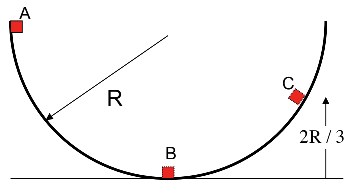
Problem 5.73

A $2x10^2$ gram particle is released from rest from point A. The radius of the frictionless bowl is 30 cm.

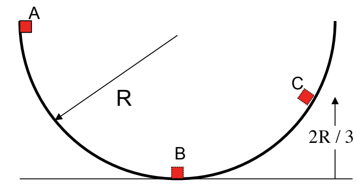


a.) Determine the gravitational potential energy at point A relative to point B.

b.) Determine the kinetic energy at point B.

c.) Determine the particle's speed at point B.

A 200 gram particle is released from rest from point A. The radius of the frictionless bowl is .30 m.



a.) Determine the gravitational potential energy at point A relative to point B.

Assuming y=0 at point B:

$$
\begin{aligned}
U_g &= mgR \\
&= (.2\text{ kg})(9.8\text{ m/s}^2)(.3\text{ m}) \\
&= .588\text{ joules}
\end{aligned}
$$

b.) Determine the kinetic energy at point B.

$$W_{net} = \Delta KE$$

$$\Rightarrow \quad W_g = (KE_B - KE_A)$$

$$\Rightarrow \quad -\Delta U_g = KE_B$$

$$\Rightarrow \quad -(mgy_B - mgy_A) = KE_B$$

$$\Rightarrow \quad -(\ 0 \ - mgR\ ) = KE_B$$

$$\Rightarrow \quad -(\ 0 \ -(.2\text{ kg})(9.8\text{ m/s}^2)(.3\text{ m})\ ) = KE_B$$

$$\Rightarrow \quad KE_B = .588\text{ joules}$$

or

$$\sum KE_A + \sum U_A + \sum W_{extraneous} = \sum KE_B + \sum U_B$$

$$(0) \ + (mgR) + \ 0 \ = \ KE_B \ + \ (0)$$

$$\Rightarrow \quad KE_B = mgR$$

$$\Rightarrow \quad KE_B = (.2\text{ kg})(9.8\text{ m/s}^2)(.3\text{ m})$$

$$\Rightarrow \quad KE_B = .588\text{ joules}$$

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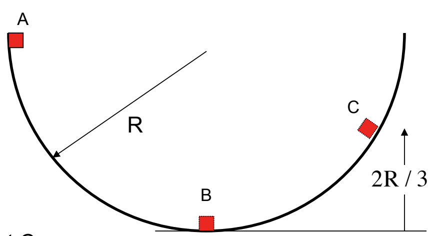
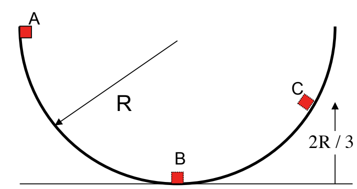
d.) Determine the particle's potential energy at point C relative to point B.



e.) Determine the particle's speed at point C.

f.) Determine the normal force acting when the particle is at point C.

A 200 gram particle is released from rest from point A. The radius of the frictionless bowl is .30 m.



c.) Determine the particle's speed at point B.

$$KE_B = \frac{1}{2}mv^2$$

$$\Rightarrow \quad v = \sqrt{\frac{2(KE_B)}{m}}$$

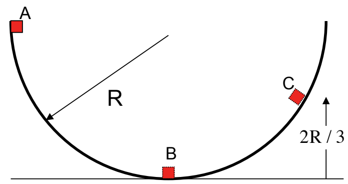
$$\Rightarrow \quad v = \sqrt{\frac{2(.588\text{ j})}{(.2\text{ kg})}}$$

$$\Rightarrow \quad v = 2.42\text{ m/s}$$

d.) Determine the particle's potential energy at point C relative to point B.

$$
\begin{aligned}
U_C &= mgy_C \\
&= (.2\text{ kg})(9.8\text{ m/s}^2)(.67(.3\text{ m})) \\
&= .394\text{ joules}
\end{aligned}
$$

A 200 gram particle is released from rest from point A. The radius of the frictionless bowl is .30 m.



e.) Determine the particle's speed at C.

$$\sum KE_A + \sum U_A + \sum W_{extraneous} = \sum KE_c + \sum U_c$$

$$(0) + (mgy_A) + 0 = \frac{1}{2}mv_c^2 + (mgy_C)$$

$$\Rightarrow \quad v_C = \sqrt{2(gy_A - gy_c)}$$

$$\Rightarrow \quad v_C = \sqrt{2(9.8 \text{ m/s}^2)(R - \tfrac{2}{3}R)}$$

$$\Rightarrow \quad v_C = \sqrt{2(9.8 \text{ m/s}^2)(\tfrac{.3}{3})}$$

$$\Rightarrow \quad v_C = \sqrt{2(9.8 \text{ m/s}^2)(\tfrac{.3}{3})}$$

f.) Determine the normal force acting when the particle is at point C.

Energy considerations yields:

$$mgR = \frac{1}{2}mv_c^{\ 2} + mg\left[\left(\frac{2}{3}\right)R\right]$$

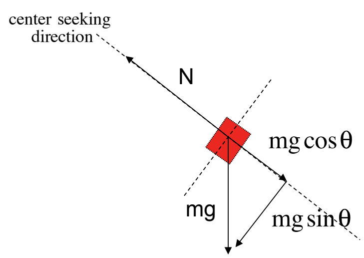
$$\Rightarrow \quad v_c = \left(\frac{gR}{3}\right)^{1/2}$$

It's nice to know "v," what what we really want is "N." So let's try Newton's Second Law and the fact that the bead is experiencing a centripetal acceleration yields:

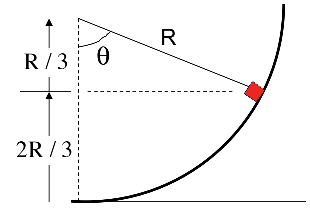
NSL:

$$\sum F_c$$

$$N - mg\cos\theta = m\frac{v^2}{R}$$



Looking at the sketch to determine the cosine:



$$\cos\theta = \frac{R/3}{R} = .333$$

Using that our conservation of energy relationship has given us a velocity expression of:

$$v_c = \left(\frac{gR}{3}\right)^{1/2}$$

we can write:

$$N = mg\cos\theta + m\frac{v^2}{R}$$

$$N = mg\cos\theta + m\frac{\left[\left(\tfrac{gR}{3}\right)^{1/2}\right]^2}{R}$$

$$\Rightarrow \quad N = mg(.33) + mg(.33)$$

$$\Rightarrow \quad N = .66mg$$