

JAF03 Unit 4 Waves and Vibrations

Task 1 In pairs think of examples of periodic oscillation / periodic motion.

Task 2 Video

Before you listen: Check the meaning of the words below.

oscillation *periodic* *to blink* *steady* *to swallow* *to wobble* *to bounce* *to float*
to generate *flat* (adj)

Now watch the video and compare your ideas with prof. Lewin's. Note down all the examples given in the film.

(source: <http://ocw.mit.edu/courses/physics/8-03-physics-iii-vibrations-and-waves-fall-2004/video-lectures/lecture-1/>)

Task 3 Read the text below and complete it with appropriate words or phrases

(source: wikipedia)

electromagnetic x 2, longitudinal, mechanical, oscillation, vacuum, restoring force, type of wave, mass transport, ultraviolet radiation

In physics, a wave is a disturbance or 1 _____ that travels through spacetime, accompanied by a transfer of energy. Wave motion transfers energy from one point to another, often with no permanent displacement of the particles of the medium—that is, with little or no associated 2 _____. They consist, instead, of oscillations or vibrations around almost fixed locations. Waves are described by a wave equation which sets out how the disturbance proceeds over time. The mathematical form of this equation varies depending on the 3 _____.

There are two main types of waves. 4 _____ waves propagate through a medium, and the substance of this medium is deformed. The deformation reverses itself owing to restoring forces resulting from its deformation. For example, sound waves propagate via air molecules colliding with their neighbours. When air molecules collide, they also bounce away from each other (a 5 _____). This keeps the molecules from continuing to travel in the direction of the wave.

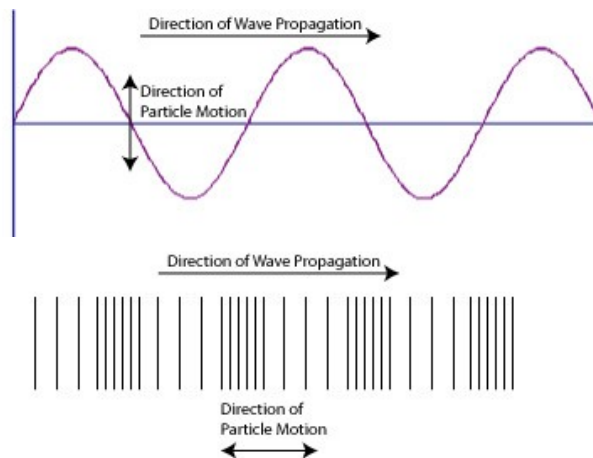
The second type of wave, 6 _____ waves, do not require a medium. Instead, they consist of periodic oscillations in electrical and magnetic fields generated by charged particles, and can therefore travel through a 7 _____. These types of waves vary in wavelength, and include radio waves, infrared radiation, visible light, 8 _____, X-rays, and gamma rays.

A wave can be transverse or 9 _____ depending on the direction of its oscillation. Transverse waves occur when a disturbance creates oscillations perpendicular (at right angles) to the propagation (the direction of energy transfer). The latter occur when the oscillations are parallel to the direction of propagation. All 10 _____ waves are transverse.

Task 4 Anatomy of waves. Match the words given with their definitions and then label the pictures.

rarefaction, trough, frequency, amplitude, crest, wavelength, compression

1. the point on the medium that exhibits the maximum amount of positive or upward displacement from the rest position.
2. the point on the medium that exhibits the maximum amount of negative or downward displacement from the rest position.
3. the maximum amount of displacement of a particle on the medium from its rest position; the distance *from rest to crest*.
4. the length of one complete wave cycle; the distance from crest to crest or from trough to trough.
5. number of crest passages per unit time.
6. a point on a medium through which a longitudinal wave is traveling that has the maximum density.
7. a point on a medium through which a longitudinal wave is traveling that has the minimum density.



Task 5 Read the text and formulate questions asking about facts presented in the text below. Write at least 5 questions. Work with a partner, take turns to ask and answer your questions.

