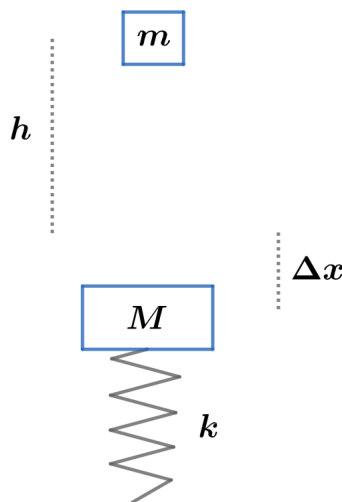# 2020B F=ma Exam: Problem 16

Kevin S. Huang

From kinematics, the time it takes for the small mass to fall is

$$h = \frac{1}{2}gt^2$$

$$t = \sqrt{\frac{2h}{g}}$$

Recall the period of oscillations of a spring-mass system is given by

$$T = 2\pi\sqrt{\frac{m}{k}}$$

In our case, the time it takes the big mass to move back to equilibrium is a quarter period,

$$t = \frac{T}{4} = \frac{\pi}{2}\sqrt{\frac{M}{k}}$$

Thus,

$$\sqrt{\frac{2h}{g}} = \frac{\pi}{2}\sqrt{\frac{M}{k}}$$

$$h = \frac{g}{2}\frac{\pi^2}{4}\frac{M}{k} = \frac{\pi^2 M g}{8k}$$

so the answer is $\boxed{D}$.