ENERGY AND SOUND

Physics 2

LESSON 1

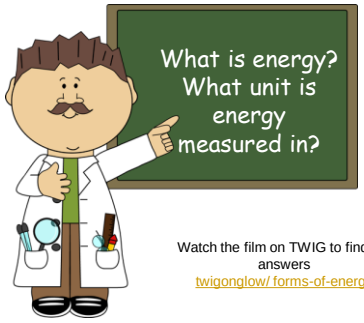
Introduction

Learning intentions

By the end of this lesson I can..

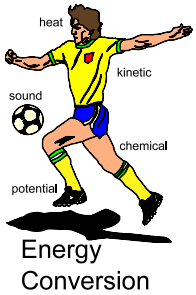
- Define what energy is
- State the unit of energy
- Give examples of the different forms of energy
- Discuss the conservation of energy

Energy



Watch the film on TWIG to find the answers
twigonglow/ forms-of-energy

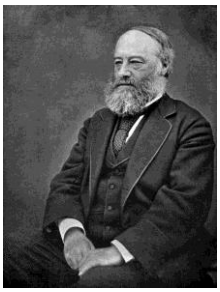
What is energy?



- Energy is needed to get jobs done, or make things work.
- To get a job done, energy must be transferred from one place to another.

Units

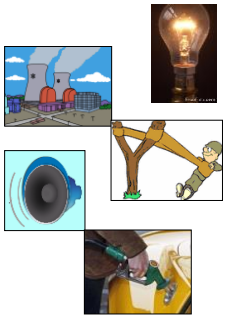
- Energy is measured in units called JOULES (J)
- *They are named after the famous scientist called James Prescott Joule, a Physicist and Brewer.*



By Henry Roscoe - The Life & Experiences of Sir Henry Enfield Roscoe (Macmillan: London and New York), p. 120, Public Domain, https://commons.wikimedia.org/w/index.php?curid=3119134

Forms of energy

- Write down as many forms of energy as you can remember from the video clip



Two groups

Making things happen
- Kinetic (movement)
- Light
- Heat
- Sound
- Electrical

- Waiting to happen
- POTENTIAL ENERGY (store)
- Gravitational
- Elastic /Strain
- Chemical

Energy crisis

Hypothesise/ Express view

Can you think of a reason these two statements seem to be in conflict?

- Have you heard people talking about the Energy Crisis?
- It concerns us all.
- But there is EXACTLY the same amount of energy now as there was at the beginning of life on Earth.

Energy crisis

- People talk about the 'energy crisis' as energy is being transferred into different forms – e.g. as heat. We are running out of fossil fuels to be used as an energy source and these are being burnt.

- In this example, the energy has been transferred from **chemical potential energy** (as the fuel) to **heat energy** (to make steam for the turbines) .

Energy law

- There is exactly the same energy in the Universe as the start of the world. We say there is an energy crisis as we are using up useful energy and transferring into less useful forms. Eventually it will all become heat.

Energy is converted or transferred it is never lost!

Homework

- Due date __/__/2019
- Create a cover page for the Energy and Sound topic

Exit questions

1. What are the units for energy?
2. What is energy needed for?
3. Name 4 different forms of energy
4. What is the law of energy? (can it be created?)

LESSON 2

Energy transformations

Learning Intentions

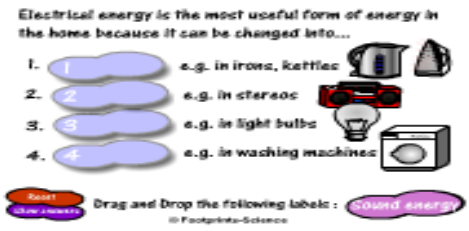
By the end of this lesson you should be able to…

- Give examples of energy transformations in common household objects
- Suggest where energy may be lost in these transformations

Forms of energy

A phone takes in electrical energy and turns it into sound and light energy.

So, the energy change in a phone is:
Electrical → Sound + Light + Heat



Energy circus

All practical activities

- Complete the activities in the energy circus
- Write the energy transfer for each activity

Does the energy all get transferred?

