

Tuesday March 17 2009

PHYS 202 Exam #2

Name _____

T.A.'s Name _____

SHOW ALL WORK. INCLUDE UNITS.

1. An oscillating mass on a spring is described by the following equation. $x = (5.0\text{m})\cos(62.8t)$
Determine the oscillating object's amplitude, frequency, period, (5 Points)

$A = 5.0\text{m}$ - 1 point

$\omega = 62.8 = 2\pi f$

$f = \frac{62.8}{2\pi} = \frac{62.8}{6.28} = 10\text{Hz}$

$T = \frac{1}{10\text{Hz}} = 0.1\text{s}$ 1 pt

2 pts
1 point for units

(If units on any are missing, -1)

2. A guitar A string is tuned to a fundamental frequency of 110Hz. The length of the guitar string between the support points is 0.65m.

A. What is the velocity of the waves traveling up and down the guitar string? (5 Points)

B. What is the wavelength and frequency of the 4th harmonic when the sound wave is traveling in air? (5 Points)

2 pts

A. $v = f\lambda$

$v = (110\text{Hz})(1.3\text{m})$

$v = 143\text{ m/s}$

1 point with units

$\lambda = 2L$ - strings fixed on both ends
 $\lambda = 2(0.65\text{m})$
 $\lambda = 1.3\text{m}$

2 pts

110
x 1.3

330
110

143.0

B.

$f_4 = 4f_1 = 4 \times 110\text{Hz} = 440\text{Hz}$

2 pts

$v_{\text{sound}} = 340\text{ m/s}$

$v = f\lambda$

2 pts

$\lambda = \frac{v}{f} = \frac{340\text{ m/s}}{440\text{ Hz}}$

$\lambda = 0.773\text{m}$

$\frac{34}{44} = \frac{17}{22} \text{ m ok}$

1 pt with units

3. A fire engine is traveling towards you at 34m/s. It has a siren that has a frequency of 900Hz. (Speed of sound is 340m/s)

What is the frequency of the siren you hear if the fire engine is traveling towards you? (10 Points)

5 points

$$f = f_0 \frac{v}{v - v_s} = \frac{900 \text{ Hz}}{1 - \frac{34 \text{ m/s}}{340 \text{ m/s}}} = \frac{900 \text{ Hz}}{1 - \frac{1}{10}} = \frac{900 \text{ Hz}}{0.9}$$

f = 1000 Hz

3 points

2 points with units.

4. An enclosed metal ball has a gauge pressure in it of 200kPa at a temperature of 7°C. The ball is submerged into a pan of hot water and the final temperature of the ball and the gas inside is 87°C. (Ignore any change in volume due to the heating of the ball. (Patm ≈ 100 kPa))

A. What is the final absolute pressure inside the metal ball? (7 Points)

B. What equation would you use if you needed to calculate the new volume of the metal ball? (3 Points)

(3 Points) (6)

relation 2pts

(V is constant, n is constant)

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{300 \text{ kPa}}{(273 + 7)} = \frac{P_2}{(273 + 87)} ; P_2 = \frac{9}{7} (300 \text{ kPa})$$

$$P_2 = \frac{9}{7} (300 \text{ kPa}) = \frac{2700 \text{ kPa}}{7} = 386 \text{ kPa}$$

Convert to kelvin 3 points

7
10k
answer + units 2pts

(B)

$$\Delta V = \beta V_0 \Delta T \leftarrow (2 \text{ pts})$$

$$V_{\text{final}} = V + \Delta V \leftarrow (1 \text{ pt})$$

5. Sam's soup is too hot, so he grabs 0.01kg of ice at 0 °C and adds it to the to 0.5kg of soup at 90 °C in a well insulated bowl of negligible thermal mass. Assume the specific heat of the soup is the same as water. Set-up the equation(s) you would use to solve for the final temperature.

YOU DO NOT NEED TO CALCULATE A FINAL ANSWER. (5 POINTS)

1 point $Q_{\text{lost}} = Q_{\text{gained}}$ 1 point 1 point 1 point

$$(m_{\text{soup}})(c_{\text{soup}})(T_i - T_f) = (m_{\text{ice}})L_f + m_w c_w (T_f - T_i)$$

OR $\rightarrow (0.5 \text{ kg})(1 \frac{\text{cal}}{\text{g}^\circ\text{C}})(90^\circ\text{C} - T_f) = (0.01 \text{ kg})(3.35 \cdot 10^5 \frac{\text{J}}{\text{kg}}) + (0.01 \text{ kg})(T_f - 0^\circ\text{C})$ 1 point

6. A 3.5cm tall slide is located 2cm from a projection lens, The image is focused onto a screen that is located 10m away.

