(9) (a) $P_0 = 120\, e^{-0.0079 \times 0}$

$= 120 \times e^{0}$

$= 120$

(b) $0.85 \times 120 = 102$

$102 = 120\, e^{-0.0079t}$

$\frac{102}{120} = e^{-0.0079t}$

$\ln 0.85 = \ln e^{-0.0079t}$

$\ln 0.85 = -0.0079t \ln e$

$t = \frac{\ln 0.85}{-0.0079}$

$t = 20.6$

Question			Generic scheme	Illustrative scheme	Max mark
9.	(a)		•1 identify initial power	•1 120	**1**

Notes:

Commonly Observed Responses:

	(b)		•2 interpret information •3 process equation •4 write in logarithmic form •5 process for t	•2 $102 = 120e^{-0.0079t}$ stated or implied by •3 •3 $e^{-0.0079t} = 0.85$ •4 $\log_e 0.85 = -0.0079t$ •5 20·572…	**4**

Notes:

1. Candidates who interpret 15% incorrectly do not gain •2, but •3, •4 and •5 are still available. See Candidate E.
2. •3 may be implied by •4.
3. Any base may be used at •4 stage. See Candidate A.
4. Accept $\ln 0.85 = -0.0079t \ln e$ for •4.
5. Accept 20·57 or 20·6 at •5.
6. The calculation at •5 must follow from the valid use of exponentials and logarithms at •3 and •4.
7. For candidates who take an iterative approach to arrive at $t = 20.6$ award 1/4.
   However, if, in the iterations P_t is evaluated for $t = 20.55$ and $t = 20.65$ then award 4/4.

Commonly Observed Responses:

Candidate A

$102 = 120e^{-0.0079t}$ •2 ✓
$e^{-0.0079t} = 0.85$ •3 ✓
$\log_{10} 0.85 = -0.0079t \log_{10} e$ •4 ✓
20.6 •5 ✓

Candidate B

$102 = 120e^{-0.0079t}$ •2 ✓
$e^{-0.0079t} = 0.85$ •3 ✓
$t = 20.6$ •4 ^ •5 ✓ 1

Candidate C

$\log_e 0.85 = -0.0079t$ •4 ✓
$t = 20.6$ years •5 ✓
$t = 20$ years 6 months

Incorrect conversion subsequent to answer is not penalised

Candidate D

$\log_e 0.85 = -0.0079t$ •4 ✓
$t = 20$ years 6 months •5 ✗

Candidate E

$15 = 100e^{-0.0079t}$ •2 ✗
$e^{-0.0079t} = 0.15$ •3 ✓ 1
$\log_e 0.15 = -0.0079t$ •4 ✓ 1
$240.1…$ •5 ✓ 1