51. We first find the velocity of the ball just before it hits the ground. During contact with the ground its average acceleration is given by

\[ a_{\text{avg}} = \frac{\Delta v}{\Delta t} \]

where \( \Delta v \) is the change in its velocity during contact with the ground and \( \Delta t = 20.0 \times 10^{-3} \) s is the duration of contact. Now, to find the velocity just before contact, we put the origin at the point where the ball is dropped (and take +\( y \) upward) and take \( t = 0 \) to be when it is dropped. The ball strikes the ground at \( y = -15.0 \) m. Its velocity there is found from Eq. 2-16: \( v^2 = -2gy \). Therefore,

\[ v = -\sqrt{-2gy} = -\sqrt{-2(9.8)(-15.0)} = -17.1 \text{ m/s} \]

where the negative sign is chosen since the ball is traveling downward at the moment of contact. Consequently, the average acceleration during contact with the ground is

\[ a_{\text{avg}} = \frac{0 - (-17.1)}{20.0 \times 10^{-3}} = 857 \text{ m/s}^2. \]

The fact that the result is positive indicates that this acceleration vector points upward. In a later chapter, this will be directly related to the magnitude and direction of the force exerted by the ground on the ball during the collision.