Question	Scheme	Marks
1(a)	$\mathrm{f}(\pm 2) = a\times(\pm 2)^3 + 7(\pm 2)^2 \pm 46\times 2 + 24$	M1
	[Remainder is] $8a-40$	A1
		(2)
(b)	$8a-40=0 \Rightarrow a=5$ *	B1*
		(1)
(c)	$5x^3+7x^2-46x+24=(x-2)(5x^2+17x-12)$	M1 A1
	$5x^2+17x-12=(5x-3)(x+4)$	dM1
	$[\mathrm{f}(x)]=(x-2)(5x-3)(x+4)$	A1
		(4)
		(7 marks)

Notes:

(a)

M1: Attempts $\mathrm{f}(\pm 2)$

OR Polynomial Division

$$\begin{array}{r l}
 & ax^2+(7+2a)x+4a-32 \\
x-2 \,\big) & ax^3+7x^2-46x+24 \\
 & \underline{ax^3-2ax^2} \\
 & (7+2a)x^2-46x+24 \\
 & \underline{(7+2a)x^2-2(7+2a)x} \\
 & (4a-32)x+24 \\
 & \underline{(4a-32)x-2(4a-32)} \\
 & 8a-40
\end{array}$$

M1 for a complete method to obtain a quotient of $ax^2+\mathrm{f}(a)x+\mathrm{g}(a)$ where f(a) and g(a) are linear in a and then obtains a linear expression in a for the remainder.

OR Tabular method

	ax^2	$(7+2a)x$	$4a-32$
x	ax^3	$(7+2a)x^2$	$(4a-32)x$
-2	$-2ax^2$	$-2(7+2a)x$	$64-8a$

So remainder is $24-(64-8a)$

M1: A complete method as above and reaches a linear expression in a in the bottom right hand box and subtracts it from 24

A1: Correct expression in a [Accept $\mathrm{f}(2)=8a-40$]

Following polynomial division the remainder must be extracted or identified as the remainder.
If their remainder has **not** been clearly identified or extracted, but then used in part (b) then award A1 here.

(b)

B1*: Sets $8a-40=0$ and correctly shows a = 5. Allow a restart, but the work must be correct for this mark, there is no ft.

(c)

M1: Attempts to factor out, or divide through, by the $(x-2)$.

Look for $(x-2)(5x^2+\alpha x+\beta)$ OR $(5x^2+\alpha x+\beta)$ as the quotient from long division where $\alpha,\beta \neq 0$

A1: Correct quadratic factor found.

dM1: Factorises their quadratic factor (usual rules).

A1: Fully factorised cubic all together on one line. Accept $[\mathrm{f}(x)]=5(x-2)\left(x-\frac{3}{5}\right)(x+4)$ but not forms with common factors in the linear terms.

Note: Question specifies all stages of working must be shown, so answers without first finding the quadratic factor score no marks. Accept alternative forms of long division.

Question	Scheme	Marks
2(a)	$\int kx^{-3}+4x^{\frac{3}{2}}\,\mathrm{d}x = k\dfrac{x^{-2}}{-2}+4\dfrac{x^{\frac{5}{2}}}{5/2}\ (+c)$	M1 A1
	$\int_1^4 kx^{-3}+4x^{\frac{3}{2}}\,\mathrm{d}x = \left[-\dfrac{k}{2x^2}+\dfrac{8x^{\frac{5}{2}}}{5}\right]_1^4 = \left(-\dfrac{k}{2\times 16}+\dfrac{8(4)^{\frac{5}{2}}}{5}\right)-\left(-\dfrac{k}{2}+\dfrac{8}{5}\right)$	M1
	$=\dfrac{15k}{32}+\dfrac{248}{5}$	A1
		(4)
(b)	$\dfrac{15k}{32}+\dfrac{248}{5}=50 \Rightarrow k=\ldots$	M1
	$k=\dfrac{64}{75}$ o.e.	A1
		(2)
		(6 marks)

Notes:

(a)

M1: Raises the power by 1 in **both** terms. Need not be simplified

Accept for example, $\alpha x^{-3+1}+\beta x^{\frac{3}{2}+1}$ for this mark.