- Think of a racing car. Do you think all of the stored energy in the fuel is transferred into kinetic energy?
- If not, what form might this energy take?

Here is a picture of a racing car. In the diagram 100 Joules of energy is stored in the fuel. This produces 30 Joules of energy to move the car forward. This means 70 Joules of energy has been wasted as heat. We can represent this in a diagram

100 J potential energy in fuel → 30 Joules kinetic energy

70 Joules heat

Energy Transfers (continued)

Electrical Bell

_____ → _____ + _____

Parachutist

_____ → _____ + _____

Energy Transfers (continued)

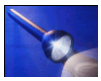
Clockwork toy

Bunsen Burner

Clapping hands

Vacuum cleaner

Energy Transfers (continued)



_____ → _____ → _____ + (_____)
(battery) (wires) (lamp)

_____ → _____ → _____ + _____
(winch) (at top) (moving cars)

Energy Transfers (continued)

Draw energy transfer diagrams for the following situations






When energy is not useful

- Often energy can be converted into a form that is not very useful
- This less useful form is often heat via friction, for example when bouncing a ball

Exit questions

1. What is the energy transfer in a clockwork toy?
2. What would the energy transfer be in a game of snooker?
3. What way is energy often 'wasted'

LESSON 3

The Steam Engine

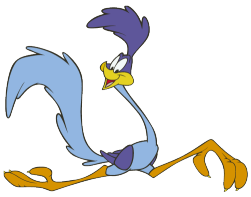
By the end of this lesson you will be able to..

- State the energy transfers in a steam engine
- Identify the energy transfers in other machines

The Steam Engine

Risk Assessment

Energy transfers in cartoons



- Watch the youtube video showing energy transfers with Roadrunner and Wile E. Coyote
- https://www.youtube.com/watch?v=IHrUXyTCr8Y

Machines

- Copy and complete this table to show the energy transfer that takes place in different machines

Machine	Energy Change
Power Station	
Catapult	
Loudspeaker	
Toaster	
Bulb	
Car	
Human	

Machine	Main Energy Change
Power Station	Nuclear/Chemical To Electrical
Catapult	Potential to Kinetic (+ sound)
Loudspeaker	Electrical to Sound (+ heat)
Toaster	Electrical to Heat (+ light)
Bulb	Electrical to Light (+ heat)
Car	Chemical to Kinetic (+ heat, sound, etc)
Human	Chemical to Heat + Kinetic + Sound

Homework

- Due date __/__/2019
- Complete the Energy Efficiency Homework task

Exit questions

- Name the first energy form in a steam engine (from the fuel)
- What tasks can be completed with a steam engine
- In cartoons when a character runs off a cliff, what is the energy transformation?

LESSON 4

Introduction to Waves

Starter – Bingo

Create a 3x3 Bingo grid containing 9 of the following words:

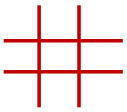
Waves gravitational sound

Electrical nuclear kinetic

light

Heat Joules chemical

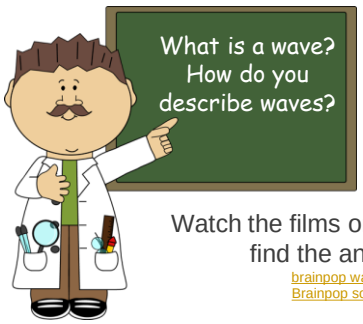
energy



By the end of this lesson you should be able to..

- State the two types of waves
- Give examples of the two types of waves
- Use the correct words to describe waves

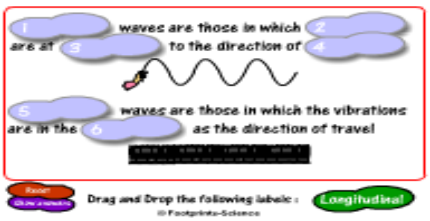
What are waves?

