

College Physics
Phys 2010
Midterm Exam 4
Fall Semester 2008

Notes

- You may use a calculator
- This test is closed book and closed notes.

NAME: Key

1. The speed of sound in air at 0°C is 331 m/s. What is the velocity of sound in air at a temperature of 30°C?

A. 336 m/s
B. 338 m/s
C. 340 m/s
D. 342 m/s
E. 349 m/s

$$V = V_0 \sqrt{\frac{T}{T_0}} = 331 \sqrt{\frac{30+273}{273}} = 349 \text{ m/s}$$

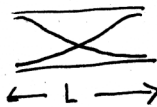
2. A sound source of 100 watts radiates sound uniformly in all directions. The intensity of the sound at a distance of 4.00 m is:

A. 0.301 W/m².
B. 0.353 W/m².
C. 0.497 W/m².
D. 0.535 W/m².
E. 0.621 W/m².

$$I = \frac{P}{4\pi r^2} = \frac{100}{4\pi (4)^2} = 0.497 \text{ W/m}^2$$

3. A 40.0 cm long organ pipe is filled with air and is open at both ends. What is the wavelength of the fundamental mode?

A. 40 cm
B. 80 cm
C. 60 cm
D. 100 cm



$$L = \frac{\lambda}{2} \rightarrow \lambda = 2L = 80 \text{ cm}$$

4. A string is stretched with a tension of 120 N. The string has a mass of 10.0 grams and has a length of 2.50 meters. The velocity of wave propagation along the string is:

A. 125 m/s.
B. 142 m/s.
C. 173 m/s.
D. 185 m/s.
E. 217 m/s.

$$F = 120 \text{ N}, \mu = \frac{10 \text{ grams}}{2.5 \text{ m}} = 4 \text{ g/m} = 0.004 \text{ kg/m}$$

$$V = \sqrt{\frac{F}{\mu}} = \sqrt{\frac{120}{0.004}} = 173 \text{ m/s}$$

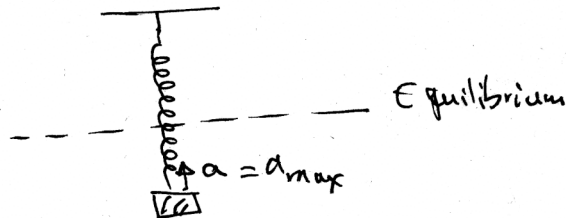
5. An equation that describes the displacement of a 2-kg mass attached to a horizontal spring in simple harmonic motion is: $x(t) = 1.20 \text{ m} \sin(2.40 \text{ rad/s } t)$. What is the spring constant?

A. 2.40 N/m
B. 11.5 N/m
C. 2.9 N/m
D. 4.8 N/m

$$x = 1.2 \sin 2.4 t \Rightarrow \omega = 2.4 \text{ rad/s}$$
$$\omega = \sqrt{\frac{k}{m}} \rightarrow k = m\omega^2 = (2)(2.4)^2 = 11.5 \text{ N/m}$$

6. A mass is suspended vertically from a spring so it is at rest at the equilibrium position. The mass is pulled straight down to an extension x and released so that it oscillates about the equilibrium position. The acceleration is greatest in magnitude and directed upward when:

A. the mass is at its maximum upward travel.
B. the mass is at the equilibrium point.
C. the mass is at its maximum lower travel.
D. the mass is somewhere between the equilibrium point and maximum extension.



7. At a party the sound intensity level of conversation is 65 dB when a record player is switched on and set to an intensity of 70 dB. What is the sound intensity level in the room now?

$$\beta = 10 \log \frac{I}{I_0} \Rightarrow 65 = 10 \log \frac{I_{\text{conv.}}}{I_0} \rightarrow I_{\text{conv.}} = (10^{-12}) (10^{6.5})$$

$$\downarrow$$

$$I_{\text{conv.}} = 3.16 \times 10^{-6} \text{ W/m}^2$$

$$70 = 10 \log \frac{I_{\text{player}}}{I_0} \rightarrow I_{\text{player}} = (10^{-12}) (10^7) = 10^{-5} \text{ W/m}^2$$

$$I_{\text{Tot}} = 10^{-5} + 3.16 \times 10^{-6} = 1.316 \times 10^{-5} \text{ W/m}^2 \Rightarrow \beta = 10 \log \frac{I_{\text{Tot}}}{I_0}$$

$$\boxed{\beta = 71.2 \text{ dB}}$$

8. Bats emit sounds of frequencies around 35 kHz and they use echolocation to find their prey. The bat is moving with a speed of 12 m/s toward an insect, which is at rest, at an air temperature of 20°C.

a. What is the frequency heard by the insect?

Speed of sound at 20°C : $v = v_0 \sqrt{\frac{T}{T_0}} = 349 \text{ m/s}$

$$f_0 = f_s \frac{1}{1 - \frac{v_s}{v}} = (35 \text{ kHz}) \frac{1}{1 - \frac{12}{349}} = \boxed{36.3 \text{ kHz}}$$

b. What frequency does the bat from the reflected sound hear?

observer moving : $f_0 = f_s \left(1 + \frac{v_s}{v}\right)$

$$f_0 = (36.3) \left(1 + \frac{12}{349}\right) = \boxed{37.5 \text{ kHz}}$$

9. A horizontal spring with a spring constant 10 N/m is attached to a block with a mass of 1.5 kg that sits on a frictionless table. When the block is 0.25 m from its equilibrium position, it has a speed of 0.6 m/s.

- Calculate the **total energy** of the block.

$$E = K_i + U_i = \frac{1}{2} m v^2 + \frac{1}{2} k x^2$$

$$E = \left(\frac{1}{2}\right)(1.5)(0.6)^2 + \frac{1}{2}(10)(0.25)^2 = \boxed{0.58 \text{ J}}$$

- Calculate the maximum displacement of the block from its equilibrium position.

$$\underbrace{U_i + K_i}_{0.58} = \underbrace{U_f + K_f}_{\frac{1}{2} k x_{\max}^2 + 0} \Rightarrow 0.58 = \frac{1}{2}(10)x_{\max}^2$$

$$\boxed{x_{\max} = 0.34 \text{ m}}$$

10. A transverse periodic wave is represented by the equation

$$y(x, t) = 2.50 \text{ cm} \cos(2,500 \text{ rad/s } t - 15.0 \text{ m}^{-1} x).$$

- What is the amplitude, angular speed, the wave length, and the speed of the wave?

$$A = 2.5 \text{ cm}, \quad \omega = 2500 \text{ rad/s}, \quad k = \text{wave \#} = \frac{2\pi}{\lambda}$$

$$15 = \frac{2\pi}{\lambda} \Rightarrow \boxed{\lambda = 0.42 \text{ m}}$$

$$\lambda = v f \rightarrow v = \frac{\lambda}{f} = \frac{\lambda}{\omega/2\pi}$$

$$\Rightarrow v = \frac{0.42}{\frac{2500}{2\pi}} = \boxed{167 \text{ m/s}}$$

- Make a graph of this wave at $t = 0$.

$$y(x, 0) = 2.5 \cos(15x)$$

