EDUCATIONAL MODULE

Food and Vacuum

In a nutshell

Participants will explore phenomena of vacuum first hand, getting to make their own vacuum chamber to exemplify two methods of food preservation - vacuum packaging and freeze drying. This shows how science and research are an integral part of our food system, and introduces a method of food preservation that will be used more and more in the future – freeze drying.

Food 2030 focus

What for?

To explore and understand the food system

For whom?

Educators

How long?

45-60 minutes

Created by

Science Centre AHHAA Foundation (Tartu, Estonia)

Something to share?

Leave us a comment about this tool on the FIT4FOOD2030 Knowledge Hub.
You can also contact Helin Haga, helin (.)haga(at) ahhaa (.) ee

This tool was developed as part of the FIT4FOOD2030 project; find this tool and many more on the FIT4FOOD2030 Knowledge Hub.

Date of creation: March 2019
How to cite?

Science Centre AHHAA Foundation (2019). Food and Vacuum. FIT4FOOD2030 project tool.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 774088

What will you gain from this?

After successfully completing this module participants will:

- Understand better different methods of preserving food.
- Understand the principles at play in the chemistry and physics behind these methods.
- Understand the schematic instructions and find solutions accordingly in order to make a vacuum chamber.
- Understand better the interlinkages between food preservation and other aspects of the food system: production, packaging, transport, waste management, retail and consumer habits.

FOOD AND VACUUM

Food and Vacuum invites participants to make their own vacuum chamber and explore the principles behind two methods of food preservation: vacuum packaging and freeze drying. An extra challenge is provided by the fact that the scheme provided doesn't list all of the steps required for the final outcome – they'll have to find solutions on their own or as a group.

The workshop is created as a science centre / science museum one-hour workshop that requires participants to be present for the whole duration, from start to finish. Trained facilitators can carry out the workshop multiple times in one day, with different participants.

The Food and Vacuum workshop could also easily be facilitated, for example, in a classroom, as part of a science festival or some other science seminar, as a fun hands-on workshop to further engage and energise the participants.

The workshop is considered non-formal education. Connections with the school curriculum can be found and the workshop could be used to tie together food and physics topics. A vacuum chamber can be useful to explore space-vacuum-related phenomena as well.

Participants of the workshop building their vacuum chamber

Thematic area

Food packaging, food preservation

Target audience

From primary school to high school

Age of participants

10-18 years old

Number of participants

10-20

Number of facilitators

1

Prior knowledge required for participation

No prerequisites.

GETTING PREPARED

Set the scene

Set the room so that all participants can be divided into groups of 4. Each group has their own table and chairs.

It is best to keep the materials participants need during the workshop at a large table at the front of the room.

Place materials on a separate table at the front of the room

Materials

- 20 glass jars
- 20 metal lids with 5 mm holes drilled into them
- 20 pieces of transparent hose (40 cm each, 5 mm in diameter)
- 20 plastic syringes (5 mm in diameter for the opening)
- 40 small aquarium one-way valves (connection with 5mm in diameter)
- 20 T-connectors for hoses (connection with 5 mm in diameter)
- 5 rulers
- 5 pairs of scissors
- 5 rolls of tape
- 3 packs of adhesive putty
- 10 small balloons (water balloons work well)
- 1 pack of freeze-dried products (such as strawberries)
- 1 pack of marshmallows
- 5 schematic instruction sheets for making a vacuum jar (see Appendix A)
- 10 mini grip bags

FLOW

STEP 1: Introduction (*1 minute*).

STEP 2: Discussion on how food is preserved – introducing vacuum packaging (*10 minutes*).

STEP 3: Distributing vacuum chamber materials(*2 minutes*).

STEP 4: Making the vacuum chamber (*15 minutes*).

STEP 5: Experimenting with a balloon in vacuum (*10 minutes*).

STEP 6: Experimenting with marshmallows (*5 minutes*).

STEP 7: Tasting freeze-dried products (*10 minutes*).

STEP 8: Conclusion and goodbyes (*2 minutes*).

FACILITATOR TIPS

For this activity, one facilitator is enough. Having basic general background knowledge about physics and chemistry is helpful.

