Question	Scheme	Marks	AOs
1(a)	$16+(21-1)\times d=24 \Rightarrow d=...$	M1	1.1b
	$d=0.4$	A1	1.1b
	Answer only scores both marks.		
		(2)	
(b)	$S_n=\frac{1}{2}n\{2a+(n-1)d\} \Rightarrow S_{500}=\frac{1}{2}\times 500\{2\times 16+499\times "0.4"\}$	M1	1.1b
	$=57900$	A1	1.1b
	Answer only scores both marks		
		(2)	
	(b) Alternative using $S_n=\frac{1}{2}n\{a+l\}$		
	$l=16+(500-1)\times "0.4"=215.6 \Rightarrow S_{500}=\frac{1}{2}\times 500\{16+"215.6"\}$	M1	1.1b
	$=57900$	A1	1.1b
		(4 marks)	

Notes

(a)

M1: Correct strategy to find the common difference – must be a correct method using a = 16, and n = 21 and the 24. The method may be implied by their working.

If the AP term formula is quoted it must be correct, so use of e.g. $u_n=a+nd$ scores M0

A1: Correct value. Accept equivalents e.g. $\frac{8}{20}, \frac{4}{10}, \frac{2}{5}$ etc.

(b)

M1: Attempts to use a correct sum formula with a = 16, n = 500 and their numerical d from part (a)

If a formula is quoted it must be correct (it is in the formula book)

A1: Correct value

Alternative:

M1: Correct method for the 500th term and then uses $S_n=\frac{1}{2}n\{a+l\}$ with their l

A1: Correct value

Note that some candidates are showing implied use of $u_n=a+nd$ by showing the following:

(a) $d=\frac{24-16}{21}=\frac{8}{21}$ (b) $S_{500}=\frac{1}{2}\times 500\left\{2\times 16+499\times\frac{8}{21}\right\}=55523.80952...$

This scores (a) M0A0 (b) M1A0

Question	Scheme	Marks	AOs
2 (i)	States that $S = a + (a+d) + ... + (a + (n-1)d)$	B1	1.1a
	$S = \quad a + \quad . \quad (a+d) + \quad (a+(n-1)d)$ $S = (a+(n-1)d) + (a+(n-2)d) + ... + a$	M1	3.1a
	Reaches $2S = n \times (2a + (n-1)d)$ And so proves that $S = \frac{n}{2}[2a + (n-1)d]$ *	A1*	2.1
		(3)	
(ii)	(a) $S = 10 + 9.20 + 8.40 + ...$		
	$64 = \frac{n}{2}(20 - 0.8(n-1))$ o.e	M1	3.1b
	$128 = 20n - 0.8n^2 + 0.8n$ $0.8n^2 - 20.8n + 128 = 0$ $n^2 - 26n + 160 = 0$ *	A1*	2.1
		(2)	
	(b) $n = 10, 16$	B1	1.1b
		(1)	
	(c) 10 weeks with a minimal correct reason. E.g. • He has saved up the amount by 10 weeks so he would not save for another 6 weeks • You would choose the smaller number • He starts saving negative amounts (in week 14) so 16 does not make sense	B1	2.3
		(1)	
			(7 marks)
Notes:			

(i)

B1: Correctly writes down an expression for the key terms S or S_n including S = or S_n =

Allow a minimum of 3 correct terms including the first and last terms, and no incorrect terms.

Score for S or $S_n = a + (a+d) + ... + (a + (n-1)d)$ with + signs, not commas

If the series contains extra terms that should not be there E.g

$S = a + (a+d) + ...(\boldsymbol{a + nd}) + (a + (n-1)d)$ score B0

M1: For the key step in reversing the terms and adding the two series.

Look for a minimum of two terms, including a and $a+(n-1)d$, the series reversed with evidence of adding, for example $2S =$ Condone the extra incorrect terms (see above) appearing.

Can be scored when terms are separated by commas

A1*: Shows correct work (no errors) with all steps shown leading to given answer.

