Question Number	Scheme	Marks
3 (i)	$\int 2(3x+5)^7\,\mathrm{d}x = \dfrac{(3x+5)^8}{12}(+c)$	M1 A1 **(2)**
(ii) (a)	By division $x^2+x-2\overline{)4x^3+x^2-7x+14}$ $\quad 4x-3$	M1 A1
	Remainder $= 4x+8$	M1
	$\dfrac{4x+8}{x^2+x-2} = \dfrac{4\cancel{(x+2)}}{\cancel{(x+2)}(x-1)}$	
	$\dfrac{4x^3+x^2-7x+14}{(x-1)(x+2)} \equiv 4x-3+\dfrac{4}{x-1}$	A1 **(4)**
(b)	$\int_3^9 \mathrm{f}(x)\,\mathrm{d}x = \left[2x^2-3x+4\ln(x-1)\right]_3^9$	M1 A1ft
	$= 126+4\ln 8-4\ln 2 = 126+8\ln 2$	dM1 A1 **(4)** **(10 marks)**

(i)

M1 Integrates and achieves $k(3x+5)^8$ where k is a constant. Any attempt that involves expanding $(3x+5)^7$ is unlikely to reach an answer in its simplest form, so probably scores M0A0, but if you think there is a meaningful attempt to factorise the answer into the required form, send to review. If a substitution is used, they must revert to x and reach $k(3x+5)^8$

A1 $\dfrac{(3x+5)^8}{12}$ with or without + c

(ii) (a)

By division

M1 Divides the cubic by x^2+x-2 and achieves a linear quotient $4x\pm...$. Watch out for different ways to present the division, e.g. grid method. They may divide first by $(x+2)$ and then by $(x-1)$ or vice versa. See exemplification below. Do not allow misreads for the quadratic divisor; or if dividing by the two linear factors separately, these must be correct.

A1 Achieves the linear quotient $4x-3$. This mark can be given even if slips in the division lead to an incorrect remainder.

M1 See one of the following 3 cases below for award of this mark. All 3 cases depend on a valid attempt at division and $Q(x)$ is their linear quotient after division.

1) If the candidate has divided the cubic by x^2+x-2, achieving a remainder $px+q$, this mark can be awarded for reaching $Q(x)+\dfrac{px+q}{x^2+x-2}$ or $Q(x)+\dfrac{px+q}{(x+2)(x-1)}$

2) If they have divided by $(x+2)$ and then $(x-1)$, they should reach an expression of the form $Q(x)+\dfrac{c}{x-1}$, where *c* is an integer. If there are slips in the division by $(x+2)$ leading to a non-zero remainder, award for reaching $Q(x)+\dfrac{px+q}{x^2+x-2}$ or $Q(x)+\dfrac{px+q}{(x+2)(x-1)}$

3) If they have divided by $(x-1)$ and then $(x+2)$, this mark can be awarded for reaching $Q(x)+\dfrac{px+q}{x^2+x-2}$ or $Q(x)+\dfrac{px+q}{(x+2)(x-1)}$

In Cases (2) and (3) there must be a correct method for combining the two remainders into a single fraction.

A1 $4x-3+\dfrac{4}{x-1}$ which may be seen in (ii) (b)

Division by the two linear factors separately – exemplification

$\dfrac{4x^3+x^2-7x+14}{x+2}=4x^2-7x+7$; followed by $\dfrac{4x^2-7x+7}{x-1}=4x-3+\dfrac{4}{x-1}$ (M1A1M1A1)

Or $\dfrac{4x^3+x^2-7x+14}{x-1}=4x^2+5x-2+\dfrac{12}{x-1}$; followed by $\dfrac{4x^2+5x-2}{x+2}=4x-3+\dfrac{4}{x+2}$ (M1A1 here for correct quotient). Then $\dfrac{12}{(x-1)(x+2)}+\dfrac{4}{x+2}=\dfrac{4}{x-1}\Rightarrow \mathrm{f}(x)=4x-3+\dfrac{4}{x-1}$ (M1A1)

