$\qquad$ Date: $\qquad$

## Waves

1. Read Chapters $12,13, \& 14$.
2. Terms to know: mechanical wave, transverse wave, longitudinal wave, surface wave, electromagnetic wave, pulse, medium, cycle, crest, trough, equilibrium position, traveling wave, period, frequency, wavelength, amplitude, phase, principle of superposition, constructive interference, destructive interference, node, antinode, standing wave, resonance, diffraction, pitch, volume (loudness), Doppler shift.
3. What is the difference between a transverse and a longitudinal wave? Draw a picture of each. Give an example of each.
Transverse - disturbance perpendicular to wave motion Longitudinal - disturbance parallel to wave motion
4. What is the difference between a traveling wave and a standing wave? What are the conditions necessary to produce a standing wave?
Traveling wave - moves along the medium
Standing wave - appears to stand still - need a wave to reflect off of a fixed point
5. What is the difference between a mechanical wave and an electromagnetic wave? Give an example of each.
Mechanical wave - disturbance that travels through a medium
Electromagnetic - oscillations of electric charges - no medium necessary
6. Sketch two pulses that will interfere constructively. Sketch two pulses that will interfere destructively.
7. How can you change the speed of a wave in a rope? How can you change the frequency? How can you change the amplitude? How can you change the wavelength?
8. When a wave crosses a boundary from one medium to another (say, from air to water or from a thick spring to a light spring) what characteristic of the wave remains the same?
The frequency stays the same. It's the wavelength, speed and amplitude that change
9. Sketch a picture of each of the following wave phenomena: reflection, diffraction, interference.
10. As a car honking its horn approaches you standing on a street corner, what do you notice about the frequency, amplitude and wavelength of the sound of the horn? What do you notice about these things as the car passes you and travels away? What is the name for this phenomenon? Doppler effect

Toward you - higher frequency, smaller wavelength, no change in amplitude
Away from you - lower frequency, larger wavelength, no change in amplitude
11. Sketch one cycle of a standing wave and label the nodes and antinodes. Sketch one-half cycle. Sketch $11 / 2$ cycles.
12. As the pitch of a sound increases, what happens to its frequency? As the loudness of a sound increases, what happens to its amplitude?
Increasing pitch means an increase in frequency
Increasing sound means an increase in amplitude
13. Which two factors will result in a wave diffracting more: narrow opening or wide opening? Small wavelength or large wavelength?
A narrow opening is harder for a wave to squeeze through, diffracts more
A large wavelength has a hard time squeezing through an opening, diffracts more

Directions: Read each question carefully and record your answers in the space provided. Be sure to show all work! Answers should be in significant figures. You will be graded on proper use of the GUESS method. If the GUESS method is not appropriate, show all work to receive partial credit. These will be the same directions on the test. Practice the GUESS method now.

Use the wave to answer questions 1-6. Length of

1. What is the wavelength of the wave? 8 m
2. What is the amplitude of the wave? 4 m
3. Over time, particle A will move in which direction? Up until the crest and then down


If a student observes 60.0 waves passing in 12 seconds:
4. What is the frequency of the wave? $\quad f=\frac{\# \text { waves }}{\text { time }}=\frac{60.0 \text { waves }}{12 \mathrm{~s}}=5.0 \mathrm{~Hz} \quad T=\frac{1}{f}=\frac{1}{5.0 \mathrm{~Hz}}=0.20 \mathrm{~s}$
5. What is the period?
6. What is the velocity of the wave?

$$
v=f \lambda=(5.0 \mathrm{~Hz})(8 \mathrm{~m})=40 \frac{\mathrm{~m}}{\mathrm{~s}} \mathrm{right}
$$

Use the waves below to answer questions 7 - 12.
Two waves, $A$ and $B$, are shown below. They are traveling in the same medium at the same time. Both have the same wavelength but different amplitudes.
7. In the space below, show the resultant wave if $A$ and $B$ interfere.

