

Question	Scheme	Marks	AOs
9(a)	$\log_{10} a = 0.304 \Rightarrow a = 10^{0.304}$ or $\log_{10} b = 0.0108 \Rightarrow b = 10^{0.0108}$	M1	3.1a
	$\log_{10} a = 0.304 \Rightarrow a = 10^{0.304}$ and $\log_{10} b = 0.0108 \Rightarrow b = 10^{0.0108}$	dM1	2.1
	$L = 2.014 \times 1.025^t$	A1	3.3
		(3)	

Notes

Must be using base 10 in (a) which may be implied by e.g. $a = 10^{0.304}$ or $b = 10^{0.0108}$

Ignore any units associated with a and b in part (a).

M1: Correct strategy to obtain a numerical expression or value for a **or** b e.g. $a = 10^{0.304}$ **or** $b = 10^{0.0108}$ **or** for a correct equation of $L = 10^{0.0108t+0.304}$

This may be implied by $a = \text{awrt } 2.01$ **or** $b = \text{awrt } 1.03$

Condone miscopies/misreads of 0.0108 and/or 0.304 as long as the intention is clear.

dM1: Depends on the first mark.

Correct strategy to obtain a numerical expression or value for a **and** b e.g. $a = 10^{0.304}$ **and** $b = 10^{0.0108}$.

This may be implied by $a = \text{awrt } 2.01$ **and** $b = \text{awrt } 1.03$

Condone miscopies/misreads of 0.0108 and/or 0.304 as long as the intention is clear.

Note that having found the value of a , it is possible to find b by substituting e.g. $t = 1$ as follows:

$$a = 10^{0.304} = 2.014, t = 1 \Rightarrow L = ab \Rightarrow b = \frac{L}{a}$$

$$t = 1 \Rightarrow \log_{10} L = 0.0108 + 0.304 = 0.3148 \Rightarrow L = 10^{0.3148} \Rightarrow b = \frac{10^{0.3148}}{2.014} = 1.025$$

A1: Correct **equation** with evaluated decimal values $a = \text{awrt } 2.014$ and $b = \text{awrt } 1.025$

This could be $L = 2.014 \times 1.025^t$ (or if correct values of a and b are seen condone

$L = 10^{0.0108t+0.304}$ and condone e.g. $L = 2.01 \times 1.03^t$ provided $a = \text{awrt } 2.014$ and $b = \text{awrt } 1.025$ are seen)

The **equation** must be seen but if it does not appear in (a) allow this to score if the correct equation appears later.

Apply isw once a correct equation is seen.

However, if there are errors in the log/index work such as

$10^{0.0108t+0.304} = 10^{0.0108t} + 10^{0.304} = \dots$ then the A mark should be withheld but allow recovery for the rest of the question.

Examples:

- $L = 10^{0.0108t+0.304} = 10^{0.0108t} \times 10^{0.304} \Rightarrow a = 10^{0.304}$ **and** $b = 10^{0.0108}$ scores M1dM1A0
- $L = 10^{0.0108t+0.304} = 10^{0.0108t} \times 10^{0.304} \Rightarrow a = \text{awrt } 2.014$ **and** $b = \text{awrt } 1.025$ scores M1dM1A1
- $L = 10^{0.0108t+0.304} = 10^{0.0108t} \times 10^{0.304}$ with only $a = \text{awrt } 2.014$ scores M1dM0A0
- $L = 10^{0.0108t+0.304} = 10^{0.0108t} \times 10^{0.304}$ with only $b = \text{awrt } 1.025$ scores M1dM0A0

Special case : Constants the wrong way round:

$a = \text{awrt } 1.025$ and $b = \text{awrt } 2.014$ with or without working scores M1dM1A0 unless the equation is formed correctly in which case the A mark can be recovered.

9(b)	a is the amount (of coal) in <u>millions of tonnes mined</u> in <u>1700</u>	B1ft	3.2a
		(1)	
9(c)	$L = 2.014 \times 1.025^{300} = \dots$ or $\log L = 0.0108 \times 300 + 0.304 \Rightarrow L = 10^{0.0108 \times 300 + 0.304} = \dots$	M1	3.4
	= awrt 3000 million tonnes or 4000 million tonnes	A1	2.2b
		(2)	

Notes

- (b) Follow through their a .
B1ft: Correct interpretation for a but must reference “**millions**” and “**tonnes**” and “**mined**” and **1700 or equivalent**. Allow equivalents for “mined” e.g. “extracted”
 Condone the omission of “coal”
 Allow equivalent alternatives e.g.
- “2.014” **million tonnes** (of coal) were **mined** in **1700**
 - “2 014 000” **tonnes** (of coal) were **mined** in **1700**
 - the amount of coal **mined** in **millions of tonnes** before the end of **1700**
- Condone “The **initial/original** amount (of coal) **mined** in **millions of tonnes**”
 Do not condone contradictory statements e.g. a is the number of millions of tonnes mined when $t = 0$ which is 0.304 million tonnes.
- (c)
M1: Substitutes $t = 299, 300$ or 301 into their model (whatever it is) **to find a value for L** .
 May see the line equation used e.g. $\log L = 0.0108 \times 300 + 0.304 \Rightarrow L = \dots$
 You do not need to be concerned about the processing.
 An incorrect value for L (e.g. not awrt 3000 or 3000 million or 4000 or 4000 million) with no substitution seen scores M0 but allow if you see $t = 299, 300$ or 301 followed by a value.
 Can be implied by awrt 3000 or 3000 million or 4000 or 4000 million.
- A1:** Correct value including units. If they use their model from (a) it must be **a correct model but condone incorrect/premature rounding or truncating in an otherwise correct model that leads to the correct value of** awrt 3000 million tonnes or awrt 4000 million tonnes or equivalent e.g. awrt 3 billion tonnes or awrt 4 billion tonnes.
 Allow equivalents e.g. awrt 3 000 000 000 tonnes or or 4 000 000 000 tonnes e.g. awrt 3×10^9 tonnes or 4×10^9 tonnes
 Just awrt 3000 or awrt 4000 without the “millions” and “tonnes” is A0

9(d)	e.g. • Not reliable since the data used for the model covered the years 1700 – 1900 • Not reliable since other forms of energy/fuel have replaced coal	B1	3.2b
		(1)	

(7 marks)

B1: The response must refer to the fact that the answer is **unreliable together with a reason** why this might be the case. Recognises that the data (gradient & intercept) are based on years that make the prediction unreliable **or** e.g. states that other forms of energy/fuel have replaced coal so the estimate is unreliable.

E.g. via extrapolation:

- Not good as based on data from 1700 – 1900
- Unreliable as based on old data
- Questionable as it has been extrapolated
- Not reliable as it is extrapolated
- By the time 2000 arrived it would be unreliable

E.g. via types of energy/fuel:

- Unreliable because in 2000 most mines had been shut down
- Unreliable because more energy comes from solar/nuclear/wind power
- Unreliable as they stopped mining as much coal in the 20th century

Ignore extra comments such as overestimate/underestimate provided they have e.g. “**unreliable**” and a **reason** and there is no contradiction.

Do **not** allow incomplete or vague statements e.g.

- Unreliable (without a valid reason)
- 3000 million tonnes is too big
- Coal will have run out
- Coal is a finite resource
- Extrapolation (without reference to it being unreliable)
- Unlikely (without reference to it being unreliable)

You may need to use your own judgement to decide if a comment is acceptable.