**13** A book of length $l$ and weight $W$ is positioned on a shelf as shown.
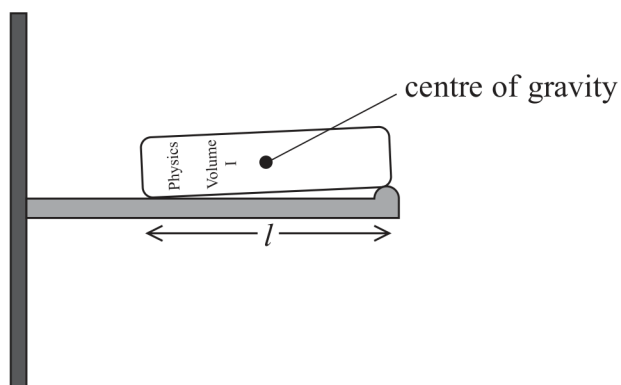
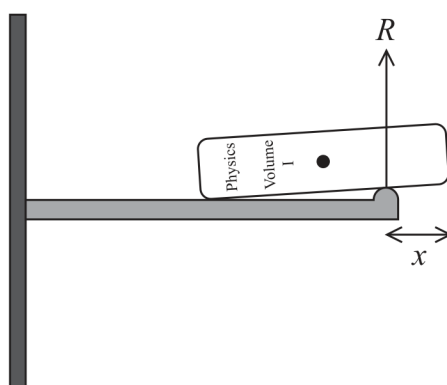

centre of gravity

(a) State what is meant by centre of gravity.

(1)

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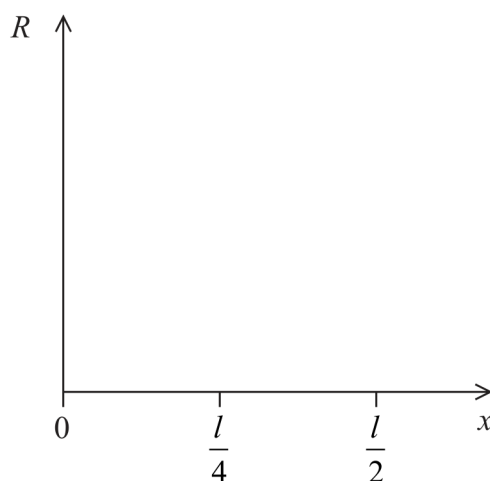(b) There are contact forces at the two positions where the book touches the shelf.

The book is moved a distance $x$ to the right as shown.



The magnitude of the contact force $R$ varies with $x$.

Sketch on the axes below the variation of $R$ with $x$ between 0 and $\dfrac{l}{2}$. You should mark the maximum value of $R$ onto the axes.

(3)

(c) Explain why the book will not remain on the shelf if $x > \dfrac{l}{2}$.

(2)

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**(Total for Question 13 = 6 marks)**