Question	Scheme	Marks	AOs
5(a)	$u_3 = £20000 \times 1.08^2 = (£)23328*$	B1*	1.1b
		(1)	
(b)	$20000 \times 1.08^{n-1} > 65000$	M1	1.1b
	$1.08^{n-1} > \frac{13}{4} \Rightarrow n-1 > \frac{\ln(3.25)}{\ln(1.08)}$ or e.g. $1.08^{n-1} > \frac{13}{4} \Rightarrow n-1 > \log_{1.08}\left(\frac{13}{4}\right)$	M1	3.1b
	Year 17	A1	3.2a
		(3)	
(c)	$S_{20} = \frac{20000(1-1.08^{20})}{1-1.08}$	M1	3.4
	Awrt (£) 915 000	A1	1.1b
		(2)	
			(6 marks)
Notes			

(a)

B1*: Uses a correct method to show that the Profit in Year 3 will be £23 328. Condone missing units

E.g. $£20000 \times 1.08^2$ or $£20000 \times 108\% \times 108\%$

This may be obtained in two steps. E.g $\frac{8}{100} \times 20000 = 1600$ followed by $\frac{8}{100} \times 21600 = 1728$ with the calculations $21600 + 1728 = 23328$ seen.

Condone calculations seen as 8% of $20000 = 1600$.

This is a show that question and the method must be seen.

It is not enough to state Year 1 = £21 600, Year 2 = £ 23 328

Question	Scheme	Marks	AOs
12 (a)	(i) Method to find p Eg. Divides $32000 = Ap^4$ by $50000 = Ap^{11}$ $p^7 = \frac{50000}{32000} \Rightarrow p = \sqrt[7]{\frac{50000}{32000}} = \ldots$	M1	3.1a
	$p = 1.0658$	A1	1.1b
	(ii) Substitutes their $p = 1.0658$ into either equation and finds A $A = \frac{32000}{'1.0658'^4}$ or $A = \frac{50000}{'1.0658'^{11}}$	M1	1.1b
	$A = 24795 \to 24805 \simeq 24\,800$ *	A1*	1.1b
		(4)	
(b)	A / $(£)24\,800$ is the value of the car on 1st January 2001	B1	3.4
	p /1.0658 is the factor by which the value rises each year. Accept that the value rises by 6.6 % a year (ft on their p)	B1	3.4
		(2)	
(c)	Attempts $100000 = '24800' \times '1.0658'^t$		
	$'1.0658'^t = \frac{100000}{24800}$	M1	3.4
	$t = \log_{1.0658}\left(\frac{100000}{24800}\right)$	dM1	1.1b
	$t = 21.8$ or 21.9	A1	1.1b
	cso 2022	A1	3.2a
		(4)	
			(10 marks)

(a) (i)

M1: Attempts to use both pieces of information within $V = Ap^t$, eliminates A correctly and solves an equation of the form $p^n = k$ to reach a value for p.

Allow for slips on the 32 000 and 50 000 and the values of t.

A1: $p =$ awrt 1.0658

Both marks can be awarded from incorrect but consistent interpretations of t. Eg.

$32000 = Ap^5, 50000 = Ap^{12}$

(a)(ii)

M1: Substitutes their $p = 1.0658$ into either of their equations and finds A

Eg $A = \frac{32000}{1.0658^4}$ or $A = \frac{50000}{1.0658^7}$ but you may follow through on incorrect equations from part (i)

A1*: Shows that A is between 24 795 and 24 805 before you see ' =24 800' or '≈ 24800'. Accept with or without units.

An alternative to (ii) is to start with the given answer.

