2009 F=ma Exam: Problem 22

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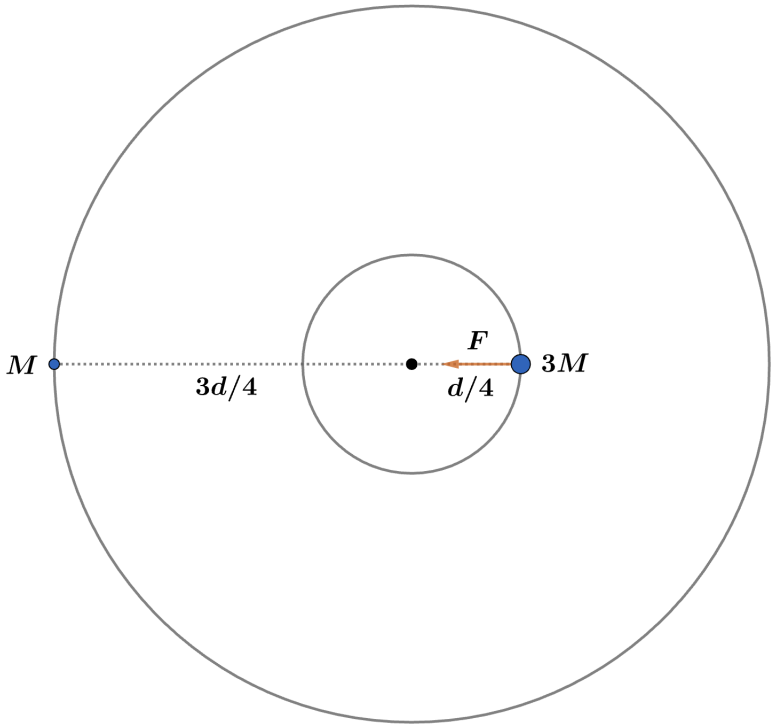

The gravitational force F on $3M$ is given by

$$F = \frac{G(3M)M}{d^2}$$

This provides the centripetal acceleration so

$$F = (3M)a_c = 3M\omega^2 r$$

Since the stars are orbiting their center of mass, $r = d/4$ for $3M$. Using $\omega = 2\pi/T$, we have

$$\frac{3GM^2}{d^2} = 3M\left(\frac{2\pi}{T}\right)^2 \frac{d}{4}$$

$$\frac{4GM}{d^3} = \frac{4\pi^2}{T^2}$$

$$T = \pi\sqrt{\frac{d^3}{GM}}$$

so the answer is $\boxed{\text{A}}$.