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Cambridge International General Certificate of Secondary Education

MARK SCHEME for the October/November 2015 series

0606 ADDITIONAL MATHEMATICS

0606/23 Paper 2 , maximum raw mark 80

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Abbreviations

awrt	answers which round to
cao	correct answer only
dep	dependent
FT	follow through after error
isw	ignore subsequent working
oe	or equivalent
rot	rounded or truncated
SC	Special Case
soi	seen or implied
www	without wrong working

1	$y = x^3 + 3x^2 - 5x - 7$		
	$\frac{dy}{dx} = 3x^2 + 6x - 5$	M1 A1	Differentiate
	$x = 2 \rightarrow \frac{dy}{dx} = 19$	A1FT	on *their* $\frac{dy}{dx}$
	$y = 3$	B1	
	eqn of tangent: $\frac{y-3}{x-2} = 19 \quad \rightarrow \quad (y = 19x - 35)$	A1FT	
2	$2x + k + 2 = 2x^2 + (k+2)x + 8$	M1	eliminate y or x
	$2x^2 + kx + 6 - k \quad (=0)$	A1	correct quadratic
	$b^2 - 4ac = k^2 - 4 \times 2(6-k)$	M1	use discriminant
	$k^2 + 8k - 48 \quad (>0)$		
	$(k+12)(k-4) \quad (>0)$	DM1 A1	attempt to solve 3 term quadratic $k = -12$ and $k = 4$
	$k < -12$ or $k > 4$	A1	
3 **(a)**	$\frac{dy}{dx} = \frac{(2-x^2)3x^2 - x^3(-2x)}{(2-x^2)^2} = \left(\frac{6x^2 - x^4}{(2-x^2)^2}\right)$	M1 A2,1,0	For quotient rule (or product rule on correct y)
(b)	$\frac{dy}{dx} = x \times \frac{1}{2}(4x+6)^{-0.5} \times 4 + (4x+6)^{0.5}$	M1 A1	product rule
	$= \frac{6(x+1)}{(4x+6)^{0.5}} \quad \rightarrow \quad k = 6$	A1	
4	$x(4 - \sqrt{3}) = 13$	M1 A1	eliminate y or x simplified
	$x = \frac{13\left(4+\sqrt{3}\right)}{\left(4-\sqrt{3}\right)\left(4+\sqrt{3}\right)}$	M1	rationalisation
	$= 4 + \sqrt{3}$	A1	
	$y = 1 - 2\sqrt{3}$	A1	

5	$(x-3)(x-3)(x-1)=0$ $x^3-7x^2+15x-9=0$ $a=-7$ $b=15$ $c=-9$	M1 A1 A1 A1	 **AG** for c
6	$\log_x 2=\dfrac{\log_2 2}{\log_2 x}$ $2\log_2 x=\log_2 x^2$ $3=\log_2 8$ $8x^2-29x+15\ \ (=0)$ $\rightarrow(8x-5)(x-3)\ \ (=0)$ $x=\dfrac{5}{8}$ or $x=3$	B1 B1 B1 M1 A1	 obtain quadratic and attempt to solve
7 (i)	$a=-\dfrac{20}{(t+2)^3}$ $t=3\ \rightarrow\ a=-0.16\text{ m/s}^2$	M1 A1 A1FT	$k(t+2)^{-3}$ oe $k=-20$
(ii)	$\dfrac{10}{(t+2)^2}$ is never zero.	B1	
(iii)	$s=-\dfrac{10}{t+2}+5$	M1 A1 A1	integrate $\dfrac{k}{t+2}$ $k=-10$ +5
(iv)	$s=\left[-\dfrac{10}{t+2}\right]_3^8=-1+2$ $=1$	M1 A1	insert limits and subtract

8 **(i)**	$\sec^2 x + \operatorname{cosec}^2 x = \dfrac{1}{\cos^2 x} + \dfrac{1}{\sin^2 x}$	B1	
	$= \dfrac{\sin^2 x + \cos^2 x}{\sin^2 x \cos^2 x}$	B1	add fractions
	$= \dfrac{1}{\sin^2 x \cos^2 x}$	B1	use of $\sin^2 x + \cos^2 x = 1$
	$= \sec^2 x \operatorname{cosec}^2 x$	B1	fully correct solution
(ii)	$\dfrac{1}{\cos^2 x \sin^2 x} = 4\dfrac{\sin^2 x}{\cos^2 x}$	M1	
	$\to \quad 4\sin^2 x = 1$	A1	correct simplified equation
	$\sin x = \pm\dfrac{1}{\sqrt{2}}$		
	$x = 135^\circ, 225^\circ$	A1, A1	
9 **(i)**	$f(x) = 3x^2 + 12x + 2 = 3(x+2)^2 - 10$		
	$a = 3$	B1	
	$b = 2$	B1	
	$c = -10$	B1	
(ii)	minimum $f(x) = -10$	B1FT	
	at $x = -2$	B1FT	
(iii)	$f\left(\dfrac{1}{y}\right) = 0 \quad \to \quad \left(\dfrac{1}{y}\right) = (\pm)\sqrt{\dfrac{10}{3}} - 2$	M1	obtain explicit expression for $\dfrac{1}{y}$ or y
	$y = -5.74, \quad -0.26$	A1, A1	