M1: Attempts $24800 \times '1.0658'^4 = (32000.34)$

Question	Scheme	Marks	AOs
7 (a)	Uses a model $V = Ae^{\pm kt}$ oe (See next page for other suitable models)	M1	3.3
	Eg. Substitutes $t = 0, V = 20\,000 \Rightarrow A = 20000$	M1	1.1b
	Eg. Substitutes $t = 1, V = 16000 \Rightarrow 16000 = 20000e^{-1k} \Rightarrow k = ..$	dM1	3.1b
	$V = 20000e^{-0.223t}$	A1	1.1b
		(4)	
(b)	Substitutes $t = 10$ in their $V = 20000e^{-0.223t} \Rightarrow V = (£\,2150)$	M1	3.4
	Eg. The model is reliable as £2150 ≈ £2000	A1	3.5a
		(2)	
(c)	Make the "-0.223" less negative. Alt: Adapt model to for example $V = 18000e^{-0.223t} + 2000$	B1ft	3.3
		(1)	
			(7 marks)

(a) Option 1

M1: For $V = Ae^{\pm kt}$ Do not allow if *k* is fixed, eg $k = -0.5$

Condone different variables $V \leftrightarrow y$ $t \leftrightarrow x$ for this mark, but for A1 *V* and *t* must be used.

M1: Substitutes $t = 0 \Rightarrow A = 20000$ into their exponential model

Candidates may start by simply writing $V = 20000e^{kt}$ which would be M1 M1

dM1: Substitutes $t = 1 \Rightarrow 16000 = 20000e^{-1k} \Rightarrow k = ..$via the correct use of logs.

It is dependent upon both previous M's.

A1: $V = 20000e^{-0.223t}$ (with accuracy to at least 3sf) or $V = 20000e^{t\ln 0.8}$

A correct linking formula with correct constants must be seen somewhere in the question

(b)

M1: Uses a model of the form $V = Ae^{\pm kt}$ to find the value of *V* when *t* = 10.

Alternatively substitutes $V = 2000$ into their model and finds t

A1: This can only be scored from an acceptable model with correct constants with accuracy to at least 2sf .

Compares *V* = (£) 2150 with (£) 2 000 and states "reliable as $2150 \approx 2000$ " or "reasonably good as they are close" or ""OK but a little high".

Allow a candidate to argue that it is unreliable as long as they state a suitable reason. Eg. ''It is too far away from £2000'' or ''It is over £100 away, so it is not good''

Do not allow ''it is not a good model because it is not the same''

In the alternative it is for comparing their value of *t* with 10 and making a suitable comment as to the reliability of their model with a reason.

$V = 20000e^{-0.223t} \Rightarrow 2000 = 20000e^{-0.223t} \Rightarrow t = 10.3$ years.

Deduction Reliable model as the time is approximately the same as 10 years. A candidate can argue that the model is unreliable if they can give a suitable reason.

(c)

B1ft: For a correct statement. Eg states that the value of their '-0.223' should become less negative.

Alt states that the value of their '0.223' should become smaller. If they refer to *k* then refer to the model and apply the same principles.

Condone the fact that they don't state their -0.223 doesn't lie in the range $(-0.223, 0)$

Question	Scheme	Marks	AOs
11 (a)	Total time for 6 km = 24 minutes + $6\times1.05+6\times1.05^2$ minutes	M1	3.4
	= 36.915 minutes = 36 minutes 55 seconds *	A1*	1.1b
		(2)	
(b)	**5** th km is $6\times1.05=6\times1.05^{1}$ **6**th km is $6\times1.05\times1.05=6\times1.05^{2}$ **7**th km is $6\times1.05\times1.05\times1.05=6\times1.05^{3}$ Hence the time for the r th km is $6\times1.05^{r-4}$	B1	3.4
		(1)	
(c)	Attempts the total time for the race = Eg. 24 minutes + $\sum_{r=5}^{r=20} 6\times1.05^{r-4}$ minutes	M1	3.1a
	Uses the series formula to find an allowable sum Eg. Time for 5 th to 20th km $=\dfrac{6.3(1.05^{16}-1)}{1.05-1}=(149.04)$	M1	3.4
	Correct calculation that leads to the **total time** Eg. Total time = 24 + $\dfrac{6.3(1.05^{16}-1)}{1.05-1}$	A1	1.1b
	Total time = awrt 173 minutes and 3 seconds	A1	1.1b
		(4)	
			(7 marks)

(a)

M1: For using model to calculate the total time.

