2019A F=ma Exam: Problem 13

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Note the juggler can only control the time t between ball tosses. For N balls, the juggler has to toss each ball with velocity v such that it takes time Nt to return. From kinematics,

$$v_0 + at = v_f$$

so

$$v - g(Nt) = -v$$

$$v = \frac{gNt}{2}$$

The juggler must deliver kinetic energy $\frac{1}{2}mv^2$ to a ball during each time interval t so

$$P = \frac{\frac{1}{2}mv^2}{t} \propto N^2 t$$

which means we minimize the time between ball tosses ($t = T$) to minimize power and

$$P \propto N^2$$

Thus, the answer is $\boxed{\text{C}}$.