A1: Correct integral with or without $+c$. Need not be simplified although indices must be simplified for this mark. Look for $k\dfrac{x^{-2}}{-2}+4\dfrac{x^{\frac{5}{2}}}{5/2}$ as a minimum.

M1: Substitutes and subtracts either way around into an expression with changed indices.

A1: Correct simplified answer. Accept e.g., $\dfrac{75k+7936}{160}$

condone e.g., $0.46875k+49.6$ with no rounded decimals.

(b)

M1: Sets the result of their changed expression from (a) [provided it is a linear expression of least **2 terms** in terms of k] equal to 50, and solves to find k

A1: Correct answer from a correct equation. Accept equivalent fractions and also accept $0.85\dot{3}$

Question	Scheme	Marks
3(a)	$u_2 = \frac{3}{2}(5) - \frac{1}{2}(5)^2 + 4 = ...(=-1)$	M1
	$u_3 = \frac{3}{2}("-1") - \frac{1}{2}("-1")^2 + 4 = (2),\ u_4 = \frac{3}{2}("2") - \frac{1}{2}("2")^2 + 4 = (5)\ [= u_1]$	M1
	e.g., $(u_4 = u_1)$ (so sequence is periodic) with period 3.	A1
		(3)
(b)	$u_{200} = -1$	B1
		(1)
(c)	$\sum_{r=1}^{200} u_r = (u_1 + u_2 + u_3) + ... + (u_{196} + u_{197} + u_{198}) + [+u_{199} + u_{200}]$	M1
	$= 66 \times (5 - 1 + 2) + 5 - 1$ OR $= 67 \times (5 - 1 + 2) - 2$	M1
	$= 400$	A1
		(3)
		(7 marks)

Notes:

(a)

M1: Substitutes 5 into the equation to find u_2

M1: Continue by using their u_2 to find the next term(s) until a repeat is found.

A1: All terms correct, (concludes periodic) **and** states period is 3

Accept either $u_1 = u_4$ or $(u_1 = 5$ and$)$ $u_4 = 5$ seen in the working with a conclusion

(b)

B1: Correct value coming from a correct sequence.

(c)

M1: Attempts to group the sum into multiples of the **three** term sum. Look for any attempt at using a multiple of the sum of their terms from part (a) e.g $\alpha(5 - 1 + 2)$ where α is an integer.

M1: Splitting the sum correctly to get 66 sets of 3 and the extra terms, or 67 sets of 3 minus one term

A1: For 400

Question	Scheme	Marks
4(a)	$\dfrac{dy}{dx}=ax^2+b+\dfrac{c}{x^2}$	M1
	$\dfrac{dy}{dx}=6x^2+7-\dfrac{3}{x^2}$	A1
	$6x^2+7-\dfrac{3}{x^2}=0\Rightarrow 6x^4+7x^2-3=0\Rightarrow(3x^2-1)(2x^2+3)=0\Rightarrow x^2=\ldots$	M1
	$\left[x^2=-\dfrac{3}{2}\text{ impossible}\right]x^2=\dfrac{1}{3}\Rightarrow(x=)\pm\dfrac{1}{\sqrt{3}}$	A1
		(4)
(b)	$6x^2+7-\dfrac{3}{x^2}\geqslant 0\Rightarrow 6x^4+7x^2-3\geqslant 0\ \left(\text{as } x^2\geqslant 0\right)$	
	So need $"3x^2-1"\geqslant 0\Rightarrow x\leqslant"-\dfrac{1}{\sqrt{3}}", x\geqslant"\dfrac{1}{\sqrt{3}}"$	M1
	$x\leqslant-\dfrac{1}{\sqrt{3}}, x\geqslant\dfrac{1}{\sqrt{3}}$ or $x<-\dfrac{1}{\sqrt{3}}, x>\dfrac{1}{\sqrt{3}}$	A1
		(2)
		(6 marks)

Notes:

(a)

M1: Differentiates with power decreased by 1 in at least two of the three terms

A1: Correct derivative. Coefficients need not be simplified, but indices must be simplified.

M1: Sets equal to 0, multiplies through and attempts to solve the **quadratic** in x^2 vis a non-calculator method reaching at least **one value for** x^2. **They must show us their method for solving the 3TQ in x^2 explicitly.** (Allow any letter to substitute for x^2)

A1: Correct values only with no other values given.