Wave A


Wave B $\qquad$
 wave, add the amplitude at each spot, mark it, and draw the wave
8. What is the wavelength of wave A?
8.0 m
9. What is the amplitude of wave $B$ ?
2.0 m
10. What is the wavelength of the combined wave?
8.0 m
11. What is the amplitude of the combined wave?
2.0 m
12. What type of interference is this?
Destructive

The waves are out of phase, when added together they create a smaller wave
13. What is the frequency of a 3.0 meter wave traveling at $100 . \mathrm{m} / \mathrm{s}$ ?

$$
f=\frac{v}{\lambda}=\frac{100 \frac{m}{s}}{3.0 \mathrm{~m}}=33 \mathrm{~Hz}
$$

14. If the frequency of a wave doubles, while the speed remains constant, what happens to the wavelength?

$$
\lambda=\frac{v}{f}=\frac{1}{2}=1 / 2 \text { Half }
$$

15. What is the wavelength of the following waves?

Wave A $\qquad$


Wave B $\qquad$

Wave $B=16.0 \mathrm{~m}$
16. A two-slit experiment is performed to measure the wavelength of a monochromatic light. The slits are 295 micrometers apart. A screen is placed 8.75 meters away and the separation between the central bright spot and the next bright spot is measured to be 21.4 millimeters.
a. Calculate the wavelength of the light.

$$
\begin{aligned}
& \text { Honors } \\
& \text { Equation! } \\
& \lambda=\frac{\mathrm{dx}}{\ell}=\frac{\left(295 \times 10^{-6} \mathrm{~m}\right)\left(21.4 \times 10^{-3} \mathrm{~m}\right)}{8.75 \mathrm{~m}}=7.21 \times 10^{-7} \mathrm{~m}
\end{aligned}
$$

b. Calculate the frequency of this light wave.

$$
f=\frac{v}{\lambda}=\frac{\left(3.00 \times 10^{8} \frac{\mathrm{~m}}{\mathrm{~s}}\right)}{7.21 \times 10^{-7} \mathrm{~m}}=4.16 \times 10^{14} \mathrm{~Hz}
$$

c. What color is the light?

Use the frequency to look up the color on the EM spectrum on the reference tables.
17. What is the frequency of a light whose wavelength is:

The speed of light is listed on the front cover of the reference tables.
b. $5.9 \times 10^{-7} \mathrm{~m} ? f=\frac{v}{\lambda}=\frac{3.00 \times 10^{8} \frac{\mathrm{~m}}{\mathrm{~s}}}{5.9 \times 10^{-7} \mathrm{~m}}=5.1 \times 10^{14} \mathrm{~Hz}$
18. What is the wavelength of a light wave whose frequency is $3 \times 10^{14} \mathrm{~Hz}$.

$$
\lambda=\frac{v}{f}=\frac{3.00 \times 10^{8} \frac{\mathrm{~m}}{\mathrm{~s}}}{3 \times 10^{14} \mathrm{~Hz}}=1 \times 10^{-6} \mathrm{~m}
$$

19. A sound wave has a frequency of 292 Hz .
a. Calculate the wavelength of the wave.

$$
\lambda=\frac{v}{f}=\frac{331 \frac{m}{s}}{292 H z}=1.13 m
$$

The speed of sound is listed on the front cover of the reference tables.
b. How long will it take for the wave to travel 25 m ?

$$
t=\frac{d}{v}=\frac{25 m}{331 \frac{m}{s}}=0.076 \mathrm{~s}
$$

Sound waves travel at constant speed in the same medium.
c. What is the period of the wave? $T=\frac{1}{f}=\frac{1}{292 \mathrm{~Hz}}=0.00342 \mathrm{~s}$
20. Which phenomenon does not occur when a sound wave reaches the boundary between air and a steel block?
(A) reflection
(B) polarization
(C) absorption
(D) refraction

Light waves can be polarized, sound waves cannot.
21. As a periodic wave travels from one medium to another, which pair of the wave's characteristics cannot change?
(A) period and amplitude
(C) amplitude and wavelength
(B) period and frequency
(D) frequency and velocity

Frequency does not change with a medium change, and period is the reciprocal of frequency
22. The distance from the Moon to Earth is $3.9 \times 10^{8}$ meters. What is the time required for a light ray to travel from the Moon to Earth?
(A) 0.65 s
(B) 3.9 s
(C) 1.3 s
(D) 2.6 s

The speed of light is listed on the front cover of the reference tables.

$$
t=\frac{d}{v}=\frac{3.9 \times 10^{8} \mathrm{~m}}{3.00 \times 10^{8} \frac{\mathrm{~m}}{\mathrm{~s}}}
$$

23. The diagram below shows a transverse wave moving to the right along a rope.


As the wave passes point $X$, the motion of $x$ will be
(A) left, then right
(B) up, then down
(C) in a circle
(D) down, then up
24. Two waves have the same frequency. Which wave characteristic must also be identical for both waves?
(A) intensity
(B) phase
(C) amplitude
(D) period
25. How many nodes are represented in the standing wave diagram below?


