# Problem 1.3

A harmonic motion has a frequency of 10 cps and its maximum velocity is 4.57 m/s. Determine its amplitude, its period, and its maximum acceleration.

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**Solution**

The period $\tau$ is the reciprocal of the linear frequency $f$.

$$\tau = \frac{1}{f} = \frac{1}{10\ \text{s}^{-1}} = 0.1\ \text{s}$$

An object in harmonic motion has a position given by

$$x(t) = A \sin 2\pi f t,$$

where $A$ is the amplitude of vibration. Differentiate the position with respect to time to get the velocity.

$$\dot{x}(t) = A(2\pi f) \cos 2\pi f t$$

The maximum velocity is

$$v_{\text{max}} = A(2\pi f).$$

Set it equal to 4.57 m/s and $f = 10$ cycles per second and solve the equation for $A$.

$$A(2\pi \cdot 10) = 4.57 \quad \rightarrow \quad A = \frac{4.57}{20\pi} \approx 0.0727\ \text{m}$$

Differentiate the velocity with respect to time to get the acceleration.

$$\ddot{x}(t) = -A(2\pi f)^2 \sin 2\pi f t$$

We conclude that the maximum acceleration is

$$a_{\text{max}} = A(2\pi f)^2 = \left(\frac{4.57}{20\pi}\right)(2\pi \cdot 10)^2 \approx 287\ \frac{\text{m}}{\text{s}^2}.$$

This answer for the maximum acceleration is in disagreement with the one at the back of the book, which reads $\ddot{x}_{\text{max}} = 278.1\ \text{m/s}^2$. The other answers for $A$ and $\tau$ are in agreement, though.