Wave Properties

1) Pulse or Wave?

a) A single disturbance travels from left to right, appearing just once and then disappearing.
b) An up-and-down motion propagates continuously from one side to another without stopping.

a) A rope is shaken steadily so that repeating peaks and troughs move along it.
b) A rope is flicked once, creating a single bump that moves along the rope.

a) A repeating pattern of compressions and rarefactions moves down the slinky.
b) One compression moves down a slinky and then stops.

a) A single splash in a pond sends out one ring of ripples.
b) A motor creates continuous ripples spreading outward on the surface of water.

a) A steady tone from a speaker travels continuously through the air.
b) One sound clap travels through the air and then fades away.

a) A brief jolt travels through a metal rod when it is struck once.
b) Continuous vibrations travel through the rod while a machine is running.

a) One sharp pluck of a guitar string sends a single disturbance along the string.
b) The string vibrates repeatedly while a note is sustained.

a) A single compression moves through air after a balloon pops.
b) Repeated compressions move through air while music is playing.

a) A repeating pattern travels along the spring when it is shaken rhythmically.
b) One bump travels along a spring after it is pushed once.

a) Continuous light travels outward from a lamp that remains on.
b) A single flash of light travels outward from a camera.

2) Through what medium?

a) A child flicks one end of a rope once, creating a single bump that travels to the other end.

b) After tossing a pebble into a still pond, circular ripples spread out over the water's surface.

c) You hear the sound of a small bell ringing across the classroom.

d) A slinky is laid out on the floor, and one end is moved up and down repeatedly.

e) Short bursts of high-frequency sound are sent into the body for imaging.

f) Light signals carrying data are sent through a long, thin glass strand for high-speed internet.

g) After an earthquake, disturbances travel through Earth's crust and mantle, sometimes shaking the surface.

h) In a sports stadium, spectators stand and sit in sequence, making a disturbance that travels around the arena.

i) When a switch is flipped, a sudden surge (spike) in voltage travels along the wire.

j) A large rubber sheet is stretched out, and someone quickly snaps one corner, sending a single ripple outward.

3) Transverse or Longitudinal Wave?

a) A single flick at one end of a rope sends a disturbance along it.

b) One end of a slinky is pushed/pulled repeatedly, compressing and expanding the coils.

c) Vibrations of a tuning fork create sound waves traveling through air.

d) A string stretched between two points is disturbed with small, repeated pulses.

e) Spectators stand up and sit down in sequence, sending a wave around the stadium.

f) Plucking a guitar string sends waves traveling along its length.

g) High-frequency sound waves are sent through solids or liquids to detect flaws.

h) Tapping the surface of a drum makes ripples that move radially across the drumhead.

i) A sudden valve closure creates a "water hammer," a pressure wave traveling through the fluid.

j) A beam of light travels through empty space (or air).

k) Striking a metal rod sideways sends a shear wave down its length.

l) A plane exceeding the speed of sound forms a shock wave (sonic boom) in air.

4) Mechanical or electromagnetic wave?

a) A speaker cone vibrates, producing pressure variations in the air that reach your ear.

b) A lamp filament (or LED) emits visible light that illuminates a room.

c) Flicking one end of a rope, creating a disturbance that travels along the rope.

d) Microwaves generates energy that heats food.

e) An antenna emits radio waves that can travel through air or space to a receiver.

f) Disturbances that travel through Earth's crust during an earthquake.

g) High-frequency sound waves pass through the body to create images.

h) X-rays are used to see inside luggage.

i) Surface water waves you see at the beach.

j) Infrared light pulses send signals from a remote to a TV or device.

k) Ultrasonic probes send sound waves into metals or other materials to detect flaws.

l) High-energy photons emitted during nuclear transitions.

m) Vibrations travel through a steel beam when it is struck with a hammer.

n) Gamma rays emitted from space are detected by orbiting satellites.

o) Ocean waves caused by distant storms travel across the sea.

p) A Wi-Fi router transmits signals that pass through walls to your device.

q) A tuning fork produces vibrations that travel through air to your ear.

r) Seismic waves generated by an underground explosion travel through rock.

s) Ultraviolet radiation from the Sun causes sunburn on exposed skin.

t) Sound waves bounce off underwater objects and return to a sonar receiver.

Review of Wavelength & Period

5) **Draw each wave** and label the amplitude and wavelength.

a) At dawn, surfers notice the ocean waves rising about 1.5 meters above the calm sea. They roll in, spaced 8 meters from crest to crest, before gently crashing onto the beach.

b) A child flicks a rope, marveling as each wave rises 10 centimeters above the resting level. The wave repeats every 40 centimeters along the rope until it dies out.

c) A curious student drops a pebble into a still pond, watching ripples that crest 2 centimeters above the calm surface. Each crest is spaced 15 centimeters apart, expanding outward in perfect circles.

d) When the guitarist plucks the A-string, the displaced string peaks at 0.5 centimeters above its resting line. The wave along the string measures 10 centimeters between crests, producing a resonant note.

e) Two friends create a standing wave on a jump rope, swinging it so the rope moves up to 20 centimeters above the midpoint. They see each crest appear 1 meter apart, forming a mesmerizing pattern of peaks and nodes.

f) A simplified diagram shows a light wave with its electric field cresting at about 1 volt per meter above zero. The distance between each crest is around 500 nanometers, placing it squarely in the visible spectrum.

