Bees buzz, bumblebees hum, and butterflies …?

Acoustics for primary schools

Perceiving sound

Generating sound

Exploring sound

Sound and health

Section 2: Generating sound

For a sound to occur something has to vibrate.

Students are shown a small plastic bucket covered with a silicone cover. On the other side is a hole in the bottom of the bucket. The students touch the bucket and the cover is plucked.

Discovery 2:

I can feel vibrations.

Generating sound

The story of the butterfly
Card 1

Story (Getting started for everyone)

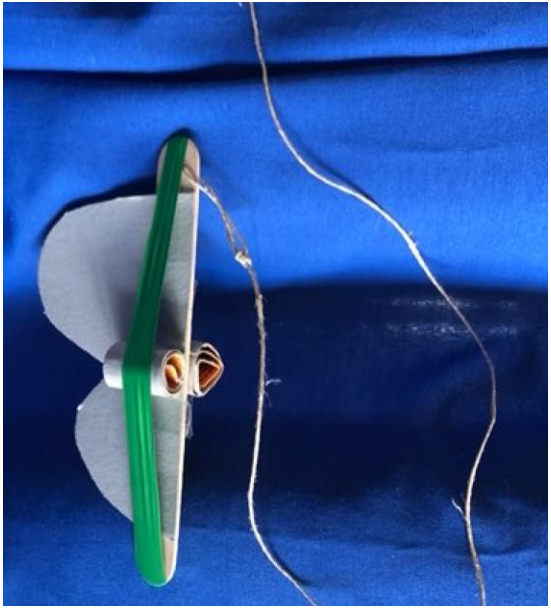
It's spring and the apple trees are in full bloom. Lisa, Tom and Bastian are standing together in the shade of the tree. A beekeeper has his beehives at the edge of the meadow. The children want to watch the bees gather pollen. There's a steady buzzing coming from the tree. Suddenly the children notice a deep humming. Bastian discovers a big, fat bumblebee. The friends ask themselves why the big bumblebee sounds so different from the bees.

The children stay by the tree and listen to the different sounds made by the bees and bumblebees for a while. Suddenly Lisa exclaims, "Oh look, there goes a pretty butterfly!" Tom and Bastian look for the butterfly but can't see it. Only when Lisa points into the right direction can they see it, too. But now they wonder why they were able to hear the bees and bumblebee but not the butterfly?

Idea: Show the the buzzing bee or all the children construct one.

Generating sound

Butterfly story
Card 1



Solution / Discovery

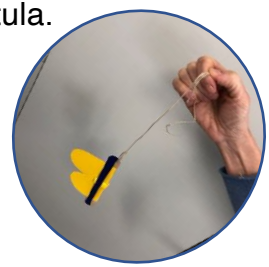
The pupils express their assumptions.
A solution is not offered yet.

At the end of the the series of experiments the pupils should be able to solve the riddle themselves.

Generating sound

Craft Instruction buzzing bee

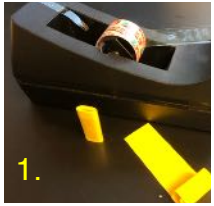
1. Roll up the cardboard strips, then glue them.
2. Carefully make a hole in the wooden spatula.
3. Glue the wings and cardboard strips onto the spatula.
4. Draw the string through the hole in the spatula.
5. Place the balloon ring around the body of the bee.

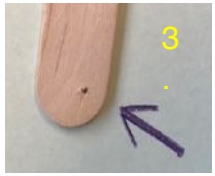


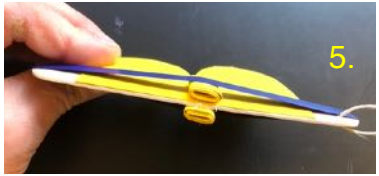
Finished! Now you can spin your bee around in a circle.

