HOMEWORK 5

Chapter 12

MC 3: A. This follows from the Principle of Superposition. The pulses add, but do not interfere with each other.

MC 5: B . Wavelength only changes, if the source moves. As the source is stationary, this eliminates the other choices.

Problems

12.1. Set Up: $v = f\lambda$

Solve: **(a)** $v = 344\ \text{m/s}$. For $f = 20{,}000\ \text{Hz}$, $\lambda = \dfrac{v}{f} = \dfrac{344\ \text{m/s}}{20{,}000\ \text{Hz}} = 1.7\ \text{cm}$. For $f = 20\ \text{Hz}$,

$$\lambda = \frac{v}{f} = \frac{344\ \text{m/s}}{20\ \text{Hz}} = 17\ \text{m}.$$

The range of wavelengths is 1.7 cm to 17 m.

(b) $v = c = 3.00 \times 10^8\ \text{m/s}$. For $\lambda = 700\ \text{nm}$,

$$f = \frac{c}{\lambda} = \frac{3.00 \times 10^8\ \text{m/s}}{700 \times 10^{-9}\ \text{m}} = 4.3 \times 10^{14}\ \text{Hz}.$$

For $\lambda = 400\ \text{nm}$,

$$f = \frac{c}{\lambda} = \frac{3.00 \times 10^8\ \text{m/s}}{400 \times 10^{-9}\ \text{m}} = 7.5 \times 10^{14}\ \text{Hz}.$$

The range of frequencies for visible light is 4.3×10^{14} Hz to 7.5×10^{14} Hz.

(c) $v = 344\ \text{m/s}$. $\lambda = \dfrac{v}{f} = \dfrac{344\ \text{m/s}}{23 \times 10^3\ \text{Hz}} = 1.5\ \text{cm}$

(d) $v = 1480\ \text{m/s}$. $\lambda = \dfrac{v}{f} = \dfrac{1480\ \text{m/s}}{23 \times 10^3\ \text{Hz}} = 6.4\ \text{cm}$

Reflect: For a given v, larger f corresponds to smaller λ. For the same f, λ increases when v increases.

12.3. Set Up: $v = f\lambda$. $f = 10.0\ \text{cycles/min} = 0.167\ \text{cycles/s} = 0.167\ \text{Hz}$.

Solve: $v = f\lambda = (0.167\ \text{Hz})(13\ \text{km}) = 2.2\ \text{km/s}$

12.14. Set Up: The distance d the wave travels in time t is $d = vt$. The distance the wave travels is twice the depth of the ocean.

Solve: $d = (1531\ \text{m/s})(3.27\ \text{s}) = 5006\ \text{m}$; the depth is 2500 m

12.30. Set Up: There are displacement nodes at the closed end of an air column. Problem 12.28 shows that Eq. (12.7) applies to a pipe closed at both ends as well as one open at both ends.

Solve: **(a)** There are displacement nodes at the floor and ceiling.

(b) $\lambda_1 = 2L = 4.90\ \text{m}$. $f_1 = \dfrac{v}{\lambda_1} = \dfrac{344\ \text{m/s}}{4.90\ \text{m}} = 70.2\ \text{Hz}$.

(c) $\lambda_2 = \dfrac{\lambda_1}{2} = 2.45\ \text{m}$. $f_2 = 2f_1 = 140\ \text{Hz}$. $\lambda_3 = \dfrac{\lambda_1}{3} = 1.63\ \text{m}$. $f_3 = 3f_1 = 211\ \text{Hz}$.

12.33. Set Up: The path difference for the two sources is d. For destructive interference, the path difference is a half-integer number of wavelengths. For constructive interference, the path difference is an integer number of wavelengths. $\lambda = v/f$

Solve: $\lambda = \dfrac{v}{f} = \dfrac{344\ \text{m/s}}{725\ \text{Hz}} = 0.474\ \text{m}$

(a) Will first produce destructive interference when $d = \lambda/2 = 0.237$ m.
(b) Will next produce destructive interference when $d = 3\lambda/2 = 0.711$ m.
(c) Will first produce constructive interference again when $d = \lambda = 0.474$ m.

12.37. Set Up: $v = f\lambda$

Solve: **(a)** $\lambda = \dfrac{v}{f} = \dfrac{1531\ \text{m/s}}{17\ \text{Hz}} = 90\ \text{m}$

(b) $f = \dfrac{v}{\lambda} = \dfrac{1531\ \text{m/s}}{0.015\ \text{m}} = 102\ \text{kHz}$

(c) $\lambda = \dfrac{v}{f} = \dfrac{344\ \text{m/s}}{25 \times 10^3\ \text{Hz}} = 1.4\ \text{cm}$

(d) For $f = 78$ kHz, $\lambda = \dfrac{v}{f} = \dfrac{344\ \text{m/s}}{78 \times 10^3\ \text{Hz}} = 4.4$ mm. For $f = 39$ kHz,

$$\lambda = \frac{v}{f} = \frac{344\ \text{m/s}}{39 \times 10^3\ \text{Hz}} = 8.8\ \text{mm}.$$

The range of wavelengths is 4.4 mm to 8.8 mm.

(e) $\lambda = 0.25$ mm so $f = \dfrac{v}{\lambda} = \dfrac{1550\ \text{m/s}}{0.25 \times 10^{-3}\ \text{m}} = 6.2\ \text{MHz}$