Sight of 24 minutes + $6\times1.05+6\times1.05^2$ or equivalent is required. Eg 24 + 6.3 + 6.615

Alternatively in seconds 24 minutes + 378 sec (6min 18 s) +396.9 (6 min 37 s)

A1*: 36 minutes 55 seconds following 36.915, 24+ 6.3+6.615 , 24 + $6\times1.05+6\times1.05^2$ or equivalent working in seconds

(b) Must be seen in (b)

B1: As seen in scheme. For making the link between the r th km and the index of 1.05
Or for EXPLAINING that "the time taken per km (6 mins) only starts to increase by 5% after the first 4 km"

(c) The correct sum formula $\dfrac{a(r^n-1)}{r-1}$, if seen, must be correct in part (c) for all relevant marks

M1: For the overall strategy of finding the total time.
Award for adding 18, 24, 30.3 or awrt 36.9 and the sum of a geometric sequence

So award the mark for expressions such as $6\times4+\sum 6\times1.05^n$ or $24+\dfrac{6(1.05^{20}-1)}{1.05-1}$

The geometric sequence formula, must be used with $r=1.05$ oe but condone slips on a and n

Question	Scheme	Marks	AOs
5 (a)	Uses $115 = 28 + 5d \Rightarrow d = (17.4)$	M1	3.1b
	Uses $28 + 2\times"17.4" = ...$	M1	3.4
	$= 62.8$ (km h $^{-1}$)	A1	1.1b
		(3)	
(b)	Uses $115 = 28r^5 \Rightarrow r = (1.3265)$	M1	3.1b
	Uses $28\times"1.3265^4" = ...$ or $\frac{115}{"1.3265"}$	M1	3.4
	$= 86.7$ (km h $^{-1}$)	A1	1.1b
		(3)	
			(6 marks)
Notes:			

(a)

M1: Translates the problem into maths using n^{th} term $= a + (n-1)d$ and attempts to find d

Look for either $115 = 28 + 5d \Rightarrow d = ...$ or an attempt at $\frac{115-28}{5}$ condoning slips

It is implied by use of $d = 17.4$ Note that $115 = 28 + 6d \Rightarrow d = ...$ is M0

M1: Uses the model to find the fastest speed the car can go in 3$^{\text{rd}}$ gear using $28 + 2"d"$ or equivalent. This can be awarded following an incorrect method of finding $"d"$

A1: 62.8 km/ h Lack of units are condoned. Allow exact alternatives such as $\frac{314}{5}$

(b)

M1: Translates the problem into maths using n^{th} term $= ar^{n-1}$ and attempts to find r

It must use the 1$^{\text{st}}$ and 6$^{\text{th}}$ gear and not the 3$^{\text{rd}}$ gear found in part (a)

Look for either $115 = 28r^5 \Rightarrow r = ...$ o.e. or $\sqrt[5]{\frac{115}{28}}$ condoning slips.

It is implied by stating or using $r = \text{awrt } 1.33$

M1: Uses the model to find the fastest speed the car can go in 5$^{\text{th}}$ gear using $28\times"r^4"$ or $\frac{115}{"r"}$ o.e.

This can be awarded following an incorrect method of finding $"r"$

A common misread seems to be finding the fastest speed the car can go in 3$^{\text{rd}}$ gear as in (a). Providing it is clear what has been done, e.g. $u_3 = 28\times"r^2"$ it can be awarded this mark.

A1: awrt 86.7 km/h Lack of units are condoned. Expressions must be evaluated.

Question Number	Scheme	Marks
9.(a)	Uses $300 \times (1.05)^{23}$	M1
	Obtains 921 or 922 or 920	A1
		[2]
(b)	Uses $S = \frac{300(1.05^{24} - 1)}{1.05 - 1}$ Must have correct *r* and *n* but can use their *a* (e.g. 315)	M1
	13351 (accept awrt 13400)	A1
		[2]
(c)	Uses $300(1.05)^{n-1} > 3000$ Or $300(1.05)^{n-1} = 3000$	M1
	$(n-1)\log 1.05 > \log 10$ Or $(n-1)\log 1.05 = \log 10$ Or $(n-1) = \log_{1.05} 10$ Or correct equivalent log work ft	M1
	$n > 48.19$ $N = 49$	A1
		[3]
		7 marks
	Notes	
(a)	M1: for correct statement of formula with correct *a, r* and *n* A1: cao (This answer implies the M1)	
(b)	M1: Correct formula with r = 1.05 and *n* = 24 ft their *a* (If they list all the terms – correct answer implies method mark) A1: answers which round to 13400 are acceptable	
(c)	M1: Correct inequality or uses equality and interprets correctly later (ft their a) M1: Correct algebra then correct use of logs on their previous line (may follow use of =, or use of *n* instead of *n* -1) Can get M0M1A0 A1: need to see 49 or 49th month **Special case**: Uses sum formula: If they reach $(1.05)^n > 1\frac{1}{2}$ and then use logs correctly to give $n\log(1.05) > \log 1\frac{1}{2}$ then give M0M1A0 If trial and error is used then the correct answer implies the method. So 49 is M1M1A1 and 48 scores M1M0A0. Similar marks follow answer only with no working.	

