Mr. Renwick's Physics 11
Worksheet - Waves and Sound Review

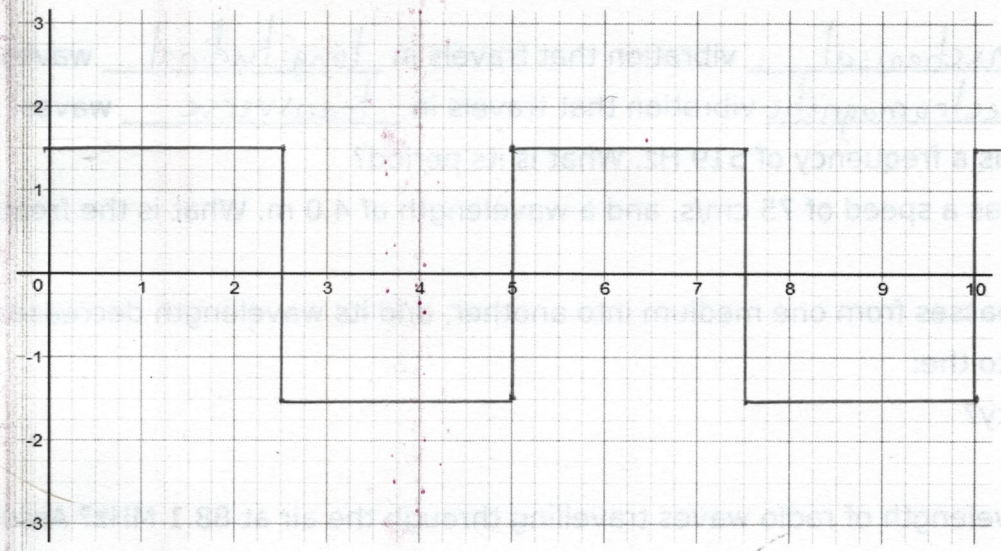
Name: _____

Questions

1. Sound is a(n) mechanical vibration that travels in longitudinal waves.
2. Light is a(n) electromagnetic vibration that travels in transverse waves.
3. A tuning fork has a frequency of 519 Hz. What is its period?
4. A water wave has a speed of 75 cm/s, and a wavelength of 4.0 m. What is the frequency of the waves?
5. A sound wave passes from one medium into another, and its wavelength decreases. What happens to the:
    a. Frequency?
    b. Speed?
6. What is the wavelength of radio waves travelling through the air at 88.1 MHz? Assume that the radio waves travel at the same speed through the air as through a vacuum.
7. What creates a node in a standing wave?
8. What is the speed of sound in air at a temperature of -25.0 °C?
9. Two speakers are placed 1.0 m apart and play a frequency of 2,000 Hz. The speed of sound in the room is 345 m/s. At what angle does the:
    a. First anti-node occur?
    b. Second anti-node occur?
10. Water waves with a wavelength of 8.0 m enter the shallow water of a harbour at 30° and refract to an angle of 20°. What is their new wavelength?
11. A light ray travelling through the air enters a light block at an angle of 45° and refracts to an angle of 39°. What is the refractive index of the glass?
12. Sapphire has a refractive index of 1.76. What is the speed of light in sapphire?
13. A 512.0 Hz tuning fork is struck at the same time as another tuning fork. Beats with a period of 2.000 s are produced. What are the 2 possible frequencies of the other tuning fork?

