47. We choose an axis through the top (where the ladder comes into contact with the wall), perpendicular to the plane of the figure and take torques that would cause counterclockwise rotation as positive. Note that the line of action of the applied force $\vec{F}$ intersects the wall at a height of $\frac{1}{5}\,8.0 = 1.6$ m; in other words, the *moment arm* for the applied force (in terms of where we have chosen the axis) is $r_\perp = \frac{4}{5}\,8.0 = 6.4$ m. The moment arm for the weight is half the horizontal distance from the wall to the base of the ladder; this works out to be $\frac{1}{2}\sqrt{10^2 - 8^2} = 3.0$ m. Similarly, the moment arms for the x and y components of the force at the ground ($\vec{F}_g$) are 8.0 m and 6.0 m, respectively. Thus, with lengths in meters, we have

$$\sum \tau_z = F(6.4) + W(3.0) + F_{gx}(8.0) - F_{gy}(6.0) = 0 \ .$$

In addition, from balancing the vertical forces we find that $W = F_{gy}$ (keeping in mind that the wall has no friction). Therefore, the above equation can be written as

$$\sum \tau_z = F(6.4) + W(3.0) + F_{gx}(8.0) - W(6.0) = 0 \ .$$

(a) With $F = 50$ N and $W = 200$ N, the above equation yields $F_{gx} = 35$ N. Thus, in unit vector notation (with the unit Newton understood) we obtain

$$\vec{F}_g = 35\,\hat{\imath} + 200\,\hat{\jmath} \ .$$

(b) With $F = 150$ N and $W = 200$ N, the above equation yields $F_{gx} = -45$ N. Therefore, in unit vector notation (with the unit Newton understood) we obtain

$$\vec{F}_g = -45\,\hat{\imath} + 200\,\hat{\jmath} \ .$$

(c) Note that the phrase "start to move towards the wall" implies that the friction force is pointed away from the wall (in the $-\hat{\imath}$ direction). Now, if $f = -F_{gx}$ and $N = F_{gy} = 200$ N are related by the (maximum) static friction relation ($f = f_{s,\max} = \mu_s N$) with $\mu_s = 0.38$, then we find $F_{gx} = -76$ N. Returning this to the above equation, we obtain

$$F = \frac{(200\,\mathrm{N})(3.0\,\mathrm{m}) + (76\,\mathrm{N})(8.0\,\mathrm{m})}{6.4\,\mathrm{m}} = 1.9 \times 10^2 \ \mathrm{N} \ .$$