There should be no incorrect terms. A minimum of 3 terms should be shown in each sum

The solution below is a variation of this.

$$S = a + (a+d) + \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots + l$$

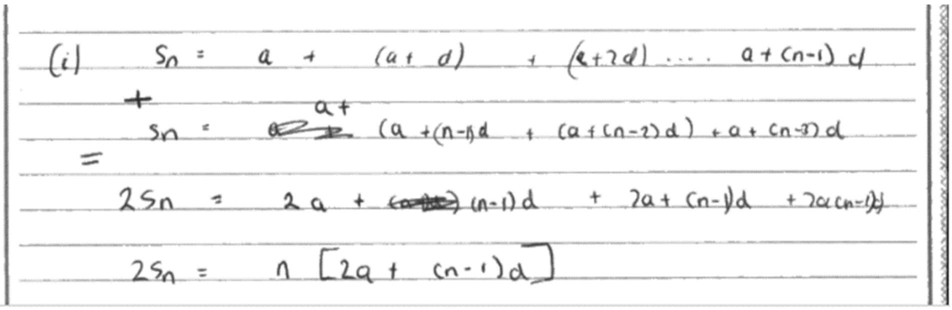
$$S = l + (l-d) + \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots + a$$

$$2S = n(a+l)$$

$$S = \frac{n}{2}(a+l) = \frac{n}{2}(a+a+(n-1)d) = \frac{n}{2}(2a+(n-1)d)$$

B1 and A1 are not scored until the last line, M scored on line 3

The following scores B1 M0 A0 as the terms in the second sum are not reversed



(i) $S_n = a + (a+d) + (a+2d) \dots\; a+(n-1)d$

$+$

$S_n = a + (a+(n-1)d + (a+(n-2)d) + a+(n-3)d$

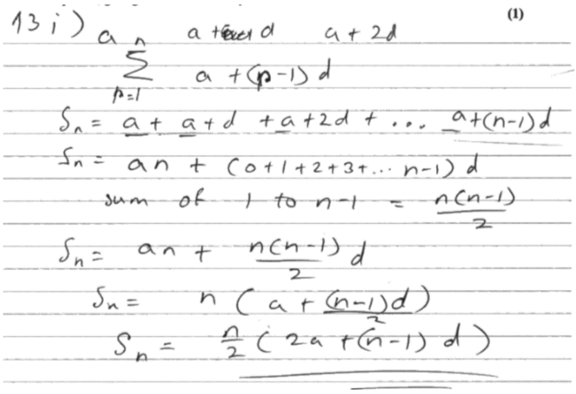
$=$

$2S_n = 2a + (n-1)d + 2a + (n-1)d + 2a(n-1)d$

$2S_n = n[2a + (n-1)d]$

SC in (a) Scores B1 M0 A0.

They use $0+1+2+\dots+(n-1) = \dfrac{n(n-1)}{2}$ which relies on the quoted proof.



13 i) $a_n \quad a+d \quad a+2d$ (1)

$\sum_{p=1} a + (p-1)d$

$S_n = a + a+d + a+2d + \dots\; a+(n-1)d$

$S_n = an + (0+1+2+3+\dots n-1)d$

sum of 1 to $n-1 = \dfrac{n(n-1)}{2}$

$S_n = an + \dfrac{n(n-1)}{2}d$

$S_n = n\left(a + \dfrac{(n-1)d}{2}\right)$

$S_n = \dfrac{n}{2}(2a + (n-1)d)$

(ii) (a)

M1: Uses the information given to set up a correct equation in *n*.

The values of *S*, *a* and *d* need to be correct and used within a correct formula

Possible ways to score this include unsimplified versions $64 = \frac{n}{2}(2\times10+(n-1)\times-0.8)$,

$64 = \frac{n}{2}(10+10+(n-1)\times-0.8)$ or versions using pence rather than £'s $6400 = \frac{n}{2}(2000+(n-1)\times-80)$

Allow recovery for both marks following $64 = \frac{n}{2}(2\times10+(n-1)-0.8)$ with an invisible ×

A1*: Proceeds without error to the given answer. (Do not penalise a missing final trailing bracket)

Look for at least a line with the brackets correctly removed as well as a line with the terms in *n* correctly combined

E.g. $64 = \frac{n}{2}(20+(n-1)\times-0.8) \Rightarrow 64 = 10n - 0.4n^2 + 0.4n \Rightarrow 0.4n^2 - 10.4n + 64 = 0 \Rightarrow n^2 - 26n + 160 = 0$

(ii)(b)

B1: $n = 10, 16$

(ii)(c)

B1: Chooses 10 (weeks) and gives a minimal acceptable reason. The reason must focus on why the answer is 10 (weeks) rather than 16(weeks) or alternatively why it would not be 16 weeks.