Question Number	Scheme	Marks
12.(a)	Uses $275000\times(1.1)^5$ or finds £442890.25 or uses $275000\times(1.1)^4$ or finds £402627.50	M1
	Finds both of the above and subtracts to give £40 262.75 and concludes approx. £40300*	M1 A1*
	Or	[3]
	Uses $275000\times(1.1)^5$ -$275000\times(1.1)^4$, $= awrt 40260 =$ 40300 (3*sf*) *	M1 M1,A1*
		[3]
(b)	Puts $275000\times(1.1)^{n-1} > 1000000$ or $275000\times(1.1)^{n-1} = 1000000$	M1
	$(1.1)^{n-1} > \frac{1000000}{275000}$ (or $\frac{40}{11}$ or 3.63 or 3.64). Or $(1.1)^{n-1} = \frac{1000000}{275000}$ (or $\frac{40}{11}$ or 3.63 or 3.64)	M1
	$n-1 > \frac{\log\left(\frac{40}{11}\right)}{\log 1.1}$ or $n-1 = \frac{\log\left(\frac{40}{11}\right)}{\log 1.1}$	M1
	($n > 14.5$ or $n > 14.6$ or $n = 15$) so the year is 2030	A1
		[4]
(c)	Uses $S = \frac{275000(1.1^n - 1)}{1.1-1}$ or uses $S = \frac{275000(1-1.1^n)}{1-1.1}$	M1
	Uses n = 11 in formula	A1
	Awrt £5 096 100	A1
	Or: adds 11 terms £275000 + 302500 + 332750 + 366025 + 402627.5 + 442890.25 + 487179.275 + 535897.2025 + 589486.9228 + 648435.615 + 713279.1765 = awrt 5096100 (see notes below)	[3]
		10 marks
	Notes	

Question Number	Scheme	Marks
8. (a)	$238 = a + k\,d$ **or** $108 = a + k\,d$ with any values for k	M1
	$238 = a + (14)d$ or $108 = a + (24)d$ or $"d" = \pm 13$	A1
	$238 = a + (14)d$ **and** $108 = a + (24)d$	A1
	Solves their simultaneous equations to obtain $a =$; (so a) = 420	M1; A1 [5]
(b)	Uses $\frac{25}{2}(2\times a+(25-1)\times"-13")$ **or** Uses $\frac{25}{2}(a+108)$, to obtain = 6600	M1 , A1 [2]
		7 marks

(a)

M1 Score for $238 = a + k\,d$ **or** $108 = a + k\,d$ with any non- zero integer value for k

A1 One of $238 = a + (14)d$, or $108 = a + (24)d$ or $"d" = \pm 13$
The $"d" = \pm 13$ can be achieved from equations such as $238 = a + (13)d$, or $108 = a + (23)d$

A1 Both $238 = a + (14)d$, **and** $108 = a + (24)d$
M1 Finds the value of a by solving a pair of simultaneous equations in a and d
A1 Achieves (a =) 420

In an alternative, working by a method of differences, you may see very few formulae: The scheme can be easily applied,
1st M1 Seeing $\frac{238-108}{10}$ or $\frac{108-238}{10}$
1st A1 For ± 13
2nd A1 For $238+13\times 14$ or $108+13\times 24$.
Note that this is achieved after the award of the next mark. It is scored as the third mark of (a) on e –pen.
2nd M1 Sight of $238+'k'\times d$ or $108+'k'\times d$ with any non- zero integer values for k and their d
3rd A1 Achieves 420

(b)

M1 Uses a correct sum formula $S=\frac{n}{2}\left(2a+(n-1)d\right)$ with $n = 25$ and their values of a and d

Alternatively uses $S=\frac{n}{2}\left(a+l\right)$ with $n = 25, l = 108$ and their value of a.

