

STEP III, 2007, Q11

- 11 (i) A wheel consists of a thin light circular rim attached by light spokes of length a to a small hub of mass m . The wheel rolls without slipping on a rough horizontal table directly towards a straight edge of the table. The plane of the wheel is vertical throughout the motion. The speed of the wheel is u , where $u^2 < ag$.

Show that, after the wheel reaches the edge of the table and while it is still in contact with the table, the frictional force on the wheel is zero. Show also that the hub will fall a vertical distance $(ag - u^2)/(3g)$ before the rim loses contact with the table.

- (ii) Two particles, each of mass $m/2$, are attached to a light circular hoop of radius a , at the ends of a diameter. The hoop rolls without slipping on a rough horizontal table directly towards a straight edge of the table. The plane of the hoop is vertical throughout the motion. When the centre of the hoop is vertically above the edge of the table it has speed u , where $u^2 < ag$, and one particle is vertically above the other.

Show that, after the hoop reaches the edge of the table and while it is still in contact with the table, the frictional force on the hoop is non-zero and deduce that the hoop will slip before it loses contact with the table.



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