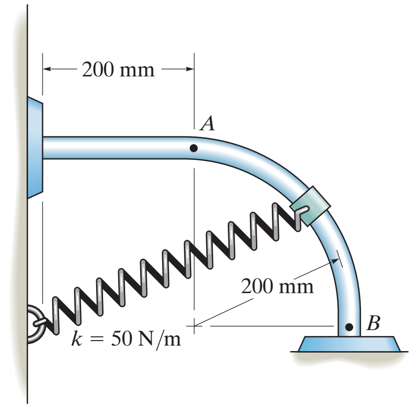
***14–68.**

The 5-kg collar has a velocity of 5 m/s to the right when it is at A. It then travels down along the smooth guide. Determine the speed of the collar when it reaches point B, which is located just before the end of the curved portion of the rod. The spring has an unstretched length of 100 mm and B is located just before the end of the curved portion of the rod.



SOLUTION

Potential Energy. With reference to the datum set through B the gravitational potential energies of the collar at A and B are

$$(V_g)_A = mgh_A = 5(9.81)(0.2) = 9.81 \text{ J}$$

$$(V_g)_B = 0$$

At A and B, the spring stretches $x_A = \sqrt{0.2^2 + 0.2^2} - 0.1 = 0.1828 \text{ m}$ and $x_B = 0.4 - 0.1 = 0.3 \text{ m}$ respectively. Thus, the elastic potential energies in the spring at A and B are

$$(V_e)_A = \frac{1}{2}kx_A^2 = \frac{1}{2}(50)\left(0.1828^2\right) = 0.8358 \text{ J}$$

$$(V_e)_B = \frac{1}{2}kx_B^2 = \frac{1}{2}(50)\left(0.3^2\right) = 2.25 \text{ J}$$

Conservation of Energy.

$$T_A + V_A = T_B + V_B$$

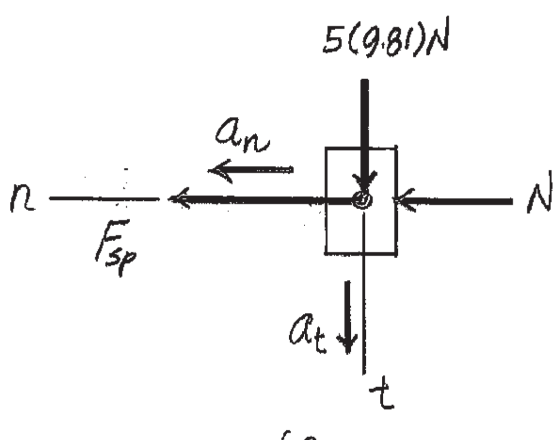
$$\frac{1}{2}(5)\left(5^2\right) + 9.81 + 0.8358 = \frac{1}{2}(5)v_B^2 + 0 + 2.25$$

$$v_B = 5.325 \text{ m/s} = 5.33 \text{ m/s} \qquad \textbf{Ans.}$$

Equation of Motion. At B, $F_{sp} = kx_B = 50(0.3) = 15 \text{ N}$. Referring to the FBD of the collar, Fig. a,

$$\Sigma F_n = ma_n; \qquad N + 15 = 5\left(\frac{5.325^2}{0.2}\right)$$

$$N = 693.95 \text{ N} = 694 \text{ N} \qquad \textbf{Ans.}$$



(a)

Ans:
$v_B = 5.33 \text{ m/s}$
$N = 694 \text{ N}$