A1 cao 6600

Question Number	Scheme	Marks
9.(a)	$130000 \times (1.02) = 132600*$ or $2\% = 2600$ and $130000 + 2600 = 132600*$	B1
		[1]
(b)	$(r =)\ 1.02$	B1
		[1]
(c)	Uses $130000 \times (1.02)^{N-1} > 260000$ **or** $130000 \times (1.02)^{N-1} = 260000$	M1
	So $(1.02)^{N-1} > 2$	A1
	$(N-1)\log_{10}(1.02) > \log_{10} 2$ or $(N-1)\log_{10}(1.02) = \log_{10} 2$ or $(N-1) > \log_{1.02} 2$ or $(N-1) = \log_{1.02} 2$	M1
	$N > \dfrac{\log_{10} 2}{\log_{10}(1.02)} + 1*$	A1cso
		[4]
(d)	$(N =)\ 37$	B1
		[1]
		7 marks
	Notes	
(a)	**B1:** A reason must be provided for this mark as the answer is printed. **Allow both** $130000 \times (1 + 2\%)$ **and** $130000 \times (102\%)$ **as both give the correct answer when entered this way on a calculator. But not** $130000 \times 1 + 2\%$	
(b)	**B1:** For 1.02 oe e.g. allow $\dfrac{51}{50}$	
(c)	**M1: Correct** inequality or equality – may use r or their r or 1.02 and may use N or n. **A1:** $(1.02)^{N-1} > 2$ cao. Allow $(1.02)^{n-1} > 2$ **M1:** Correct use of logs power rule on their previous line which must have come from using the n^{th} term of a GP. Condone missing brackets for this mark e.g. $N - 1\log_{10}(1.02) > \log_{10} 2$. (May follow use of $=$ instead of $>$ or use of r instead of 1.02 or use of N instead of N - 1). These cases can get M0A0M1. Allow the base to be absent or just 'ln' for this mark. If the inequality sign is reversed at this point, still allow the M1. **A1*:** Answer is **exactly** as printed (**including the bases**) and **all** inequality work should be correct and all previous marks scored and **no missing brackets earlier.** Allow this mark to score from a correct previous line provided the power rule is used. So fully correct work leading to $(N-1)\log_{10}(1.02) > \log_{10} 2 \Rightarrow N > \dfrac{\log_{10} 2}{\log_{10}(1.02)} + 1$ **scores the final M1A1 but** $(1.02)^{N-1} > 2 \Rightarrow N > \dfrac{\log_{10} 2}{\log_{10}(1.02)} + 1$ **scores M0A0 (no explicit use of power rule)**	
(d)	**B1:** Only need $N = 37$ – may follow trial and error or uses logs to a different base. Do not allow $N \geq 37$ or $N > 37$ or $N = 37.0$	

!

<table>
<tr><th>Question Number</th><th colspan="2">Scheme</th><th>Marks</th></tr>
<tr><td>14 (a)</td><td colspan="2">Allow the use of S or S_n throughout without penalty.
$S = a + ar + ar^2 + ...ar^{n-1}$ and $rS = ar + ar^2 + ar^3 + ...ar^n$
There must be a minimum of '3' terms and must include the first and the nth term. Condone for this mark only $S = a + ar + ar^2 + ...ar^n$ and $rS = ar + ar^2 + ar^3 + ...ar^{n+1}$ and allow commas instead of +'s but see note below.</td><td>M1</td></tr>
<tr><td></td><td>$S - rS = a - ar^n$</td><td>Subtracts either way around. As a special case allow $S - rS = a + ar^n$. For this mark, their S and their rS must be different but it must be S and rS they are considering with possible missing terms or slips.</td><td>M1</td></tr>
<tr><td></td><td>$\Rightarrow S(1-r) = a(1-r^n) \Rightarrow S = \dfrac{a(1-r^n)}{(1-r)}$</td><td>dM1: Dependent upon both previous M's. It is for taking out a common factor of S and achieving $S = \ldots$

