| Question | Scheme | | Marks | AOs |
|---|---|---|---|---|
| **14(a)** | $\log_{10} P = mt + c$ | | M1 | 1.1b |
| | $\log_{10} P = \frac{1}{200}t + 5$ | | A1 | 1.1b |
| | | | **(2)** | |
| **(b)** | **Way 1:**<br>As $P = ab^t$ then<br>$\log_{10} P = t\log_{10} b + \log_{10} a$ | **Way 2:**<br>As $\log_{10} P = \frac{t}{200} + 5$ then<br>$P = 10^{\left(\frac{t}{200}+5\right)} = 10^5 10^{\left(\frac{t}{200}\right)}$ | M1 | 2.1 |
| | $\log_{10} b = \frac{1}{200}$ or $\log_{10} a = 5$ | $a = 10^5$ or $b = 10^{\left(\frac{1}{200}\right)}$ | M1 | 1.1b |
| | So $a$ = 100 000 **or** $b$ = 1.0116 | | A1 | 1.1b |
| | Both $a$ = 100 000 **and** $b$ = 1.0116 (awrt 1.01) | | A1 | 1.1b |
| | | | **(4)** | |
| **(c)(i)** | The initial population | | B1 | 3.4 |
| **(c)(ii)** | The proportional increase of population each year | | B1 | 3.4 |
| | | | **(2)** | |
| **(d)(i)** | 300000 to nearest hundred thousand | | B1 | 3.4 |
| **(d)(ii)** | Uses $200\,000 = ab^t$ with their values of $a$ and $b$ or<br>$\log_{10} 200000 = \frac{1}{200}t + 5$ and rearranges to give $t$ = | | M1 | 3.4 |
| | 60.2 years to 3sf | | A1ft | 1.1b |
| | | | **(3)** | |
| **(e)** | Any two valid reasons- e.g.<br>• 100 years is a long time and population may be affected by wars and disease<br>• Inaccuracies in measuring gradient may result in widely different estimates<br>• Population growth may not be proportional to population size<br>• The model predicts unlimited growth | | B2 | 3.5b |
| | | | **(2)** | |

| **Question 14 continued** |
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| **Notes:** |
| **(a)**<br>**M1:** Uses a linear equation to relate log $P$ and $t$<br>**A1:** Correct use of gradient and intercept to give a correct line equation |
| **(b)**<br>**M1:** **Way 1:** Uses logs correctly to give log equation; **Way 2:** Uses powers correctly to "undo" log equation and expresses as product of two powers<br>**M1:** **Way 1:** Identifies log $b$ or log $a$ or both; **Way 2:** Identifies $a$ or $b$ as powers of 10<br>**A1:** Correct value for $a$ or $b$<br>**A1:** Correct values for both |
| **(c)(i)**<br>**B1:** Accept equivalent answers e.g. The population at $t = 0$<br><br>**(c)(ii)**<br>**B1:** So accept rate at which the population is increasing each year or scale factor 1.01 or increase of 1% per year |
| **(d)(i)**<br>**B1:** cao<br><br>**(d)(ii)**<br>**M1:** As in the scheme<br>**A1ft:** On their values of $a$ and $b$ with correct log work |
| **(e)**<br>**B2:** As given in the scheme – any two valid reasons |