**📘 Lecture 4: Wave Fundamentals**

1. **Which of the following best describes a transverse wave?**  
   A. Particles vibrate parallel to the wave's direction  
   B. Particles vibrate perpendicular to the wave's direction  
   C. The wave does not involve particle motion  
   D. Particles vibrate in a circular motion  
   ✅ **Answer: B**  
   🧠 **Explanation**: In a transverse wave, particles vibrate perpendicular to the direction of wave propagation. This is typical in waves on a string or light waves.
2. **A wave is described by y(x, t) = (6.0 mm) sin(kx + (600 rad/s)t + φ). What is the period of the wave?**  
   A. 0.0105 s  
   B. 0.0050 s  
   C. 0.00167 s  
   D. 0.00105 s  
   ✅ **Answer: A**  
   🧠 **Explanation**: The angular frequency ω = 600 rad/s. Period T = 2π / ω = 2π / 600 ≈ 0.0105 s.
3. **What determines the direction a sinusoidal wave is traveling?**  
   A. The sign of amplitude  
   B. The sign before ωt in the wave equation  
   C. The frequency  
   D. The wavelength  
   ✅ **Answer: B**  
   🧠 **Explanation**: If the wave is written as sin(kx − ωt), it travels in the **positive x-direction**. If it's sin(kx + ωt), it travels in the **negative x-direction**.
4. **The frequency of a wave is 50 Hz and its wavelength is 2 m. What is the wave speed?**  
   A. 25 m/s  
   B. 100 m/s  
   C. 50 m/s  
   D. 2.5 m/s  
   ✅ **Answer: B**  
   🧠 **Explanation**: Wave speed v = f × λ = 50 Hz × 2 m = **100 m/s**.
5. **Which quantity has the SI unit rad/m?**  
   A. Angular frequency  
   B. Phase constant  
   C. Wave number (k)  
   D. Amplitude  
   ✅ **Answer: C**  
   🧠 **Explanation**: Wave number k = 2π / λ, which has units of radians per meter (rad/m).
6. **The displacement y(x, t) = A sin(kx − ωt) represents:**  
   A. Standing wave  
   B. Longitudinal wave  
   C. Transverse traveling wave  
   D. A stationary particle  
   ✅ **Answer: C**  
   🧠 **Explanation**: This is the standard form of a transverse wave traveling in the positive x-direction.
7. **If a point on the wave retains its displacement while moving, what must stay constant?**  
   A. Time  
   B. Position  
   C. Phase (kx − ωt)  
   D. Frequency  
   ✅ **Answer: C**  
   🧠 **Explanation**: For a point to retain its displacement, the **phase** of the sine function must stay the same.
8. **A wave has a period of 0.2 s. How many full oscillations occur in 5.0 s?**  
   A. 25  
   B. 5  
   C. 10  
   D. 20  
   ✅ **Answer: A**  
   🧠 **Explanation**: Number of cycles = total time / period = 5.0 / 0.2 = **25 oscillations**.
9. **Which of the following is true for y(x,t) = A sin(kx − ωt)?**  
   A. Displacement depends only on time  
   B. Amplitude varies with x  
   C. Wave shape moves with time  
   D. Wave is stationary  
   ✅ **Answer: C**  
   🧠 **Explanation**: Since the equation depends on both x and t, the wave **moves over time**.
10. **To find displacement at a specific location and time from the wave equation, you:**  
    A. Use amplitude and frequency only  
    B. Plug x and t into y(x,t)  
    C. Differentiate y(x,t)  
    D. Use angular frequency and wave number  
    ✅ **Answer: B**  
    🧠 **Explanation**: The wave equation directly gives the displacement if you substitute x and t.

