Chapter 20 (Answers are all A's)

1. Find the displacement of a simple harmonic wave of amplitude 6.44 m at t = 0.71 s. Assume that the wave number is 2.34 m^{-1}, the angular frequency is 2.88 rad/s, and that the wave is propagating in the +x direction at x = 1.21 m.

A) 4.55 m B) 1.05 m C) 3.54 m D) 2.25 m

Formula: $y = a \sin(kx-\omega t+\varphi_0)$. Here, $\varphi_0 = 0$.

2. Find the speed of an ocean wave whose displacement is given by $y = 3.7 \cos(2.2x - 5.6t)$ where x and y are in meters and t is in seconds.

A) 2.5 m/s B) 1.9 m/s C) 3.5 m/s D) 4.5 m/s

Formula: $y = a \cos(kx - \omega t+ \varphi_0) = a \sin(kx- \omega t + \varphi_1)$, where $\varphi_1 = \varphi_0 + \pi/2$. Here $\varphi_0 = 0$.

3. Transverse waves propagate at 43.2 m/s in a string that is subjected to a tension of 60.5 N. If the string is 19.0 m long, what is its mass?
A) 0.616 kg B) 0.259 kg C) 0.437 kg D) 0.715 kg

Formula: $v = \sqrt{\frac{T}{\mu}}$ and $\mu = M/L$.

4. The density of aluminum is 2700 kg/m3. If transverse waves propagate at 34 m/s in a 4.6 mm diameter aluminum wire, what is the tension on the wire?

A) 52 N B) 31 N C) 42 N D) 62 N

Formula: $v = \sqrt{\frac{T}{\mu}}$, $\mu = \rho A$ and $A = \pi r^2$.

5. A 4.24 m long, 1.27 kg rope under a tension of 475 N oscillates with a frequency of 11.2 Hz. If the oscillation amplitude is 6.32 cm, how much energy is required to keep the rope oscillating for 5.52 s?

A) 651 J B) 553 J C) 605 J D) 697 J

Formula derivation: differentiate y-displacement to derive the speed along y and, k.e. of a small segment, then find the average power. Here is the formula for average power:

$P = \frac{1}{2}\mu v \omega^2 a^2$ and energy required = $P\Delta t$, where $\Delta t = 5.52$s.

6. Light from a laser forms a 1.31 mm diameter spot on a wall. If the light intensity in the spot is 3.69 × 104 W/m2, what is the power output of the laser?

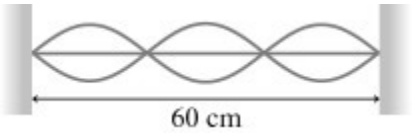
A) 49.7 mW B) 30.8 mW C) 41.7 mW D) 57.7 mW Formula: $P = IA$, where $A = \pi r^2$

Chapter 21

1. A 0.335 m string is clamped at both ends. If the lowest standing wave frequency in the string is 326 Hz, what is the wave speed? A) 218 m/s B) 270 m/s C) 331 m/s D) 412 m/s

Formula: $f_1 = v/2L$

2. A standing wave is oscillating at 690 Hz on a string, as shown in the figure. What is the wave speed?



A) 280 m/s B) 410 m/s C) 210 m/s D) 140 m/s Formula: $v = f\lambda$

3. A violin with string length 32 cm and string density 1.5 g/cm resonates with the first overtone of an organ pipe with one end closed. The pipe length is 2 m. What is the tension in the string? A) 1000 N B) 110 N C) 450 N D) 4100 N

Formula: $f_{violin} = f_{pipe}$ (resonance phenomena), $f_{2pipe} = 3*f_{1pipe} = 3v_{sound}/4L$, $v = \sqrt{\frac{T}{\mu}}$

4. A simple harmonic wave described by the equation y(t) = 0.54 cos(3.1x – 2.3t) reflects from both ends of a string that is clamped at each end, resulting in a standing wave that is the sum of y(t) and and its reflection. What is the amplitude of the standing wave at x = 0.22 m? The quantities x and y are in meters, and t is in seconds. A) 0.84 m B) 0.57 m C) 0.67 m D) 0.77 m

Formula: $A(x) = 2a\cos(kx)$

5. Two stereo speakers mounted 4.52 m apart on a wall emit identical sound waves. You are standing at the opposite wall of the room at a point directly between the two speakers. You walk 2.11 m parallel to the wall, to a location where you first notice that the sound intensity is much less. If the wall along which you are walking is 10.7 m from the wall with the speakers, what is the wavelength of the sound waves? A) 1.71 m B) 2.05 m C) 2.57 m D) 2.91 m

Please look at the example we did in class.

Chapter 22

1. A double slit illuminated with light of wavelength 588 nm forms a diffraction pattern on a screen 11 cm away. The slit separation is d = 2464 nm. What is the distance Δx between orders m = 6 and m = 4? A) 5.25 × 107 nm B) 92.19 × 107 nm C) 10.5 × 107 nm D) 2.63 × 107 nm Formula: $d\sin\theta_m = m\lambda$ and $\tan\theta_m = y_m/L$, $\Delta x = y_{m2} - y_{m1}$

2. Two sources of light illuminate a double slit simultaneously. One has wavelength 570 nm and the second has an unknown wavelength. The *m* = 5 bright fringe of the unknown wavelength overlaps the *m* = 4 bright fringe of the light of 570 nm wavelength. What is the unknown wavelength? A) 456 nm B) 326 nm C) 380 nm D) 713 nm Formula: $d\sin\theta_m = m\lambda$, and $m_1\lambda_1 = m_2\lambda_2$

3. A grating with 316 lines/mm is illuminated with light of wavelength 531 nm. What is the angular separation between the two lines formed in order m = 2? A) 39.2° B) 19.6° C) 42.2° Formula: $d\sin\theta_m = m\lambda$ and $\tan\theta_m = y_m/L$

4. A single slit with width 820 nm is illuminated with light of wavelength 555 nm. How many minima occur in the angular range from θ = 0° to θ = ±26 ? A) 1.3 minima B) 0.65 minima C) 1.16 minima D) 0.59 minima

Formula: $a\sin\theta_p = p\lambda$

5. Light from a He-Ne laser of wavelength 633 nm passes through a circular aperture. It is observed on a screen 4.0 m behind the aperture. The width of the central maximum is 5.4 cm. What is the diameter of the hole? A) 110 µm B) 2.0 µm C) 6600 µm D) 960 µm

Formula: $a\sin\theta_p = 1.22\,\lambda$

6. It is observed that moving a mirror of a Michelson interferometer a distance of 100 µm causes 990 bright-dark-bright fringe shifts. What is the wavelength of the light?

A) 202 nm B) 101 nm C) 404 nm D) 303 nm

Formula: $\Delta L = \Delta m\,\lambda/2$