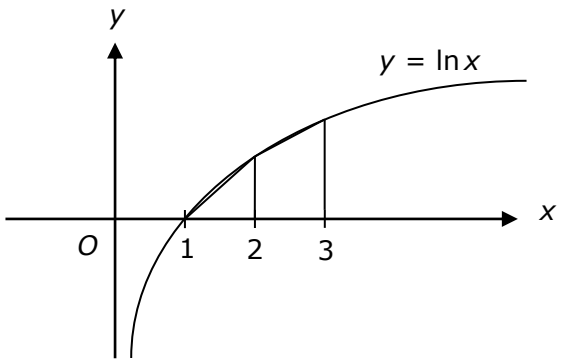
MA SQ 11 (a) Sketch the graph of $y = \ln x$ in the space provided. **1**

(b) Use the trapezoidal rule with three function values to find an approximation to $\int_1^3 \ln x \, dx$. **2**

(c) State whether the approximation found in part (b) is greater than or less than the exact value of $\int_1^3 \ln x \, dx$. Justify your answer. **1**

(a)



(b)

x	1	2	3
$\ln x$	0	$\ln 2$	$\ln 3$

$$\int_1^3 \ln x \, dx \approx \frac{b-a}{2n}\{f(a)+f(b)+2[f(x_1)+\ldots f(x_{n-1})]\}$$

$$= \frac{1}{2}\{0+\ln 3+2\ln 2\}$$

$$= \frac{1}{2}(\ln 3 + 2\ln 2)$$

$$= 1.242453325\ldots$$

$$= 1.24 \text{ (2 dec pl)}$$

(c) The approximation using the trapezoidal rule is less than the exact value because $y = \ln x$ is concave down and the trapezia are under the curve.