This tool needs to be carried out together with the participants. During multi-stakeholder dialogues you as a facilitator (or moderator) have an important role to play to ensure the active participation of all the participants in the given time frame while also reaching the session goals.

As a facilitator you need several skills and competences, such as verbal and non-verbal skills, negotiating skills, flexibility, and leadership. You will need to create an environment in which all participants feel secure, are able to speak up and give their perspective on issues being discussed. This means that you may have to stimulate some participants to speak more often, while you may have to prevent other participants to speak too often or too long. It also means that you will need to avoid discussions on issues that are not directly relevant.

A brief guide with facilitation tips are provided in this address:
https://knowledgehub.fit4food2030.eu/facilitatorstips

STEP 1: INTRODUCTION

1 MINUTE

Introduce the workshop and set the agenda. Tell participants that in this workshop they will make their own vacuum pump, test it out and learn how it connects with food preservation.

> TIPS & TRICKS
> For smooth implementation, use this module with groups of students of the same age, so as to allow a speed of work that suits everybody and leaves nobody behind.

STEP 2: DISCUSSION ON HOW FOOD IS PRESERVED – INTRODUCING VACUUM PACKAGING

10 MINUTES

Start by asking participants questions and let them express different opinions about:

How is food preserved?
How long can different food be preserved?
Why do we need to preserve food?
How would it be possible to store and preserve food for as short time as possible? What would be the benefits? What would be negative about it?
What are the causes of food deterioration? (i.e. the things you need to protect food from when preserving it.)

If possible, write down on a whiteboard (as participants answer), the causes of food deterioration and add any missing ones:

- Growth and activities of **microorganisms**, mainly bacteria, yeasts and moulds
  (this can lead to contamination or production of toxic compounds in food, which is dangerous for humans);
- **Temperature**, both heat and cold
  (low temperatures are used to slow down biological and chemical deterioration of food);
- **Moisture** and dryness
  (water is a good breeding ground for microbes);
- **Air** and in particular **oxygen**
  (oxygen helps microorganisms grow and facilitates chemical breakdown of nutrients, such as lipids);
- **Light**
  (photodeterioration, which causes chemical reactions in vitamins, pigments, amino acids and fats);
- **Time**
  (deterioration can generally be slowed down, but not stopped);
- Activities of **natural food enzymes**
  (for example peeled apples becoming brown quickly);
- Insects, **parasites** and rodents;

Use this extra information to add key facts to the answers that participants give:

*United Nations estimates that **one third of the food produced globally is lost** or wasted, either thrown away after a meal or the food gets bad and inedible during transport or preservation. Also, 23 million people in Europe annually fall ill from eating **contaminated food**. In United States that number is 48 million, one in six people, every year. World Health Organization notes that malnourished people are more vulnerable to foodborne diseases and households suffering from famine rarely discard contaminated food.*

*It is evident that although **sourcing our fresh food locally** is the best way to minimize our ecological footprint (less packaging, transport, cooling etc.), preserving food correctly while it reaches the hungry millions is very important. Packaging and different food preservation methods help here.*

*Use of **preservative ingredients** helps fight off microbes, but preservatives have their own effects on health, taste and other properties of food. For example sugar and salt are known natural preservatives often added to food as well (jams and beef jerky), but they are not healthy in their own right. However, modern packaging and other methods can alleviate the need of using any preservatives and food processing.*

*Intelligent packaging (IP) helps to monitor the safety of food. A simple widespread example of IP is the use of barcodes to identify food and its properties. A more futuristic example is the use of **time-temperature indicators** or oxygen indicators in packaging. Time-temperature indicators show how long food has been stored and how long it has been in favorable or unfavorable conditions. The active ingredients in the indicators change color slowly in cold or frozen conditions, and more rapidly in warmer conditions, indicating (more precisely than best-before dates) if the food is safe to eat or not. These solutions have found commercial use in USA, Japan and Australia, but Europe is lagging behind because of strict regulations of food-contact materials that can't keep up with technological innovations.*

***Vacuum packaging** – pumping out the air prior to sealing the food in plastic – helps to preserve food 3-5 times longer, because air and oxygen is removed from the product, which inhibits the growth of microorganisms and inhibits oxidation processes. It also locks components of food (aroma components, nutrients) in one place, prevents contamination, preserves the level of moisture, reduces packaging volume and fixes food in a certain position (good for displaying food in a retail store).*