Sound Waves

Since sound cannot travel in a vacuum, acoustic engineers can design soundproof barriers or rooms. If you remove the air between two walls you will be able to greatly reduce the amount of sound that is transmitted. You can also place sound absorbing materials, like the insulation in your home, between the walls to cut down on the transmission of sound waves.

Compared to light, sound waves travel relatively slowly. Because of this slowness in the movement of sound waves, your brain is able to help you locate the source of a sound. There is a measurable difference in the time it takes the sound to reach both of your ears. From this you can tell where the source is located.

You can use sound to measure distances. Using the equation $d=(t_{\text{echo}} \times v_{\text{sound}})/2$, where t_{echo} is the time required for an echo and v_{sound} is the velocity of sound, mountain climbers can determine the width of a valley, while exploration geophysicists can determine the depth of an oil well.

Similarly, SONAR (sound navigation and ranging) is used in detecting objects underwater based on an acoustic echo. The time difference between the signal being sent and received indicates the distance to the object. Today the fishing industry both commercial and recreational use sonar to locate schools of fish. This has also been used in locating ships, and their cargo, when they have sunk.

The massive compression waves produced by an earthquake are similar to sound waves. By using a process of triangulation, and knowing how fast these waves travel in the earth's crust, seismologists are able to determine the epicentre of an earthquake.

Compression waves travel faster in solids than through air. Because of this it is possible to detect the tremors produced by an explosion before you hear the sound of an explosion off in the distance.

Ultrasonic or high-frequency sound waves have been used to clean jewellery and teeth, help animals communicate and aid physicians in making observations of internal organs. It has also been used to remove kidney and gallstones by breaking the stones. Burglar alarms can use the Doppler effect to detect motion in a room.

The quality of sound coming from a musical instrument depends upon the number of harmonic frequencies produced and their relative intensities. Wind instruments rely on resonance while stringed instruments make use of the law of strings.

Eavesdropping or "listening without being seen", makes use of the fact that sound can diffract or bend as it travels through your house. Light waves, however do not bend in this manner. Therefore, you can hear around corners that you cannot see around.

If you have a two-speaker P.A. system, interference patterns can be created. This is an area where nodal lines and antinodal lines are produced. In an area of nodal lines the sound will be softer whereas in an area of antinodal lines the sound will be louder.

Task 6 Waves quiz

1. A transverse wave is transporting energy from east to west. The particles of the medium will move _____.

- a. east to west only
- b. both eastward and westward
- c. north to south only
- d. both northward and southward

2. A wave is transporting energy from left to right. The particles of the medium are moving back and forth in a leftward and rightward direction. This type of wave is known as a _____.

- a. mechanical
- b. electromagnetic
- c. transverse
- d. longitudinal

3. Describe how the fans in a stadium must move in order to produce a longitudinal stadium wave.

4. A sound wave is a mechanical wave, not an electromagnetic wave. This means that

- a. particles of the medium move perpendicular to the direction of energy transport.
- b. a sound wave transports its energy through a vacuum.
- c. particles of the medium regularly and repeatedly oscillate about their rest position.
- d. a medium is required in order for sound waves to transport energy.

5. A science fiction film depicts inhabitants of one spaceship (in outer space) hearing the sound of a nearby spaceship as it zooms past at high speeds. Critique the physics of this film.

6. If you strike a horizontal rod vertically from above, what can be said about the waves created in the rod?

- a. The particles vibrate horizontally along the direction of the rod.
- b. The particles vibrate vertically, perpendicular to the direction of the rod.
- c. The particles vibrate in circles, perpendicular to the direction of the rod.
- d. The particles travel along the rod from the point of impact to its end.

7. Which of the following is not a characteristic of mechanical waves?

- a. They consist of disturbances or oscillations of a medium.
- b. They transport energy.
- c. They travel in a direction that is at right angles to the direction of the particles of the medium.
- d. They are created by a vibrating source.

8. The sonar device on a fishing boat uses underwater sound to locate fish. Would you expect sonar to be a longitudinal or a transverse wave?