4724 Core Mathematics 4

1	Long Division For leading term $3x^2$ in quotient	B1	
	Suff evid of div process (ax^2, mult back, attempt sub)	M1	
	(Quotient) = $3x^2 - 4x - 5$	A1	
	(Remainder) = $-x + 2$	A1	
	Identity $3x^4 - x^3 - 3x^2 - 14x - 8 = Q(x^2 + x + 2) + R$	*M1	
	$Q = ax^2 + bx + c, R = dx + e$ & attempt ≥ 3 ops.	dep*M1	If $a = 3$, this $\Rightarrow$ 1 operation
	$a = 3, b = -4, c = -5$	A1	dep*M1; Q = $ax^2 + bx + c$
	$d = -1, e = 2$	A1	
	Inspection Use 'Identity' method; if $R = e$, check cf(x) correct before awarding 2nd M1		
		4	
2	Indefinite Integral Attempt to connect $\mathrm{d}x$ & $\mathrm{d}\theta$	*M1	Incl $\frac{\mathrm{d}x}{\mathrm{d}\theta}$ or $\frac{\mathrm{d}\theta}{\mathrm{d}x}$; not $\mathrm{d}x = \mathrm{d}\theta$
	Reduce to $\int 1 - \tan^2\theta \, (\mathrm{d}\theta)$	A1	A0 if $\frac{\mathrm{d}\theta}{\mathrm{d}x} = \sec^2\theta$; but allow all following A marks
	Use $\tan^2\theta = (1, -1) + (\sec^2\theta, -\sec^2\theta)$	dep*M1	
	Produce $\int 2 - \sec^2\theta \, (\mathrm{d}\theta)$	A1	
	Correct √ integration of function of type $d + e\sec^2\theta$	√A1	including $d = 0$
	EITHER Attempt limits change (allow degrees here)	M1	(This is 'limits' aspect; the
	OR Attempt integ, re-subst & use original ($\sqrt{3}, 1$)		integ need not be accurate)
	$\frac{1}{6}\pi - \sqrt{3} + 1$ isw Exact answer required	A1	
		7	

3	**(i)**	$\left(1+\frac{x}{a}\right)^{-2} = 1+(-2)\frac{x}{a}+\frac{-2.-3}{2}\left(\frac{x}{a}\right)^2+\ldots$	M1		Check 3rd term; accept $\frac{x^2}{a}$
		$= 1-\frac{2x}{a}+\ldots$ or $1+\left(-\frac{2x}{a}\right)$	B1		or $1-2xa^{-1}$ (Ind of M1)
		$\ldots + \frac{3x^2}{a^2}+\ldots$ (or $3\left(\frac{x}{a}\right)^2$ or $3x^2a^{-2}$)	A1		Accept $\frac{6}{2}$ for 3
		$(a+x)^{-2} = \frac{1}{a^2}\left\{\text{their expansion of } \left(1+\frac{x}{a}\right)^{-2}\right\}$ mult out	√A1	**4**	$\frac{1}{a^2}-\frac{2x}{a^3}+\frac{3x^2}{a^4}$ **;** accept eg a^{-2}
	(ii)	Mult out $(1-x)$(their exp) to produce all terms/cfs(x^2)	M1		Ignore other terms
		Produce $\frac{3}{a^2}+\frac{2}{a}(=0)$ or $\frac{3}{a^4}+\frac{2}{a^3}$ $(=0)$ or AEF	A1		Accept x^2 if in both terms
		$a=-\frac{3}{2}$ www seen anywhere in (i) or (ii)	A1	**3**	Disregard any ref to $a=0$
			7		
4	**(i)**	Differentiate as a product, $u\,dv + v\,du$	M1		or as 2 separate products
		$\frac{d}{dx}(\sin 2x) = 2\cos 2x$ <u>or</u> $\frac{d}{dx}(\cos 2x) = -2\sin 2x$	B1		
		$e^x(2\cos 2x + 4\sin 2x) + e^x(\sin 2x - 2\cos 2x)$	A1		terms may be in diff order
		Simplify to $5e^x \sin 2x$ www	A1	**4**	Accept $10e^x \sin x \cos x$
	(ii)	Provided result (i) is of form $k\,e^x \sin 2x$, k const			
		$\int e^x \sin 2x\,dx = \frac{1}{k}e^x(\sin 2x - 2\cos 2x)$	B1		
		$[e^x(\sin 2x - 2\cos 2x)]_0^{\frac{1}{4}\pi} = e^{\frac{1}{4}\pi}+2$	B1		
		$\frac{1}{5}\left(e^{\frac{1}{4}\pi}+2\right)$	B1	**3**	Exact form to be seen
		SR Although 'Hence', award M2 for double integration by parts and solving + A1 for correct answer.			
			7		

5 (i)	$\frac{dy}{dx} = \frac{\frac{dy}{dt}}{\frac{dx}{dt}}$ aef used	M1	
	$= \frac{4t+3t^2}{2+2t}$	A1	
	Attempt to find t from one/both equations	M1	<u>or</u> diff (ii) cartesian eqn $\rightarrow$ M1
	State/imply $t = -3$ is only solution of both equations	A1	subst $(3,-9)$, solve for $\frac{dy}{dx} \rightarrow$ M1
	Gradient of curve = $-\frac{15}{4}$ or $\frac{-15}{4}$ or $\frac{15}{-4}$	A1 **5**	grad of curve = $-\frac{15}{4} \rightarrow$ A1

[**SR** If $t = 1$ is given as solution & not disqualified, award A0 + √A1 for grad = $-\frac{15}{4}$ & $\frac{7}{4}$;