Examples of how long food can be preserved without and with vacuum packaging:

- *Bread – 2 days in room temperature, 8 days vacuum packaged in room temperature;*
- *Coffee, nuts, pasta – 120 days in dry conditions in room temperature, 360 days vacuum packaged in room temperature;*
- *Raw meat – 2-3 days in a refrigerator, 6-9 days vacuum packaged in a refrigerator.*

***Modified Atmosphere Packaging** (MAP) is a similar popular technique, where air is also evacuated from the package, but is then replaced with another air mixture, usually lacking in oxygen and containing high levels of CO_2 or inert nitrogen. The effects are basically the same as vacuum packaging, but the resulting package is larger.*

The history of vacuum packaging goes back to World War II, when allied soldiers used evacuated latex bags were used to help preserve frozen food. Commercial use started in 1940s and plastic packaging became preferred.

*The plastic used in vacuum packaging can be used only once. This is the controversial and **wasteful** aspect of this method, but it does prevent food loss. Developing world experiences food loss because of inadequate preservation and packaging techniques (before the food arrives at the market), while developed world does not have this problem, instead uneaten food is thrown away at supermarkets and at homes. **It is debatable, which is more harmful for the environment**: the production and waste management of single use plastics used in vacuum packaging or the production and waste management of un-vacuum-packaged food that is lost.*

***Greenhouse gas (GHG) footprint produced by food waste** is calculated by adding up the footprints of all the steps in the production process of wasted food – growing, producing fertilizers, transport, refrigeration etc.*

Wasted food also usually ends up in landfills, where it produces a potent GHG methane. This adds up to ***4.4 billion tons*** *of CO_2 equivalent GHG emissions annually in the world, caused by food waste. If food waste were a country, it would rank third in GHG emissions, behind China and USA. Food waste has almost the same GHG footprint as global road transportation.*

As food is wasted in the final stages of the food cycle in the developed world (as opposed to production, storage and transportation in the developing world), ***developed world is accountable*** *for a larger part of the GHG emissions of food waste, because more energy and resources are used up by the time our food is wasted.*

TIPS & TRICKS

"It was a fantastic activity and the children loved it but they were more focussed on the practical side than thinking about how useful the vacuums could be." A comparison between previous and futuristic methods used for food packaging could be even more effective for promoting innovative ways of packaging. Another idea could be to give children a brief and some materials and asking how these could be used to preserve food.

- Teacher who implemented the module in the classroom

STEP 3: DISTRIBUTING VACUUM CHAMBER MATERIALS

2 MINUTES

Give each table (or have them come over to the front of the room and pick up) a schematic instructions sheet for building a vacuum pump, tape, half a pack of adhesive putty, scissors, a ruler, and for each person:

- a jar
- a lid
- a syringe
- 40 cm hose
- a T-connector
- 2 one-way valves

STEP 4: MAKING THE VACUUM CHAMBER

15 MINUTES

Instruct everybody to make their own vacuum chamber by reading the schematic and using their available tools. Have group members help each other and walk around and help them, as necessary. You'll find one possible way of assembling the chamber on the last page of the Teachers' Guide featured in Appendix B.

A common mistake that people might make is putting the valves on in the wrong way. Adhesive putty and tape are necessary to seal the hole in the jar lid.

TIPS & TRICKS

Mix things up. You could take this workshop a step further by adding optional pieces or wrong pieces in the making of the vacuum machine to build further the experimenting aspect and competences for collaborative work.

STEP 5: EXPERIMENTING WITH A BALLOON IN VACUUM

10 MINUTES

When participants are nearing completion, hand out two balloons per group. Instruct them to blow into the balloons a little and close them (water balloons have a suitably limited size). Ask them to place the balloons inside the vacuum chamber and see what happens when they start pumping out the air from the chamber.

