

**Docente:** *Fabrizia De Bernardi*

**Scuola:** Liceo Classico-Scientifico "Peano-Pellico" – Cuneo

**Titolo del modulo:** WHAT IS SOUND

**Classi coinvolte:** 4B - 2018/19

**Numero di allievi coinvolti:** 24

**Numero di ore dedicate al modulo in ogni classe:** 14

**Metodologia utilizzata:** le lezioni si sono svolte sia in aula con il supporto di materiale multimediale (presentazioni ppt, video tratti da You Tube, Khan academy, Graphic design for education, Bozeman science, PHET Colorado University simulations, ecc.), sia in laboratorio di fisica per un esperimento sull'interferenza delle onde sonore, sia in laboratorio di informatica per la stesura della relazione dell'esperimento. Le lezioni si sono sempre svolte in modo interattivo, sollecitando gli studenti a porre domande o rispondere a domande, a esporre una "review" degli argomenti della lezione precedente, a svolgere attività a coppie. Anche il test finale, comprendente parti teoriche ed esercizi, è svolto a coppie. Il docente ha svolto l'intero modulo in L2, salvo brevissimi e rari interventi in lingua italiana per spiegare concetti più complessi.

Gli studenti hanno dato mostra di divertirsi, anche grazie alla peculiarità dell'argomento che coinvolge anche aspetti sonori e concetti di teoria musicale. Hanno accettato di esporre in lingua inglese e di discutere anche tra di loro in inglese svolgendo le attività, pur con qualche incertezza e difficoltà.

**Esempi di attività svolte/task/verifiche finali:**

Le lezioni hanno compreso una review iniziale, possibilmente esposta da qualche studente, la lezione frontale vera e propria con ausilio di un ppt e dei video, domande e risposte, un'attività finale a coppie.

**Esempio di attività lezione 1:**

1) What's the difference between sound and noise?

.....  
.....

2) Sound waves are ..... waves that can't spread in the .....

They travel in the air with a speed given approximately by .....

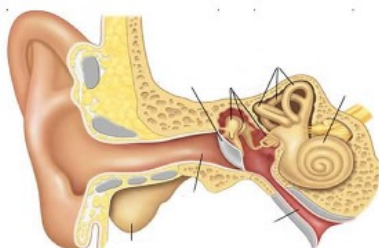
3) Sound waves travel with the highest speed in:

- a. gases                      b. liquids                      c. solids

4) WHAT HAPPENS WHEN A SOUND ENTERS YOUR EAR?

LABEL THE PICTURE USING THE FOLLOWING WORDS:

Earlobe/ eardrum/ hammer/ anvil/ stirrup/ cochlea /semicircular canals  
auditory nerve/ ear canal/ Eustachian Tube



6) DO BATS HEAR INFRA or ULTRASOUNDS?

.....

7) WHICH FREQUENCY DOES YOUR EAR HEAR THE BEST?

- a) 0,4 Hz                      b) 3800 Hz  
c) 10 Hz                      d) 12000 Hz

8) MATCH THE PROPERTY with THE CORRECT PHYSICAL QUANTITY (draw 3 arrows)

|             |                     |
|-------------|---------------------|
| Pitch       | Harmonics/overtones |
| Loudness    | Frequency           |
| Tone/Timbre | Amplitude           |

9) Amplitude is related to the .....of sound.

In which way does it depend on distance?

Write down the formula: .....