(b)

M1: Selects the outside region for **their** values.

A1: Correct range, accept with loose or strict inequalities.

Accept any valid notation.

For example:

$\left\{x:x\leqslant-\dfrac{1}{\sqrt{3}}\right\}\cup\left\{x:x\geqslant\dfrac{1}{\sqrt{3}}\right\}$ or $\left\{x:x<-\dfrac{1}{\sqrt{3}}\right\}\cup\left\{x:x>\dfrac{1}{\sqrt{3}}\right\}$

$x\leqslant-\dfrac{1}{\sqrt{3}}$ OR $x\geqslant\dfrac{1}{\sqrt{3}}$ Do not accept $x\leqslant-\dfrac{1}{\sqrt{3}}$ AND $x\geqslant\dfrac{1}{\sqrt{3}}$ for the **A** mark

Question	Scheme	Marks
5(a)	$\frac{1}{2}\times\underline{0.25}\underline{\underline{\left(5.389+6.469+2\left(6.231+6.815+7.028+6.901+6.732\right)\right)}}$	<u>B1</u> <u>M1</u>
	$\left(=\frac{1}{8}\times\left(11.858+2\left(33.707\right)\right)=\frac{1}{8}\times 79.272\right)$	
	= awrt 9.91	A1
		(3)
(b)	$\int\sqrt{x}\left(3+\frac{1}{x^2}\right)\mathrm{d}x=\int\left(3x^{\frac{1}{2}}+x^{-\frac{3}{2}}\right)\mathrm{d}x=\ldots x^{\frac{3}{2}}\pm\ldots x^{-\frac{1}{2}}$	M1
	$=2x^{\frac{3}{2}}-2x^{-\frac{1}{2}}\ (+c)$	A1A1
		(3)
(c)	$\int_3^{4.5}\sqrt{x}\left(3+\frac{1}{x^2}\right)\mathrm{d}x=\left(2(4.5)^{\frac{3}{2}}-2(4.5)^{-\frac{1}{2}}\right)-\left(2(3)^{\frac{3}{2}}-2(3)^{-\frac{1}{2}}\right)=\ldots(8.911\ldots)$ $\Rightarrow$ Area $R=\text{"}9.909\text{"}-\text{"}8.911\text{"}=\ldots$	M1
	= awrt 1.0	A1
		(2)
		(8 marks)

Notes:

(a)

B1: For using $h = 0.25$ or equivalent for the width in an attempt at the trapezium rule. Must be used as part of the attempt, not just stated separately.

M1: Correct bracket structure for the trapezium rule.

$$\ldots\ldots\ldots\ldots\underline{\underline{\left(5.389+6.469+2\left(6.231+6.815+7.028+6.901+6.732\right)\right)}}$$

Look for first + last y values + 2(attempt at sum of remaining values). If one value is missing, allow the M as a slip, but M0 if 1st or last value repeated. Must be y values used.

A1: awrt 9.91

(b)

M1: Expands the brackets and attempts to integrate, look for power increasing by 1 at least once in either a term with power $\frac{1}{2}$ or $-\frac{3}{2}$

A1: One of the two terms correct. Need not be simplified for this mark.

A1: Both terms correct (no need for c). Must be simplified coefficients. Accept equivalents, e.g. $2\left(\sqrt{x^3}-\frac{1}{\sqrt{x}}\right)$ or $2\left(\frac{x^2-1}{\sqrt{x}}\right)$

(c)

M1: Applies limits 3 and 4.5 to their answer to (b) and attempts to subtract the result from the answer to (a).

.**A1:**, awrt 1.0 isw Note: Allow an answer of $9.91 - 8.91 = 1$ following correct work.