Let them try to explain (and fill in the blanks with prompting questions, if necessary) the following question: **Why does the balloon increase in size when air is pumped out of the vacuum chamber?**

> ***Vacuum*** *is the absence of air and other materials inside a space. Air pressure is absent inside a perfect vacuum, however the vacuum in our chamber is not perfect, thus some air molecules and low air pressure remains.*
>
> *Air balloon (and also marshmallows and for example shaving foam) has air trapped inside an elastic container. The large pressure inside the balloon gives a filled balloon its shape and size (by inducing more force upon the elastic material), but* ***atmospheric pressure still acts upon the balloon, limiting its size****. If we lower the pressure (inside our vacuum chamber) our balloon can take a larger form, because the pressure inside the balloon is not counteracted by the atmospheric pressure.*

STEP 6: EXPERIMENTING WITH MARSHMALLOWS

5 MINUTES

Hand participants marshmallows to try out in their vacuum pumps as well.

Hand each table a couple of mini grip bags and have them try to seal something of their own choice inside the bag, using the vacuum pump. It is a two-person job. They will have to remove the hose from the jar lid, but they will have to remove it in a next step anyway.

"Observing the effects of the vacuum chamber on marshmallows and other products that can change shape is particularly exciting; participants, at their own initiative, often place their phones in the chamber to test the effect of vacuum on sound travelling."

AHHAA's facilitator, commenting the testing of the module

STEP 7: TASTING FREEZE-DRIED PRODUCTS

10 MINUTES

Coming back to freeze drying, explain how vacuum pumps are used for freeze drying. It is time to bring out the freeze-dried products and have participants taste them.

Ask participants: **how this freeze-dried fruit tastes like and how it differs from fresh fruit.**

Freeze drying *is a food preservation method that consists of the following steps:*

1) *Freeze all the water content inside the food;*
2) *Place the food in (near-)vacuum;*
3) *Heat the food (can be up to 38 °C);*
4) *Ice sublimates directly into water vapor, collect the vapor by letting it condense on a cold surface;*
5) *(For best possible storing conditions, break the vacuum with an inert gas and package your product.)*

This method results in food that will have ***empty space where ice crystals used to be****, thus it maintains its form and can be easily rehydrated. The nutritional content, flavours and smells generally* ***remain unchanged****, unlike canning or regular dehydration. Freeze dried products can be stored in* ***room temperature*** *and they are* ***very light****, as they are missing all of their original water content (for example, 90% of the mass of fruits can be water). The dehydration also prevents the growth of* ***microbes****.*

Hermetically sealed freeze dried products can be stored ***up to 25 years****. A simple container in room temperature, like a cookie jar, can safely store such products for a couple of months. Contact with air (and more precisely water vapor inside the air) will gradually rehydrate freeze dried food.*

Because of its light weight and ease of storage, freeze dried food is ***great for astronauts, military combatants, campers*** *and to stock* ***bomb shelters****. But all of freeze drying benefits are useful for regular food preservation as well and could see use in a wider extent in the future.*

The main drawback is currently the ***cost of freeze drying****, as it is a technologically difficult process. Home freeze dryers are available for 2000-3000 euros, but commercial freeze drying is done in special rooms and complexes. Nevertheless, proponents of freeze drying imagine that large supermarkets could all use freeze drying rooms, to prevent food loss by applying it on products nearing the end of their shelf life, effectively stopping the spoiling process.*

STEP 8: CONCLUSION AND GOODBYES

2 MINUTES

Thank the participants for attending! Let them keep their vacuum pump systems, if they desire, but the jars with lids will stay in the facilitator's possession, for future workshops.

Encourage participants to continue experimenting with their vacuum pump at home, by repurposing an old jar and making a hole in the lid (possibly with parents' help). Shaving cream gives out excellent results in a vacuum chamber as well.

Remove the adhesive materials from the vacuum pumps and take them apart to reuse in future workshops.

TIPS & TRICKS

Try the vacuum jar over a longer period. When implementing this activity with a classroom or in a location that participants will revisit regularly, you could extend the activity by testing the efficacy of the vacuum chambers produced over a two-week observation period. Leave a food product in each jar and arrange for regular observations. Appendix B provides further details while Appendix C contains a student Activity Card.

