Question Number	Scheme	Marks
3 (i)	$\int (2x-5)^7 \, \mathrm{d}x = \dfrac{(2x-5)^8}{16} + c$	M1 A1 **(2)**
(ii)	$\int \dfrac{4\sin x}{1+2\cos x} \, \mathrm{d}x = -2\ln(1+2\cos x) \quad (+c)$	M1 A1
	$\int_0^{\frac{\pi}{3}} \dfrac{4\sin x}{1+2\cos x} \, \mathrm{d}x = \left[-2\ln(1+2\cos x)\right]_0^{\frac{\pi}{3}} = -2\ln 2 + 2\ln 3 = \ln\dfrac{9}{4}$	dM1 A1 **(4)**
		(6 marks)

(i)

M1: Achieves $a(2x-5)^8$ or equivalent where a is a constant. Alternatively achieves au^8 with $u = (2x-5)$

Allow this mark from a miscopy such as $\int (2x-3)^7 \, \mathrm{d}x = k(2x-3)^8$

A1: Achieves $\dfrac{(2x-5)^8}{16} + c$ or exact simplified equivalent such as $\dfrac{1}{16}(2x-5)^8 + c$. **The +*c* (o.e) must be present.**

Any attempts that start by multiplying out $(2x-5)^7$ are likely to end in failure. They are unlikely to get an expression of the form $a(2x-5)^8$

FYI

$(2x-5)^7 = 128x^7 - 2240x^6 + 16800x^5 - 70000x^4 + 175000x^3 - 262500x^2 + 218750x - 78125$

Score B1 SC for at least 5 out of 8 **correct** terms of

$\dfrac{128}{8}x^8 - \dfrac{2240}{7}x^7 + \dfrac{16800}{6}x^6 - \dfrac{70000}{5}x^5 + \dfrac{175000}{4}x^4 - \dfrac{262500}{3}x^3 + \dfrac{218750}{2}x^2 - 78125x$

(ii)

M1: Achieves $b\ln(1+2\cos x)$ or $b\ln|1+2\cos x|$ where b is a constant. Condone a missing bracket

Alternatively achieves $b\ln u$ with $u = 1+2\cos x$ (You may see $b\ln ku$ which is also correct)

A1: Achieves $-2\ln(1+2\cos x)$, $-2\ln|1+2\cos x|$ or $-2\ln u$ o.e .with $u = 1+2\cos x$ oe. There is no need for $+c$ This may be left unsimplified. Only condone a missing bracket if subsequent work implies one

dM1: Substitutes **both** 0 and $\dfrac{\pi}{3}$ into an expression of the form $b\ln(1+2\cos x)$ a or $b\ln|1+2\cos x|$ and subtracts either way around . There must have been some attempt to evaluate the trig terms

Alternatively substitutes both 3 and 2 into an expression of the form $k\ln u$ and subtracts

A1: $\ln\dfrac{9}{4}$

Note that algebraic integration must be seen here. Candidates using their calculators to just write down $\int_0^{\frac{\pi}{3}} \dfrac{4\sin x}{1+2\cos x} \, \mathrm{d}x = 0.81093... = \ln\dfrac{9}{4}$ should be awarded 0 marks

Question Number	Scheme	Marks
4	$A = \dfrac{80pe^{0.15t}}{pe^{0.15t}+4}$	
(a)	$30 = \dfrac{80p}{p+4}$	M1
	$30p+120 = 80p \Rightarrow p = \dfrac{120}{50} = 2.4$ *	A1* **(2)**
(b)	$50 = \dfrac{80\times 2.4e^{0.15T}}{2.4e^{0.15T}+4} \Rightarrow 72e^{0.15T} = 200$	M1 A1
	$\Rightarrow 0.15T = \ln\left(\dfrac{200}{72}\right) \Rightarrow T = 6.8$	dM1 A1 **(4)**
(c)	80 m^2	B1 **(1)**
		(7 marks)

(a)

M1: Sets $A = 30$ and $e^{0.15\times 0} = 1$ to set up an equation in p.

A1*: Achieves $p = 2.4$ with no significant (*) errors and with one correct **linear (non fractional)** equation in p. * Condone minor slips as long as they are recovered before reaching the given answer.

An example of this would be

$$p+4(30) = 80p \Rightarrow 30p+120 = 80p \Rightarrow 50p = 120 \Rightarrow p = 2.4$$

Alt method

M1: Sets $p = 2.4$, $e^{0.15\times 0} = 1$ and attempts the value of $(A) = \dfrac{80\times 2.4\times 1}{2.4\times 1+4}$

A1*: Achieves $A = 30$ with no errors and concludes that $p = 2.4$. Condone $30 = \dfrac{192}{6.4}$ ✓

(b) Allow $t \leftrightarrow T$ here

M1: Sets $A = 50$, $p = 2.4$ and proceeds to an equation of the form $ce^{0.15t} = d \quad c\times d > 0$

Condone slips, e.g. on the 0.15. You may see $de^{-0.15t} = c \quad c\times d > 0$

A1: Achieves $72e^{0.15t} = 200$ o.e.

dM1: Correct order of operations to find T/t

For example $0.15T = \ln\left(\dfrac{200}{72}\right) \Rightarrow T = ...$ or

$\ln 72 + 0.15T = \ln 200 \Rightarrow 0.15T = ... \Rightarrow T = ...$

A1: AWRT 6.8

(c)

B1: Requires units as well. 80 m^2

Students lacking work in part (b)

Example 1: $50 = \dfrac{80\times 2.4e^{0.15T}}{2.4e^{0.15T}+4} \Rightarrow T = awrt\ 6.8$ can be awarded SC 1000