Materials

- cardboard wings, 12 cm long
- 2 cardboard strips, 2 cm x 10 cm each
- wooden spatula, 15 cm
- thin string, approx. 50 cm long
- balloon
- scotch tape and/or glue



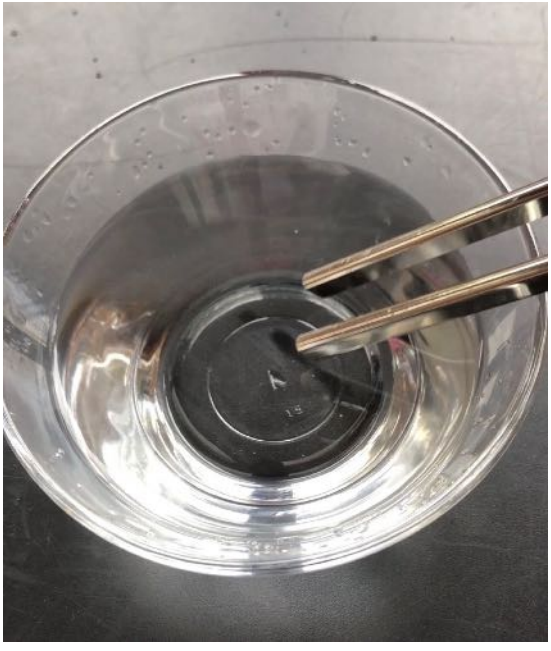




Generating sound

Tuning fork in a water bowl

Card 2a



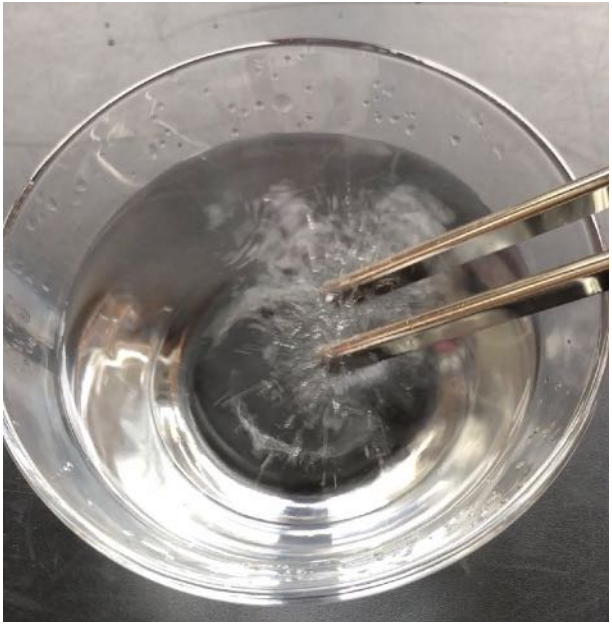
Student experiment

- Place a bowl of water on the table.
- Take a tuning fork.
- Tap the tuning fork against your knee and dip it into the water immediately (not too deeply).
- What can you observe?

Generating sound

Tuning fork in a water bowl

Card 2a



Solution / Discovery

- The vibrations of the tuning fork produce a sound.
- You can see the vibrations well in the water.
- The vibrations create small waves.

Generating sound

Tuning fork with a ping pong ball on a string
Card 2b

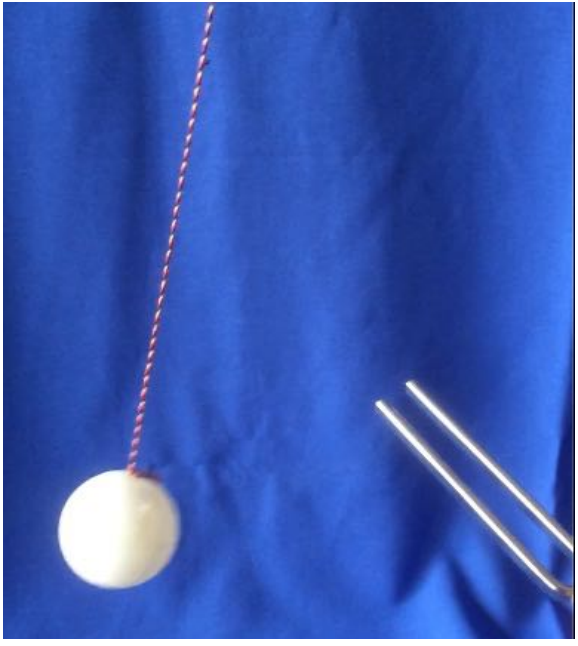
Student experiment

- Take a tuning fork and a ping pong ball that has a thin string fastened to it.
- Hold the string with the ping pong ball with one hand.
- With the other hand tap the tuning fork on your knee and immediately hold it close to the ping pong ball.
- What do you observe?