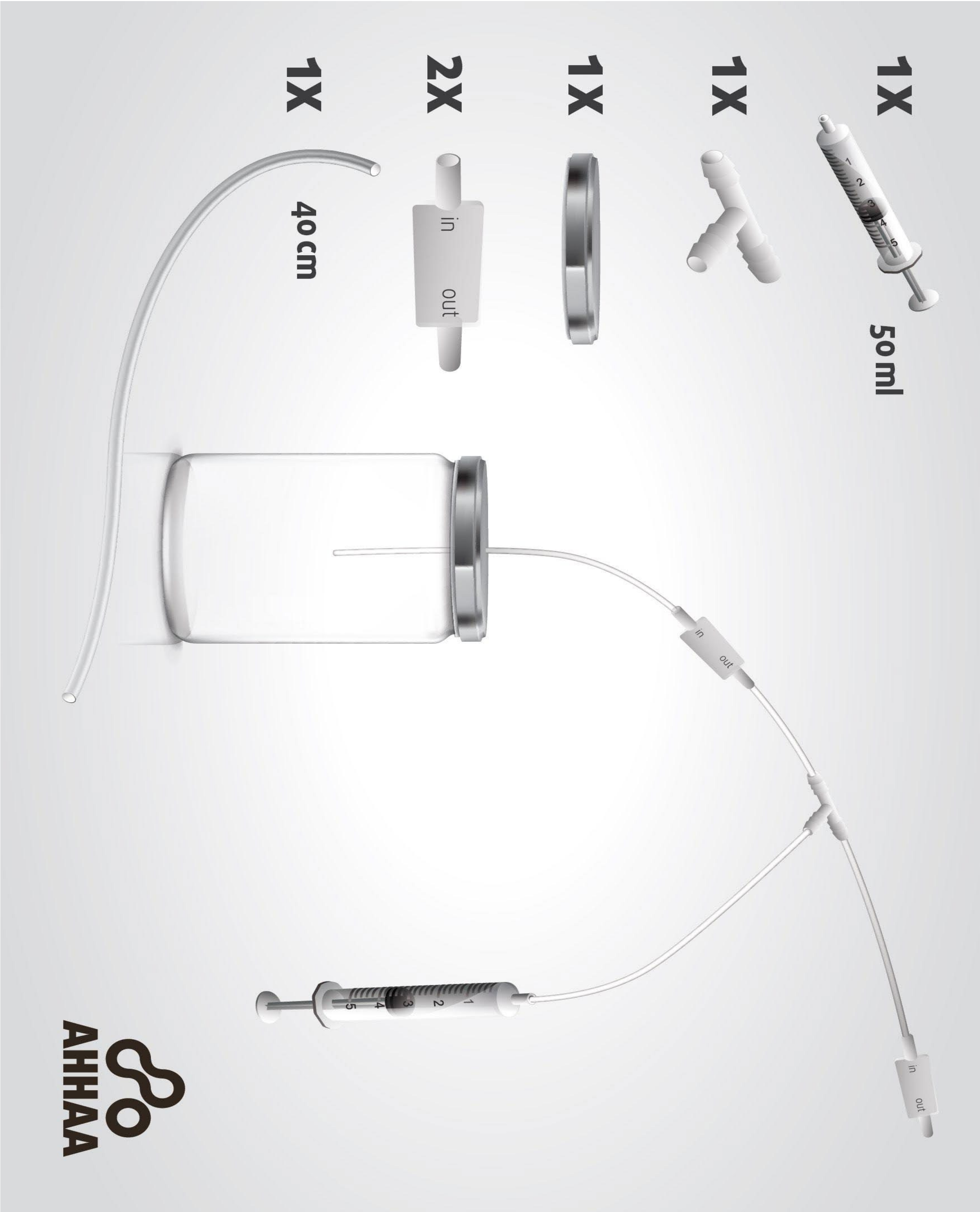
"Fifteen were a complete success, several were rock solid and a few had some mould on it. One was a total failure and had the most amount of mould I've ever seen. The kids loved it!'