**Lecture 4 (continued)**

1. **If time increases in y(x,t) = A sin(kx − ωt + φ), what must happen to x to keep the phase constant?**  
   ✅ **Answer: C** – x must increase.  
   🧠 Explanation: To keep (kx − ωt + φ) constant, if t increases, x must also increase.
2. **If it takes 0.001133 s to move from +2 mm to –2 mm, what’s the period?**  
   ✅ **Answer: B** – 0.002266 s.  
   🧠 Explanation: That’s half a cycle, so full period = 2 × 0.001133.
3. **If the wave is sin(kx − ωt), in which direction does it travel?**  
   ✅ **Answer: B** – Positive x-direction.  
   🧠 Explanation: Minus sign before ωt means wave moves in +x.
4. **Which is NOT a mechanical wave property?**  
   ✅ **Answer: C** – Can travel in vacuum.  
   🧠 Explanation: Mechanical waves need a medium.
5. **For y = 0.02 sin(4πx − 200πt), what's λ?**  
   ✅ **Answer: B** – 0.5 m.  
   🧠 Explanation: k = 4π → λ = 2π / k = 0.5.
6. **What does amplitude represent?**  
   ✅ **Answer: B** – Maximum displacement.  
   🧠 Explanation: Amplitude is how far particles move from equilibrium.
7. **Two points have same y but different velocities. Why?**  
   ✅ **Answer: B** – They are out of phase.  
   🧠 Explanation: Velocity depends on the time derivative, not just position.
8. **What is φ (phi) in the wave equation?**  
   ✅ **Answer: B** – Phase constant.  
   🧠 Explanation: It shifts the wave horizontally.
9. **Which gives wave speed?**  
   ✅ **Answer: C** – v = λ / T.  
   🧠 Explanation: Speed = wavelength / period.
10. **Wave: y = 0.01 sin(2πx − 400πt). Find f.**  
    ✅ **Answer: A** – 200 Hz.  
    🧠 Explanation: f = ω / 2π = 400π / 2π = 200.

**📗 Lecture 5: Wave Speed and String Properties**

1. **What does wave speed on a string depend on?**  
   ✅ **Answer: B** – Tension and linear mass density.  
   🧠 Explanation: v = √(T / μ).
2. **Correct formula for string wave speed?**  
   ✅ **Answer: C** – √(T / μ).  
   🧠 Explanation: Standard wave speed on a stretched string.
3. **T = 36 N, μ = 0.004 kg/m. v = ?**  
   ✅ **Answer: B** – 30 m/s.  
   🧠 Explanation: v = √(36 / 0.004) = √900 = 30.
4. **What sets the frequency of a wave?**  
   ✅ **Answer: D** – The source.  
   🧠 Explanation: Frequency is independent of string tension or μ.
5. **μ increases, tension constant → what happens to v?**  
   ✅ **Answer: C** – Decreases.  
   🧠 Explanation: More mass per meter → slower wave.
6. **Unit of linear density (μ)?**  
   ✅ **Answer: B** – kg/m.  
   🧠 Explanation: Mass per length.
7. **Amplitude at x=0, t=0 means...?**  
   ✅ **Answer: B** – Peak displacement.  
   🧠 Explanation: It’s the max y value from equilibrium.
8. **y = 2 sin(20x − 600t) → v = ?**  
   ✅ **Answer: C** – 30 m/s.  
   🧠 Explanation: v = ω/k = 600 / 20.
9. **If ω = 600, what’s f?**  
   ✅ **Answer: A** – 100 Hz.  
   🧠 Explanation: f = ω / 2π ≈ 600 / 6.28 ≈ 95.5.
10. **T = 15 N, v = 30 m/s → μ = ?**  
    ✅ **Answer: C** – 0.0167 kg/m (16.7 g/m).  
    🧠 Explanation: μ = T / v² = 15 / 900.

**Lecture 5 (continued)**

1. **If frequency increases and wave speed stays constant, what happens to wavelength?**  
   ✅ **Answer: B** – It decreases.  
   🧠 Explanation: v = fλ → if f ↑ and v constant, λ must ↓.
2. **Which of the following does NOT affect wave speed on a string?**  
   ✅ **Answer: B** – String length.  
   🧠 Explanation: Speed depends on tension and linear density, not length.
3. **String A is twice as dense as string B (same tension). What’s the speed ratio vA/vB?**  
   ✅ **Answer: A** – 1/√2 (slower).  
   🧠 Explanation: v ∝ 1/√μ → greater density → lower speed.
4. **y = 0.05 sin(πx − 2πt). What is λ?**  
   ✅ **Answer: C** – 2 m.  
   🧠 Explanation: k = π → λ = 2π / π = 2.
5. **If ω = 100π and k = 10π, what is wave speed?**  
   ✅ **Answer: B** – 10 m/s.  
   🧠 Explanation: v = ω / k = 100π / 10π = 10.