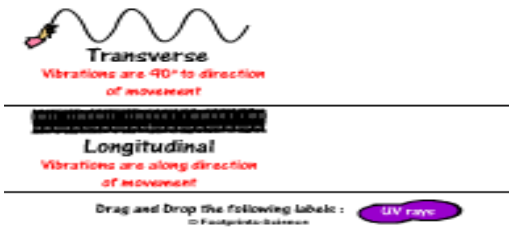


Watch the films on Brainpop to find the answers

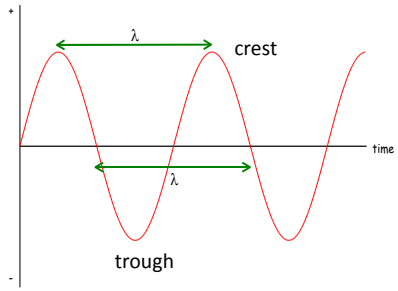
brainpop waves
Brainpop sound

Transverse and longitudinal





Describing waves

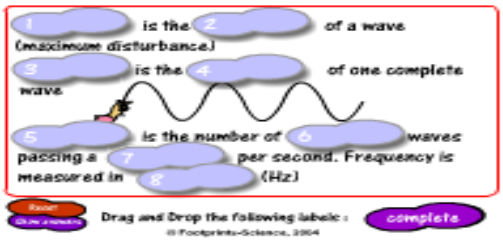


Wave definitions

- Crest: top point of a wave
- Trough: bottom point of a wave
- Wavelength (λ): crest to crest or trough to trough
- Amplitude: distance from zero position to crest

We know all waves…

- Carry energy
- Are transverse or longitudinal
- All have crests, troughs and an amplitude



Exit questions

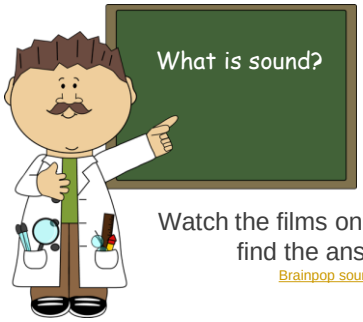
1. What are the two types of wave?
2. What kind of wave is a sound wave?
3. What kind of wave is a light wave?
4. What is wavelength?
5. What is amplitude?
6. What is a crest?
7. What is a trough (of a wave)?

LESSON 5

Sound waves

By the end of this lesson you should be able to…

- Explain what sound is
- Identify the type of wave sound is



Watch the films on Brainpop to find the answers

Brainpop sound

Speed, Distance and time

- Watch the youtube video to show how to set out questions in Physics
- https://www.youtube.com/watch?v=u7akhlAS5Ck

IESSUU

- Information
- Equation
- Substitution
- Solution
- Units
- Underline

- This is used from S1 to Advanced Higher

Example

- A sound wave travels 3400m in 10s. Calculate the speed of the sound wave.

Solution

v = ?
d = 3400m
t = 10s

$$v = \frac{d}{t}$$

$$v = \frac{3400}{10}$$

v = 340 m/s

Calculating the speed of sound

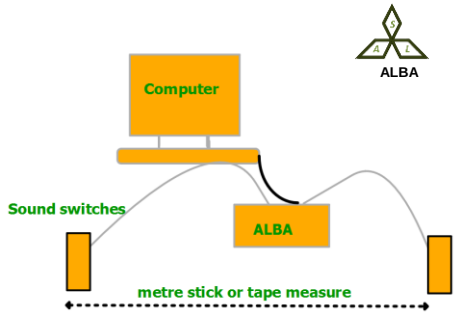
We use the formula:

$$v = \frac{d}{t}$$

Where:
v = speed (measured in m/s)
d = distance (measured in m)
t = time (measured in s)

The speed of sound in air is 340 m/s

Measuring the speed of sound



Practice questions

- There are practice questions on page 7 of the homework booklet

Exit questions

1. What are the units for speed?
2. What are the units for distance?
3. What are the units for time?
4. What equation do we use to calculate the speed of sound?
5. What is the speed of sound in air?