Alt: By comparing terms / using an identity. This must be of the correct form but condone slips (say in signs).
$4x^3+x^2-7x+14\equiv(ax+b)(x+2)(x-1)+c(x+2)$

M1 Correct method to find two constants, e.g. $x=1\Rightarrow 12=3c\Rightarrow c=4$, compare terms in $x^3\Rightarrow 4=a$

A1 Two correct constants

M1 Correct method to find all three constants

A1 $4x-3+\dfrac{4}{x-1}$ which may be seen in (ii) (b)

(ii) (b)

M1 Integrates their $ax+b+\dfrac{c}{x-1}$ to achieve a correct $c\ln(x-1)$ AND one of the other two terms: $\dfrac{1}{2}ax^2$ or bx for their *a*, *b* and *c*. Condone invisible brackets in the log term as long as there is a recovery when substituting limits.

A1ft $\displaystyle\int ax+b+\frac{c}{x-1}\,\mathrm{d}x=\frac{1}{2}ax^2+bx+c\ln(x-1)$. Follow through on their a,b and c. Condone a spurious integration symbol and d*x* after integration.

dM1 Dependent on the first M1. Substitutes in both limits and subtracts. Condone missing brackets around the expression involving the lower limit.

A1 $126+4\ln 4$ or $126+8\ln 2$ or any equivalent involving a single log term. Withhold this mark if a spurious integration symbol or d*x* features in their final answer. Award A0 if a constant of integration is included. Isw after a correct expression.

Question Number	Scheme	Marks
4	$\log_{10} h = 2.4 - 0.25\log_{10} m$	
(a)	$\log_{10} h = 2.4 - 0.25\log_{10} 3 \Rightarrow h = 10^{2.4-0.25\log_{10} 3}$	M1
	$\Rightarrow h = 191$	A1
		(2)
(b)	Example: One correct law $\log_{10} h = 2.4 + \log_{10} m^{-0.25}$	M1
	Full method in forming an equation linking h and m, e.g. $h = 10^{2.4} \times m^{-0.25}$	dM1
	$\Rightarrow h = \dfrac{251}{m^{0.25}}$	A1
		(3)
(c)	The resting heart rate (in beats per minute) for (a mammal of mass) 1 kg	B1
		(1)
		(6 marks)

(a)

M1 Substitutes $m = 3$ into the given equation and uses the correct order of operations to find h. Can be implied by a correct value for h.

A1 awrt 191

(b)

M1 Makes a first step towards achieving an answer. Sight of a correct rule or law used. Will usually be awarded for one of:

- Application of a power rule e.g. $-0.25\log_{10} m \rightarrow \log_{10} m^{-0.25}$
- An attempt to make h the subject. E.g. $\log_{10} h = 2.4 - 0.25\log_{10} m \rightarrow h = 10^{2.4-0.25\log_{10} m}$
- Both of the above applied at once, e.g. $\log_{10} h = 2.4 - 0.25\log_{10} m \rightarrow h = \dfrac{10^{2.4}}{m^{0.25}}$ or $10^{2.4} \times m^{-0.25}$

In this case, M1 dM1 are scored together.

dM1 Dependent on the first M1. Full and complete method to make h the subject, with logs being correctly removed, e.g. $\log_{10} h = 2.4 + \log_{10} m^{-0.25} \Rightarrow h = 10^{2.4} \times m^{-0.25}$

A1 Achieves $h = \dfrac{251}{m^{0.25}}$ with at least one intermediate step (see M1) between the given equation and the final answer. Accept ¼ or 0.250 in place of 0.25 and allow awrt 251. Do not accept $p = 251, q = 0.25$ for this mark without seeing the full equation.

Note: It is possible to score 000 in (b) despite a numerator of 251 if an incorrect method is used.

Note: Allow full marks for part (b) if full working is shown correctly in (a).

SC: Award SC110 for use of $m = 3$ in part (a), and making h the subject, reaching $h = \dfrac{10^{2.4}}{3^{1/4}}$ and then writing down $p = 251, q = 0.25$ in part (b).

(c)

B1 "The (resting) heart rate (in beats per minute) for (a mammal of mass) 1 kg". Also accept "The beats per minute for (a mammal of mass) 1 kg."