

1 Selected Ch 11 Problems

1. A 1300kg car has four springs, one between each wheel and the frame. Each spring has a spring constant of 20000N/m. If the people in the car have a mass of 160kg, find the frequency of the vibration of the car if it is driven over a pothole. Also, find the angular frequency and the period.

Ans) Each spring supports a quarter of the total mass, so each spring supports a mass of $m_s = \frac{1}{4}(m_{car} + m_{passengers}) = 365kg$. Now that we have this, we can use the formula given to find the angular frequency (velocity), the frequency, and the period.

$$\begin{aligned}\omega &= \sqrt{\frac{k}{m}} = \sqrt{\frac{200000}{365}} = 7.41rad/s \\ f &= \frac{\omega}{2\pi} = 1.18Hz \\ T &= \frac{1}{f} = .847s\end{aligned}$$

2. Given the equation of motion (simple harmonic motion) for an object is $x = (.250m)\cos(\frac{\pi}{8.00}t)$ find the amplitude, frequency, and period.

Ans) The general form of the equation of motion is $x = A * \cos(\omega t)$. The amplitude is obviously $A = .250m$. We find the frequency and period in the same way as in the previous problem.

$$\begin{aligned}f &= \frac{\omega}{2\pi} = .0625Hz \\ T &= \frac{1}{f} = 16.0s\end{aligned}$$

3. Regarding the previous problem, find the maximum velocity and acceleration. Also, using energy considerations, find the velocity when the object is at half the total amplitude.

Ans) The v_{max} is given by the simple equation of $v_{max} = \omega * A = .0983m/s$. The max acceleration is just the a_{rad} referred to by the book, which is $a_{max} = A\omega^2 = .0386m/s^2$. Now, for finding the velocity at any point we can use the derivation on page 343 of our book, which is basically conservation of energy.

$$\begin{aligned}v &= \omega\sqrt{A^2 - x^2} \\ v &= .393\frac{rad}{s}\sqrt{(.250m)^2 - (.125m)^2} \\ v &= .085rad/s\end{aligned}$$

4. While hanging out on the moon you decide to try and figure out what the gravity on the moon actually is. You take out a pendulum of length .2m and measure that it swings 28 times per minute. What do you calculate for the gravity of the moon?

Ans) We know that in general the period of a pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$. We can

find the period of our pendulum because period is defined as how long it takes to come back to it's original value, or starting point (in layman's terms). So, our period is $T = \frac{60.0s}{28.0} = 2.14s$. Now, we can plug this in and solve for g.

$$g = \frac{4\pi^2 L}{T^2}$$
$$g = 1.72m/s^2$$

This is quite close to the real value, which is $g_{moon} = 1.62m/s^2$.