LESSON 6

Speed of Sound experiment outside

By the end of this lesson you should be able to …

- Complete an experiment measuring the speed of sound
- Discuss what measurements must be taken
- Plan a safe experiment
- Discuss why the result found may not match the accepted value for the speed of sound

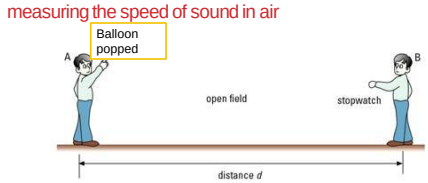
Measuring the speed of sound

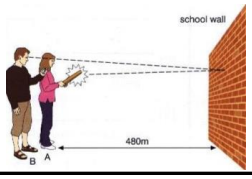
Planning

In your tables discuss an experiment to measure the speed of sound. Think about:

- What you need to measure
- How will you measure it?
- What equipment might you need?

Experiment-
measuring the speed of sound in air





Remember:

- Start the timer when you **see** the pupil make the sound
- Stop the timer when you **hear** the sound

Experimental write up

Write this experiment up as a scientific report. Remember to include:

- Aim: what were you trying to investigate?
- Hypothesis: what did you expect to happen? (remember the speed of sound is 340 m/s)
- Diagram: a labelled diagram of the experimental set up
- Method: what you did (include the variables kept constant)
- Results: what did you find? (this should have a v = d/t calculation)
- Conclusion: Did your results match 340m/s? if not, why not?

LESSON 7

How do we hear?

By the end of this lesson you should know…

- How humans can hear
- What range humans can hear
- The danger level for human hearing

Example

- Two school pupils stand 560 m apart. One pupil bashes a cymbal. The other student starts their clock when they see the cymbal move and stops the clock when they hear the cymbal move. The stopwatch reads 1.70s
- Calculate the speed of sound in air.
- d = 560m $v = \frac{d}{t}$
- t = 1.70s
- v = $v = \frac{560}{1.7}$
- $v = \frac{560}{1.7}$ = 329 m/s

What can sound travel through?

Sound can travel through:

- Solids
- Liquids
- Gases

But it CANNOT travel through a vacuum.

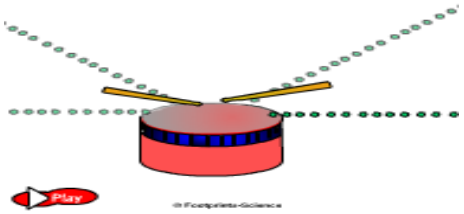
- What do you think sound travels best through?

Sound in a vacuum

- Sound cannot travel in a vacuum
- 'In space, no one can hear you scream…'

- Watch the video to see what happens when the air is removed in a bell jar
- Bell Jar Experiment

How we can hear..



Range of human hearing

- Humans can hear sounds between 20Hz and 20,000 Hz.
- Some animals can hear frequencies higher than these – can you think of an example?
- Range of human hearing test- put your hand up when you start to hear the signal and put it down when you cant.

https://www.youtube.com/watch?v=qNf9nzvnd1k

What did you notice..

- About how much you could hear compared to your teacher
- About the wavelength of the waves as the frequency (pitch) increased?

For next time…

- If you can, download an app on your phone that will measure decibel level
- DeciBel is a good one

Exit Questions…

1. Which state of matter does sound travel fastest through?
2. What can sound NOT travel through?
3. How can we hear?
4. What range of frequency can humans hear?

LESSON 9

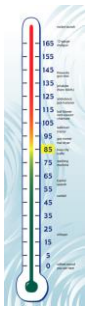
Volume

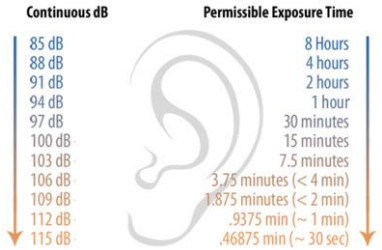
By the end of this lesson you should be able to..