A1*: Fully correct proof with no errors or omissions. The use of commas instead of +'s is an error.
$S = \dfrac{a(r^n - 1)}{(r-1)}$ without reaching the printed answer is A0</td><td>dM1A1*</td></tr>
<tr><td></td><td colspan="2"></td><td>(4)</td></tr>
<tr><td>(a) Way 2</td><td>$S = \dfrac{\left(a + ar + ar^2 + ...ar^{n-1}\right)(1-r)}{1-r}$</td><td>Gives a minimum of '3' terms and must include the first and the nth and multiplies top and bottom by $1 - r$</td><td>M1</td></tr>
<tr><td></td><td>$S = \dfrac{a + ar + ar^2 + ...ar^{n-1} - ar - ar^2 - ... - ar^n}{1-r}$</td><td>Expands the top with a minimum of '3' terms in each and must include the first and the nth term</td><td>M1</td></tr>
<tr><td></td><td>$S = \dfrac{a(1-r^n)}{(1-r)}$</td><td>dM1: Dependent upon both previous M's. It is for taking out a common factor of a on top and achieving $S = \ldots$

A1*: Fully correct proof with no errors or omissions. The use of commas instead of +'s is an error.
$S = \dfrac{a(r^n - 1)}{(r-1)}$ without reaching the printed answer is A0</td><td>dM1A1</td></tr>
</table>

(b)	$U = 180\times 0.93^n$ with $n = 4$ or 5	Attempts $U = 180\times 0.93^n$ with $n = 4$ or 5. Accept $U = 167.4\times 0.93^n$ with $n = 3$ or 4. Allow 93% for 0.93	M1
	$U_5 = 180\times(0.93)^5 = 125.2$ (litres)	Cso. Awrt 125.2	A1*
	Allow 93% or 1 – 7% for 0.93		
			(2)
(c)	Attempts $S_n = \frac{a(1-r^n)}{(1-r)}$ with any combination of: $n = 20/21$ $a = 180/167.4$ and $r = 0.93$ Allow 93% for 0.93		M1
	$S = \frac{167.4(1-0.93^{20})}{(1-0.93)}$ or $S = 180\times\frac{0.93(1-0.93^{20})}{(1-0.93)}$ or $S = \frac{180(1-0.93^{21})}{(1-0.93)} - 180$ A correct numerical expression for the sum (may be implied by awrt 1831) Allow 93% or 1 – 7% for 0.93		A1
	1831 (litres)	1831 **only** (Ignore units). Do not isw here, so 1831 followed by $1831\times 20 = ...$ scores A0.	A1
			(3)
			(9 marks)

Listing:

(b)	Sight of awrt 180, 167, 156, 145, 135, 125	Starts with 180 and multiplies by 0.93 either 4 or 5 times showing each result at least to the nearest litre and chooses the 5th or 6th term	M1
	$U_5 = 125.2$ (litres)	Must see all values accurate to 1dp: e.g. awrt 180, 167.4, 155.7, 144.8, (134.6 or 134.7), 125.2	A1*
			(2)
(c)	$\text{Total} = 180\times 0.93 + 180\times 0.93^2 + ... + 180\times 0.93^{19} + 180\times 0.93^{20} = ...$ Finds an expression for the sum of 20 or 21 terms		M1
	All sums accurate to awrt 1dp 167.4+155.7+144.8+134.6+125.2+.....42.2 A correct numerical expression for the sum (may be implied by awrt 1831)		A1
	1831 (litres)	1831 **only** (Ignore units). Do not isw here, so 1831 followed by $1831\times 20 = ...$ scores A0.	A1
			(3)

