29. We refer to its starting point as A, the point where it first comes into contact with the spring as B, and the point where the spring is compressed $|x|$ = 0.055 m as C. Point C is our reference point for computing gravitational potential energy. Elastic potential energy (of the spring) is zero when the spring is relaxed. Information given in the second sentence allows us to compute the spring constant. From Hooke's law, we find

$$k = \frac{F}{x} = \frac{270 \text{ N}}{0.02 \text{ m}} = 1.35 \times 10^4 \text{ N/m} .$$

(a) The distance between points A and B is $\vec{F}_g$ and we note that the total sliding distance $\ell + |x|$ is related to the initial height h of the block (measured relative to C) by

$$\frac{h}{\ell + |x|} = \sin \theta$$

where the incline angle θ is 30°. Mechanical energy conservation leads to

$$K_A + U_A = K_C + U_C$$
$$0 + mgh = 0 + \frac{1}{2}kx^2$$

which yields

$$h = \frac{kx^2}{2mg} = \frac{(1.35 \times 10^4 \text{ N/m})(0.055 \text{ m})^2}{2(12 \text{ kg})\,(9.8 \text{ m/s}^2)} = 0.174 \text{ m} .$$

Therefore,

$$\ell + |x| = \frac{h}{\sin 30°} = \frac{0.174 \text{ m}}{\sin 30°} = 0.35 \text{ m} .$$

(b) From this result, we find $\ell = 0.35 - 0.055 = 0.29$ m , which means that $\Delta y = -\ell \sin\theta = -0.15$ m in sliding from point A to point B. Thus, Eq. 8-18 gives

$$\Delta K + \Delta U = 0$$
$$\frac{1}{2}mv_B^2 + mg\Delta h = 0$$

which yields $v_B = \sqrt{-2g\Delta h} = \sqrt{-(9.8)(-0.15)} = 1.7 \text{ m/s}$.