- State the units of volume
- Know the volume at which loud sounds can damage our ears
- Explain how to protect our hearing

What is a decibel?

- A decibel (dB) is the unit used to describe the intensity of a sound
- What is a decibel?





How loud are these sounds?

- Decibel Comparison

- Use an app to measure the sound level of certain everyday tasks
- Make sure to record the distance from the source

Task	Distance (m)	Sound Level dB

Can loud noises be dangerous?

What's the danger level?

With extended exposure, **noises** that reach a decibel level of 85 can cause permanent damage to the hair cells in the inner ear, leading to hearing loss.

How can we protect our hearing?

For next lesson…

- Please take some headphones/earphones and your device that you listen to music on

Exit questions

1. What is the unit we use when describing volume?
2. What is the danger level that can damage our ears?
3. How can we protect our hearing?

LESSON 10

How to protect yourself from harm

By the end of this lesson you should be able to…

- Be aware of what volume you listen to your music at
- Explain why this could be dangerous (if it is over 85 dB)
- Communicate how the public can protect their hearing

Meet Rosie…

- Rosie can be used to measure the volume that you are listening to your music at
- Be careful, she's very expensive!

What happens if my music is too loud?

Listening to music at too high a volume can affect the hair cells in your ears.

"Repeated exposure damages your hair cells. It would be like walking on blades of grass and you step on the grass and the grass flattens, but it comes back up. And the more you do it, the more it stays down. And eventually it doesn't come back up, so it becomes permanent." - *Michele Abrams, clinical audiologist at Southern Connecticut State University*

Ear hair cell video

Task..

- Create a poster or leaflet that you might see in a Doctor's waiting room telling patients how to protect their hearing
- Your poster should include:
- How hearing works
- The danger level of dB
- How you can protect your hearing

Exit questions

1. What is the dangerous volume for our hearing?
2. How can listening to loud music damage our hearing?
3. How should we protect our ears/our hearing?

LESSON ELEVEN

Describing sound waves

By the end of this lesson you should be able to…

- Name the equipment used to measure sound traces
- State what happens to the amplitude of a wave as the volume increases
- State what happens to the frequency of a wave as the pitch increases
- Draw traces for different sounds

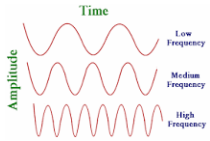
Recap

Label this wave with:

Crest, trough, amplitude, axis

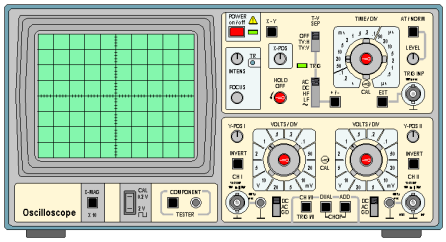
Frequency

Frequency is the number of waves per second. Frequency is measured in hertz (Hz)



The higher the *frequency* of the wave, the more *frequently* we see a wave

Oscilloscopes



We can use an oscilloscope to help get an image of sound waves.

We can also use a picoscope connected to a microphone to show the same thing as an oscilloscope

On your sound waves worksheet…

Draw the trace for…

- Higher volume, same pitch,
- Same volume, higher pitch
- Speech
- Waves an octave apart (What is an octave?)
- Lower volume, same pitch
- Same volume, lower pitch

In summary..

- As volume increases, the amplitude of the wave increases
- As pitch increases, the frequency increases
- The frequency doubles when a note is played an octave higher

Exit questions

1. What is frequency?
2. What are the units for frequency?
3. What can we use to show a sound trace?
4. As the volume of a sound increases, what happens to the sound trace?
5. As the pitch of a sound increases, what happens to the sound trace?

