31. (a) The work done by you in moving the sphere of mass m_2 equals the change in the potential energy of the three-sphere system. The initial potential energy is

$$U_i = -\frac{Gm_1m_2}{d} - \frac{Gm_1m_3}{L} - \frac{Gm_2m_3}{L-d}$$

and the final potential energy is

$$U_f = -\frac{Gm_1m_2}{L-d} - \frac{Gm_1m_3}{L} - \frac{Gm_2m_3}{d} \ .$$

The work done is

$$\begin{aligned} W &= U_f - U_i = Gm_2\left(m_1\left(\frac{1}{d} - \frac{1}{L-d}\right) + m_3\left(\frac{1}{L-d} - \frac{1}{d}\right)\right) \\ &= (6.67\times 10^{-11}\,\mathrm{m^3/s^2\cdot kg})(0.10\,\mathrm{kg})\left[(0.80\,\mathrm{kg})\left(\frac{1}{0.040\,\mathrm{m}} - \frac{1}{0.080\,\mathrm{m}}\right)\right. \\ &\qquad \left. +(0.20\,\mathrm{kg})\left(\frac{1}{0.080\,\mathrm{m}} - \frac{1}{0.040\,\mathrm{m}}\right)\right] \\ &= +5.0\times 10^{-11}\ \mathrm{J}\ . \end{aligned}$$

(b) The work done by the force of gravity is $-(U_f - U_i) = -5.0\times 10^{-11}\,\mathrm{J}$.