Doppler effect

To stay on track:

The liveworksheets on the Doppler effect and the homework given at the end of the worksheets, should take you a week to complete and mark.

The memo to the homework will be sent at the end of the week ☺

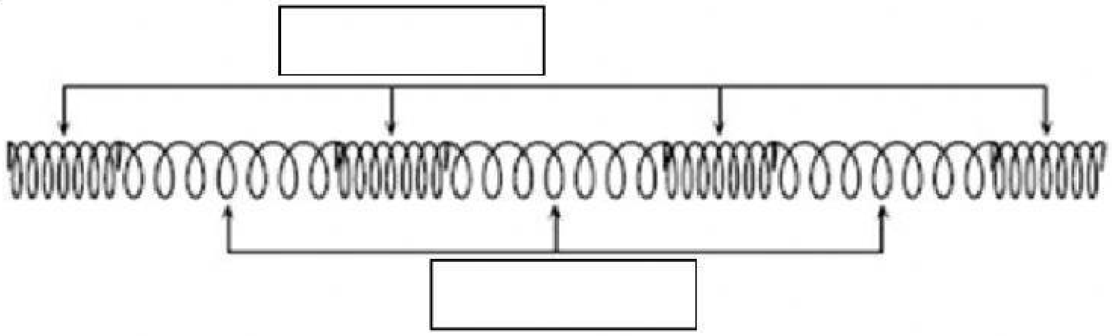
1. Sound waves are examples of transverse longitudinal waves

2. ______________ are regions in the above mentioned wave where the particles are closest together.

3. ______________are regions in the above mentioned wave where the particles are furthest apart.

Label the wave sections below:

4.



5. __________of a wave refers to the no of compressions (or rarefactions) that pass a given point per _________.

6. The time taken for two successive compressions (or rarefactions) to pass a given point is known as the ___________ of the wave.

7. Period of a wave is measured in __________ (only give the unit symbol)

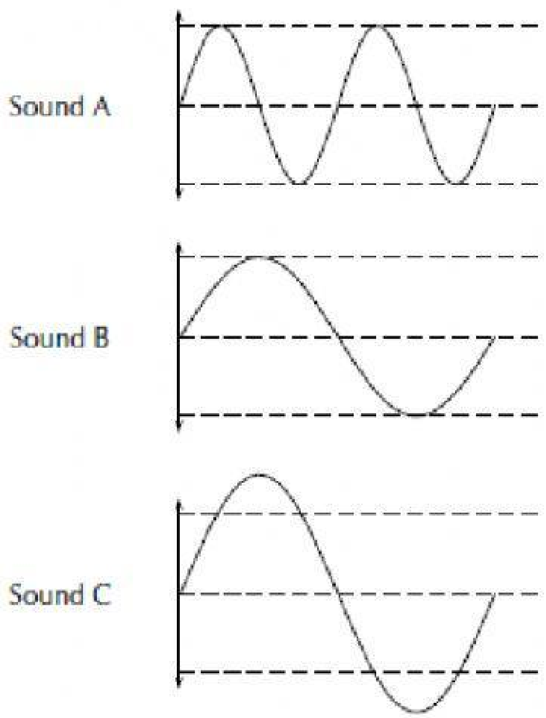
8. Frequency of a wave is measured in ___________(only give the unit symbol)

Think back to the gr 10 waves section

9. What instrument was used to convert sound waves into transverse waves

____

When this instrument is used, we can represent sound waves as follows:



Looking at these representation of sound waves:

10. The amplitude frequency corresponds to the pitch of the sound

11. The amplitude frequency corresponds to the loudness of the sound

12. Which wave (only state A, B or C) represents the wave with:

a) the sound with the highest pitch

b) the loudest sound

When an ambulance with its siren on passes by a listener the pitch of the sound produced will change as it passes by the listener.

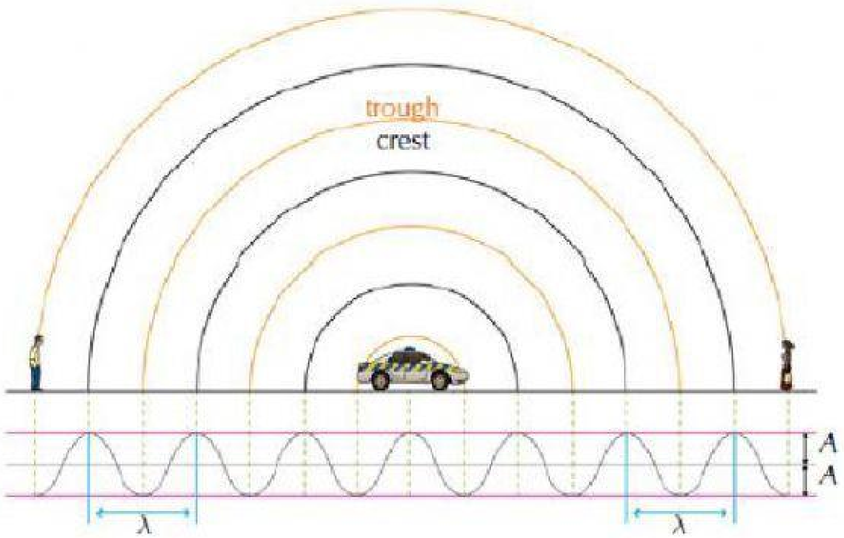
https://www.youtube.com/watch?v=0rJPvGML9A0