LESSON TWELVE

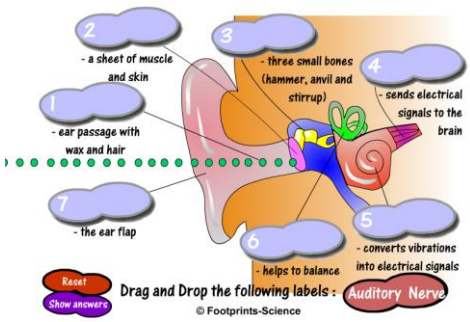
The ear

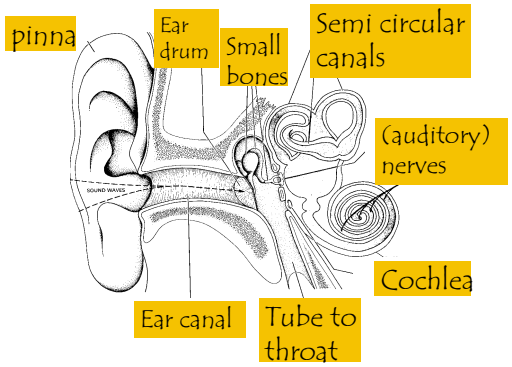
By the end of this lesson you should be able to…

- Name the parts of the ear
- Explain the function of each part

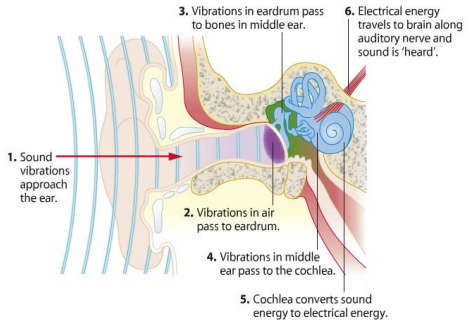
The ear

Brainpop - The Ear





Part of Human Ear	What It Does
Pinna	Collects as many sound waves as possible.
Ear Drum	Detects sound waves by vibrating.
Stirrup, Anvil and Hammer	Amplifies the vibrations.
Cochlea	Has a liquid that vibrates which makes cilia create an electrical signal.
Auditory Nerve	Passes electrical signals to the brain.



Exit questions

1. What is the pinna?
2. What is the name for the tube that the sound waves travel through before they reach the eardrum?
3. What is the name of the part that sends signals to the brain?
4. Name a bone in the ear

LESSON 13

Human Hearing vs Animal Hearing

By the end of this lesson you should know..

- How some animals ears are different
- Why this can help them hear better
- How this relates to physics (as adaptations are part of biology too!)

What is different about these animals?



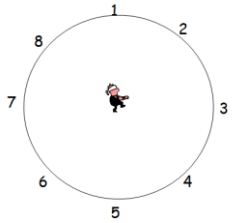

These animals all use their large ears to help them hear. Other animals have large ears for other purposes (e.g. elephants for cooling)

Animal hearing

- Animal Hearing video (20 mins)

Why do we need two ears?

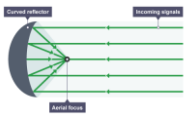
- We need two ears to hear. We need two ears to be able to detect the direction the sound is coming from. When one ear is covered it is much harder to tell where the sound is coming from although you can still detect the sound.
- Some people are better at detecting direction than others. With two ears it is still hard to detect some directions especially around the sides.



Think about what hand gesture someone would use to make you speak up…

Curved reflectors

- A curved reflector reflects the signal to a focus – in this case sound
- This is why out ears have a vaguely curved shape, and we 'cup' our ears to hear better
- Animals with large ears are often prey – they can use this advanced hearing to detect predators



Tin can phones

How do you think tin can phones work?

Use your knowledge of everything so far, including longitudinal waves and curved reflectors

Tin can phones

- Artsy video of longest can phone

- Talking causes little vibrations in the air in front of your mouth, as you can tell by speaking into your hand. When you send those vibrations into the can, they cause the back end to vibrate.
- This vibration is passed along the string and into the other can. When that can vibrates, it creates vibrations in the air once again — and you can hear the other person's voice!

Think of other things that might use a curved reflector

- Hint: there could be one on the side of your house!

Exit questions

1. How do humans ears compare to some animals?
2. Which is better for hearing?
3. Why do we 'cup' our ears to hear better?
4. How does a tin can phone work?