g) In a small electronics lab, a student notes that the sine wave on the oscilloscope peaks at 2 volts above the zero baseline. Each peak arrives every 5 milliseconds, repeating smoothly across the screen.

h) A sudden tremor makes the seismograph pen spike 2 millimeters above its central baseline. Each wave crest appears roughly 2 seconds apart, capturing the rhythmic shaking of the ground.

i) A classic grandfather clock's pendulum swings 5 degrees to each side of center, reaching its maximum amplitude. It completes one full oscillation in 1.5 seconds before returning to the midpoint once again.

j) In a hospital ward, a patient's heartbeat trace on the monitor spikes 0.2 volts above the baseline. Each peak recurs every 1 second, reflecting the steady rhythm of the heart.

k) Standard household current in the United States presents an alternating voltage wave peaking at about 170 volts above zero. Each cycle takes only 16.7 milliseconds, matching the 60 hertz frequency.

l) On a small circuit board, an LED pulses from 0 to 5 volts in a sharp rise and fall. Every 0.5 seconds, the light flashes again, creating a half-second on/off rhythm.

Review of Wavelength & Period

6) A student flicks one end of a rope at a frequency of 4 Hz, producing waves that are 0.5 m apart (crest to crest). Calculate the wave speed.

7) A wave pool creates regular waves traveling at a speed of 6 m/s, with each wave crest passing a fixed point 1.5 times per second. Find the wavelength.

8) A certain color of laser light has a wavelength of 600 nm, and it travels at the speed of light, 3.0×10^8 m/s. Calculate the frequency.

9) A high-pitched whistle emits sound at a frequency of 2,000 Hz. You want to know how long it takes for one complete oscillation (one cycle) of the wave. Find the wave period.

10) At the beach, you count 15 wave crests passing a fixed post in 30 seconds. Measuring the distance between adjacent wave crests gives 3.0 meters. Find the frequency of the waves, then calculate the wave speed, given the wavelength, λ=3.0 m.

11) A water wave has a wavelength of **2.5 m** and travels at **5.0 m/s**. Find the **frequency** of the wave.

12) A sound wave travels through air at **340 m/s** and has a frequency of **170 Hz**. Calculate the **wavelength** of the sound wave.

13) A rope produces waves with a wavelength of **0.80 m**. If the wave speed is **4.0 m/s**, how many wave crests pass a point each second?

14) A wave has a period of **0.20 s** and a wavelength of **1.5 m**. Calculate the **wave speed**.

15) A radio wave has a frequency of **1.0×10^6 Hz** and travels at **3.0×10^8 m/s**. Find the **wavelength** of the wave.

16) You observe **12 complete waves** pass a buoy in **8.0 seconds**. If the wavelength is **2.0 m**, determine the **wave speed**.

17) A vibrating string produces waves with a frequency of **50 Hz** and a wavelength of **0.40 m**.
Find the **period** of the wave.

Review of Sinusoidal Functions

18) A platform vibrates vertically with an amplitude of **4 cm**. One complete oscillation takes **2.5 s**.
   a) Determine the **period T** and **frequency f**.
   b) Write the displacement function $y(t)$, assuming the platform passes through equilibrium moving upward at $t = 0$.
   c) Find the **first time** $t > 0$when the platform reaches its **maximum height**.

19) A buoy in calm water oscillates up and down with an amplitude of **6 cm**. You observe **18 complete oscillations in 36 s**.
   a) Calculate the **frequency** and **period** of the motion.
   b) Write a sine function describing the buoy's vertical motion.
   c) How long does it take for the buoy to go from **maximum height back to equilibrium**?

20) A vibrating ruler produces simple harmonic motion with a frequency of **8 Hz** and an amplitude of **1.5 cm**.
   a) a) Find the **period T**.
   b) Write $y(t)$assuming the ruler passes through $y = 0$upward at $t = 0$.
   c) How many times does the ruler reach **maximum displacement** in the first **1.5 s**?

21) A transverse wave on a rope travels at **0.75 m/s** and has a frequency of **3.0 Hz**. The amplitude is **4 cm**.
   a) Calculate the **wavelength**.
   b) Write the spatial wave function $y(x)$at a fixed instant, assuming no phase shift at $x = 0$.
   c) Find the **smallest positive** $x$where the rope is at **maximum displacement**.

22) Ocean swells move past a pier with a speed of **5.0 m/s**. Crests are observed **every 8.0 m**. The wave amplitude is **0.6 m**.
   a) Determine the **wavelength**.
   b) Write a sine function describing the wave shape at one moment in time.
   c) How far apart are **adjacent zero-crossings** along the wave?

23) A microwave signal travels at **3.0×10^8 m/s** and oscillates at **2.45×10^9 Hz**.
   a) Calculate the **wavelength**.
   b) Write the spatial electric field function $E(x)$, assuming $E = 0$at $x = 0$and increasing.
   c) What distance must you move from $x = 0$to reach the **first maximum field strength**?

24) A transverse wave travels along a stretched string with an amplitude of **2.0 cm**. The wave speed is **1.0 m/s**, and the frequency is **5.0 Hz**.
   a) Calculate the **wavelength** of the wave.
   b) Write the **spatial wave function** $y(x)$for a snapshot in time, assuming the wave passes through $y = 0$at $x = 0$and is increasing there.
   c) Determine the **smallest positive distance** $x$at which the string reaches **maximum displacement**.