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			
		$\boxed{4}$		

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		
		$\boxed{7}$		

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 $a=0$
			$\boxed{7}$		
4	**(i)**	Differentiate as a product, $u\,\mathrm{d}v+v\,\mathrm{d}u$	M1		or as 2 separate products
		$\frac{\mathrm{d}}{\mathrm{d}x}(\sin 2x)=2\cos 2x$ <u>or</u> $\frac{\mathrm{d}}{\mathrm{d}x}(\cos 2x)=-2\sin 2x$	B1		
		$\mathrm{e}^x(2\cos 2x+4\sin 2x)+\mathrm{e}^x(\sin 2x-2\cos 2x)$	A1		terms may be in diff order
		Simplify to $5\,\mathrm{e}^x\sin 2x$ www	A1	**4**	Accept $10\mathrm{e}^x\sin x\cos x$
	(ii)	Provided result (i) is of form $k\,\mathrm{e}^x\sin 2x$, k const			
		$\int \mathrm{e}^x\sin 2x\,\mathrm{d}x=\frac{1}{k}\mathrm{e}^x(\sin 2x-2\cos 2x)$	B1		
		$[\mathrm{e}^x(\sin 2x-2\cos 2x)]_0^{\frac{1}{4}\pi}=\mathrm{e}^{\frac{1}{4}\pi}+2$	B1		
		$\frac{1}{5}\left(\mathrm{e}^{\frac{1}{4}\pi}+2\right)$	B1	**3**	Exact form to be seen
		SR Although 'Hence', award M2 for double integration by parts and solving + A1 for correct answer.			
			$\boxed{7}$		

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]		
			9	
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 $A\ln\lvert 5-x\rvert$ or $A\ln\lvert x-5\rvert$	√B1	but <u>not</u> $A\ln(x-5)$
		$\int \frac{B}{x-3}\,dx = B\ln(3-x)$ or $B\ln\lvert 3-x\rvert$ or $B\ln\lvert x-3\rvert$	√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 $\frac{12}{13}+c=0$ <u>or</u> $\frac{12}{13}+3b+2c=0$	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

$\boxed{9}$

8	**(i)**	$\frac{\mathrm{d}}{\mathrm{d}x}\left(y^2\right)=2y\frac{\mathrm{d}y}{\mathrm{d}x}$	B1	
		$\frac{\mathrm{d}}{\mathrm{d}x}(uv)=u\ \mathrm{d}v+v\ \mathrm{d}u$ used on $(-7)xy$	M1	
		$\frac{\mathrm{d}}{\mathrm{d}x}\left(14x^2-7xy+y^2\right)=28x-7x\frac{\mathrm{d}y}{\mathrm{d}x}-7y+2y\frac{\mathrm{d}y}{\mathrm{d}x}$	A1	(= 0)
		$2y\frac{\mathrm{d}y}{\mathrm{d}x}-7x\frac{\mathrm{d}y}{\mathrm{d}x}=7y-28x\rightarrow\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{28x-7y}{7x-2y}$ www AG	A1 **4**	As AG, intermed step nec
	(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 $\frac{\mathrm{d}y}{\mathrm{d}x}$	M1	$\left(\frac{\mathrm{d}y}{\mathrm{d}x}=7\ \text{or}\ 0\right)$
		Find eqn of tgt, with their $\frac{\mathrm{d}y}{\mathrm{d}x}$, 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**	

$\boxed{10}$

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 = $\dfrac{1}{k_2}\ln 2 + \text{their}\,(\text{i})$ (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 $\theta = 60$ correspond; a second M1 for eqn where $t = t$ and $\theta = 40$ correspond & M1 for correct use of limits. Final answer scores 2.

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