-Teacher who implemented the module in the classroom

APPENDIX A: SCHEMATIC INSTRUCTION SHEET FOR MAKING A DIY VACUUM CHAMBER (P. 11)

APPENDIX B: TEACHERS' GUIDE (PP. 12-14)

APPENDIX C: ACTIVITY CARD FOR STUDENTS (PP.15-16)


1X
50 ml
1X
1X
2X
in
out
1X
40 cm
in
out
in
out
AHHAA

Vacuum Chamber

Duration

45 min
+ 2 weeks observation

Related topics

AIR PRESSURE · MOLD · FOOD PRESERVATION · PRESSURE · VACUUM · LUNGS · FOAM

What you need (for each group)

- **0,5 l** Jar
- **40 cm** Silicone tube
- **2 pcs** Air valve
- **1pc 50 ml** Syringe

- T-connector
- Insulating tape or adhesive pads
- Scissors
- Marshmallow
- Balloon
- Buzzer and a suitable battery

- Shaving foam (or similar) (1 can per class)
- Piece of fruit or other food
- Ruler

Optional:
- Small disposable plastic cups for foam
- Freeze- dried berries/ fruits for tasting
- Rubber gloves
- Pressure gauge

Instructions

The task of the participants is to build a vacuum pump (one per each group).

There are several ways to build a working vacuum pump. One of them is shown on the additional page of this teacher guide. If the participants do not have any ideas how to start, they can be directed towards that solution.

The vacuum chamber can also be built simply by attaching the syringe to the lid of the jar using a silicone tube, but it does not allow all of the air to be removed from the jar. This would require a system that, on the one hand would remove air from the jar, but on the other hand, wouldn't let it go back to the system. A suitable tool for that purpose is a T-connector which has three branches. Air valves should be attached so that one of them prevents the air from going back into jar and the other allows the air to leave the system (diagram on the additional page). A well-sealed jar gives the best results. Insulating tape or adhesive pads are good for sealing.

The pressure gauge helps to determine the change in pressure. Place it in the jar while testing. It is more convenient to put shaving foam in a cup before you put it in the jar. The volume of materials filled with gas increases when the pressure in the jar is reduced as the gas inside them begins to expand. Sounds become quieter as air pressure decreases. No sound is transmitted in a full vacuum.

The devices built by our participants do not reach a full vacuum because the system will have some leaks and the pump itself is not powerful enough. The presence of air is indicated by the balloon not retaining its size (swells and pulls back), the sound of the buzzer and also the jar remaining intact. Vacuum chambers that are used in science laboratories are made of materials that withstand high pressure and temperature changes.

By looking at the water status diagram (figure 1), you can discuss with participants if their vacuum chamber could be improved so that it could also be used for freeze-drying.

Explanation

Pressure gauge is used to measure the pressure while pumping tires, barometer is a device that measures atmospheric pressure, meteorologists use the unit millibars in weather forecasts.

As liquids and gases are not structured as solid bodies, the pressure that is exerted on them is carried equally in every direction.

Breathing is possible due to pressure changes in our lungs. During inhaling, the diaphragm contracts, the thoracic cavity expands and the lungs expand. **Negative pressure** created in the lungs allows air from outside to enter the trachea and flow into lungs. As we exhale, the diaphragm relaxes, reduces space in the chest and pushes air out of the lungs.

A vacuum is a state when there is no substance (including air and other gases) in a space. An approximate vacuum fills the whole universe. Due to the lack of pressure in a vacuum, there is no resistance to moving bodies.

Astronauts wear pressurized suits in outer space. An unprotected living being can withstand a vacuum environment without losing consciousness for about 15 to 20 seconds, assuming they have exhaled deeply. The widely popular belief that the human body will explode in a vacuum is not true because the skin and cell walls are strong enough to prevent the bodily fluids from boiling and tissues from swelling. Studies and animal experiments have shown that even an unconscious human can endure vacuum for one minute without any damage to the body or the brain.

Freeze-drying technology was developed by NASA scientists to make bringing food into space easier. Freeze-dried food is first frozen, then it is placed in a vacuum chamber that has a heated bottom. The aim is to reach the pressure and temperature at which ice sublimes (goes directly from solid to gaseous state; see figure 1). The extracted water vapor is caught on pipes that are cooled down to -80 °C.

This method allows preserves up to 98% of the nutritional value and the food tastes and smells as it did before. All food can be freeze-dried: berries, vegetables, fruits, mushrooms, herbs, meat, seafood etc. Although the volume of the food stays the same, 70 to 90 percent of its weight is lost. Depending on packaging, the shelf-life of freeze-dried food can be up to 25 years. Freeze-dried food is considered raw food because the process takes place at temperatures below 40 °C. Freeze-drying is a great solution to prevent food from spoiling in grocery stores, although the best way to prevent food wasting is to consume locally produced food, because a considerable amount of food spoils during transportation.