If $t = 1$ is given/used as only solution, award A0 + √A1 for grad = $\frac{7}{4}$]

(ii)	$\frac{y}{x} = t$	B1	
	Substitute into either parametric eqn	M1	
	Final answer $x^3 = 2xy + y^2$	A2 **4**	

[**SR** Any correct unsimplified form (involving fractions or common factors) $\rightarrow$ A1]

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6 (i)	$4x \equiv A(x-3)^2 + B(x-3)(x-5) + C(x-5)$	M1	
	$A = 5$	A1	'cover-up' rule, award B1
	$B = -5$	A1	
	$C = -6$	A1 **4**	'cover-up' rule, award B1

Cands adopting other alg. manip. may be awarded M1 for a full satis method + 3 @ A1

(ii)	$\int \frac{A}{x-5} dx = A\ln(5-x)$ or $A\ln\|5-x\|$ or $A\ln\|x-5\|$	√B1	but <u>not</u> $A\ln(x-5)$
	$\int \frac{B}{x-3} dx = B\ln(3-x)$ or $B\ln\|3-x\|$ or $B\ln\|x-3\|$	√B1	but <u>not</u> $B\ln(x-3)$

<u>If candidate is awarded B0,B0</u>, then award **SR** √ B1 for $A\ln(x-5)$ **and** $B\ln(x-3)$

$\int \frac{C}{(x-3)^2} dx = -\frac{C}{x-3}$		√B1	
$5\ln\frac{3}{4} + 5\ln 2$ aef, isw	√ $A\ln\frac{3}{4} - B\ln 2$	√ B1	Allow if **SR** B1 awarded
-3	√ $\frac{1}{2}C$	√B1 **5**	

[Mark at earliest correct stage & isw; no ln 1] **9**

7	**(i)**	Attempt scalar prod {**u**.(4**i** + **k**) or **u**.(4**i** + 3**j** + 2**k**)}= 0	M1	where **u** is the given vector
		Obtain $\frac{12}{13}+c=0$ or $\frac{12}{13}+3b+2c=0$	A1	
		$c=-\frac{12}{13}$	A1	
		$b=\frac{4}{13}$	A1	cao No ft
		Evaluate $\left(\frac{3}{13}\right)^2+(\text{their } b)^2+(\text{their } c)^2$	M1	Ignore non-mention of $\sqrt{\ }$
		Obtain $\frac{9}{169}+\frac{144}{169}+\frac{16}{169}=1$ AG	A1 **6**	Ignore non-mention of $\sqrt{\ }$

	(ii)	Use $\cos\theta=\frac{\boldsymbol{x}.\boldsymbol{y}}{\lvert\boldsymbol{x}\rvert\lvert\boldsymbol{y}\rvert}$	M1	
		Correct method for finding scalar product	M1	
		36° (35.837653…) Accept 0.625 (rad)	A1 **3**	From $\frac{18}{\sqrt{17}\sqrt{29}}$

SR If 4**i**+**k** = (4,1,0) in (i) & (ii), mark as scheme but allow final A1 for 31°(31.160968) or 0.544

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8	**(i)**	$\frac{d}{dx}\left(y^2\right)=2y\frac{dy}{dx}$	B1	
		$\frac{d}{dx}(uv)=u\ dv+v\ du$ used on $(-7)xy$	M1	
		$\frac{d}{dx}\left(14x^2-7xy+y^2\right)=28x-7x\frac{dy}{dx}-7y+2y\frac{dy}{dx}$	A1	(= 0)
		$2y\frac{dy}{dx}-7x\frac{dy}{dx}=7y-28x\rightarrow\frac{dy}{dx}=\frac{28x-7y}{7x-2y}$ www AG	A1 **4**	As AG, intermed step nec

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	(ii)	Subst x = 1 into eqn curve & solve quadratic eqn in y	M1	$(y=3 \text{ or } 4)$
		Subst x = 1 and (one of) their y-value(s) into given $\frac{dy}{dx}$	M1	$\left(\frac{dy}{dx}=7 \text{ or } 0\right)$
		Find eqn of tgt, with their $\frac{dy}{dx}$, going through (1, their y)	*M1	using (one of) y value(s)
		Produce either $y=7x-4$ or $y=4$	A1	
		Solve simultaneously their two equations	dep*M1	provided they have two
		Produce $x=\frac{8}{7}$	A1 **6**	

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9	**(i)**	$\dfrac{20}{k_1}$ (seconds)	B1 **1**	

(ii)	$\dfrac{d\theta}{dt} = -k_2(\theta - 20)$	B1 **1**	

(iii)	Separate variables or invert each side	M1	Correct eqn or very similar
	Correct int of each side (+ c)	A1,A1	for each integration
	Subst $\theta = 60$ when $t = 0$ into eqn containing 'c'	M1	or $\theta = 60$ when t = their $(\mathbf{i})$
	c $(\text{or} - c)$ = ln 40 or $\dfrac{1}{k_2}\ln 40$ or $\dfrac{1}{k_2}\ln 40k_2$	A1	Check carefully their 'c'
	Subst their value of c and $\theta = 40$ back into equation	M1	Use scheme on LHS
	$t = \dfrac{1}{k_2}\ln 2$	A1	Ignore scheme on LHS
	Total time = $\dfrac{1}{k_2}\ln 2 + \text{their (i)}$ (seconds)	√A1 **8**	

SR If the negative sign is omitted in part **(ii)**, allow all marks in **(iii)** with ln 2 replaced by $\ln\frac{1}{2}$.

SR If definite integrals used, allow M1 for eqn where t = 0 and θ = 60 correspond; a second M1 for eqn where t = t and θ = 40 correspond & M1 for correct use of limits. Final answer scores 2.

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