Generating sound

Tuning fork with a ping pong ball on a string

Card 2b



Solution / Discovery

- The vibrations of the tuning fork produce a sound.
- The vibrations of the tuning fork cause the ping pong ball to move.
- You can **see** the vibrations in the movement of the ping pong ball.

Generating sound

Cymbal over the palm of your hand
Card 3

Student experiment (partner work)

- Take a cymbal (instrument) and a drumstick.
- Stand opposite each other.
- One child holds the cymbal and the drumstick.
- You hold the palm of your hand under the cymbal (see photo).
- The first child hits the cymbal with the drumstick.
- What does your hand feel?
- Go very close to the cymbal with your hand and then touch it gently.

Generating sound

Cymbal over the palm of your hand
Card 3

Solution / Discovery

- The vibrations cause a sound.
- The vibrations can barely be seen with the eye.
- But you can **feel** the vibrations well with your hands.

Generating sound

Metal sticks

Card 4a

Student experiment

- You see two metal sticks of different lengths that are fixed to the table by a book and two clamps.
- Press the longer stick down firmly with your thumb and then let go.
- Press the shorter stick down firmly with your thumb and then let go.
- What do you observe?

Generating sound

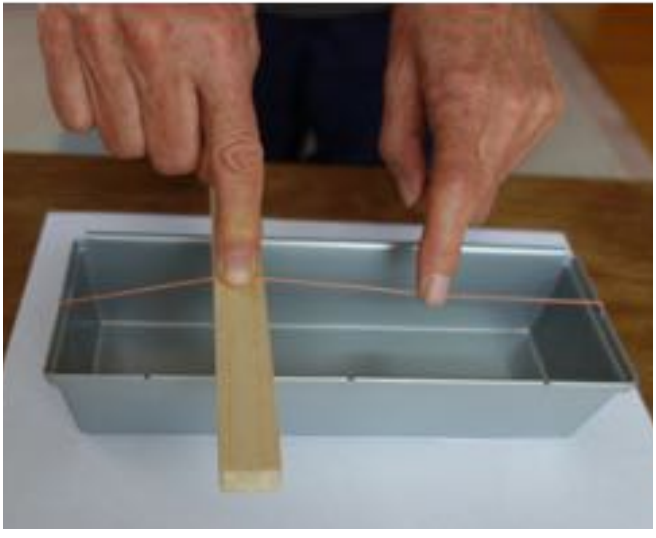
Metal sticks
Card 4a

Solution / Discovery

- A sound is produced by the vibrations.
- The **short** stick vibrates **faster.** I hear a **higher** tone.
- The long stick vibrates more **slowly.** I hear a **deeper** tone.