Question Number	Scheme	Marks
11 (a)	Attempts $U_4 = 6000\times(1.015)^3 = 6274$ (tonnes)	M1A1*
		(2)
(b)	Attempts $U_N = 6000\times 1.015^{N-1} > 8000$	M1
	$1.015^{N-1} > \frac{8000}{6000}$ oe	A1
	$\log\left(1.015^{N-1}\right) > \log\left(\frac{4}{3}\right) \Rightarrow N > \frac{\log\left(\frac{4}{3}\right)}{\log(1.015)} + 1 = (20.3)$	M1A1
	$(N) = 21$	A1
		(5)
(c)	Attempts $S_n = \frac{a(1-r^n)}{(1-r)}$ with $n = 10$ $a = 6000/30000$ and $r = 1.015$	M1
	$S = 5\times\frac{6000(1.015^{10}-1)}{(1.015-1)}$ OR $S = \frac{30000(1.015^{10}-1)}{(1.015-1)}$	A1
	Awrt £321 000	A1
		(3)
		(10 marks)

(a)

M1 Attempts to use ar^3 with $a = 6000$, $r = 1.015$. Accept $r = 1+1.5\%$
Condone for this mark r =1.15 or 1.0015 Accept a list of 4 terms with the same conditions

A1* cso $6000\times(1.015)^3 = 6274$ (tonnes).

If candidate states $U_4 = 6000\times(1.015)^3 = 6274.07$ (tonnes) or 6274.0 (or anything that rounds to 6274) they don't need to round to the given answer.

(b)

M1 Attempts to use $ar^{n-1}...8000$ or $ar^n...8000$ with $a = 6000$, $r = 1.015$ or $1+1.5\%$ condoning values of r being 1.15 or 1.0015

A1 For reaching the intermediate result $1.015^{n-1}...\frac{4}{3}$ or $1.015^n...\frac{4}{3}$.

Allow $\frac{4}{3}$ to be rounded or truncated to 1.33 (to 2dp or better)

M1 Uses logs correctly to get n or n-1 This mark may be awarded from a sum formula

A1 This is scored for a 'correct' (unrounded) answer. It may be left in log form. If the candidate has used n instead of n-1, they will not score this unless they subsequently reach a final answer of 21. Allow for N or n.

Accept versions of $n...\frac{\log\left(\frac{4}{3}\right)}{\log(1.015)} + 1 = (20.3)$ or $n...\log_{1.015}\left(\frac{4}{3}\right) + 1 = (20.3)$ or

$n...\frac{\log(1.33)}{\log(1.015)} + 1 = (20.15)$

A1 $(N) =$ 21 Do not accept $N > 21$ etc
The two final A marks may be implied by finding 'n' and adding 1 to reach 21

Question Number	Scheme	Marks
6. (a)	Uses $1000 = 600 + 80(N-1) \Rightarrow N = 6$	M1,A1 **[2]**
(b)	Uses $\frac{15}{2}(2\times 600 + (15-1)\times 80) = (£)17400$	M1 A1 **[2]**
(c)	Total for Saima = $\frac{15}{2}(2A + 14A) = (120A)$	B1
	Sets $120A = 17400 \Rightarrow A = 145$	M1A1 **[3]**
		(7 marks)

(a)

M1 Attempts to use the formula $u_n = a + (n-1)d$ to find the value of 'n'.
Evidence would be $1000 = 600 + 80(N-1)$
Alternatively attempts $\frac{1000-600}{80}+1$ or repeated addition of £80 onto £600 until £1000 is reached

A1 $N = 6$ or accept the 6th year (or similar). The answer alone would score both marks.

(b)

M1 Uses a correct sum formula $S = \frac{n}{2}(2a + (n-1)d)$ with $n = 15, a = 600, d = 80$
Alternatively uses $S = \frac{n}{2}(a + l)$ with $n = 15,\ a = 600,\ l = 600 + 14\times 80$ or 1720
Accept the sum of 15 terms starting 600 + 680+ 760+ 840+....

A1 cao (£)17400

(c)

B1 Finds the sum for Saima.
Accept unsimplified forms such as $\frac{15}{2}(2A + 14A)$ or $\frac{15}{2}(A + 15A)$ or the simplified answer of $120A$
Remember to isw following a correct answer

M1 Sets their $120A$ equal to their answer to (b) and proceeds to find a value for A.
They must be attempting to calculate sums rather than terms to score this mark.
Condone slips on the sum of an AP formula and award for a valid attempt from GP formula.