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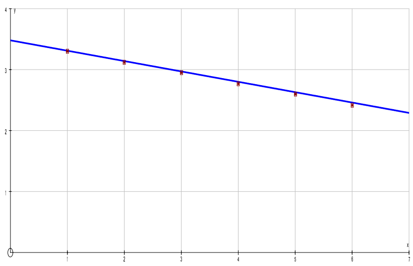
<table>
<tr><td>10 (i)</td><td>$\frac{d}{dx}(e^{2-x^2}) = -2xe^{2-x^2}$</td><td>B1</td><td>$k = -2$</td></tr>
<tr><td>(ii)</td><td>$-\frac{3e^{2-x^2}}{2} + c$</td><td>M1
A1FT</td><td>De^{2-x^2}
$D = \frac{-3}{2}$ or $\frac{3}{k}$</td></tr>
<tr><td>(iii)</td><td>$\left[-\frac{3e^{2-x^2}}{2}\right]_1^{\sqrt{2}} = -\frac{3}{2} + \frac{3}{2}e$
2.58</td><td>M1

A1</td><td>insert limits on their (ii) and subtract</td></tr>
<tr><td>(iv)</td><td>$y = 3xe^{2-x^2}$
$\frac{dy}{dx} = 3x(-2xe^{2-x^2}) + 3e^{2-x^2}$
$\frac{dy}{dx} = 0 \quad \to \quad x = \pm\frac{1}{\sqrt{2}} = \pm 0.707$
$y = \pm\frac{3}{\sqrt{2}}e^{1.5} = \pm 9.51$</td><td>M1
A1

A1

A1</td><td>product rule

both x or a pair

both y</td></tr>
<tr><td>11 (i)</td><td>$\log N = \log A - t\log b$</td><td>B1</td><td></td></tr>
<tr><td>(ii)</td><td>
<table>
<tr><td>t</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>log N</td><td>3.30</td><td>3.11</td><td>2.95</td><td>2.77</td><td>2.60</td><td>2.41</td></tr>
<tr><td>ln N</td><td>7.60</td><td>7.17</td><td>6.79</td><td>6.38</td><td>5.98</td><td>5.56</td></tr>
</table>

</td><td>M1

M1

A1</td><td>find logs of N

plot log$N$ or ln$N$ against t or $-t$

straight line passing through five points</td></tr>
<tr><td>(iii)</td><td>gradient $= -\log b = \frac{2.415 - 3.3}{5} \quad \to \quad b = 1.5$
intercept = $\log A = 3.47 \quad \to \quad A = 2950$</td><td>DM1
DM1
A1</td><td>set gradient = –log$b$ and solve
set intercept = log$A$ and solve
both values correct</td></tr>
<tr><td>(iv)</td><td>$t = 10 \quad \to \quad N = \frac{2950}{1.5^{10}} = 51$</td><td>B1</td><td></td></tr>
<tr><td>(v)</td><td>$N = 10 \to 1.5^t = 295 \to t = \frac{\log 295}{\log 1.5}$
$= 14$ years</td><td>M1

A1</td><td>substitute $N = 10$, their A, b into given or transformed equation</td></tr>
</table>

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12	$v_p = \begin{pmatrix} 250\cos 20^\circ \\ 250\sin 20^\circ \end{pmatrix}, \; v_r = \begin{pmatrix} V\cos 30^\circ \\ V\sin 30^\circ \end{pmatrix}, \; v_w = \begin{pmatrix} 0 \\ w \end{pmatrix}$	B1	
	$v_r = v_p + v_w$ $\begin{pmatrix} V\cos 30^\circ \\ V\sin 30^\circ \end{pmatrix} = \begin{pmatrix} 250\cos 20^\circ \\ 250\sin 20^\circ \end{pmatrix} + \begin{pmatrix} 0 \\ w \end{pmatrix}$		
	$V = \dfrac{250\cos 20^\circ}{\cos 30^\circ}$	M1	equate x components and solve
	$= 271\,\text{km/hr}$	A1	
	$w = V\sin 30^\circ - 250\sin 20^\circ$	M1	equate y components and solve
	$= 50.1\,\text{km/hr}$	A1	
	OR triangle with sides 250 V w opposite angles 60° 110° 10°	B1	
	sine rule: $\dfrac{w}{\sin 10^\circ} = \dfrac{250}{\sin 60^\circ}$	M1	apply to correct triangle and solve
	$w = 50.1\,\text{km/hr}$	A1	
	$\dfrac{V}{\sin 110^\circ} = \dfrac{250}{\sin 60^\circ}$	M1	apply to correct triangle and solve
	$V = 271\,\text{km/hr}$	A1	

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