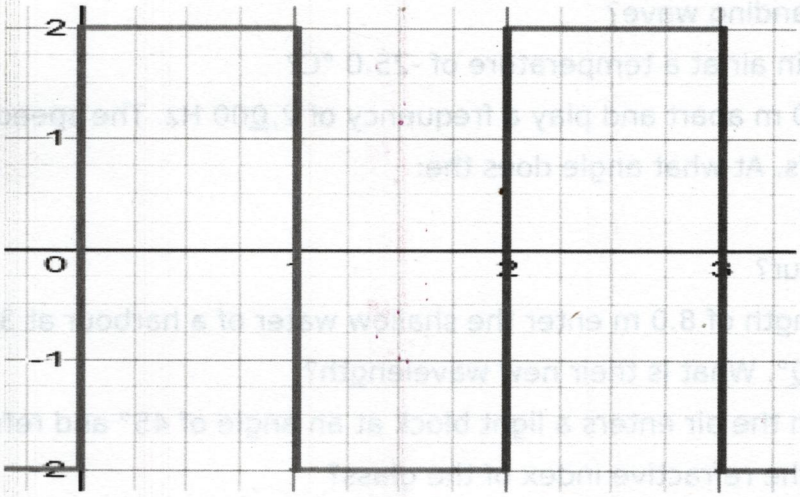
See over →

14. Graph a square wave with a frequency of 0.2 Hz and a distance from crest to trough of 3.0 m.

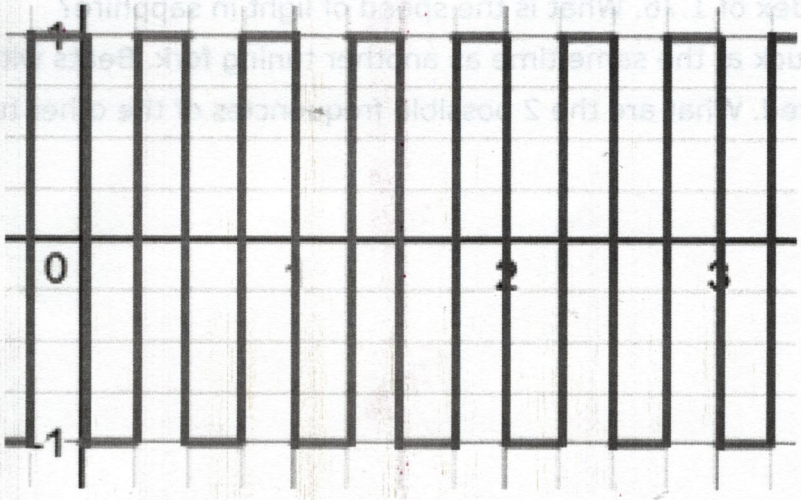


$T = \frac{1}{f} = \frac{1}{0.2\,Hz} = 5\,s$

15.