Generating sound

Rubber band guitar
Card 4b



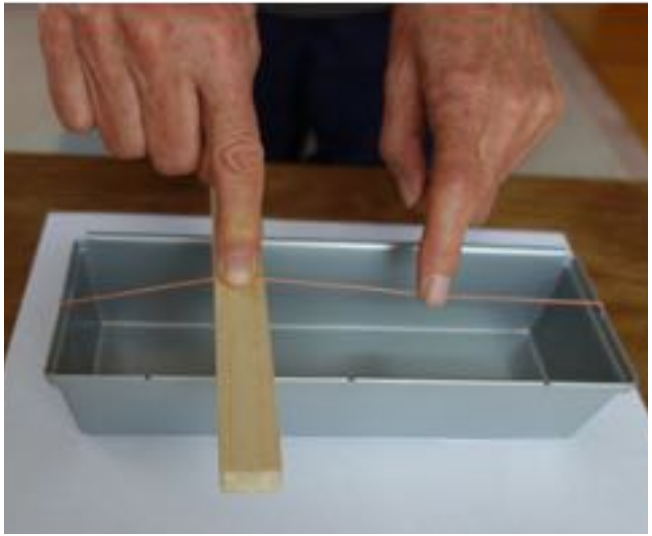
Student experiment

- Here is a plastic box with a rubber band around it. A wooden stick is placed across the box between the box and the rubber band. With your finger press firmly on the rubber band directly on the wooden stick.
- The stick divides the rubber band into a short and a long part.
- What happens when you pluck the short part of the rubber band?
- What happens when you pluck the long part of the rubber band?

Generating sound

Rubber band guitar

Card 4b



Solution / Discovery

- The rubber band vibrates when you pluck it.
- You can hear a sound because of the vibrations.
- The **short** part of the rubber band vibrates **faster**, so I hear a **higher** tone.
- The **long** part of the rubber band vibrates more **slowly**, so I hear a **deeper** tone.

Generating sound

Boomwhackers
Card 4c

Student experiment

- Try the various boomwhackers out. If you don't have any boomwhackers take long plastic or cardboard pipes.
- Tap them with your hand or blow over them.
- What do you think happens?
- What can you hear? Formulate a rule.

Generate sound

Boomwhackers
Card 4c

Solution / Discovery

- By tapping or blowing over the boomwhackers the air in the pipes vibrates.
- The vibrations create a sound.
- The air in the **shorter** pipes vibrate **faster**, so I hear a **higher** tone.
- The air in the **longer** pipes vibrates more **slowly**, so I hear a **deeper** tone.

Generating sound

Sound hose (whirly tube)
Card 5

Student experiment

- You will need a sound hose (Whirly Tube) or a rippled plastic hose.
- Hold the hose on one end.
- Swing it around over your head. Then change the speed.
- What can you find out?

Generating sound

Sound hose (Whirly Tube)

Card 5

Solution / Discovery

- Vibrations occur through spinning.
- Vibrations create a tone.
- The **faster** the vibrations are, the **higher** the tone is.
- The **slower** the vibrations are, the **deeper** the tone is.

Generating sound

A coin in a balloon

Card 6

Student experiment

- Take a balloon and put a 10 cent coin into it and blow it up. Tie a knot into the balloon opening.
- Hold the balloon in your hand and make a turning motion with your wrist (see photo). Turn the balloon quickly.
- What happens when the coin turns?
- Change the turning speed.

Generating sound

A coin in a balloon
Karte 6

Solution / Discovery

- The sound is created by the rippled edge of the coin.
- When the coin rolls the ripples hit against the balloon, as on a drum.
- The balloon vibrates, thereby creating a sound.
- The **faster** the turning motion is, the **higher** the tone is.
- The **slower** the turning motion is, the **deeper** the tone is.

Generating sound

Constructing pan pipes
Slide 7 (supplement)

Constructing pan pipes

Material per pupil:

Cardboard 8cm x5cm; double-sided adhesive tape 8cm x 5cm; scissors; jumbo-sized straws 1cm diameter; modeling clay.

- Cut 5 pieces of straw in lengths of 11cm, 10cm, 9cm, 8cm, 7cm.
- Glue the pieces of cardboard and the double-sided adhesive tape together.
- Fasten the pieces of jumbo straw to the adhesive tape.
- Close the ends of the straws with the modeling clay.
- Blow over the pipes with pursed lips.

Generating sound

Constructing pan pipes

Slide 7 (supplement)

Solution / Discovery

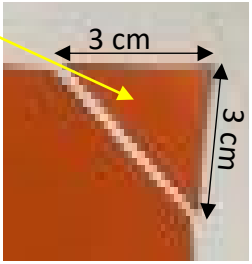
- The air vibrates when you blow into the pipes.
- The vibration causes a sound.
- The air vibrates **faster** in a **short** pipe, therefore, I hear a **higher** tone.
- The air vibrates more **slowly** in a **longer** pipe, therefore, I hear a **deeper** tone.

