Portable Vacuum Chamber Set

C15-6521-W0

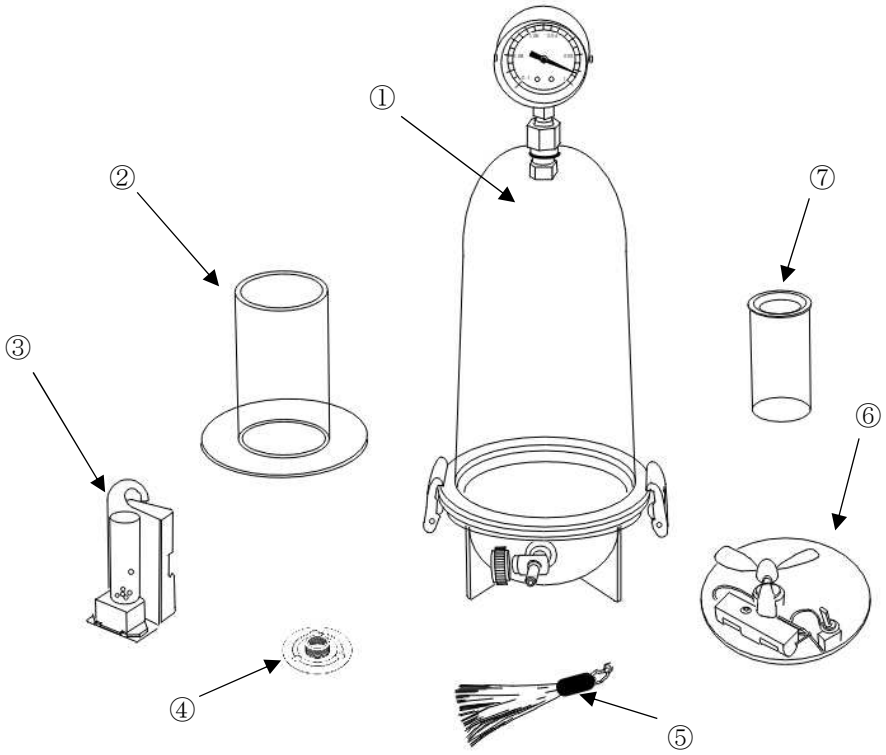
Instruction manual

Mar.2023

Safety Precaution

- ✓ Do not disassemble, repair, and remodel this product. The warranty will be void.
- ✓ Read all the instruction manuals that come with the set beforehand.
- ✓ Instruct students about the operating procedure and the safe ways of conducting experiments with this product prior to experiments.
- ✓ Always carry students' experiments under the supervision of teachers/trainers.

Contents and Specification



① Portable Vacuum Chamber MVP-100HVN: 1 pc

Outward form: 304 mm (H) x 156 mm (Max. diameter),

Effective height: 235 mm, (cylinder section: 187 mm, diameter: 110 mm).

Accessory: Bourdon pressure gauge

② Container: 1 pc, 103 mm (H) x 114 mm (diameter), Acrylic resin

③ Vacuum buzzer (vibrating spy-window type): 1 pc

Dimensions: approx. 30x34x74mm, Weight: approx. 29g (battery not included)

④ Ring bracket: 1 pc ⑤ Mini Windsock: 1 pc

⑥ Small fan: ca. 40 mm (H) x 114 mm (diameter) (battery not included) ⑦Sample container: 1 pc

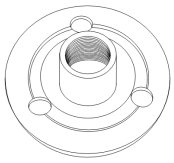
Introduction

This product is a set of Portable Vacuum Chamber made of lightweight and pressure-resistant reinforced plastics with a Bourdon pressure gauge and some accessories, which handles easily for users and is unbreakable and safer than a conventional glass bell jar. The pressure gauge at the top of the chamber indicates the air pressure level in the chamber during the experiments, which enables students to perceive what the vacuum level is inside.

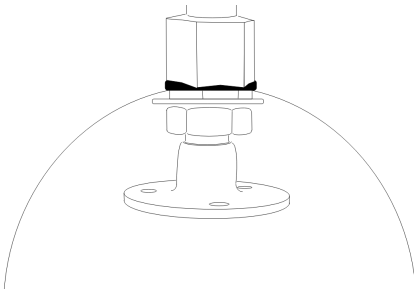
How to Use

1. Setting Portable Vacuum Chamber

Screw the ring bracket on the top of the inside chamber with your hands.