Question	Scheme	Marks	AOs
3(a)(i)	$a_1 = 3,\ a_2 = 5,\ a_3 = 3\ ...$	B1	1.1b
(ii)	2	B1	1.1b
		(2)	
(b)	$\sum_{n=1}^{85} a_n = 42\times(3+5)+3$ o.e.	M1	3.1a
	$= 339$	A1	1.1b
		(2)	
		(4 marks)	

Notes:

(a)(i) Mark (a)(i) and (a)(ii) together.

B1: States the values of at least $a_2 = 5$ and $a_3 = 3$. This is sufficient but if more terms are given they must be correct. There is no need to see e.g. $a_2 = ...,\ a_3 = ...$ just look for values.

Allow an algebraic approach e.g. $a_{n+1} = 8 - a_n,\ a_{n+2} = 8-(8-a_n) = a_n$

A conclusion is **not** needed.

(a)(ii)

B1: States that the order of the periodic sequence is 2

Allow "second order", "it repeats every 2 numbers" or equivalent statements that convey the idea of the period being 2.

Note that ±2 is B0

(b)

M1: Attempts a <u>**correct**</u> method to find $\sum_{n=1}^{85} a_n$

For example $\sum_{n=1}^{85} a_n = 42\times(3+5)+3,\ \sum_{n=1}^{85} a_n = \frac{84}{2}\times 3 + 42\times 5 + 3$ or $\sum_{n=1}^{85} a_n = 43\times(3+5)-5$

or $\sum_{n=1}^{85} a_n = 43\times 3 + 42\times 5$ or $\sum_{n=1}^{85} a_n = \frac{85}{2}\times 8 - 1$

There may be other methods e.g. "Chunking": 5×(3 + 5) = 40, 40 × 8 = 320, 320 + 3×3 +2×5 = 339

A1: 339. Correct answer only scores both marks.

Attempts to use an AP formula score M0

Question	Scheme	Marks	AOs
4(a)	$R=\sqrt{2^2+8^2}=\sqrt{68}=2\sqrt{17}$	B1	1.1b
	$2\cos\theta+8\sin\theta=R\cos\theta\cos\alpha+R\sin\theta\sin\alpha$ $2=R\cos\alpha \quad 8=R\sin\alpha$ $\tan\alpha=\frac{8}{2}\Rightarrow\alpha=...$	M1	1.1b
	$\alpha=$ awrt 1.326	A1	2.2a
		(3)	
(b)(i)	$4.5\times"2\sqrt{17}"$	M1	1.1b
	$9\sqrt{17}$	A1	2.2a
(ii)	awrt 1.33	B1ft	2.2a
		(3)	
		(6 marks)	

Notes

(a)

B1: $R=2\sqrt{17}$ or $\sqrt{68}$.

$\pm2\sqrt{17}$ or $\pm\sqrt{68}$ score B0

(Condone if this comes from e.g., $8=R\cos\alpha \quad 2=R\sin\alpha$)

Decimal answers score B0 unless the exact value is seen then apply isw.

M1: Proceeds to a value for α from $\tan\alpha=\pm\frac{8}{2}$, $\cos\alpha=\pm\frac{2}{"\sqrt{68}"}$, $\sin\alpha=\pm\frac{8}{"\sqrt{68}"}$

May be implied by awrt 1.33 radians or 76 degrees

A1: awrt 1.326 for α. Apply isw if this is then subsequently rounded to e.g. 1.33

(b)(i)

M1: For a value of $\pm4.5\times$their R or allow $\pm 4.5R$ (with the letter R)

But not embedded in an expression e.g. $9\sqrt{17}\cos(\theta-\alpha)$ unless extracted later.

Note that the sum may be found as $9\cos x+36\sin x$ with the maximum then found using calculus

e.g. $S=9\cos x+36\sin x\Rightarrow\frac{dS}{dx}=-9\sin x+36\cos x=0\Rightarrow\tan x=4\Rightarrow\sin x=\frac{4}{\sqrt{17}},\ \cos x=\frac{1}{\sqrt{17}}$

$\Rightarrow 9\cos x+36\sin x=9\sqrt{17}$. This will score M1 once they reach $\pm4.5\times$their R

May be implied by $9\sqrt{17}$ or awrt 37.1 (which may come from a graphical method)

May also see e.g. $\text{Max}(9\cos x+36\sin x)=\sqrt{9^2+36^2}=...$

A1: $9\sqrt{17}$ or exact equivalent e.g. $\sqrt{1377}$, $4.5\sqrt{68}$, $4.5(2\sqrt{17})$ and apply isw once a correct answer is seen

(ii)

B1ft: awrt 1.33 (or follow through on their α even if in degrees (76), no matter how accurate)