> The trough hits first so it will move down, then the crest comes so it moves up.

Nodes - the points of minimum disnlacement
(A) 6
(B) 4
(C) 3
(D) 1
26. The frequency of a light wave is $5.0 \times 10^{14}$ hertz. What is the period of the wave?
(A) $6.0 \times 10^{7} \mathrm{~s}$
(B) $5.0 \times 10^{-14} \mathrm{~s}$
(C) $2.0 \times 10^{-15} \mathrm{~s}$
(D) $1.7 \times 10^{6} \mathrm{~s}$

27. An astronomer on Earth studying light coming from a star notes that the observed light frequencies are lower than the actual emitted frequencies. The astronomer concludes that the distance between the star and Earth is
(A) increasing
(B) not changing
(C) decreasing

[^0]28. The diagram below shows two pulses, each of length $\lambda$, traveling toward each other at equal speed in a rope.


The crests line up with troughs and cancel

Which diagram best represents the shape of the rope when both pulses are in region $A B$ ?
A)

B) A $\qquad$

D) $A_{A} \cap \cap_{B}$
29. What is the wavelength of a 30 . hertz period wave moving at 60 . meters per second?
(A) $1,800 \mathrm{~m}$
(B) 2.0 m
(C) $20 . \mathrm{m}$
(D) 0.50 m

$$
\lambda=\frac{v}{f}=\frac{60 \cdot \frac{m}{s}}{30 \cdot H z}
$$

30. The driver of a car sounds the horn while traveling toward a stationary person. Compared to the sound of the horn heard by the driver, the sound heard by the stationary person has
(A) higher pitch and longer wavelength
(B) lower pitch and shorter wavelength
(C) lower pitch and longer wavelength
(D) higher pitch and shorter wavelength
Doppler Effect
As the sounds moves toward the wavelength decreases so the frequency increases so the nitch increases
31. When an opera singer hits a high-pitch note, a glass on the opposite side of the opera hall shatters. Which statement best explains this phenomenon?
(A) The singer and the glass are separated by an integral number of wavelengths.
(B) The frequency of the note and natural vibration frequency of the glass are equal.
(C) The vibrations of the note are polarized by the shape of the opera hall.
(D) The amplitude of the note increases before it reaches the glass.

This is resonance
32. The periodic wave in the diagram below has a frequency of 40. hertz.


What is the speed of the wave?
(A) $13 \mathrm{~m} / \mathrm{s}$
(B) $120 \mathrm{~m} / \mathrm{s}$
(C) $60 . \mathrm{m} / \mathrm{s}$
(D) $27 \mathrm{~m} / \mathrm{s}$
33. What is the angle between the direction of propagation of a transverse wave and the direction in which the amplitude of the wave is measured?
(A) $90^{\circ}$
(B) $180^{\circ}$
(C) $45^{\circ}$
(D) $0^{0}$

Transverse wave - the particles vibrate perpendicular to the wave motion
34. In the diagram below, the distance between points $A$ and $B$ on a wave is 0.10 meter.


This wave must have
(A) a wavelength of 0.10 m
(C) an amplitude of 0.20 m
(B) a wavelength of 0.20 m
(D) an amplitude of 0.10 m
35. Light is to brightness as sound is to This is the amplitude of the waves
(A) period
(B) loudness
(C) speed
(D) color
36. What is the period of a periodic wave that has a frequency of 60 . hertz?
(A) $1.7 \times 10^{-2} \mathrm{~s}$
(B) $3.3 \times 10^{2} \mathrm{~s}$
(C) $2.0 \times 10^{4} \mathrm{~s}$
(D) $3.0 \times 10^{-3} \mathrm{~s}$
$T=\frac{1}{f}=\frac{1}{60 \cdot H z}$
37. A monochromatic beam of light has a frequency of $6.5 \times 10^{14}$ hertz. What color is this light?
(A) orange
(B) yellow
(C) blue
(D) violet

Use the frequency to look up the color on the EM spectrum on the reference tables.
38. A periodic wave travels through a rope, as shown in the diagram below.

