

46.27 A $5lb_m$ mass hangs from a spring with a spring constant of $15\frac{lb_f}{in}$. What is the linear frequency of vibration for the system?

- A. $1Hz$
- B. $5Hz$
- C. $11Hz$
- D. $34Hz$

Sketch and label the system. Search for **Free Vibration** and apply the formula for the natural frequency which is a function of the mass and the spring constant. Since the problem uses US Customary units, it will be necessary to include the gravitational constant, g_c , for consistency. This is not required for similar problems using SI units. Solve for the natural frequency.

$$\omega_n = \sqrt{\frac{kg_c}{m}} = \sqrt{\frac{\left(15\frac{lb_f}{in}\right)\left(12\frac{in}{ft}\right)\left(32.2\frac{ft\cdot lb_m}{s^2\cdot lb_f}\right)}{5lb_m}} = 34.05\frac{rad}{s}$$

Infer the relationship between linear frequency, f , and natural frequency, ω_n , using the equations for the period shown on the same page under the phrase: **Undamped Natural Period of Vibration**. Solve for the linear frequency, f . The units associated with 2π are implied to be radians per cycle, such that the linear frequency ultimately has units of cycles (or oscillations) per second aka Hz .

$$\frac{2\pi}{\omega_n} = \frac{1}{f}$$

$$f = \frac{\omega_n}{2\pi} = \frac{34.05\frac{rad}{s}}{2\pi\frac{rad}{cycle}} = 5.42\frac{cycles}{s} = 5.42Hz$$

Answer B

46.28 A museum is maintained at $68^\circ F$ and 45% relative humidity. What is the vapor pressure of the space?

- A. $0.15inHg$
- B. $0.31inHg$
- C. $0.34inHg$
- D. $0.69inHg$

Use the definition of **Relative Humidity**, which is the ratio of the vapor pressure and the maximum possible pressure of water vapor in air at a given temperature, the saturation pressure.

$$\phi = \frac{p_w}{p_{ws}}$$

Use the table **Properties of Saturated Water and Steam** (Temperature) to obtain the saturation pressure for $68^\circ F$ water.