

## STEP III, 2012 Q10

- 10 A small ring of mass  $m$  is free to slide without friction on a hoop of radius  $a$ . The hoop is fixed in a vertical plane. The ring is connected by a light elastic string of natural length  $a$  to the highest point of the hoop. The ring is initially at rest at the lowest point of the hoop and is then slightly displaced. In the subsequent motion the angle of the string to the downward vertical is  $\phi$ . Given that the ring first comes to rest just as the string becomes slack, find an expression for the modulus of elasticity of the string in terms of  $m$  and  $g$ .

Show that, throughout the motion, the magnitude  $R$  of the reaction between the ring and the hoop is given by

$$R = (12 \cos^2 \phi - 15 \cos \phi + 5)mg$$

and that  $R$  is non-zero throughout the motion.



# NextStepMaths.com

To view mark schemes, fully worked solutions and examiner's comments, and for more details about tutoring and other services offered, go to [NextStepMaths.com](https://www.NextStepMaths.com)