Waves only transfer energy
from location to location


As the wave travels, what is transferred between points $A$ and $B$ ?
(A) neither mass nor energy
(C) both mass and energy
(B) energy, only
(D) mass, only
39. The distance between successive antinodes in the standing wave pattern shown below is equal to

| Antinode to |
| :---: |
| antinode is crest |
| to crest, which is |
| half a wave. |


(A) 2 wavelength
(B) $1 / 2$ wavelength
(C) $1 / 3$ wavelength
(D) 1 wavelength
40. Which of the above occurs when two waves that are in phase with each other meet at the same time in the same medium?
(A) polarization
(B) Doppler shift
(C) diffraction
(D) constructive interference
(E) destructive interference
41. Which of the above occur when a light wave is made to vibrate in only one plane?
(A) polarization
(B) Doppler shift
(C) diffraction
(D) constructive interference
(E) destructive interference
42. Which of the above occurs when an observer notices a change in a train whistle's pitch as it passes by?
(A) polarization
(B) Doppler shift
(C) diffraction
(D) constructive interference
(E) destructive interference
43. Which of the above occurs when a wave passes through a small opening?
(A) polarization
(B) Doppler shift
(C) diffraction
(D) constructive interference
(E) destructive interference
44. A girl on the beach observes 4 waves pass by in 2 seconds, each with a wavelength of 0.5 meter. The speed of the wave is
(A) $0.25 \mathrm{~m} / \mathrm{s}$
(B) $0.5 \mathrm{~m} / \mathrm{s}$
(C) $1.0 \mathrm{~m} / \mathrm{s}$
(D) $2.0 \mathrm{~m} / \mathrm{s}$
(E) $4.0 \mathrm{~m} / \mathrm{s}$

Questions 45 through 47 refer to the following diagram.

45. The wavelength of the wave above is
(A) 0.5 m
(B) 1.0 m
(C) 2.0 m
(D) 4.0 m
(E) 6.0 m
46. The amplitude of the wave shown above is
(A) 0.5 m
(B) 1.0 m
(C) 2.0 m
(D) 4.0 m
(E) 6.0 m
47. The frequency of the wave shown above is
(A) 0.2 Hz
(B) 0.4 Hz
(C) 2 Hz
(D) 4 Hz
(E) 5 Hz
48. As a wave passes from a spring to another spring with a greater tension
(A) the speed of the wave decreases
(B) the frequency of the wave increases
(C) the frequency of the wave decreases
(D) the amplitude of the wave increases
(E) the speed of the wave increases
49. One end of a horizontal string is fixed to a wall, as shown. A transverse wave pulse is generated at the other end, moves toward the wall, and is reflected at the wall. Which of the diagrams below best represents the pulse after it is reflected from the wall?

50. The diffraction of a wave through a single opening produces
(A) refraction
(B) an angle of incidence
(C) an increase in speed of the wave
(D) a semicircular wave pattern
(E) a decrease in speed of the wave
51. A standing wave is produced in a vibrating string as shown


If the length of the string is 1.5 m and the frequency of the vibrating motor is 60 Hz , the speed of the wave is
(A) $15 \mathrm{~m} / \mathrm{s}$
(B) $20 \mathrm{~m} / \mathrm{s}$
(C) $40 \mathrm{~m} / \mathrm{s}$
(D) $60 \mathrm{~m} / \mathrm{s}$
(E) $90 \mathrm{~m} / \mathrm{s}$
52. Sound waves of a constant frequency are being emitted by a horn as it moves to the right, as shown. At which point would a listener hear a pitch that was lower than she would hear if the horn was at rest?

(A) A
(B) B
(C) C
(D) D
(E) E
53. Which of the following colors, when passed through a double-slit opening, will produce the widest central band of light?
(A) red
(B) orange
(C) yellow
(D) green
(E) blue
54. The Doppler effect produces apparent changes in
(A) loudness
(B) pitch
(C) amplitude
(D) velocity
(E) acceleration
55. If light is passed through a double-slit opening onto a screen, the pattern produced on the screen is
(A) a bright central band of light with slightly diminished, alternating bright and dark bands called antinodes and nodes
(B) a bright central band of light with tiny lines toward the edge of the screen
(C) a large circle of light with tiny circles around it
(D) equally sized concentric circles of light
(E) one antinode and no node
56. Two waves approach each other in the same rope at the same time, as shown.


When the two waves are exactly between points $P$ and $Q$, the shape of the rope will be



[^0]:    Doppler Effect
    As the star moves away the wavelength increases so the frequency decreases

