57. From mechanical energy conservation (or simply using Eq. 2-16 with $\vec{a} = g$ downward) we obtain

$$v = \sqrt{2gh} = \sqrt{2(9.8)(1.5)} = 5.4 \text{ m/s}$$

for the speed just as the body makes contact with the ground.

(a) During the compression of the body, the center of mass must decelerate over a distance $d = 0.30$ m. Choosing $+y$ downward, the deceleration a is found using Eq. 2-16

$$0 = v^2 + 2ad \quad \Longrightarrow \quad a = -\frac{v^2}{2d} = -\frac{5.4^2}{2(0.30)}$$

which yields $a = -49 \text{ m/s}^2$. Thus, the magnitude of the net (vertical) force is $m|a| = 49m$ in SI units, which (since $49 = 5(9.8)$) can be expressed as $5mg$.

(b) During the deceleration process, the forces on the dinosaur are (in the vertical direction) $\vec{N}$ and $m\vec{g}$. If we choose $+y$ upward, and use the final result from part (a), we therefore have $N - mg = 5mg$, or $N = 6mg$. In the horizontal direction, there is also a deceleration (from $v_o = 19$ m/s to zero), in this case due to kinetic friction $f_k = \mu_k N = \mu_k(6mg)$. Thus, the net force exerted by the ground on the dinosaur is

$$F_{\text{ground}} = \sqrt{f_k^2 + N^2} \approx 7mg \ .$$

(c) We can applying Newton's second law in the horizontal direction (with the sliding distance denoted as Δx) and then use Eq. 2-16, or we can apply the general notions of energy conservation. The latter approach is shown:

$$\frac{1}{2}mv_o^2 = \mu_k(6mg)\Delta x \quad \Longrightarrow \quad \Delta x = \frac{19^2}{2(6)(0.6)(9.8)} \approx 5 \text{ m} \ .$$