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)	$17+5\sin\left(\frac{\pi T}{12}\right)=16+6\sin\left(\frac{\pi T}{12}\right)+3\cos^2\left(\frac{\pi T}{12}\right)$	**M1**
	Use of: $\cos^2\left(\frac{\pi T}{12}\right)=1-\sin^2\left(\frac{\pi T}{12}\right)$	**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 $\frac{\pi}{12}=15^{\circ}$ 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 : $f(3)=504-(119+216)=...,f(4)=672-(119+384)=...,$ $f(5)=840-(119+600)=...,f(6)=1008-(119+864)=...$	**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**
	Value of *n* / **Value of f(*n*)**: 1 → $25=5^2$; 2 → $121=11^2$; 3 → $169=13^2$; 4 → $169=13^2$; 5 → $121=11^2$; 6 → $25=5^2$	
		(3)
(ii)	$^nC_r+{}^nC_{r+1}=\dfrac{n!}{r!(n-r)!}+\dfrac{n!}{(r+1)!(n-(r+1))!}$ $\left[(n-r)!=(n-r)(n-r-1)!\Rightarrow(n-(r+1))!=\dfrac{(n-r)!}{(n-r)}\right]$	**M1**
	$=\dfrac{n!(r+1)}{(r+1)!(n-r)!}+\dfrac{n!(n-r)}{(r+1)!(n-r)!}$ **OR** $\dfrac{n!(n-r-1)!(r+1)!+n!r!(n-r)!}{r!(n-r)!(r+1)!(n-r-1)!}$	**dM1**
	$=\dfrac{n!(r+1+n-r)}{(r+1)!(n-r)!}$ **OR** $\dfrac{n!\left[(n-r-1)!(r+1)!+r!(n-r)!\right]}{r!(n-r)!(r+1)!(n-r-1)!}$	**ddM1**
	$=\dfrac{n!(n+1)}{(r+1)!(n-r)!}=\dfrac{(n+1)!}{(r+1)!((n+1)-(r+1))!}={}^{n+1}C_{r+1}$ *	**A1***
		(4)
		(7 marks)
Notes:		
(i)		