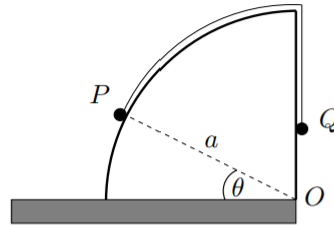


STEP III, 2010 Q9

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The diagram shows two particles, P and Q , connected by a light inextensible string which passes over a smooth block fixed to a horizontal table. The cross-section of the block is a quarter circle with centre O , which is at the edge of the table, and radius a . The angle between OP and the table is θ . The masses of P and Q are m and M , respectively, where $m < M$.

Initially, P is held at rest on the table and in contact with the block, Q is vertically above O , and the string is taut. Then P is released. Given that, in the subsequent motion, P remains in contact with the block as θ increases from 0 to $\frac{1}{2}\pi$, find an expression, in terms of m , M , θ and g , for the normal reaction of the block on P and show that

$$\frac{m}{M} \geq \frac{\pi - 1}{3}.$$



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