Ring bracket



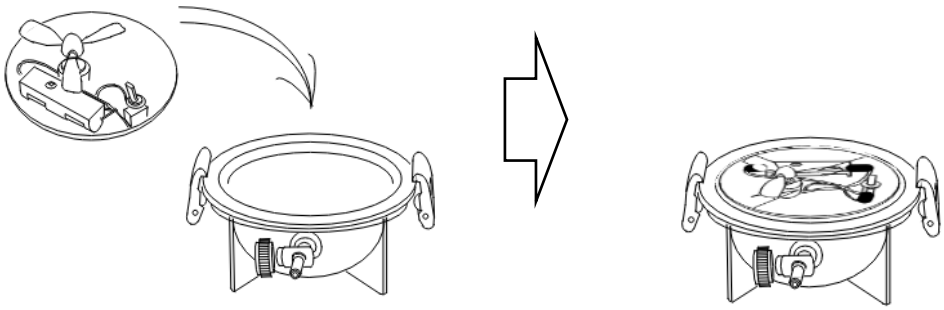
Portable Vacuum Chamber with Ring bracket

2. Install batteries in a battery holder on the back of the vacuum buzzer (vibrating spy-window type).

Put two AA-type batteries to a battery holder on the back of the buzzer. The buzzer starts to beep as soon as installing them. As the buzzer has no switch, remove the batteries from the battery holder when you don't use the buzzer in the experiment.

3. Install a battery into a battery holder of the small fan and set the fan onto the chamber base.

Put an AA-type battery to a battery holder on the back of the small fan and check its operation by switching it on. And place the small fan on the chamber base, and check its condition (see below Fig.). After the check, switch it off.



Experiments' Guide

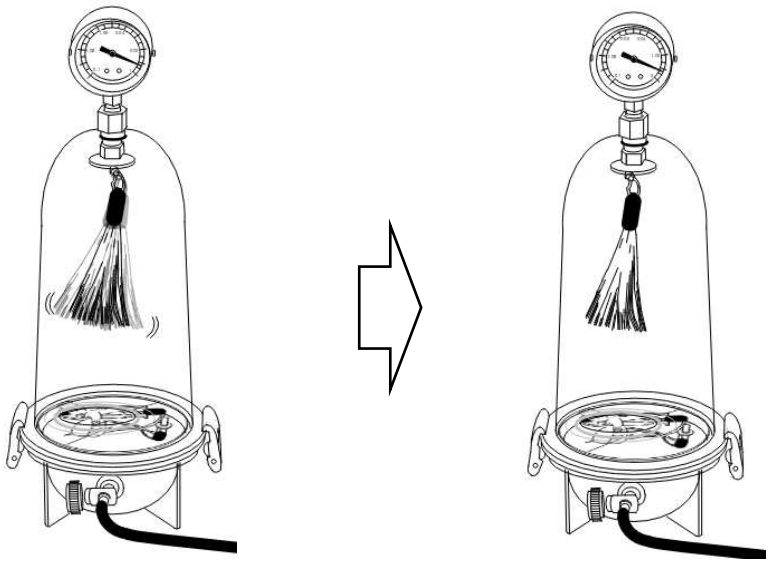
1. Air flowing

[Objective]
To demonstrate that air-flowing stops in vacuum-condition in the chamber.

[Apparatus]
Portable Vacuum Chamber, Small fan (AA battery), Mini Windsock, an electric vacuum pump, a vacuum hose

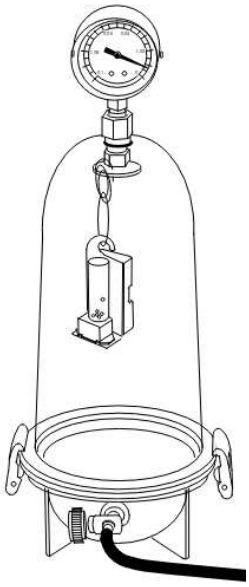
[Procedure]
1. Install a battery into the small fan and set it onto the chamber base refer to "How to Use" section.
2. Suspend Mini Windsock from Ring bracket (refer to "How to use") of the upper chamber with a paper clip or other strings.
3. Turn on the switch of the fan, set the upper chamber on the base, and fix them to seal the chamber with its buckles. You will see Mini Windsock swinging inside.
4. Join a nozzle of the chamber to a vacuum pump with a vacuum hose, open its valve, and start the pump to draw the air in the chamber.
5. Observe the movement of the Mini Windsock in the chamber.
6. After observation, close the valve of the chamber, remove the vacuum hose from it, and stop the vacuum pump.
7. Finally, slowly open the valve and let air back into the chamber.
8. The flow of inside air comes back and Mini Windsock swings again.

You will observe that the Mini Windsock gradually stops swinging even though the small fan works while the pump draws the air from the chamber and the pressure gauge lowers. And then, the Mini Windsock moves again when the air pressure goes back to the atmospheric one in the chamber by opening the valve. By observing a phenomenon in the demonstration, students can realize the vacuum condition.