A. What is the effective focal length of the lens? (5 Points)

B. What is the size of the image on the screen? (5 Points)

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$$

$$\frac{1}{2 \text{ cm}} + \frac{1}{10 \text{ m}} = \frac{1}{f}$$

$$\frac{1}{2 \cdot 10^{-2}} + \frac{1}{10} = \frac{1}{f}$$

$$50 + 0.1 = \frac{1}{f}$$

$$f \approx 2 \text{ cm}$$

$$(f = 1.996 \text{ cm})$$

either is ok

$$M = \frac{d_i}{d_o} = \frac{10 \text{ m}}{2 \text{ cm}} = 500 \leftarrow 2 \text{ pts}$$

$$h_o = (-500)(3.5 \text{ cm}) = 17.5 \text{ m} \leftarrow 2 \text{ pts}$$

- sign not needed so 17.5 m is ok units 1 pt

7. Light rays traveling in air are incident onto a transparent material at an angle of 45°. It is observed that the refracted angle is 30°.

A. What is the index of refraction of the material (5 Points)

B. At what angle is light reflected off the surface? (2 points)

A) $n_1 \sin \theta_1 = n_2 \sin \theta_2$ 2 pts

$$1 (\sin 45^\circ) = n_2 \sin 30^\circ$$

$$\frac{\sqrt{2}}{2} = n_2 \frac{1}{2}$$

$$n_2 = \sqrt{2} = 1.414$$

B) $\theta_i = \theta_r \leftarrow 2 \text{ points (Show work)}$

$$\theta_r = 45^\circ \leftarrow 1 \text{ point}$$

8. The following questions are related to Light as a wave.

A. Monochromatic light is incident upon two very narrow slits that are separated by a distance of 0.050mm apart. Successive ~~low~~ order fringes on a screen 1m away are 10mm apart. (Hint, you can use small angle approximation, $\sin\theta = \tan\theta$.) What is the wavelength of the light? (7 Points)

3pts $\rightarrow d \sin\theta = m\lambda \quad m=1$

$\sin\theta \approx \tan\theta = \frac{10\text{mm}}{1\text{m}} = 10^{-2} \approx \sin\theta$

$(0.05\text{mm})(\sin\theta) = \lambda$ (2pts)

$(0.05\text{m})(10^{-2}) = \lambda$

$5 \cdot 10^{-5} \cdot 10^{-2} = \lambda$

$\lambda = 5 \cdot 10^{-7} \text{m} = \underline{\underline{500\text{nm}}}$ (2pts answer + units)

B. Monochromatic light is incident upon a single slit that is 1.3×10^{-3} mm wide. If the angle between the center maximum and the first dark fringes is 30° , what is the wavelength of the light used? (7 Points)

$D \sin\theta = m\lambda$ (4 points)

$(1.3 \cdot 10^{-6} \text{m})(\sin 30^\circ) = \lambda$ (1 point)

$0.65 \cdot 10^{-6} \text{m} = \lambda$

$\lambda = 6.5 \cdot 10^{-7} \text{m}$

$\lambda = \underline{\underline{650\text{nm}}}$ (Answer with units 2pts)

C. The second order maximum from a multiple slit diffraction grating, whose slits are 2.4×10^{-3} mm apart, occurs at an angle of 30° from the central maximum when projected onto a screen. What is the wavelength of the light? (6 Points)

2 points $\rightarrow d \sin\theta = m\lambda$ (2 points)

$(2.4 \cdot 10^{-3} \text{mm})(\sin 30^\circ) = 2\lambda$

$\lambda = \frac{(2.4 \cdot 10^{-6} \text{m})(0.5)}{2} = \frac{2.4 \cdot 10^{-6} \text{m}}{4}$

$\lambda = 6 \cdot 10^{-7} \text{m} = \underline{\underline{600\text{nm}}}$ (2 points answer with units)