Mark scheme

Kinematics

Additional Mathematics 0606 · Questions from Paper 1 and Paper 2

Total marks

77

MARKS FOR EACH QUESTION

1	2	3	4	5	6	7	8	9	10	Total
3	4	5	8	8	8	9	10	11	11	**77**

Question 1 **[3]**

1(a)	As v–t graph but negative portion reflected in x-axis	**B1**	
1(b)	Straight line with positive gradient	**B1**	
	Straight line starting at O	**B1**	

Question 2 **[4]**

2(a)	Area under graph = 800 $\frac{1}{2}(10 \times 10) + (10 \times 10) + \frac{1}{2}(10(10 + V)) + \frac{15V}{2} = 800$	**M1**	For attempt to find the area, allow one error and one omission.
	$V = 48$	**A1**	
2(b)	$(-)\frac{their\ V}{15}$	**M1**	Allow omission of negative sign.
	$-\frac{16}{5}\text{ms}^{-2}$ oe	**A1**	**FT** on *their V* but must be negative.

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Question 3 **[5]**

3(a)	$\frac{ds}{dt} = -\frac{3}{2}(1+3t)^{-\frac{3}{2}}$	**2**	**M1** for $a(1+3t)^{-\frac{3}{2}}$ **A1** all correct
	When t = 1, $\frac{ds}{dt} = -\frac{3}{16}$ Speed = $\frac{3}{16}$	**A1**	
3(b)	Acceleration = $\frac{27}{4}(1+3t)^{-\frac{5}{2}}$	**B1**	Allow unsimplified
	$(1+3t)^{-\frac{5}{2}}$ is always positive (so acceleration can never be zero.)	**B1**	Any valid explanation.

Question 4 **[8]**

4(a)	Factorises or solves $3t^2 - 30t + 72 = 0$ or $t^2 - 10t + 24 = 0$	**M1**	
	$t = 4, t = 6$	**A1**	
	Integrates v to find F(t): $\frac{3t^3}{3} - \frac{30t^2}{2} + 72t$	**M2**	**M1** for any two terms correct
	Correct substitution for F(6) – F(4) or F(4) – F(6)	**M1**	**dep** on at least **M1** for integration **FT** *their* 4 and *their* 6 provided they are **both positive**
	4 (m)	**A1**	**dep** on all previous marks being awarded
4(b)	$[a =] 6t - 30$	**B1**	
	[When $t = 2$: $a = 6(2) - 30 =$] -18 (ms^{-2}) cao	**B1**	

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Question 5 **[8]**

5(a)	$\left[v=\int\frac{-45}{(t+1)^2}\,\mathrm{d}t=\right]\frac{-45(t+1)^{-1}}{-1}+C$ or better	**B2**	**B1** for $\left[v=\int\frac{-45}{(t+1)^2}\,\mathrm{d}t=\right]k(t+1)^{-1}$
	$50=\frac{their45}{0+1}+C$	**M1**	
	$[v=]\frac{45}{t+1}+5$	**A1**	
5(b)	$[\mathrm{F}(t)=]\quad[45\ln(t+1)+5t]_1^{10}$	**B2**	**B1** for (*their* 45)ln(t + 1)
	F(10) – F(1)	**M1**	**dep** on at least **B1**
	122 (m) or 121.7[13…] rot to 4 or more sf	**A1**	**dep** on all previous marks awarded

Question 6 **[8]**

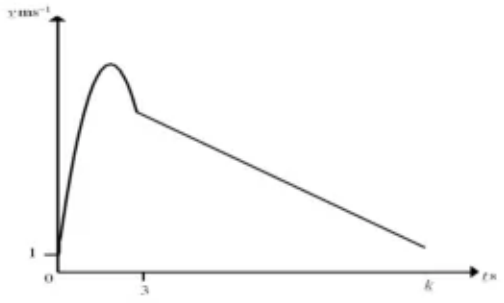
6(a)	$\left[v=\frac{\mathrm{d}s}{\mathrm{d}t}=\right]1+2\sin t$ soi	**B1**	
	Puts *their* $1+2\sin t=0$ and solves for t	**M1**	**FT** a + $b$sin$t$ where a and b are non-zero
	$t=\frac{7\pi}{6}$	**A1**	
	$s=\frac{7\pi}{6}+2-2\cos\frac{7\pi}{6}$	**M1**	**FT** *their* $t\neq 0$; dep on previous **M1**
	7.4[0] or 7.397[24...] (metres) rot to 4 or more sig figs	**A1**	
6(b)	$t=\frac{11\pi}{6}$	**B1**	
6(c)	7.3972... + (7.3972... – 6.7123...)	**M1**	
	8.08[20...] (metres)	**A1**	

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Question 7 [9]

7(a)(i)	110 (m)	**B1**	
7(a)(ii)		**B2**	**B1** for a line joining $(0,5)$ and $(10,5)$ **B1** for a line joining $(10,-2)$ and $(40,-2)$
7(b)(i)	$v=(2t+4)^{\frac{1}{2}}(+c)$	**M1**	For $k(2t+4)^{\frac{1}{2}}$
	$9=4+c$	**M1**	**Dep** for attempt to find c using $v=9$ and $t=6$ in *their* v
	$(2t+4)^{\frac{1}{2}}+5$	**A1**	
7(b)(ii)	$s=\frac{1}{3}(2t+4)^{\frac{3}{2}}\quad(+5t+d)$	**M1**	For $k(2t+4)^{\frac{3}{2}}$
	$\frac{1}{3}=\frac{64}{3}+30+d$	**M1**	**Dep** for attempt to find d using $s=\frac{1}{3}$ and $t=6$ in *their* s
	$\frac{1}{3}(2t+4)^{\frac{3}{2}}+5t-51$	**A1**	

