| Question Number | Scheme | Marks |
|---|---|---|
| **8 .(i)** | States $(S=)\quad a+\quad (a+d)\quad +.....\{a+(n-2)d\}+\{a+(n-1)d\}$ | B1 |
| | $(S=)\{a+(n-1)d\}+\{a+(n-2)d\}+.....(a+d)\quad +a$ and adds | M1 |
| | $2S=n\{2a+(n-1)d\}\Rightarrow S=\frac{n}{2}\{2a+(n-1)d\}$ * | A1* |
| | | **(3)** |
| **(ii)** | (a) $u_5=22$ | B1 |
| | (b) $\sum_{n=1}^{59}u_n=(5+10+15+...)+(-3+3-3+...)$ | |
| | $=\frac{59}{2}\{10+58\times5\}+(-3)=8850-3=8847$ | M1 B1 A1 |
| | | **(4)** |
| | | **(7 marks)** |

(i)

B1 Writes down an expression for $S$ in a minimum of 3 in $a$ and $d$ terms including the first and last terms.
Eg. States that $S=a+(a+d)+(a+2d)+.....+a+(n-2)d+a+(n-1)d$

$S=a+(a+d)+...+l$ scores B1 only if $l=a+(n-1)d$ is later identified as only two terms in $a$ and $d$.

M1 Attempts to reverse their sum and add terms. Must include at least two pairs of matching terms to be enough to establish the pattern (allow if second sum misses last terms).

A1* Correctly achieves the given result including the intermediate line $2S=n\{2a+(n-1)d\}$ There must be no errors and at least 3 terms should have been shown for the sum and its reverse.

If $S=a_1+a_2+...+a_n$ is used allow the B and final A only if $a_m=a+(m-1)d$ (oe) is clearly identified in the working, or other clear reasoning why each term gives $2a+(n-1)d$, but the M may be gained.

If commas used instead of + in the summation, eg $S=a,(a+d)...,a+(n-2)d,a+(n-1)d$ the score B0 as no correct sum, but allow M1A1 if the sum is implied by working and all else is correct.

If you see other attempts you feel are worthy of credit then consult your team leader.

(ii) (a)

B1 22

(ii) (b)

M1 Attempts to use the sum of an AP with $n=59,a=5,d=5$ Also allow $\frac{n}{2}(a+l)=\frac{59}{2}(5+59\times5)$

B1 For $\sum_{n=1}^{59}3\times(-1)^n=-3$

A1 8847

Listing terms can score 3/3 as it is a correct method and can be marked per main scheme.

Answers with no incorrect working can score 3/3 If the correct answer appears from incorrect working then apply SC M0B1A0.

There are other variations on how to do this part (b)(ii) such as

Alt 1: Splits to odd and even terms:

$$S_{\text{odd}} + S_{\text{even}} = \frac{1}{2}(2+292)\times 30 + \frac{1}{2}(13+293)\times 29 = 4410 + 4437 = 8847$$

M1 separates into the two sequences and applies summation formula to at least one

B1 Correct expression for both summations (must have correct number of terms for each)

A1 8847

Alt 2: Pairs terms (or can be first term + pairs)

$$S = (2+13)+(12+23)+...+(282+293)+292$$

$$= 15+35+...+575+292 = \frac{29}{2}(15+575)+292 = 8847$$

M1 pairs terms appropriately, may use $1^{st}$ + ($2^{nd}$+$3^{rd}$) + …+ ($58^{th}$ +$59^{th}$) and applies summation formula to the terms

B1 For the extra term correctly shown 2+… or …+ 292

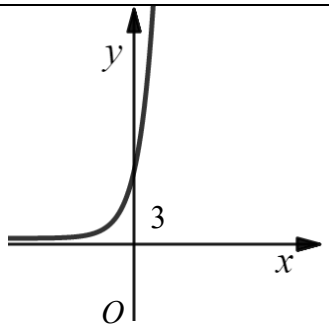
A1 8847

In general apply

M1 For a correct overall strategy that includes a summation

B1 For dealing with the $\sum(-1)^n$ correctly within the strategy (which may be for a correct overall expression in many cases).

A1 8847

| Question Number | Scheme | Marks |
|---|---|---|
| **9.(a)** |  Shape<br><br>$(0,3)$ | B1<br><br>B1<br><br>**(2)** |
| **(b)** | $6^{1-x} = 3\times 4^{x}$<br>$(1-x)\log 6 = \log 3 + x\log 4$<br>$x(\log 4 + \log 6) = \log 6 - \log 3$<br>$\Rightarrow x = \dfrac{\log\left(\frac{6}{3}\right)}{\log(4\times 6)} \Rightarrow x = \dfrac{\log 2}{\log 24}$ | M1 dM1 A1<br><br>ddM1 A1*<br><br>**(5)** |
| | Alt Method: $6^{1-x} = 3\times 4^{x} \Rightarrow \dfrac{6}{6^{x}} = 3\times 4^{x}$<br>$\Rightarrow \dfrac{6}{3} = 6^{x}4^{x} \Rightarrow 2 = 24^{x}$<br>$\Rightarrow \log_{10} 2 = x\log_{10} 24 \Rightarrow \dfrac{\log_{10} 2}{\log_{10} 24}$ | M1<br><br>dM1A1<br><br>ddM1A1*<br><br>**(5)**<br>**(7 marks)** |

(a)

B1 Correct shape and position. Should be increasing, always above the $x$ axis and must be in both quadrants 1 and 2. Be tolerant with the asymptote as long as it does not cross the axis or clearly bend away (but don't be concerned if there is a gap between curve and axis).

B1 Intercept at $(0,3)$ Accept 3 or $(3,0)$ marked on the axis, but $(3,0)$ away from the graph is B0. Their graph must have crossed the positive $y$ axis to score this mark. Ignore any $x$ intercepts

(b)

M1 Attempt to takes logs (any base, including 6) and attempts either the addition law or the power law Eg. $\log 6^{1-x} \rightarrow (1-x)\log 6$ or $\log 3\times 4^{x} \rightarrow \log 3 + \log 4^{x}$ (Condone invisible brackets for Ms)

dM1 Takes logs of both sides and attempts **both** the addition law and the power law to achieve a linear equation in $x$ (can still be in any base at this stage)

A1 A correct linear equation in $x$ (any base).

ddM1 Attempts to make $x$ the subject of the formula with no incorrect log work. Allow with just log, but any other base must be changed to base 10 to allow this mark.

A1* Proceeds to the given answer showing a correct intermediate step with no incorrect working seen.

For example $x(\log 4 + \log 6) = \log 6 - \log 3 \Rightarrow x = \dfrac{\log\left(\frac{6}{3}\right)}{\log(4\times 6)}$ or $\ldots \Rightarrow x\log 24 = \log 2 \Rightarrow x = \dfrac{\log 2}{\log 24}$

Alt (b): M1: applies index law to $6^{1-x}$ ie $6/6^{x}$

dM1: rearranges to equation of form $a^{x} = b$ using correct power laws (ie $p^{x}q^{x} = (pq)^{x}$) A1: Correct equation

ddM1: solve equation of the form shown using logs A1: correctly achieved.