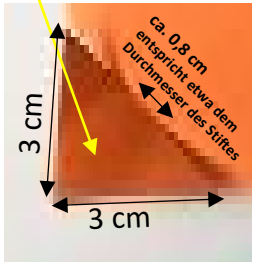
Therefore:

- The **longer** the pipe (= air column) is, the **deeper** the tone is.
- The **shorter** the pipe (= air column) is, the **higher** the tone is.

Generating sound

Constructing a buzzing pipe
Slide 8 (supplement)





Material per pupil

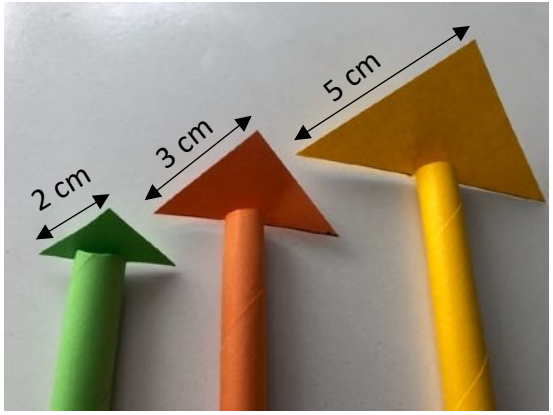
Paper square 21cm x 21cm; pencil; scotch tape.

See last slide for instructions on how to print out.

- Draw a diagonal line on the front and back of the square.
- Cut one corner off and cut into the other.
- Using a pencil, roll the paper so that it forms a pipe (the diagonal lines fit perfectly on each other).
- Fasten the end with scotch tape.
- Press the corner (triangle) that you cut into lightly towards the pipe.
- **Suck air in through** the pipe

Generating sound

Constructing a buzzing pipe
Slide 8 (supplement)



Solution / Discovery

The triangle vibrates when you suck air in.

The vibrations cause a sound.

Supplement: Construct another buzzing pipe and cut a somewhat smaller triangle. When rolling the pipe use the same pencil so that the pipes are the same size.

Now compare the tones of the buzzing pipes.

The **bigger** the triangle is, the more **slowly** it vibrates and the **deeper** the tone is.

The **smaller** the triangle is, the **faster** it vibrates and the **higher** the tone is.

Generating sound

Flatulating buckets

Slide 9 (supplement)

... From flea to elephant flatulence

(Idee: Science on Stage Festival 2019, Cascais/Portugal)

Material

- empty containers of different diameters
- parcel string
- one bead per container
- damp cloth

- Hold the container firmly.
- Take hold of the string with the damp cloth.
- Keeping the pressure on the string rub the string with the damp cloth using a downward motion.

Tip: You can place the container on your shoulder or have someone hold it.

Generating sound

Flatulating buckets

Side 9 (supplent)

Solution / Discovery

Rubbing the string causes the bottom of the container to vibrate.

The vibrations cause a sound.

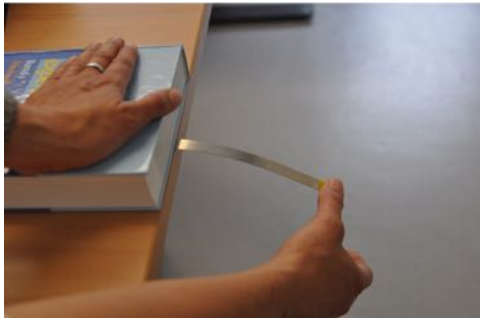
Compare the tones:

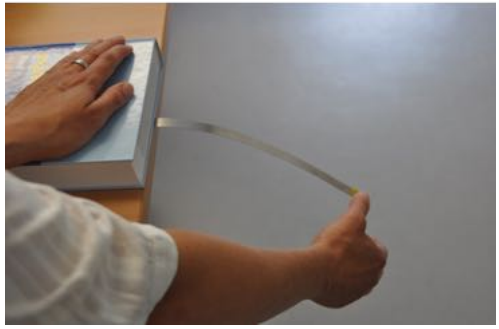
The **bigger the diameter** of the bottom of the bucket is, the **more slowly it vibrates** and the **deeper** the tone is.