**📙 Lecture 6: Superposition and Standing Waves**

1. **What happens when two waves overlap?**  
   ✅ **Answer: B** – Their displacements add (superposition).  
   🧠 Explanation: Net displacement is the algebraic sum.
2. **Two in-phase waves traveling in same direction = ?**  
   ✅ **Answer: D** – Wave with double amplitude.  
   🧠 Explanation: Constructive interference.
3. **Two identical waves in opposite directions = ?**  
   ✅ **Answer: C** – Standing wave.  
   🧠 Explanation: Opposing waves create nodes and antinodes.
4. **What is a node?**  
   ✅ **Answer: C** – Point that never moves.  
   🧠 Explanation: Net displacement = 0.
5. **Where is max amplitude in a standing wave?**  
   ✅ **Answer: D** – Antinode.  
   🧠 Explanation: Displacement is max at antinodes.
6. **y = 0.5 sin(kx)cos(ωt). Amplitude of each wave?**  
   ✅ **Answer: C** – 0.25 cm.  
   🧠 Explanation: Each wave has half the amplitude of the standing wave.
7. **Distance between adjacent nodes = ?**  
   ✅ **Answer: B** – λ/2.  
   🧠 Explanation: Nodes are spaced half a wavelength apart.
8. **y = A sin(kx)cos(ωt). Where is a node?**  
   ✅ **Answer: B** – sin(kx) = 0.  
   🧠 Explanation: That makes y = 0 for all t.
9. **sin(kx) = ±1 in standing wave → ?**  
   ✅ **Answer: C** – Antinode.  
   🧠 Explanation: Max amplitude = antinode.
10. **In y = 0.04 sin(5πx)cos(40πt), distance between 1st and 3rd node?**  
    ✅ **Answer: B** – 0.2 m.  
    🧠 Explanation: Node spacing = λ/2 = 0.2 m apart.

**📕 Lecture 7: Reflections and Resonance**

1. **What happens when a wave reflects from a fixed boundary?**  
   ✅ **Answer: C** – Inverted.  
   🧠 Explanation: Fixed ends invert the pulse (hard reflection).
2. **At a free end, a wave pulse reflects...?**  
   ✅ **Answer: B** – In phase (not inverted).  
   🧠 Explanation: Free end = soft reflection.
3. **Standing waves form only at...?**  
   ✅ **Answer: D** – Fundamental, harmonics, resonant frequencies.  
   🧠 Explanation: All of the above are correct.
4. **Lowest mode of vibration?**  
   ✅ **Answer: A** – Fundamental.  
   🧠 Explanation: The simplest standing wave (1 loop).
5. **String: L = 1.25 m, m = 2.00 g, T = 7.00 N → speed?**  
   ✅ **Answer: C** – ~66.4 m/s.  
   🧠 Explanation: μ = 0.002 / 1.25 = 0.0016 → v = √(7 / 0.0016).
6. **Antinode in a standing wave...?**  
   ✅ **Answer: B** – Max displacement.  
   🧠 Explanation: Full amplitude occurs at antinodes.
7. **Longest wavelength in 1.2 m string with fixed ends?**  
   ✅ **Answer: B** – 2.4 m.  
   🧠 Explanation: λ = 2 × L = 2.4 m.
8. **Waves out of phase by 180° = ?**  
   ✅ **Answer: B** – Destructive interference.  
   🧠 Explanation: Opposite amplitudes cancel.
9. **y′ = 0.5 sin(πx/3)cos(40πt). Distance between nodes?**  
   ✅ **Answer: A** – 3 cm.  
   🧠 Explanation: k = π/3 → λ = 6 → node spacing = λ/2 = 3 cm.