A1 cao $A = 145$

Question Number	Scheme	Marks
14 (a)	$u_6 = 8000\times(0.85)^5 = 3549.6 \approx 3550$	M1, A1
		[2]
(b)	States $\lvert r \rvert < 1$ **or** 0.85 < 1 **and makes no reference to terms**	B1
		[1]
(c)	$S_\infty = \frac{a}{1-r} = \frac{8000}{1-0.85} =$ awrt 53333 53334 $\frac{160\,000}{3}$	M1A1
		[2]
(d)	Uses $S_N = \frac{8000(1-0.85^N)}{1-0.85}$	M1
	$\frac{8000(1-0.85^N)}{1-0.85} = 40000 \Rightarrow 0.85^N = 0.25$	dM1 A1
	$\Rightarrow N = \frac{\log 0.25}{\log 0.85} (= 8.53) \Rightarrow N = 9$	M1 A1
		[5] **[10 marks]**

(a)

M1 Attempts $u_6 = 8000\times(r)^5$ with $r = 0.85$ or 85% or $1-0.15$ or 1-15%

A1* Completes proof. States $u_6 = 8000\times(0.85)^5$ oe (see above) and shows answer is awrt 3549.6 or 3550

(b)

B1 States $\lvert r\rvert < 1$ or 0.85 < 1 **and makes no reference to terms**

Allow $r<1$ $-1<r<1$ **and makes no reference to terms**

Allow for an understanding of why S_∞ exists. Accept $0.85^n \to 0$ as $n\to\infty$ or $r^n \to 0$ as $n\to\infty$

Do not allow from an incorrect statement... if they give $r = 0.15$

Do not allow on an explanation that is based around terms.

Eg Do not allow $8000\times 0.85^{n-1} \to 0$ as $n\to\infty$

Do not allow as $r<1$ $u_n \to 0$ and so a limit exists

Do not allow if they state 85% is less than 100%

If you feel that a candidate deserves this mark then please seek advice.

(c)

M1 Attempts $S_\infty = \frac{8000}{1-r}$ with $r = 0.85$ oe

A1 $\frac{8000}{1-0.85}$ with an answer of awrt 53333 or 53 334 or $\frac{160\,000}{3}$

3.			
(a)	$120000\times(1.05)^3=138915$ *	Or $120000\times1.05\times1.05\times1.05=138915$ Or 120000, 126000, 132300, 138915 Or a = 120000 and $a\times(1.05)^3=138915$	B1
			(1)
(b)	$120000\times(1.05)^{n-1}>200000$	Allow n or $n-1$ and ">", "<", or "=" etc.	M1
	$\log 1.05^{n-1}>\log\left(\frac{5}{3}\right)$	Takes logs correctly Allow n or $n-1$ and ">", "<", or "=" etc.	M1
	$(n-1>)\dfrac{\log\left(\frac{5}{3}\right)}{\log 1.05}$ or equivalent e.g $(n>)\dfrac{\log\left(\frac{7}{4}\right)}{\log 1.05}$	Allow n or $n-1$ and ">", "<", or "=" etc. Allow $1.\dot{6}$ or awrt 1.67 for 5/3.	A1
	2024	M1: Identifies a calendar year using their value of n or n - 1 A1: 2024	M1A1
			(5)
(c)	$\dfrac{a(1-r^n)}{1-r}=\dfrac{120000\left(1-1.05^{11}\right)}{1-1.05}$	M1: Correct sum formula with n = 10, 11 or 12 A1: Correct numerical expression with n = 11	M1 A1
	1704814	Cao (Allow 1704814.00)	A1
			(3)
			[9]

	Listing or trial/improvement in (b)	
	U_{10} = 186 159.39, U_{11} = 195 467.36, U_{12} = 205 240.72	
	Attempt to find at least the 10th or 11th or 12th terms correctly using a common ratio of 1.05 (all the terms need **not** be listed)	M1
	Forms the geometric progression correctly to reach a term > 200 000	M1
	Obtains an "11th" term of awrt 195 500 **and** a "12th" term of awrt 205 200	A1
	Uses their number of terms to identify a calendar year	M1
	2024	A1
		(5)