55. (a) By combining Newton's second law $F - mg = ma$ (where F is the force exerted up on her by the floor) and Eq. 2-16 $v^2 = 2ad_1$ (where $d_1 = 0.90 - 0.40 = 0.50\,\text{m}$ is the distance her center of mass moves while her feet are on the floor) it is straightforward to derive the equation

$$K_{\text{launch}} = (F - mg)d_1$$

where $K_{\text{launch}} = \frac{1}{2}mv^2$ is her kinetic energy as her feet leave the floor. We mention this method of deriving that equation (which also follows from the work-kinetic energy theorem Eq. 7-10, or – suitably interpreted – from energy conservation as expressed by Eq. 8-31) since the energy approaches might seem paradoxical (one might sink into the quagmire of questions such as "how can the floor possibly provide energy to the person?"); the Newton's law approach leads to no such quandaries. Next, her feet leave the floor and this kinetic energy is converted to gravitational potential energy. Then mechanical energy conservation leads straightforwardly to

$$K_{\text{launch}} = mgd_2$$

where $d_2 = 1.20 - 0.90 = 0.30\,\text{m}$ is the distance her center of mass rises from the time her feet leave the floor to the time she reaches the top of her leap. Now we combine these two equations and solve $(F - mg)d_1 = mgd_2$ for the force:

$$F = \frac{mg(d_1 + d_2)}{d_1} = \frac{(55\,\text{kg})(9.8\,\text{m/s}^2)(0.50\,\text{m} + 0.30\,\text{m})}{0.50\,\text{m}} = 860\ \text{N}\ .$$

(b) She has her maximum speed at the time her feet leave the floor (this is her "launch" speed). Consequently, the equation derived above becomes

$$\frac{1}{2}mv^2 = (F - mg)d_1$$

from which we obtain

$$\begin{aligned} v &= \sqrt{\frac{2(F - mg)d_1}{m}} \\ &= \sqrt{\frac{2\left(860\,\text{N} - (55\,\text{kg})\left(9.8\,\text{m/s}^2\right)\right)(0.50\,\text{m})}{55\,\text{kg}}} \\ &= 2.4\ \text{m/s}\ . \end{aligned}$$