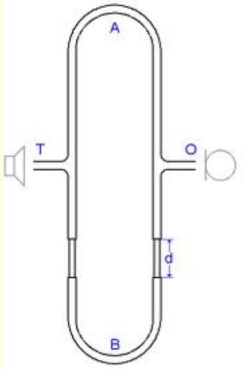
**Esempio di attività lezione 4 - problem solving:**

1. Joe is in his car moving towards Betty (who is stationary in her car) at .55c. It is getting dark and Betty does not have her headlights on, so Joe flashes his brights at Betty. If the frequency of the light which Joe emits from his headlights is 4500 Hz, at what frequency does Betty hear the sound?
2. Mary is walking through the streets of downtown Tualatin and comes to an intersection where the walk signal is blinking to stop walking. Mary thinks she is smarter than the signal though and she tries to make a last minute run for the other side of the street. She realizes she isn't going to make it when a speeding truck coming toward her at the speed of 24 m/s is honking its horn at the frequency of 6037 Hz. With what frequency is the wave reaching Mary right before she gets struck by the truck? (remember the speed of sound is 343 m/s)
3. As a train pulls out of the station going 50 m/s it blasts its horn, what is the frequency heard by the train if the passengers still at the station are hearing 384 Hz?

**Esempio di attività – lezione 6: Esperimento in laboratorio e relazione**

**Laboratory: Quincke Tube**

You can experiment interference of sound waves using an instrument called Quincke's Tube from the name of its inventor. The sound produced by a loudspeaker goes into the two branches of the tube. Your ear is near the other hole.



Spiegazione in classe del funzionamento dell'apparato sperimentale.

Realizzazione dell'esperimento in laboratorio.

**RESULTS OF THE EXPERIMENT**

When the lengths of the two branches differ by .....  
 the exiting waves are.....and the ear hears an intense sound which  
 becomes.....until it.....  
 when you ..... the movable branch in order to make the difference of the two paths  
 equal to .....

Relazione a coppie dell'esperimento con elaborazione dei dati sperimentali su scheda parzialmente compilata.

Write down the measures you have obtained, with a short description. Write down the absolute and relative errors related to your direct measurements.

| Quantity | in case of ... | Wave length =   | Absolute error | Relative error |
|----------|----------------|-----------------|----------------|----------------|
|          |                |                 |                |                |
|          |                |                 |                |                |
|          |                |                 |                |                |
|          |                |                 |                |                |
|          |                |                 |                |                |
|          |                |                 |                |                |
|          |                |                 |                |                |
|          |                |                 |                |                |
|          |                | Average value = |                |                |

Starting from these data and other values that you should know (the frequency, for example), calculate the wavelength of the sound travelling in the tube and the speed of sound.

## Test finale in classe, a coppie

### Class test

- 1) Explain in your own words what sound is, how it is possible to produce a sound and how it propagates, why the speed of sound can change... and so on.  
[Try to use the passive form and the conditional form at least once]

.....  
.....  
.....  
.....  
.....

- 2) Explain the difference between reverberation and echo and which physical phenomenon produces these two effects.  
[Try to use the passive form and the conditional form at least once]

.....  
.....  
.....  
.....

Write your calculations on the back of the page.

- 3) If you beat on a steel railway tracks, how long will the vibration take to cover a distance of 2 km?  
(Think about the order of magnitude of the speed of sound in a solid medium.)

A)  $t = 0,33$  h                      B)  $t = 3,3$  s                      C)  $t = 0,33$  s                      D)  $t = 0,5$  min

- 4) Choose among these couples of sounds the one which, in your opinion, could produce audible beats and calculate the frequency of beats:

A) 440 Hz, 880 Hz                      B) 440 Hz, 330 Hz                      C) 440 Hz, 1320 Hz                      D) 440 Hz, 436 Hz

The frequency of beats is \_\_\_\_\_

These beats are produced by the A strings of two identical violins. One violin is not well tuned. What percentage do you have to increase the tension of the off-key string to cut out beats? \_\_\_\_\_

- 5) Suppose that a violin produces a sound with an intensity equal to  $10^5$  times the intensity corresponding to the threshold of hearing; what will be the intensity you actually hear when ten identical violins are playing together? Will it be ten times higher?

- 6) The distance between the frets of a guitar is greater for two lower notes than it is for two higher notes. Every fret separates two notes that differ by a semitone.



Try to understand what kind of mathematical function (power function, exponential function, logarithmic function...) represents the increasing length of the vibrating part of the string, starting from the shortest one (position 22 = L). Are you able to find the exact expression for this function?