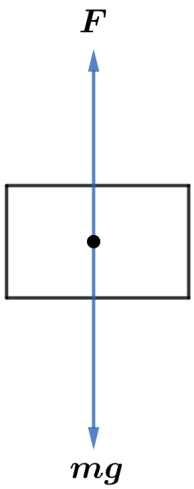
2022A F=ma Exam: Problem 9

Kevin S. Huang

First setup:



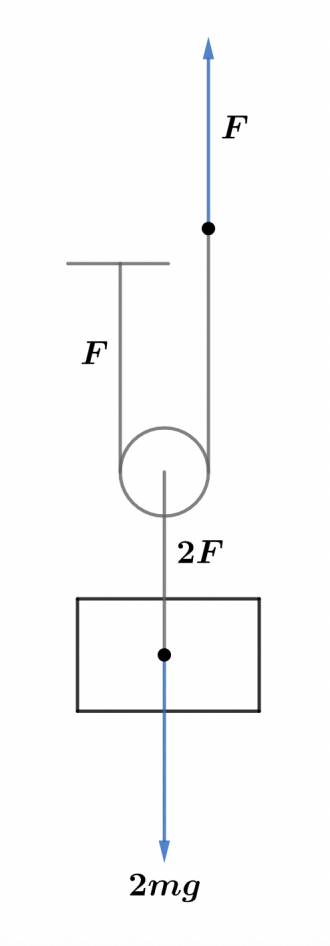
To pull the rope with constant velocity, we have

$$F_v - mg = 0$$
$$F_v = mg$$

To pull the rope with constant acceleration a, we have

$$F_a - mg = ma$$
$$F_a = m(g + a)$$

Second setup:



To pull the rope with constant velocity, we have

$$2F_v - 2mg = 0$$
$$F_v = mg$$

To pull the rope with constant acceleration a, we have

$$2F_a - 2mg = 2ma_p$$

where a_p is the acceleration of the block (and also acceleration of the pulley).

Let the pulley move up by a_p and the rope move up by a_r. Enforcing conservation of string,

$$-2a_p + a_r = 0$$

Thus, the pulley's acceleration and the rope's acceleration are related by

$$a_p = a_r/2$$

Substituting back,

$$2F_a - 2mg = ma$$
$$F_a = m\left(g + \frac{a}{2}\right)$$

Compared to before, F_v stayed the same while F_a decreased, so the answer is $\boxed{\text{A}}$.