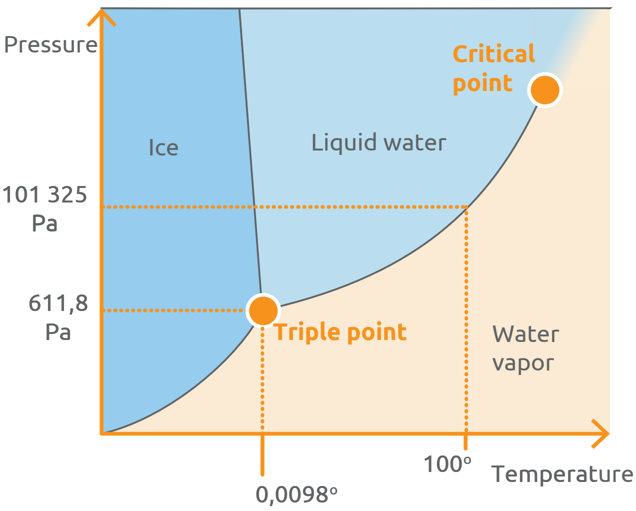


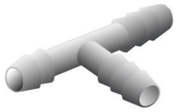
Figure 1. Water phase diagram

Freeze-dried food should be kept at a constant temperature, be protected from sunlight and the package should also keep moisture away. Package however does not always guarantee food freshness, because even packaged food can get spoiled when kept under wrong conditions. Therefore, scientists are working on “smart labels” that react to even small temperature or chemical compound changes. If any difference occurs, smart label changes its color.

Keywords for online search:

Pressure, vacuum, pressure gauge, mold, vacuum packaging, barometer, vacuum meter, phase diagram, freeze-drying, mmHg to Pa, smart packaging

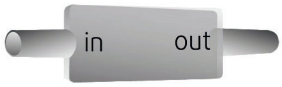
1x



1x

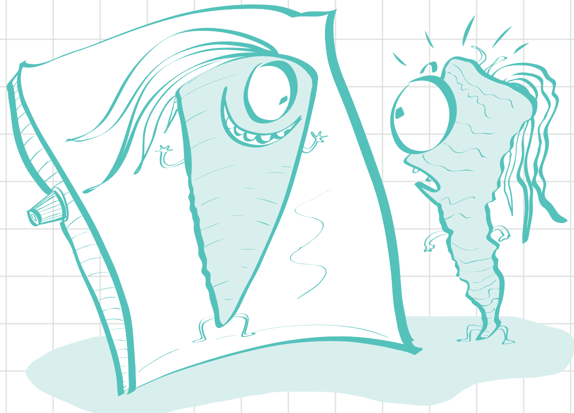
1x

1x (40cm)



2x

This material was developed using co-funding by European Union's Horizon 2020 programme under grant agreement No 774088.



VACUUM CHAMBER

The maximum length of a straw you can use to suck water from a well is 4 m. Beyond that the vacuum in our mouth will not be enough. Theoretically, it is possible to pump water up to 10.3 m high using a vacuum, before the water column pressure overpowers the air pressure and even a full vacuum would not get further.

Mold and bacteria cannot reproduce in an oxygen-deprived environment, therefore vacuum packaging is a good option to preserve food. By placing frozen food in a special type of vacuum chamber, it is possible to transform ice crystals in food directly into gas. The result is water-free freeze-dried food, which has the original taste and texture. Since freeze-dried food can be stored for decades, it can also help prevent food waste and be used more widely in the future.

There is a partial vacuum between the two metal layers of a thermos. This allows to keep a constant temperature for a long time.

TASK

Build a vacuum chamber to explore the effect of pressure changes.

1 IDEAS

How does the placement of air valves affect air movement?

What can you do to prevent air leaks and air moving back to the jar?

What can you do to make your jar as airtight as possible?

2 BUILDING

Build a vacuum chamber and test the device with a small inflated balloon.

EXPERIMENT

DEVICE DOES NOT WORK

How can you remove the air from the syringe without disconnecting it?

TRY AGAIN

DEVICE WORKS

DISCUSSION

Are there any similarities between our lungs and the balloon placed in the vacuum chamber?