The **smaller the diameter** of the bottom of the bucket is, the **faster it vibrates** and the **higher** the tone is.

Research question about the story:

Why can I hear a bee and a bumblebee but not a butterfly?





Experiment:

Metal sticks under the book – repeat the experiment and let the students reflect on what it has to do with the bee, the bumblebee and the butterfly.

(If necessary, read the story to the pupils again)

Research question about the story:

Why can I hear a bee and a bumblebee but not a butterfly?

Solution / Discovery

A bee has small wings that vibrate very fast, thereby creating a high tone. We can hear the tone.
The wing beat of a bee: 200-250 times per second (200-250 Hz).

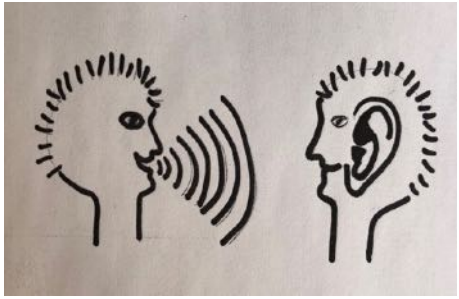
A bumblebee has bigger wings that vibrate somewhat more slowly, thereby creating a deeper tone. We can hear the tone.
The wing beat of a bumblebee: 150 times per second (150 Hz).

A butterfly has bigger wings that vibrate much more slowly and create an even deeper tone. This tone is not within our hearing range.
The wing beat of a butterfly: 10 times per second (10 Hz).

➔ **Human beings cannot hear vibrations under 20 Hz and over 20,000 Hz.**

Generating sound

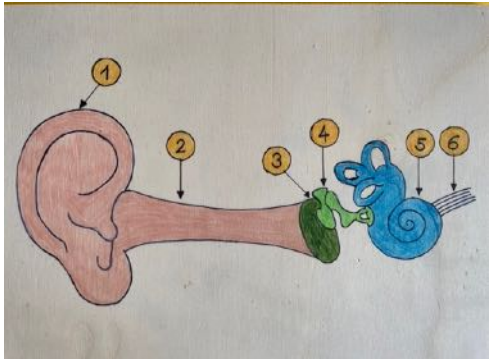
summary



This is what I know now!

For a sound to occure something has to vibrate.
I can see or feel many vibrations.

What vibrates in my ear?