Question	Scheme	Marks
6(i)	E.g $7^{x+3}=5\Rightarrow(x+3)\log 7=\log 5\Rightarrow x=\dfrac{\log 5}{\log 7}-3$ or $x+3=\log_7 5\Rightarrow x=...$ Alt: $7^{x+3}=5\Rightarrow 7^x=\dfrac{5}{7^3}\Rightarrow x=\log_7\dfrac{5}{343}$	M1
	$=-2.17$	A1
		(2)
(ii)(a)	$\log_8 64y^3=\log_8 64+\log_8 y^3$ or $\log_8 y^3=3\log_8 y$ or $\log_8 64=2$ Or $\log_8\left(64y^3\right)\Rightarrow\log_8\left(4y\right)^3\Rightarrow 3\log_8\left(4y\right)$ or $\log_8 4=\dfrac{2}{3}$	M1
	$18\left(\log_8 y\right)^2+5\log_8\left(64y^3\right)=73\Rightarrow 18\left(\log_8 y\right)^2+5\log_8 64+5\log_8 y^3=73$ $\Rightarrow 18\left(\log_8 y\right)^2+5\times 2+15\log_8 y=73$	dM1
	$\Rightarrow 18\left(\log_8 y\right)^2+15\log_8 y-63=0\Rightarrow 6\left(\log_8 y\right)^2+5\log_8 y-21=0$ *	A1*
		(3)
(b)	$\left(2\log_8 y-3\right)\left(3\log_8 y+7\right)=0\Rightarrow\log_8 y=\dfrac{3}{2},-\dfrac{7}{3}\Rightarrow y=8^k$	M1
	e.g $y=8^{\frac{3}{2}}$ or $8^{-\frac{7}{3}}$ oe	A1
	e.g $16\sqrt{2}$ or $\sqrt{512}$ and $\dfrac{1}{128}$ oe	A1
		(3)
		(8 marks)

Notes:

(i)

M1: Correct method for solving to find x, e.g. takes logs and rearranges, as shown in scheme. May divide through by 7^3 first or take log to base 7. There must be evidence of correct use of logs.

A1: Correct answer, accept awrt -2.17

(ii)(a)

M1: Attempt the sum or power law of logs on the $\log_8 64y^3$ or applies $\log_8 64=2$ in the proof or

Note this cannot be scored for an attempt at $\left(\log_8 y\right)^2=2\log_8 y$

dM1: Correct use of both the sum and the power law of logs seen or implied on the $\log_8 64y^3$ term and simplifies the $\log_8 64$ to achieve a quadratic in any form.

A1*: Correctly rearranges to the printed equation **with no errors seen** and use of the log laws clear.

(b)

M1: Solves the **given** quadratic and uses a correct method to obtain at least one solution for y from an equation of form $\log_8 y=k$. i.e., $\log_8 y=k\Rightarrow y=8^k$. Accept a calculator method to solve the 3TQ.

A1: At least one correct **exact** answer in either exponential or numerical form.

A1: Both correct, accepting any equivalent **exact** forms. ie., exponential or numerical

Question	Scheme	Marks
7(a)	$(3,6)$	B1
		(1)
(b)	Gradient $=\dfrac{6-0}{3-0}(=2)$	M1
	Hence equation of l is $y=2x$	A1
		(2)
(c)	Distance from O to centre is $\sqrt{3^2+6^2}=...\left(=3\sqrt{5}\right)$	M1
	$\Rightarrow r=3\sqrt{5}\pm\sqrt{5}$	M1
	For radius either $2\sqrt{5}$ or $4\sqrt{5}$ or one correct value for k	A1
	For both 20 and 80	A1
		(4)
		(7 marks)

Notes:

(a)
B1: Correct centre. Allow $x=3,\ y=6$
(b)
M1: Attempts the gradient from O to the centre. May be implied by $\pm\dfrac{6}{3}$ ft their centre.

OR from the equation $y=2x$ seen.
A1: Correct equation from correct centre.