That sound you hear Sheldon making is the perfect representation of the Doppler effect.

Doppler effect definition: it is the apparent change in frequency (or pitch) of a sound when the sound source and the listener move with respect to each other.

Think of what it sounds like when you watch formula one racing cars. When the car races towards you pitch of the sound is **higher** (not to be confused with the loudness of the sound). But when car moves away from you, the pitch decreases and the sound is **lower**.

What causes this?



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Imagine a police car with it's siren on.

When the car is standing still- the wavelengths of the sound waves are equal everywhere and thus the frequency is the same everywhere.

This causes the pitch of the sound to be the same no matter where the listener is standing.

But when the police car is travelling towards the listener- the waves in front of the car get closer together (they are in essence "catching up to each other") as the car moves forward.

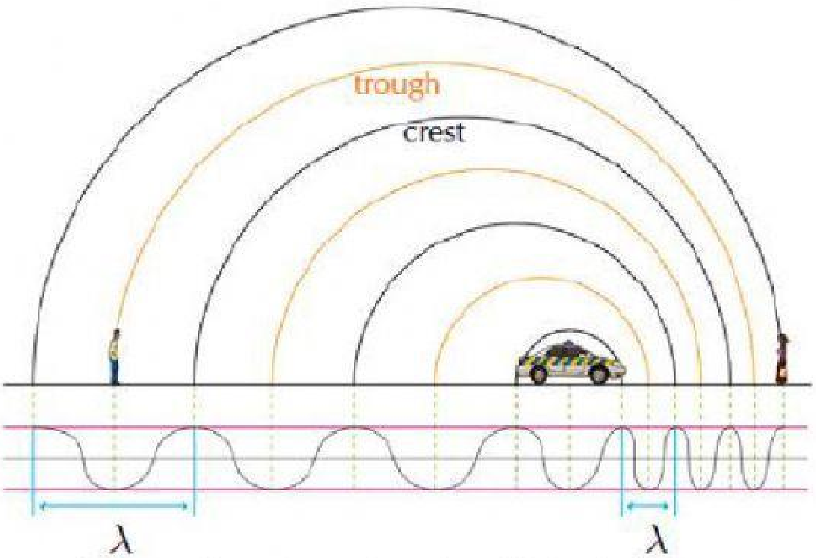

Image source: pg 256 eveything science,siyavula gr 12 physical science

The wavelength in front of the police car are now shorter and thus the frequency will

_____________ since wavelength is ____________ proportional to the frequency.

When the frequency increases, the pitch of the sound will increase. (it ***sounds*** higher)

The formula to calculate the frequency that the learner hears is the following formula

$$f_L = \frac{v \pm v_L}{v \pm v_S} f_S$$

f_L - the frequency heard by the listener (Hz)

v (both) - the speed of sound in air (usually given on the data sheet as 343m.s^{-1})

v_L – the speed at which the listener is moving (m.s^{-1})

v_s – the speed at which the source (making the sound) is moving (m.s^{-1})

f_s – frequency made by the source (the "real" frequency) (Hz)

You are usually going to be asked to calculated the frequency heard by the listener (the observed frequency)

In grade 12 you are **only** going to get questions where either the source of the sound or the listener is stationary (thus either v_L or v_s would equal to zero)

Situation 1:Source moving towards a stationary listener

$$f_L = \frac{v \pm v_L}{v \pm v_S} f_S$$

In this case the listener is standing still and thus $V_L = 0$ m.s^{-1}

This observed frequency heard by the listener is going to be higher than the fs (frequency made of the source).

It makes no difference whether you add or subtract the zero

$$f_L = \frac{V + 0}{V \pm Vs} f_S$$

Your answer (f_L) thus needs to be as big as possible.

In order to achieve this the denominator will have to be as small as possible and thus you will need to subtract the values at the bottom in order to make the answer value as big as possible.

Numerator

$$f_L = \frac{V}{V - Vs} f_S$$

Denominator

Or you can write it as:

$$f_L = \frac{V \cdot f_S}{V - Vs}$$

When a car approaches you, the sound waves that reach you have a shorter wavelength and a higher frequency. *You hear a higher pitch sound.*