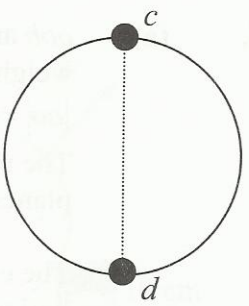
2007 6 **(b)** A bead slides on a smooth fixed circular hoop, of radius r, in a vertical plane.

The bead is projected with speed $\sqrt{10gr}$ from the highest point c.

It impinges upon and coalesces with another bead of equal mass at d.

cd is the vertical diameter of the hoop.



Show that the combined mass will not reach the point c in the subsequent motion.

Let v be the speed of c : when it reaches d

Total energy at c = Total energy at d

$$\frac{1}{2}m(10gr)+mg(2r)=\frac{1}{2}mv^2+mg(0) \qquad 5$$

$$v^2=14gr \qquad 5$$

Let v_1 be the speed of : the combined mass at d

$$mv+m(0)=2mv_1$$

$$v_1=\frac{1}{2}v \qquad 5$$

For the combined mass : to reach c with speed v_2

$$\frac{1}{2}(2m)(v_1)^2+(2m)g(0)=\frac{1}{2}(2m)(v_2)^2+(2m)g(2r)$$

$$m\left(\frac{v^2}{4}\right)=m(v_2)^2+4mgr$$

$$\frac{14gr}{4}=(v_2)^2+4gr$$

$$\Rightarrow (v_2)^2=-\frac{1}{2}gr \qquad 5$$

This is not possible $\Rightarrow$ the combined mass will not reach c. 5

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