

# SPH3U UNIVERSITY PHYSICS

WAVES & SOUND  
Interference of Waves  
(P.416-419)

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## Interference of Waves

*On the surface of a lake on a windy day, you will see many complicated wave motions. The water surface appears this way because when waves from various directions and with various amplitudes and wavelengths meet, new waves are generated in a process called **interference**.*



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## Interference of Waves

**NOTE!**  
*The interference that the waves undergo can either be constructive or destructive.*



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### Wave Interference at the Particle Level

You already know that waves are the result of particle vibrations, and that the particles in the medium are connected by forces that behave like small springs. So when two waves meet, the forces on their particles are added together, as shown.

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### Wave Interference at the Particle Level

**NOTE!**  
After the waves have passed through each other, none of their characteristics (i.e. wavelength, frequency, or amplitude) change.

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### Wave Interference at the Particle Level

This is called the **principle of superposition**: the resulting amplitude of two interfering waves is the sum of the individual amplitudes.

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**Interference of Waves**

**INTERFERENCE**

- occurs when two waves act on the same particles of a medium
- two types → constructive and destructive

**PRINCIPLE OF SUPERPOSITION**

- the resulting amplitude of two interfering waves is the sum of the individual amplitudes

**NOTE!**

After the waves have passed through each other, none of their characteristics – wavelength, frequency, or amplitude – change.

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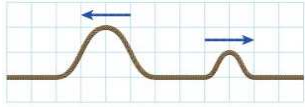
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**Interference of Waves**

**Constructive interference** occurs when two or more waves combine to form a wave with an amplitude greater than the amplitudes of the individual waves. This occurs for transverse waves when a crest meets a crest, causing a **supercrest**, or a trough meets a trough, causing a **supertrough**.



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**Interference of Waves**

**CONSTRUCTIVE INTERFERENCE**

- occurs when two crests (supercrest) or two troughs (supertrough) meet
- new wave with a larger amplitude is created



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**Interference of Waves**

**Destructive interference** occurs when two or more waves that are out of phase combine to form a wave with an amplitude less than at least one of the initial waves. This occurs when a crest meets a trough.

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**Interference of Waves**

**DESTRUCTIVE INTERFERENCE**

- occurs when a crest and a trough meet
- new wave with a smaller amplitude is created

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**Interference of Waves**

**NOTE!**  
Constructive and destructive interference also occurs for all longitudinal waves including sound waves!

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### Interference of Waves

**PRACTICE**

1. State whether the interference is constructive or destructive when:

- (a) a large crest meets a small trough
- (b) a supertrough is formed
- (c) a small compression meets a large compression

(a) destructive  
(b) constructive  
(c) constructive

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### Interference of Waves

**PRACTICE**

2. (a) What happens when two billiard balls, rolling toward one another, collide head on?  
(b) How does this differ from two waves or pulses that collide head on?

(a) they rebound backwards from the collision  
(b) waves pass through each other without affecting their motion

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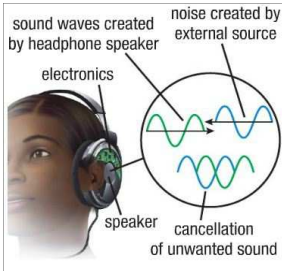
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### Technology That Uses Interference – DYK?

*Many people work in an environment that contains a lot of unwanted sound. In some cases, the noise is loud enough to permanently damage a person's hearing. In the late 1980s, noise-cancelling headphones were introduced. Not only can these devices protect the human ear, but they can also be used to reduce damage to equipment and machinery.*



The diagram shows a person's head wearing headphones. Labels include: 'electronics' pointing to the earcup, 'speaker' pointing to the earcup, 'sound waves created by headphone speaker' pointing to a blue wave inside the earcup, 'noise created by external source' pointing to a blue wave outside the earcup, and 'cancellation of unwanted sound' pointing to a green wave inside the earcup that is out of phase with the external noise.

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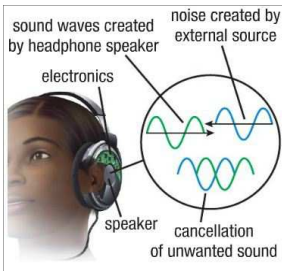
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### Technology That Uses Interference – DYK?

*The technology uses the concept of destructive interference. The electronics inside the headphone generate a wave that is out of phase with sound waves in the exterior environment. This out-of-phase wave is played inside the headset, effectively cancelling the outside noise. Such devices also allow users to listen to music at lower volume levels, reducing potential damage to their hearing.*



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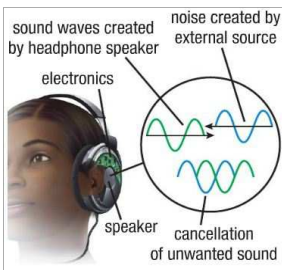
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### Technology That Uses Interference – DYK?

**TECHNOLOGY THAT USES ...**  
❖ noise-cancelling headphones



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### ✓ Check Your Learning

**TEXTBOOK**  
P.419 Q.1,2 (Practice)  
P.419 Q.2  
P.437 Q.1-3,5 (Rogue Waves)

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