55. (a) We use constant acceleration kinematics. If down is taken to be positive and a is the acceleration of the heavier block, then its coordinate is given by $y = \frac{1}{2}at^2$, so

$$a = \frac{2y}{t^2} = \frac{2(0.750\,\mathrm{m})}{(5.00\,\mathrm{s})^2} = 6.00 \times 10^{-2}\ \mathrm{m/s^2}\ .$$

The lighter block has an acceleration of $6.00 \times 10^{-2}\,\mathrm{m/s^2}$ upward.

(b) Newton's second law for the heavier block is $m_h g - T_h = m_h a$, where m_h is its mass and T_h is the tension force on the block. Thus,

$$T_h = m_h(g-a) = (0.500\,\mathrm{kg})\left(9.8\,\mathrm{m/s^2} - 6.00 \times 10^{-2}\,\mathrm{m/s^2}\right) = 4.87\ \mathrm{N}\ .$$

(c) Newton's second law for the lighter block is $m_l g - T_l = -m_l a$, where T_l is the tension force on the block. Thus,

$$T_l = m_l(g+a) = (0.460\,\mathrm{kg})\left(9.8\,\mathrm{m/s^2} + 6.00 \times 10^{-2}\,\mathrm{m/s^2}\right) = 4.54\,\mathrm{N}\ .$$

(d) Since the cord does not slip on the pulley, the tangential acceleration of a point on the rim of the pulley must be the same as the acceleration of the blocks, so

$$\alpha = \frac{a}{R} = \frac{6.00 \times 10^{-2}\,\mathrm{m/s^2}}{5.00 \times 10^{-2}\,\mathrm{m}} = 1.20\ \mathrm{rad/s^2}\ .$$

(e) The net torque acting on the pulley is $\tau = (T_h - T_l)R$. Equating this to $I\alpha$ we solve for the rotational inertia:

$$\begin{aligned} I &= \frac{(T_h - T_l)R}{\alpha} \\ &= \frac{(4.87\,\mathrm{N} - 4.54\,\mathrm{N})(5.00 \times 10^{-2}\,\mathrm{m})}{1.20\,\mathrm{rad/s^2}} \\ &= 1.38 \times 10^{-2}\ \mathrm{kg{\cdot}m^2}\ . \end{aligned}$$