terms collected.
Fourth A1 for a correct equation for t or T
Third DM1, dependent on second M1. for solving for T
Fifth A1 155

Please note that any incorrect answer to (b) will lead to an answer of 155 in (c) and can score max 6/8;

Solutions with the correct answer of 155 will need to be checked carefully.

Solutions to 4 (c) **N.B.** $t = T - 115$

A.	$1960 = (25 \times 20) + (30 \times 8) + (\frac{1}{2} \times 30 \times 12) + (60 \times 8) + 8 \times t + \frac{1}{2} \times t \times 12$	M1 A3 **ft**
	$1960 = 500 + 240 + 180 + 480 + 14t$	M1 A1
	$T = 115 + 40$	M1
	$= 155$	A1

B. $1960 = (25 \times 20) + \frac{1}{2} \times 30 \times (20 + 8) + (60 \times 8) + \frac{1}{2} \times t \times (20 + 8)$ M1 A3 **ft**

$1960 = 500 + 420 + 480 + 14t$ M1 A1

$T = 115 + 40$ M1

$= 155$ A1

C. $1960 = 8T + \frac{1}{2} \times 12 \times (55 + 25) + \frac{1}{2} \times 12 \times (T - 115)$ M1 A3 **ft**

$1960 = 8T + 480 + 6T - 690$

$1960 = 14T - 210$ M1 A1

$155 = T$ M1 A1

D. $1960 = 20T - \frac{1}{2} \times 12 \times (60 + T - 25)$ M1 A3 **ft**

$1960 = 20T - 6T - 210$

$1960 = 14T - 210$ M1 A1

$155 = T$ M1 A1

E. $1960 = (55 \times 20) - \frac{1}{2} \times 30 \times 12 + (60 \times 8) + \frac{1}{2} \times t \times (20 + 8)$ M1 A3 **ft**

$1960 = 1100 - 180 + 480 + 14t$ M1 A1

$T = 115 + 40$ M1

$= 155$ A1

F. $1960 = (8 \times 115) + \frac{1}{2} \times 12 \times (55 + 25) + \frac{1}{2} \times 28 \times (T - 115)$ M1 A3 **ft**

$1960 = 920 + 480 + 14T - 1610$

$1960 = 14T - 210$ M1 A1

$155 = T$ M1 A1

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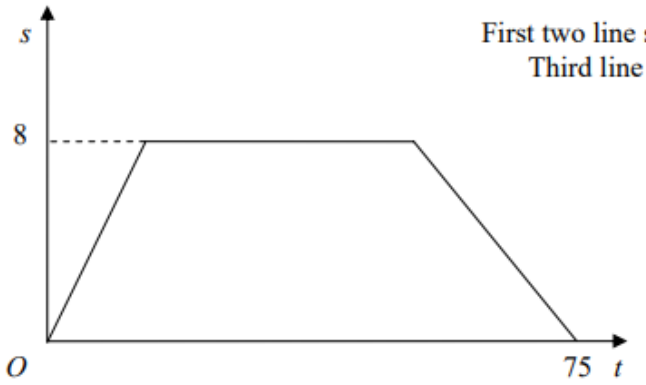
6.

Q2.	(a)	 First two line segments Third line segment 8, 75	B1 B1 B1 (3)
	(b)	$\frac{1}{2}\times 8\times(T+75)=500$ Solving to $T=50$	M1 A2 (1,0) DM1 A1 (5) **[8]**