3 EKSPERIMENT I

Explore, how does the change of pressure affect shaving foam, marshmallows and sound.

4 EKSPERIMENT II

During two weeks, observe, what happens to food placed in the vacuum chamber. Try this experiment for example with a piece of bread, fruit or a biscuit. As a control experiment observe the same food in regular air conditions.

Which data should you collect?
How should you collect the data?
Will you take photos?

SUMMARY

Describe the effect of air pressure changes on shaving foam, marshmallows and sound.

Did the decreased pressure effect food preservation?

DISCUSSION

Why does the volume of foam, balloon and marshmallow increase while pumping air out of the jar?

Very low atmospheric pressures can make saliva in the mouth boil, but not blood or other body liquids (as sometimes shown in sci-fi movies), because cells and body's internal environment can maintain the required pressure.

ATTENTION!

Scissors are sharp.

Jar can slip while removing the lid.

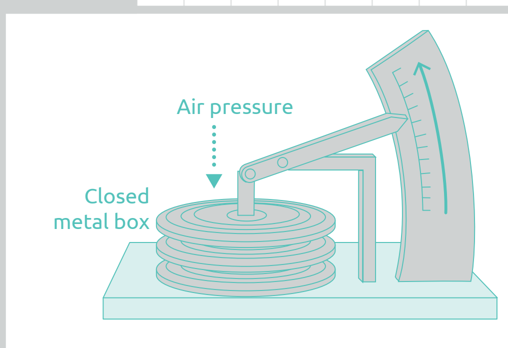
When pressure increases, for example while diving, dissolution of nitrogen and other gases in the blood improves. As pressure decreases, the solubility of gas is reduced and gas builds up in bubbles. If the pressure declines rapidly, lungs cannot remove bubbles fast enough and the diver gets decompression sickness.

ADDITIONAL INFORMATION

Pressure is the force applied perpendicular to a surface divided by its area:

$$p = \frac{F}{S}$$

p = pressure,
F = force,
S = area.



A pressure gauge is used to measure pressure in liquids and gases.

Atmospheric pressure at sea level is:
1 atm (atmosphere) =
101325 Pa (Pascal) =
1,013 bar =
760 mmHg (millimetres of mercury).

Atmospheric pressure at sea level varies between 870-1085 mbar.

Pressure decreases by half for every 5.54 km of height.

Sound cannot travel through a vacuum, because there is no air or other molecules to transfer sound vibrations.

Air valve (in/out) allows air to move only in one direction.

This material was developed using co-funding by European Union's Horizon 2020 programme under grant agreement No 774088.

Authors: Kristel Schreiner, Pille Randjärv, Sander Kask, Üllar Kivila, Helen Järvpõld, Elisabeth Parman, Andes Kuura.

VACUUM CHAMBER

Draw a sketch of your vacuum chamber design and modify it later if necessary.

What are the factors affecting the reliability and quality of a device? How can the device be improved?

Observe the effect of pressure changes on different objects. Write the results in a table below.

Object	Brief description of the test result, estimated measurement results
Shaving foam	
Marshmallow	
Slightly inflated balloon	
Buzzer	

What indicates that there is not a vacuum in the device, only a reduced pressure instead?

Vacuum packaging and shelf life

Based on your previous knowledge, explain whether you think the food is better preserved in the air or in the vacuum chamber you built.

During 2 weeks, on 6 different days, observe two sets of food, first one placed in the vacuum chamber and the second one under normal air conditions. Write down your observations.

Day	Normal air (control test)	Inside the vacuum chamber
Day ...		
Day ...		
Day ...		
Day ...		
Day ...		
Day ...		

Were the results expected? How can you explain the results?

You took a bottle of water with you on a mountain trip, drank all of the water at an altitude of 3000 meters and put a closed bottle back in the bag. What happens to the closed empty water bottle 60 m above the sea level and why?

Could a similar change occur even if the altitude would not change? ☐ Yes ☐ No

KEYWORDS FOR ONLINE SEARCH

Pressure, vacuum, pressure gauge, mold, vacuum packaging, barometer, manometer, phase diagram, freeze drying, mmHg to Pa, smart packaging, modified atmosphere packaging

Coordinated by:

Partners

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 774088