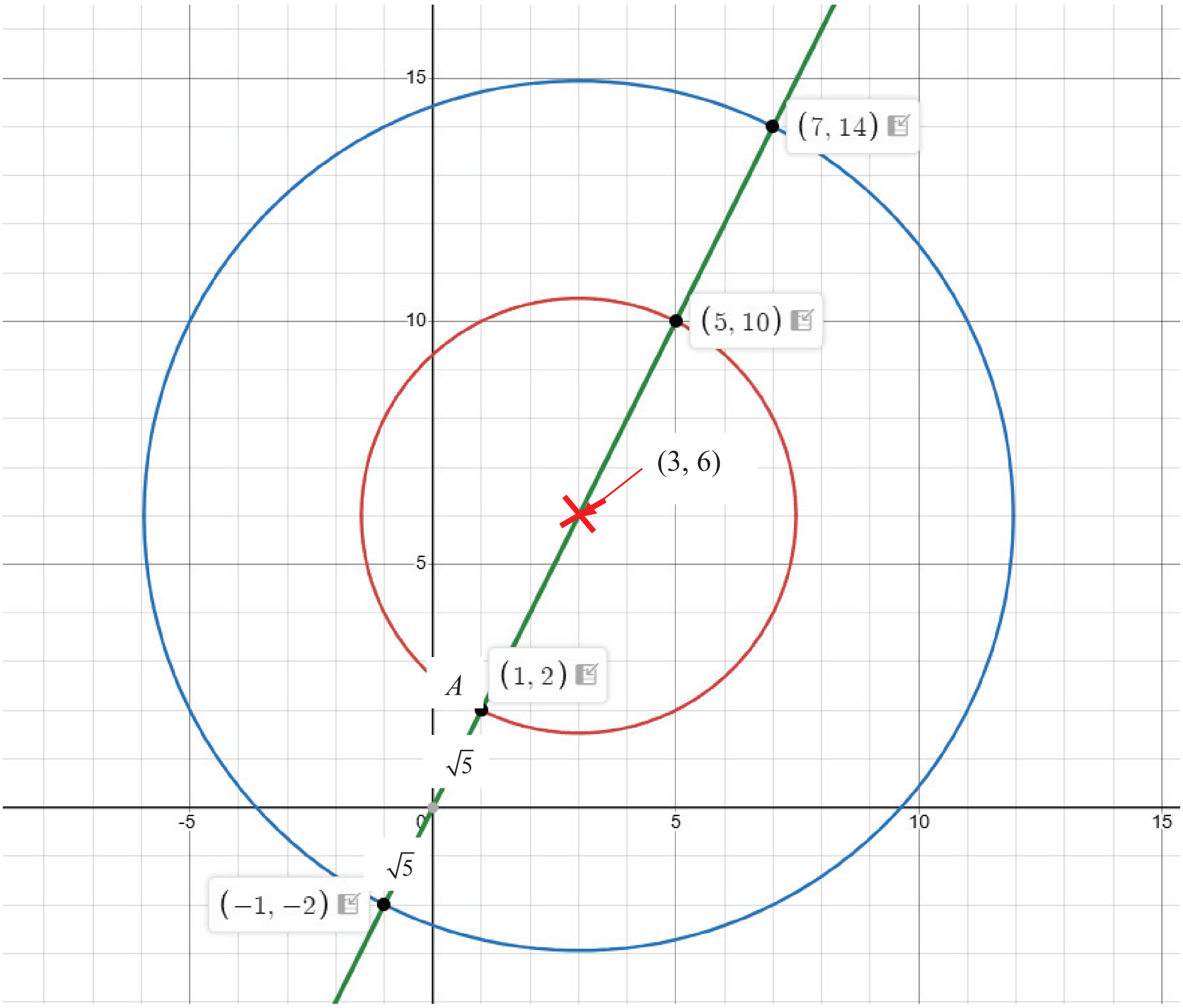
(c)
M1: Attempts the distance from the origin to the centre of the circle.
M1: Finds the radius as the sum or difference of their distance and $\sqrt{5}$
A1: For one of the two possible radii correct or one of the two possible values for k correct.
A1: Both values correct.

Question	Scheme	Marks
Alt 1(c)	A lies on the line $y=2x\Rightarrow x^2+(2x)^2=\left(\sqrt{5}\right)^2\Rightarrow x=...$	M1
	$\Rightarrow k=(\text{"}\pm1\text{"}-3)^2+(\text{"}\pm2\text{"}-6)^2=...$	M1
	One of 20 or 80 ; both 20 and 80	A1;A1
		(4)

M1: Uses the equation to obtain a general point on the line and applies distance $OA=\sqrt{5}$ to find at least one x coordinate.
M1: Uses their coordinates of A to find at least one value for k using the circle equation.
A1: One of the two possible values for k correct.
A1: Both values correct.

