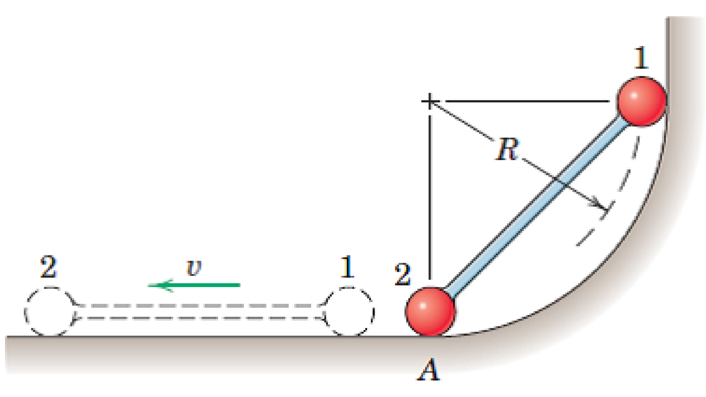
Engineering Mechanics | (8th Edition)

Problem

The two small spheres, each of mass *m*, are rigidly connected by a rod of negligible mass and are released from rest in the position shown and slide down the smooth circular guide in the vertical plane. Determine their common velocity *v* as they reach the horizontal dashed position. Also find the force *N* between sphere 1 and the supporting surface an instant before the sphere reaches the bottom position *A*.



Problem 4/6

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Step-by-step solution

Step 1 of 3

Apply conservation of energy.

Therefore, the energy at initial position must be equal to the energy at final position.

$$P.E_1 + K.E_1 = P.E_2 + K.E_2 \quad \ldots\ldots (1)$$

Here, $P.E$ is potential energy and $K.E$ is kinetic energy and the subscripts 1 and 2 indicate initial and final positions.

Position – 1:

Apply the conditions as follows:

Potential energy is $P.E_1 = mgR$

Kinetic energy is $K.E_1 = 0$

Position – 2:

Apply the conditions as follows:

Potential energy is $P.E_2 = 0$

Kinetic energy is $K.E_2 = \frac{1}{2}(2m)v^2$

Here *v* is common velocity of the system.

Substitute mgR for $P.E_1$, 0 for $K.E_1$, 0 for $P.E_2$, and $\frac{1}{2}(2m)v^2$ for $K.E_2$ in the equation (1).

$$mgR + 0 = 0 + \frac{1}{2}(2m)v^2$$

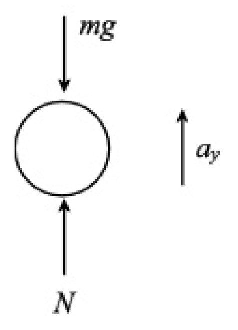
$$v = \sqrt{gR}$$

Therefore, the common velocity of the system is $v = \sqrt{gR}$.

Comment

Step 2 of 3

The sphere – 1 reaches the bottom of the circular surface with acceleration equal to centrifugal acceleration.



Thus, state the acceleration in the vertical direction:

$$a_y = \frac{v^2}{R}$$

Substitute $\sqrt{gR}$ for *v*.

$$a_y = \frac{gR}{R} = g$$

Comment

Step 3 of 3

Balance the forces in *y* – direction from the figure as shown:

$$N - mg = ma_y$$

Substitute g for a_y in the above equation.

$$N - mg = mg$$
$$N = 2mg$$

Therefore, the reaction at the instant before sphere reaches the bottom position is $\boxed{2mg}$.

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Chapter 4, Problem 16P

The two small spheres, each of mass m, and their connecting rod of negligible mass are rotating about their center G with...

See solution

Chapter 4, Problem 30P

The carriage of mass 2m is free to roll along the horizontal rails and carries the two spheres, each of mass m, mounted on rods...

See solution

Videos related to Chapter 4

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Examples related to Chapter 4

Example 1

The system of four particles has the indicated particle masses, positions, velocities, and external forces. Determine r ¯ , r ˙ ¯ , r ¨ ¯ , T, G, H O , H ˙ O , H G , and H ˙ G .

Show more

Example 2

Example 3

Example 4

Example 5