Question Number	Answer	Mark
	Use $v = \int a \, \mathrm{d}t$ $= \lambda t - \mu \ln(2t+3) \quad (+C)$	M1
	$= 3t - 4\ln(2t+3) \quad (+C)$	A1
	Use $t = 0, v = 2\ln 3 \Rightarrow C = \cdots$	DM1
	$(v =) 3t - 4\ln(2t+3) + 6\ln 3$ * $(p = 3, q = -4, r = 6)$	A1*
		(4)
2(b)	Use $x = \int v \, \mathrm{d}t$ to include integrated terms of the form $\frac{pt^2}{2} + (r \ln 3)t$	M1
	Use integration by parts on the term $q\ln(2t+3)$ $\lambda t \ln(2t+3) + \mu \int \frac{t}{2t+3} \mathrm{d}t$	M1
	$(x =)$ $\frac{3}{2}t^2 + (6\ln 3)t - 4t\ln(2t+3) + 4t - 6\ln(2t+3) + 6\ln 3$	A1
	12.3 (m)	A1
		(4)
		(8)
	Notes for Question 2	
2(a)		
M1	Correct method to obtain *v* from *a* by integrating with respect to *t*. Must reach a form that includes: $\lambda t - \mu \ln(2t+3)$ No need for the constant of integration. M0 for use of $v\frac{\mathrm{d}v}{\mathrm{d}x}$	
A1	Correct two terms	
DM1	Dependent on previous M. Use initial conditions to evaluate constant of integration.	
A1*	Obtain result in given form from correct algebraic integration. The values of *p*, *q* and *r* can be embedded in a correct solution – they do not need to be stated separately. Accept correct terms for *v* in any order.	
2(b)		
M1	Integrate their expression for *v* with respect to *t*. Must reach a form that includes: $\frac{pt^2}{2} + (r \ln 3)t$ Ignore their integration of $q\ln(2t+3)$ for this method mark.	
M1	Independent. Use integration by parts to integrate $q\ln(2t+3)$ with respect to *t* at least as far as: $\lambda t \ln(2t+3) + \mu \int \frac{t}{2t+3} \mathrm{d}t$	
A1	Any equivalent form including the correct constant of integration (6ln3)	
A1	Must be 3sf. Correct answer must follow correct algebraic integration and the correct value for the constant of integration seen.	

	No need to see substitution of $t = 3$ into their correct expression.	

3. (a) Use algebraic integration to show that the centre of mass of a uniform semicircular lamina of radius r is $\frac{4r}{3\pi}$ from the centre of the semicircle.

[You may assume, without proof, that the area of a circle of radius r is πr^2]

(5)

In the template shown shaded in Figure 2, C_1 is a semicircular lamina with a semicircular lamina C_3 removed. A semicircular lamina C_2 is attached to C_1.

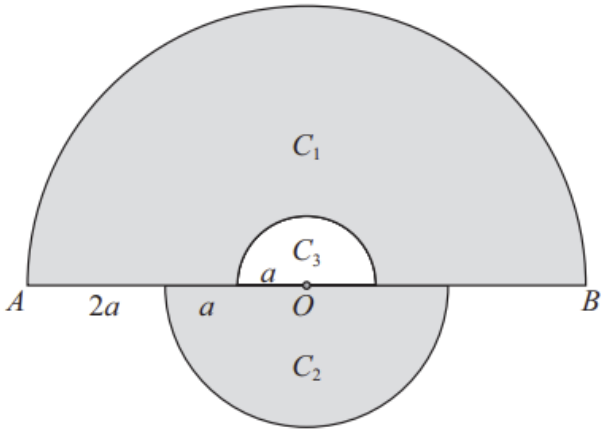


Figure 2

- C_1 has radius $4a$, diameter AB and centre O
- C_2 has radius $2a$ and centre O
- C_3 has radius a and centre O

Laminas C_1 and C_2 are made from the same material and lie in the same plane.

The template is freely suspended from A and hangs in equilibrium with AB at an angle of $\theta°$ to the downward vertical.

(b) Find the value of θ

(7)