<table>
<tr><td rowspan="4">Alt 2 (c)</td><td>Deduces that as A lies on $y=2x$ then
EITHER $\sqrt{5}=\sqrt{1^2+2^2}$ OR $\sqrt{5}=\sqrt{(-1)^2+(-2)^2}$</td><td>M1</td></tr>
<tr><td>$\Rightarrow k=(\text{"}\pm 1\text{"}-3)^2+(\text{"}\pm 2\text{"}-6)^2=...$</td><td>M1</td></tr>
<tr><td>One of 20 or 80 ; both 20 and 80</td><td>A1;A1</td></tr>
<tr><td></td><td>(4)</td></tr>
<tr><td colspan="3">M1: Deduces that the coordinates of A must be either (1, 2) or $(-1,-2)$
M1: Uses their coordinates of A to find at least one value for k using the circle equation.
A1: One of the two possible values for k correct.
A1: Both values correct.</td></tr>
</table>

USEFUL SKETCH



Question	Scheme	Marks
8(a)	$(k+4x)^{12} = k^{12} + \dots$	B1
	$+\underline{\binom{12}{1}}k^{11}(4x)^1 + \underline{\binom{12}{2}}k^{10}(4x)^2 + \underline{\binom{12}{3}}k^9(4x)^3 + \dots$	M1
	$(k+4x)^{12} = k^{12} + 48k^{11}x + 1056k^{10}x^2 + 14080k^9x^3 + \dots$	A1A1
		(4)
(b)	$14080k^9 = \frac{55}{2} \Rightarrow k^9 = \frac{1}{512} \Rightarrow k = \dots$	M1
	$k = \frac{1}{2}$	A1
		(2)
(c)	$"48\left(\frac{1}{2}\right)^{11}"$ or $"1056\left(\frac{1}{2}\right)^{10} \times 2"$	M1
	$48\left(\frac{1}{2}\right)^{11} + 1056\left(\frac{1}{2}\right)^{10} \times 2 = \dots = \frac{267}{128}$	dM1A1
		(3)
		(9 marks)

Notes:

(a)
B1: For the correct constant term of k^{12} in their expression. They may have initially factored out the k, but must achieve the correct constant in the final expression for this mark.
M1: Correct binomial coefficients linked with **correct** powers of x in their expansion. Accept alternative notation, such as ${}^{12}C_1$ or just 12, 66, 220, for the coefficients. (The power 1 need not be seen.) The powers of 4 and k may be missing or incorrect.
ALT for the M mark

$$k^{12}\left(1+\frac{4x}{k}\right)^{12} = \left[k^{12}\right]\left(1+\underline{12}\times\left(\frac{4\underline{x}}{k}\right)+\left[\underline{\frac{12\times 11}{2!}}\right]\times\left(\frac{4\underline{x}}{k}\right)^{\underline{2}}+\left[\underline{\frac{12\times 11\times 10}{3!}}\right]\times\left(\frac{4\underline{x}}{k}\right)^{\underline{3}}+\right)$$

With **correct** coefficients (with the correct denominators [2 and 6 oe]) and with the **correct** power of x
A1: Any two of the final three terms correct and simplified
A1: All three of the final terms correct and simplified.
Note: Students may attempt to take out a common factor of k^{12} first. In such cases the **B** mark is for correct constant term in their final expansion, **M** follows as above, correct coefficients linked to correct powers of x. The first **A** can be awarded as above or SC $k^{12}\left(1+\frac{48}{k}x+\frac{1056}{k^2}x^2+\frac{14080}{k^3}x^3\right)$ (oe), final **A** as scheme

(b) **M1:** Sets their x^3 coefficient equal to $\frac{55}{2}$ and proceeds to a value for *k*. They must have had a *k* in their coefficient. **A1:** Correct answer. **(c)** **M1:** Correct attempt for at least one of the two terms in y^3 in the expansion • Using their coefficients from (a) (which may not have involved *k*). • Realises the *y*'s are squared. • May be part of an attempt at a full expansion. Allow with *k* or their value of *k*. **dM1:** Correct attempt at finding both terms and adding, must have both involved *k* (which may be left as *k*), but otherwise follow through their attempt at (a). May be part of an attempt at a full expansion. **A1:** Correct answer, accept $\frac{267}{128}y^3$, but must have been extracted from a full expansion and identified as the answer.

