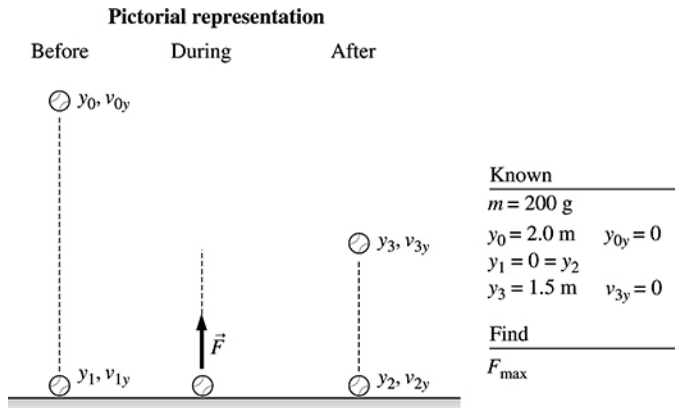
9.29. Model: Model the ball as a particle that is subjected to an impulse when it is in contact with the floor. We will also use constant-acceleration kinematic equations. Ignore any forces other than the interaction between the floor and the ball during the collision in the impulse approximation.

Visualize:



Solve: To find the ball's velocity just before and after it hits the floor:

$$v_{1y}^2 = v_{0y}^2 + 2a_y(y_1 - y_0) = 0 \text{ m}^2/\text{s}^2 + 2(-9.8 \text{ m/s}^2)(0 - 2.0 \text{ m}) \Rightarrow v_{1y} = -6.261 \text{ m/s}$$

$$v_{3y}^2 = v_{2y}^2 + 2a_y(y_3 - y_2) \Rightarrow 0 \text{ m}^2/\text{s}^2 = v_{2y}^2 + 2(-9.8 \text{ m/s}^2)(1.5 \text{ m} - 0 \text{ m}) \Rightarrow v_{2y} = 5.422 \text{ m/s}$$

The force exerted by the floor on the ball can be found from the impulse-momentum theorem:

$$mv_{2y} = mv_{1y} + \int F dt = mv_{1y} + \text{area under the force curve}$$

$$\Rightarrow (0.200 \text{ kg})(5.422 \text{ m/s}) = -(0.200 \text{ kg})(6.261 \text{ m/s}) + \tfrac{1}{2}F_{\text{max}}(5.0 \times 10^{-3} \text{ s})$$

$$\Rightarrow F_{\text{max}} = 9.3 \times 10^2 \text{ N}$$

Assess: A maximum force of 9.3×10^2 N exerted by the floor is reasonable.