Question Number	Scheme	Marks
4 (a)	$\dfrac{4x^3+2x^2+3x+8}{x^2+4} \equiv Ax+B+\dfrac{Cx+D}{x^2+4}$	
(i)	Any correct value of $A=4,\ B=2$ or $C=-13$	B1
	Full method to find values for A, B and C E.g. $4x^3+2x^2+3x+8 \equiv (Ax+B)(x^2+4)+Cx+D$ Or $x^2+0x+4\overline{)4x^3+2x^2+3x+8}$ $\begin{array}{l}4x+2\\ \\ \hline -13x\end{array}$	M1
	$A=4,\ B=2$ and $C=-13$	A1
(ii)	E.g. Using $4x^3+2x^2+3x+8 \equiv (Ax+B)(x^2+4)+Cx+D$ For example $x^2 \Rightarrow B=2 \qquad x=0 \Rightarrow 4\times 2+D=8 \qquad D=0$ *	B1*
		(4)
(b)	$\int\left(Ax+B+\dfrac{Cx}{x^2+4}\right)\mathrm{d}x=\dfrac{Ax^2}{2}+Bx,+\dfrac{1}{2}C\ln\left(k\left(x^2+4\right)\right)$ k any constant	B1 ft, M1 A1ft
	$\displaystyle\int_1^4 \frac{4x^3+2x^2+3x-8}{x^2+4}\,\mathrm{d}x=\left[2x^2+2x-\frac{13}{2}\ln\left(k\left(x^2+4\right)\right)\right]_1^4$	
	$=\left(32+8-\dfrac{13}{2}\ln 20\right)-\left(2+2-\dfrac{13}{2}\ln 5\right)=36+\dfrac{13}{2}\ln\dfrac{1}{4}=36-13\ln 2$	dM1 A1
		(5)
		(9 marks)

(a)(i) Note – mark part (a) as a whole.

B1: Any correct value of A, B or C. Must be correctly identified to its letter by label or position in the identity, not just a value.

M1: A full method to find values for A, B and C.

If they attempt $4x^3+2x^2+3x+8 \equiv (Ax+B)(x^2+4)+Cx+D$ the expression must be correct.

If they attempt by division then they must proceed to a linear quotient and a linear remainder. Alternative notations of long division may be seen. Correct values for A, B and C will imply the method mark.

A1: Correct A, B, C or correct expression.

Note: attempts at long division but mixing up the constants to give $-13x+\dfrac{4x+2}{x^2+4}$ can score the method mark only.

(a)(ii)

B1*: Fully shows that $D = 0$ from clear and correct work.

Using $4x^3 + 2x^2 + 3x + 8 \equiv (Ax + B)\left(x^2 + 4\right) + Cx + D$ they would need to set up (at least) two correct equations and solve, with appropriate substitutions seen, to show that $D = 0$

Using division the working must be fully correct with the remainder shown as just $-13x$ and minimal conclusion or indication $D = 0$

FYI

$$\begin{array}{r} 4x+2 \\ x^2+0x+4\overline{)\,4x^3+2x^2+3x+8} \\ 4x^3+0x^2+16x \\ \hline 2x^2-13x+8 \\ 2x^2+0x+8 \\ \hline -13x \end{array}$$

Make sure the remainder is $-13x$ and not just -13

Using verification is also acceptable, e.g. after finding values, expanding both sides with $D = 0$ in place, and checking expressions agree.

(b)

B1ft: Integrates their $Ax + B$ to $\frac{Ax^2}{2} + Bx \ \ (A, B \neq 0)$

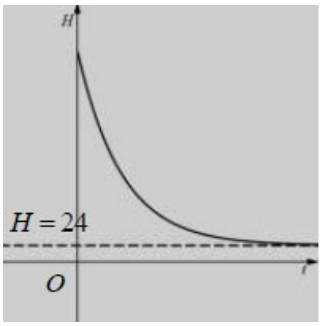
M1: Integrates their $\frac{Cx}{x^2+4}$ to $\ldots \ln\left(k\left(x^2+4\right)\right)$ where k is any constant (most likely $k = 1$). Condone invisible brackets, $\ln x^2 + 4$. Condone the answer coming from $\frac{Cx}{2x}\ln(x^2+4)$ as long as the spurious x's are cancelled (which may occur after substitution).

They should be using $D = 0$ to access this mark, $\frac{Cx+D}{x^2+4}$ with $D \neq 0$ to $\ldots \ln\left(k\left(x^2+4\right)\right)$ is M0. If they split the fraction a valid attempt must be made at both parts in order to score the M – send to review in such instances.

A1ft: Correct integration for their $\frac{Cx}{x^2+4}$ Condone invisible brackets, $\ln x^2 + 4$ (oe)

dM1: Substitutes 1 and 4 into an expression of the form $Px^2 + Qx + R\ln\left(k\left(x^2+4\right)\right)$, subtracts either way around and attempts to collect terms (condone slips combining ln terms) reaching single constant and ln terms. "Invisible brackets" on a $\ln x^2 + 4$ term must have been recovered to score this mark.

A1: $36 - 13\ln 2$

Question Number	Scheme	Marks
5 (a)	$304(°\text{C})$	B1 **(1)**
(b)	 Shape or Asymptote Fully correct Shape and Asymptote	M1 A1 **(2)**
(c)	$144 = 280\,e^{-0.05t} + 24 \Rightarrow 280\,e^{-0.05t} = 120$ Correct use of lns $\Rightarrow -0.05t = \ln\frac{120}{280} \Rightarrow t = 16.95$	M1 dM1 A1 **(3)**
(d)	$\left(\frac{dH}{dt} =\right) -0.05 \times 280\,e^{-0.05t}$ $\frac{dH}{dt} = -0.05 \times (H - 24) \Rightarrow \frac{dH}{dt} = 1.2 - 0.05H$	M1 M1, A1cso **(3)** **(9 marks)**

(a)

B1: 304

(b)

M1: Correct shape or correct asymptote. For the shape the curve must be at least in the upper half plane with negative gradient which levels out to 0, but which may be asymptotic to the *x*-axis. Be tolerant with curves that begin to turn back on themselves for this mark if the intent is clear.
For the asymptote it must be an asymptote for their curve (not just a dashed line with no curve approaching it), and may just be labelled 24 on the *y*-axis for this mark.

A1: Correct shape and asymptote. For the shape the curve must be in quadrant 1 only, starting on the *H* axis with negative gradient which levels to 0 at the asymptote which must be above the *x*-axis. It must not cross the asymptote or clearly turn back on itself, but condone touching the asymptote and slight "pen flicks" at the end.
The asymptote must be an equation, $H = 24$ but condone $y = 24$. Must be an equation, not just 24 labelled as the intercept of the asymptote.

(c)

M1: Substitutes $H = 144$ into the equation and proceeds at least as far as $Ae^{\pm 0.05t} = B$ condoning slips.

dM1 Uses correct ln work to find *t*.

Method 1: $Ae^{-0.05t} = B \to e^{\pm 0.05t} = k \to \pm 0.05t = \ln k \to t = ...$

Method 2: $Ae^{-0.05t} = B \to \ln A - 0.05t = \ln B \to t = ...$

May be implied by a correct f.t. value following reaching an equation $Ae^{\pm 0.05t} = B$

A1 Awrt 16.95. Condone awrt 16.95 minutes.