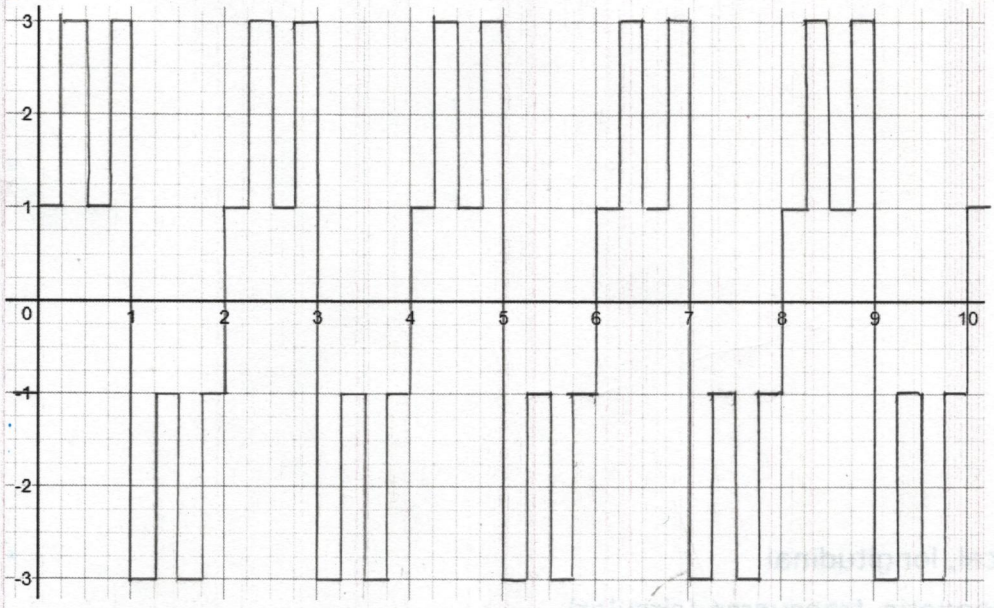


Wave 1

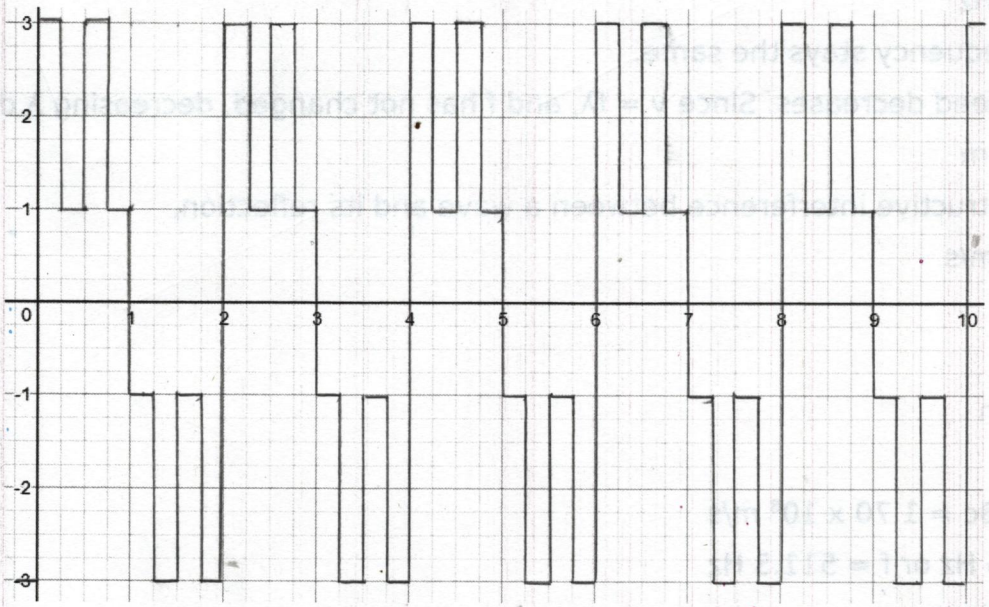


Wave 2

a. Draw the waveform of wave 1 plus wave 2.



b. Draw the waveform of wave 1 minus wave 2. Hint: Subtracting a number is the same as adding the opposite number (i.e. 5 - 2 = 5 + -2).



16. A wave has a fundamental frequency of 126 Hz. What is the:
    a. First harmonic?
    b. First overtone?
    c. Second harmonic?
    d. Second overtone?
17. What is the speed of a plane flying at Mach 3.00 through -10.0 °C air?
18. While camping, a camper sees a flash of lightning. 11 seconds later, they hear thunder. How far away was the lightning? Assume that the temperature is 20.0 °C.

See over →

Answers

1. Mechanical, longitudinal
2. Electromagnetic, transverse (circular)
3. $T = 1.93 \times 10^{-3}$ s
4. $f = 0.19$ Hz
5. a. The frequency stays the same.
   b. The speed decreases. Since $v = f\lambda$, and f has not changed, decreasing λ decreases v.
6. $\lambda = 3.40$ m
7. Total destructive interference between a wave and its reflection.
8. $v = 316$ m/s
9. a. 9.9°
   b. 20°
10. $\lambda = 5.5$ m
11. $n_2 = 1.1$
12. $v = 0.568c = 1.70 \times 10^8$ m/s
13. $f = 512.5$ Hz or $f = 511.5$ Hz
14. See solutions.
15. See solutions.
16. a. 126 Hz
    b. 252 Hz
    c. 252 Hz
    d. 378 Hz
17. $v = 975$ m/s
18. $d = 3{,}800$ m $= 3.8$ km

3. $f = \frac{1}{T} \Rightarrow T = \frac{1}{f} = \frac{1}{519\,Hz} = 0.00193\,s = 1.93 \times 10^{-3}\,s = 1.93\,ms$

4. $v = f\lambda$

$$f = \frac{v}{\lambda} = \frac{75\ cm/s}{4.00\,m} = \frac{0.75\ m/s}{4.00\,m} = 0.1875\,Hz$$

$f = 0.19\,Hz$

5. a. Frequency does not change from one medium to another

b. $v_1 = f\lambda_1$, $v_2 = f\lambda_2$ } f are the same, so if $\lambda_2 < \lambda_1$, $v_2 < v_1$

$\therefore$ velocity decreases

6.