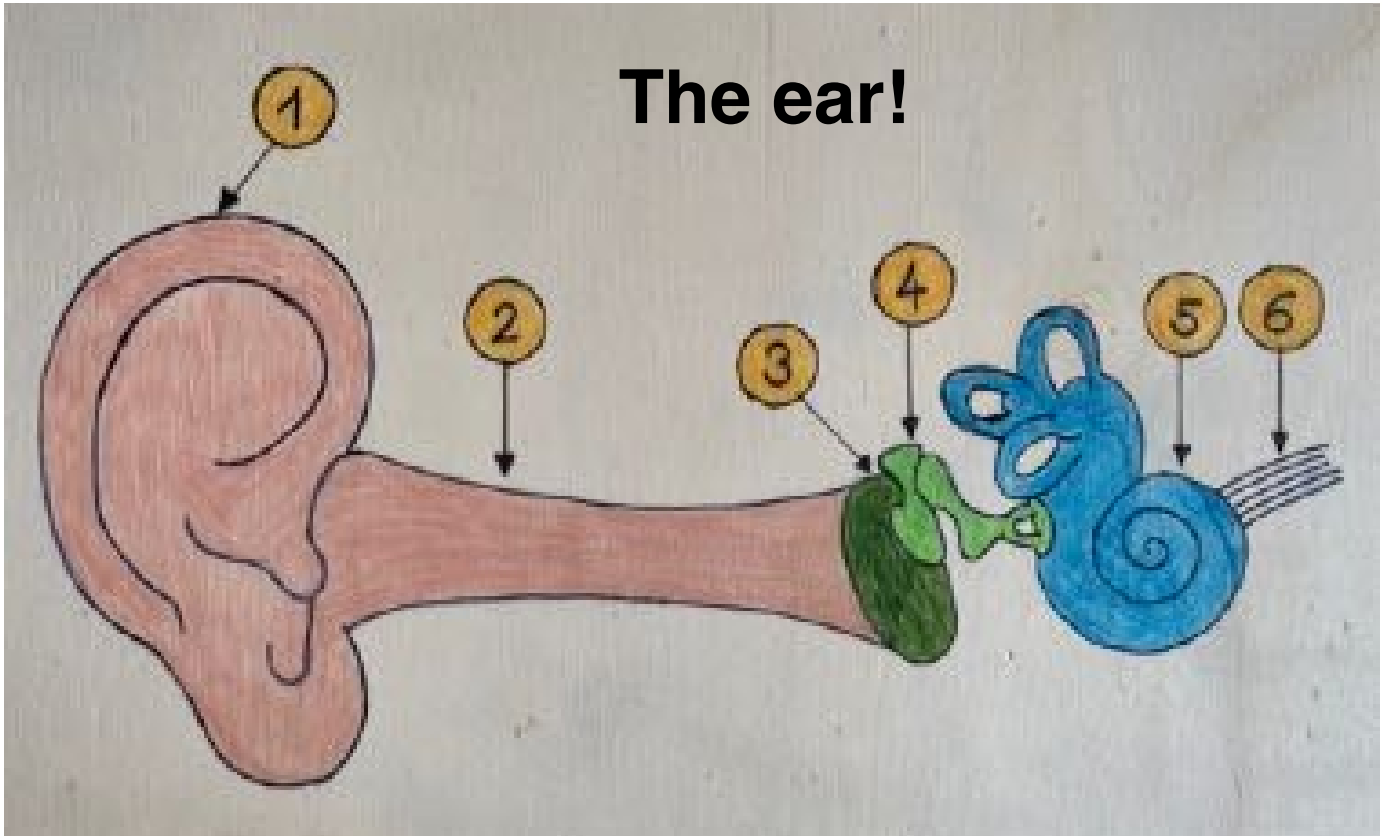
The sound waves cause the _____

to vibrate. The eardrum directs the vibrations to the

_____

and than to the _____ .

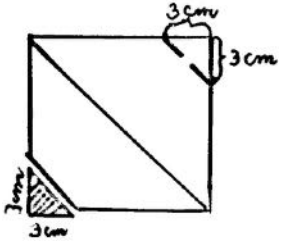
1) pinna 2) ear canal 3) eardrum 4) auditory ossicle 5) cochlea 6) auditory nerve



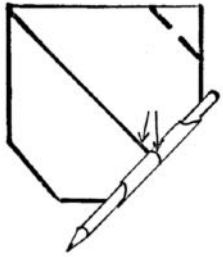
1) pinna
2) ear canal
3) eardrum
4) auditory ossicle
5) cochlea
6) auditory nerve

Handicraft instructions: buzzing pipe

1. Cut a square out of an A4 sheet (21 cm x 21 cm)



2. Draw the diagonal and the two corners as shown in the picture. One corner is cut off, the other incised.



3. Now turn your piece of paper over and draw the diagonal on the back as well. Now roll the paper into a tube with the help of a pencil. Make sure that the two drawn diagonals run in one line. (look at the arrows in the figure)

4. Tape the end of the paper to the pipe with tape.

5. Press the cut corner (triangle) slightly towards the tube.

Task: **Suck air in through** the pipe.

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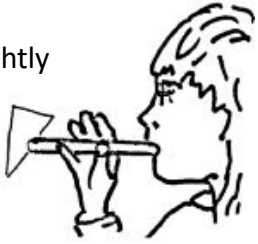


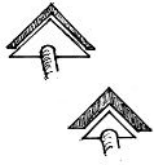
That I have learned:

Depending _____ the triangle is,

the _____ the tone sounds.

Additional task:

Make a second (and third) growler. In order for the pipes to be the same thickness, you have to use the same pen! Cut the triangle a little smaller on the second growler (and even smaller on the third).



Compare the tones on the growlers with the different sized triangles.