Question	Scheme	Marks
9(a)	At 12 noon $t=(12-8)=4$ so $\theta=17+5\sin\left(\frac{4\pi}{12}\right)$	M1
	$\theta=17+5\sin\left(\frac{4\pi}{12}\right)=(17+4.33...)\approx 21.3(°\text{C})$	A1
		(2)
	Alt: Working backwards from the given answer	
	$21.3=17+5\sin\left(\frac{\pi t}{12}\right)\Rightarrow\sin\left(\frac{\pi t}{12}\right)=\frac{43}{50}\Rightarrow t=\frac{12}{\pi}\arcsin\left(\frac{43}{50}\right)=...$	M1
	$t\approx 4$ with a conclusion; 8am + 4 = 12 noon	A1
		(2)
(b)	$17+5\sin\left(\frac{\pi T}{12}\right)=16+6\sin\left(\frac{\pi T}{12}\right)+3\cos^2\left(\frac{\pi T}{12}\right)$ Use of: $\cos^2\left(\frac{\pi T}{12}\right)=1-\sin^2\left(\frac{\pi T}{12}\right)$	M1 B1
	$3\sin^2\left(\frac{\pi T}{12}\right)-\sin\left(\frac{\pi T}{12}\right)-2=0\,*$	A1*
		(3)
(c)	$\Rightarrow\left(3\sin\left(\frac{\pi T}{12}\right)+2\right)\left(\sin\left(\frac{\pi T}{12}\right)-1\right)=0\Rightarrow\sin\left(\frac{\pi T}{12}\right)=-\frac{2}{3},1$	B1
	$\Rightarrow T=\frac{12}{\pi}\left[(\pi-)\arcsin\left(-\frac{2}{3}\right)\right]$ or $\frac{12}{\pi}\left[\arcsin\left(-\frac{2}{3}\right)+2\pi\right]$ or $T=\frac{12}{\pi}\arcsin(1)$	M1
	$T=6,\text{awrt}\,14.8,\text{awrt}\;21.2$	A1A1 A1
		(5)
		(10 marks)

Notes:

(a)
M1: Substitutes $t=4$ into the equation.
A1: Correct expression **seen** leading to awrt 21.3
Note: This is a show question and using $t=8$ leading to a value of $\theta=21.3$ is M0A0
Alt
M1: Substitutes 21.3 into the equation and works backwards to find a value for T
Allow working in degrees for the M mark
A1: Correct value for T with a conclusion that 8 am + 4 hrs = 12 noon.

(b)

M1: Sets the two equations equal.

B1 [M1 in Epen]: For use of **correct** Pythagorean identity to form an expression in just sine. This mark is specifically for the **correct** use of $\cos^2\left(\frac{\pi T}{12}\right)=1-\sin^2\left(\frac{\pi T}{12}\right)$

A1*: Correct simplified quadratic with no errors seen. Allow with t or T.

(c)

B1: Correct roots of quadratic seen – **both required**. Allow these value from a substitution for $\sin\left(\frac{\pi T}{12}\right)$, for example $x=-\frac{2}{3}$, 1 seen, but do **not** isw if one of these values is 'rejected'.

M1: Uses arcsin with any of their solutions and rearranges to find a value for T (or t). Can be scored from any equation $\sin\left(\frac{\pi T}{12}\right)=k$ where $|k|\leqslant 1$, Allow for any appropriate solution (including negatives). E.g. if $\sin\left(\frac{\pi T}{12}\right)=-\frac{2}{3}$ or $\sin\left(\frac{\pi T}{12}\right)=1$ has been found then any of -2.787, 14.787, 21.213 or 6 can imply this mark (if method not explicitly shown).

Note: If they work in degrees they must convert $\frac{\pi}{12}=15°$ otherwise it is M0

A1: At least one correct positive value for T or t (awrt 3 s.f. where appropriate). See scheme for answers

A1: Two correct values

A1: All three values correct to 3.s.f. as appropriate.

Ignore any extra values outside of the range – withhold this mark for extra values within range.