$v = f\lambda$

$$\lambda = \frac{v}{f} = \frac{3.00 \times 10^8\ m/s}{88.1 \times 10^6\ Hz} = 340.5\,m$$

$\lambda = 340\,m$

7. Total destructive interference of a wave and its reflection

8. $v = 331\ m/s + 0.6\frac{m/s}{°C} \times T = 331\ m/s + 0.6\frac{m/s}{°C} \times (-25\,°C) = 331\ m/s - 15\ m/s$

$v = 316\ m/s$

9. a. $d\sin\theta_{min} = n\lambda$ $\quad v = f\lambda \Rightarrow \lambda = \frac{v}{f}$

$$\sin\theta_{min} = \frac{n\lambda}{d}$$

$$\theta_{min} = \sin^{-1}\left(\frac{n\lambda}{d}\right) = \sin^{-1}\left(\frac{n \times \frac{v}{f}}{d}\right) = \sin^{-1}\left(\frac{nv}{fd}\right)$$

$$\theta_{min_1} = \sin^{-1}\left(\frac{1 \times 345\ m/s}{2000\ Hz \times 1.0\ m}\right) = 9.9^\circ$$

b. $$\theta_{min_1} = \sin^{-1}\left(\frac{2 \times 345\ m/s}{2000\ Hz \times 1.0\ m}\right) = 20.2^\circ$$

$$\theta_{min_2} = \underline{20}^\circ$$

10. $\frac{\sin\theta_2}{\sin\theta_1} = \frac{v_2}{v_1}$ $\quad v_2 = f\lambda_2$ $\quad v_1 = f\lambda_1$

$$\frac{\sin\theta_2}{\sin\theta_1} = \frac{f\lambda_2}{f\lambda_1}$$

$$\lambda_2 = \lambda_1 \times \frac{\sin\theta_2}{\sin\theta_1} = 8.0\ m \times \frac{\sin 20}{\sin 30} = 5.5\ m$$

11. $n_{air} = 1.0003$

$$\frac{\sin\theta_2}{\sin\theta_1} = \frac{n_1}{n_2}$$

$$\frac{\sin\theta_{air}}{\sin\theta_{glass}} = \frac{n_{glass}}{n_{air}}$$

$$n_{glass} = n_{air} \times \frac{\sin\theta_{air}}{\sin\theta_{glass}} = 1.0003 \times \frac{\sin 45}{\sin 39} = 1.1$$

12. $n = \frac{c}{v}$

$nv = c$

$v = \frac{c}{n} = \frac{1}{n} \cdot c = \frac{1}{1.76} c = 0.568c$

$v = \frac{c}{n} = \frac{3.00 \times 10^8 \text{ m/s}}{1.76} = 1.70 \times 10^8 \text{ m/s}$

13. $f_{beats} = \frac{1}{T_{beat}} = \frac{1}{2 s} = 0.5 \text{ Hz}$

$f_{beats} = |f_1 - f_2|$

if $f_1 - f_2 > 0$

$f_{beats} = f_1 - f_2$

$f_2 + f_{beats} = f_1$

$f_2 = f_1 - f_{beats} = 512 \text{Hz} - 0.5 \text{ Hz} = 511.5 \text{ Hz}$

if $f_1 - f_2 < 0$

$f_{beats} = -(f_1 - f_2) = -f_1 + f_2$

$f_{beats} + f_1 = f_2$

$f_2 = f_1 + f_{beats} = 512 \text{ Hz} + 0.5 \text{Hz}$

$f_2 = 512.5 \text{ Hz}$

14/15 See other sheets

16.

Fundamental	1st overtone	2nd overtone	
1st Harmonic	2nd harmonic	3rd harmonic	a. 126 Hz
126 Hz	$2 \times 126 \text{ Hz}$	$3 \times 126 \text{ Hz}$	b. 252 Hz
	$= 252 \text{ Hz}$	$= 378 \text{ Hz}$	c. 252 Hz
			d. 378 Hz

17. $M = \frac{v}{v_{sound}}$

$v_{sound} = 331\ m/s + 0.6\frac{m/s}{°C} \times t = 331\ m/s + 0.6\frac{m/s}{°C}(-10°C) = 325\ m/s$

$v = M \cdot v_{sound} = 3.00 \times 325\ m/s = 975\ m/s$

18. $v_{sound} = 331\ m/s + 0.6\frac{m/s}{°C} \times T = 331\ m/s + 0.6\frac{m/s}{°C}(20.0°C) = 343\ m/s$

$d = v \cdot t = 343\ m/s \times 11\ s = 3,773\ m$

$d = 3,800\ m = 3.8\ Km$