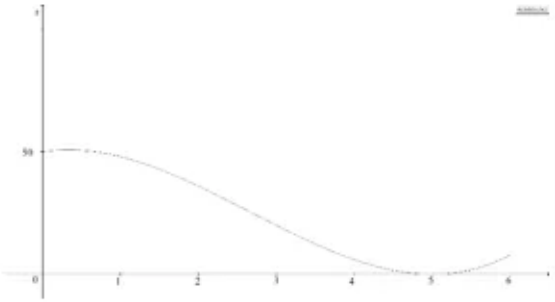
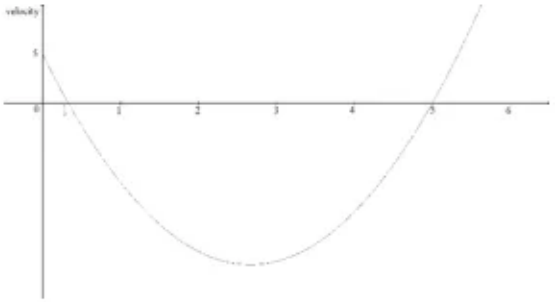
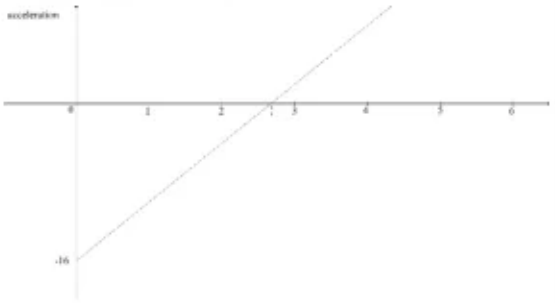
Question 8 [10]

8(a)	$v=1+12t-3t^2$	**B1**	
	$v=12-\frac{2}{3}t$	**B1**	
		**2**	**B1** for correct shape for $0 \leqslant t \leqslant 3$, with v-intercept of 1 and end point (3, 10) soi and maximum point **B1** for a line with negative gradient for $3 \leqslant t \leqslant k$, start point (3, 10) soi and end point above the t-axis

8(b)	When $t = 3$, $s = 30$	**B1**	
	$\frac{1}{2}(10+12-\frac{2}{3}k)(k-3)=57-30$ oe or $12k-\frac{k^2}{3}-3\ [-30]=57\ [-30]$ oe	**2**	**M1** for attempt at area using $t=k$
	$k = 6$ or $k = 30$	**2**	**A1** for $-\frac{1}{3}k^2+12k-60[=0]$ or $k^2-36k+180[=0]$ oe
	$k = 6$	**A1**	as v is negative when $k = 30$

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Question 9 **[11]**

9(a)	$\frac{ds}{dt} = 3t^2 - 16t + 5$ oe	**2**	**M1** for attempt at differentiation of a product or expansion and differentiation with at least two out of three terms of *their* expansion differentiated correctly **A1** all correct, allow factorised
	$t = \frac{1}{3},\ t = 5$	**2**	**Dep M1** for attempt to solve *their* $\frac{ds}{dt} = 0$, must be in quadratic form **A1** for both
9(b)		**2**	**B1** for a correct curve in the first quadrant only. There must be an indication of a max point in the correct position and a min point at $(5,\ 0)$ **B1** for $(0,\ 50)$ provided basic curve shape is correct
9(c)		**2**	**B1** for a quadratic curve in the first and fourth quadrants **B1** for $(0,\ 5)$, $\left(\frac{1}{3},\ 0\right)$ or $(0.333,\ 0)$ marked and passing through $(5,\ 0)$ on the x-axis
9(d)(i)	Acceleration = $6t - 16$	**B1**	
9(d)(ii)		**2**	**B1** for a straight line with a positive gradient in the first and fourth quadrants, meeting the vertical axis **Dep B1** for $\left(\frac{8}{3},\ 0\right)$ or $(2.67,\ 0)$ and $(0, -16)$

Question 10 **[11]**

10(a)	$v = \frac{10}{2t+1} - 5$	**2**	**M1** for $v = \frac{A}{2t+1} - 5$
	When $v = 0,\ t = \frac{1}{2}$	**2**	**Dep M1** for attempt to solve *their* $v = 0$
10(b)	When $t = \frac{1}{2}$, $s = 0.9657$ or $5\ln 2 - 2.5$ **and** when $t = 2$ $s = -1.9528$ or $5\ln 5 - 10$	**2**	**FT** on *their t* from part **(a)** **B1FT** for when $t = \frac{1}{2}$, $s = 0.9657$ or $5\ln 2 - 2.5$
	3.88	**2**	**M1** for distance = $2(their 0.9657) + 1.9528$
10(c)	$-\frac{20}{(2t+1)^2}$ oe	**2**	**M1** for $\frac{B}{(2t+1)^2}$, where B is an integer
10(d)	–0.2	**B1**	Mark final answer, do not isw.

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