Question	Scheme	Marks
10(i)	Two of : $f(3)=504-(119+216)=\ldots, f(4)=672-(119+384)=\ldots,$ $f(5)=840-(119+600)=\ldots, f(6)=1008-(119+864)=\ldots$	**M1**
	All of the above, with at least two correct values.	**M1**
	So $f(1)=25=5^2=f(6), f(2)=121=11^2=f(5), f(3)=169=13^2=f(4)$ hence all are perfect squares.	**A1**
	<table><tr><th>Value of n</th><th>Value of f(n)</th></tr><tr><td>1</td><td>$25=5^2$</td></tr><tr><td>2</td><td>$121=11^2$</td></tr><tr><td>3</td><td>$169=13^2$</td></tr><tr><td>4</td><td>$169=13^2$</td></tr><tr><td>5</td><td>$121=11^2$</td></tr><tr><td>6</td><td>$25=5^2$</td></tr></table>	
		(3)
(ii)	$${}^nC_r+{}^nC_{r+1}=\frac{n!}{r!(n-r)!}+\frac{n!}{(r+1)!(n-(r+1))!}$$ $$\left[(n-r)!=(n-r)(n-r-1)!\Rightarrow(n-(r+1))!=\frac{(n-r)!}{(n-r)}\right]$$	**M1**
	$$=\frac{n!(r+1)}{(r+1)!(n-r)!}+\frac{n!(n-r)}{(r+1)!(n-r)!}$$ **OR** $$\frac{n!(n-r-1)!(r+1)!+n!r!(n-r)!}{r!(n-r)!(r+1)!(n-r-1)!}$$	**dM1**
	$$=\frac{n!(r+1+n-r)}{(r+1)!(n-r)!}$$ **OR** $$\frac{n![(n-r-1)!(r+1)!+r!(n-r)!]}{r!(n-r)!(r+1)!(n-r-1)!}$$	**ddM1**
	$$=\frac{n!(n+1)}{(r+1)!(n-r)!}=\frac{(n+1)!}{(r+1)!((n+1)-(r+1))!}={}^{n+1}C_{r+1}\ *$$	**A1***
		(4)
		(7 marks)

Notes:

(i)

M1: Attempts f(n) for at least two values between 3 and 6 inclusive (need not be correct values), but if the values are incorrect, working must be seen with values obtained.

M1: Attempts all 4 remaining values, with at least two correct values.
A1: All remaining values for f(n) for n = 3 to 6 attempted with correct values found, shown to be squares and minimal conclusion.
Note: If all valid values are correct, but f (0) and/or f (7) are also included, do not award the A mark in (i)
(ii)
M1: Attempts the sum of the binomial coefficients using the formula.
Allow a slip in $(n-r+1)!$ instead of $(n-r-1)!$
dM1: Puts the terms over a common denominator which need not be simplified in either one of the two forms shown.
ddM1: Factorises the numerator which need not be simplified in either of one of the two forms shown.
A1*: Achieves the correct form for the new coefficient from correct work and deduces equal to the required coefficient. Must achieve the correct expression with $(n + 1) - (r + 1)$ shown.

Alt (ii)	$^{n+1}C_{r+1} - {}^nC_{r+1} = \dfrac{(n+1)!}{(r+1)!(n+1-r-1)!} - \dfrac{n!}{(r+1)!(n-(r+1))!}$	**M1**
	$= \dfrac{(n+1)\times n!}{(r+1)!(n-r)\times(n-r-1)!} - \dfrac{n!}{(r+1)!(n-r-1)!} = \dfrac{n!}{(r+1)!(n-r-1)!}\times\left(\dfrac{n+1}{n-r}-1\right)$	**dM1**
	$= \dfrac{n!}{(r+1)!(n-r-1)!}\times\left(\dfrac{r+1}{n-r}\right)$	**ddM1**
	$= \dfrac{n!}{r!(n-r)!} = {}^nC_r \Rightarrow {}^nC_r + {}^nC_{r+1} = {}^{n+1}C_{r+1}$ *	**A1***
		(4)

Notes:
Alt (ii) **M1:** Attempts the shown difference of binomial coefficients using the formula. Allow if slips are made in the signs, e.g. $(n-r+1)!$ instead of $(n-r-1)!$ **dM1:** Splits the factorials and takes out the common factor. Alt per main scheme is putting over a common denominator but with the difference instead of sum. The denominator need not be simplified. **ddM1:** Simplifies the factored term to a single fraction (oe if putting over common denominator). **A1*:** Deduces equal to the required coefficient and concludes the requisite result.