Atmospheric pressure　　Vacuum condition

2. Transmission of Sound



[Objective]
To demonstrate that sound needs a medium (air) for transmission.

[Apparatus]
Portable Vacuum Chamber, Vacuum buzzer (AA battery), an electric vacuum pump, a vacuum hose, a rubber band, a paper clip

[Procedure]
1. Install a battery (AA type) into the Vacuum buzzer to beep.
2. Suspend Vacuum Buzzer from Ring Bracket on the upper part of the chamber with a rubber band and a paper clip. Make sure the vacuum buzzer is apart from the surface of the chamber. Otherwise, the chamber transmits the buzzer's beep to the outside via its body even though there is no air inside.
3. Set the upper chamber on the base and fix them to seal the chamber with its buckles.
4. Join a nozzle of the chamber to a vacuum pump with a vacuum hose, open the nozzle, and start the pump to draw the air in the chamber.
5. Check the beep sound becomes fainter and fainter while the pump draws the air from the chamber and the pressure gauge lowers.
6. Close the nozzle, remove the vacuum hose from the nozzle, and stop the pump.
7. Check the beep sound from the chamber again.
8. Slowly open the valve and let air back into the chamber.
9. Check the beep sound change from the chamber.
10. Remove the upper part from the chamber base by unlocking the buckles.
11. Remove the vacuum buzzer from the Ring Bracket and turn off its switch.

Before drawing the air out of the chamber, initially, you can see the movement of small balls jumping on the buzzer and hear the beep sound from the chamber. When the vacuum pump is started, the sound becomes fainter and fainter with time as more air is drawn out (the inside air pressure lowers). Finally, even though the small balls are still jumping (the buzzer is working), the sound becomes so soft that you hardly hear it. As opening the valve to fill the chamber with air and gradually return it to atmospheric pressure, you can hear the sound of the buzzer from the chamber again. These phenomena demonstrate that air is a medium of sound travel, and sound cannot travel through vacuum conditions.

3. Decompression boiling

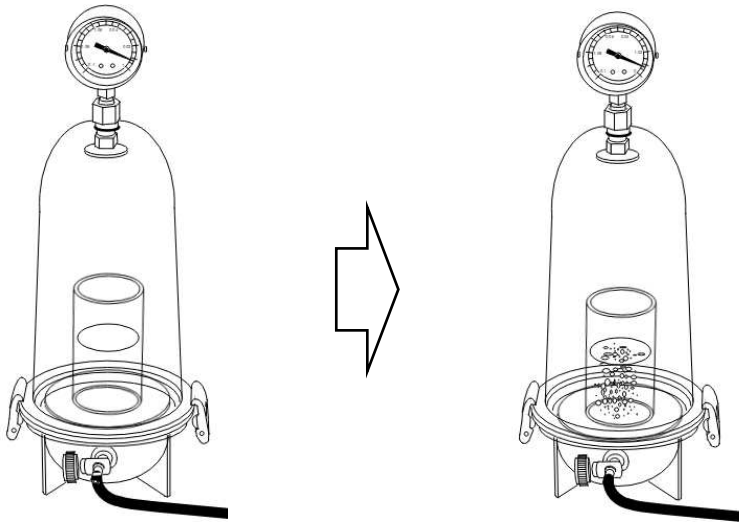
[Objective]
To demonstrate a phenomenon of boiling water at a lower temperature than its boiling point in the decompression chamber.

[Apparatus]
Portable Vacuum Chamber, Container, an electric vacuum pump, a vacuum hose, some hot water

[Procedure]

1. Pour some hot water (around 80 degrees C) into Container and place Container on the chamber base.
2. Set the upper chamber on the base and fix them to seal the chamber with its buckles.
3. Join a nozzle of the chamber to a vacuum pump with a vacuum hose, open the nozzle, and start the pump to draw the air in the chamber.
4. Pumping the air out from the chamber and the pressure gauge lowering, the hot water starts gradually boiling.
5. Close the nozzle, remove the vacuum hose from the nozzle, and stop the pump.
6. Finally, slowly open the valve and let air back into the chamber.

The boiling point of water is 100 degrees Celsius at atmospheric pressure, but it becomes under 100 degrees Celsius on a top of a mountain due to lower pressure than the atmospheric one as well known. This experiment demonstrates that generating a such condition in the chamber allows hot water around 80 degrees Celsius to boil at the lab level.



Atmospheric pressure　　Vacuum condition

4. Differential pressure

[Objective]
To demonstrate a phenomenon of water moving by differential pressure between two containers.

[Apparatus]

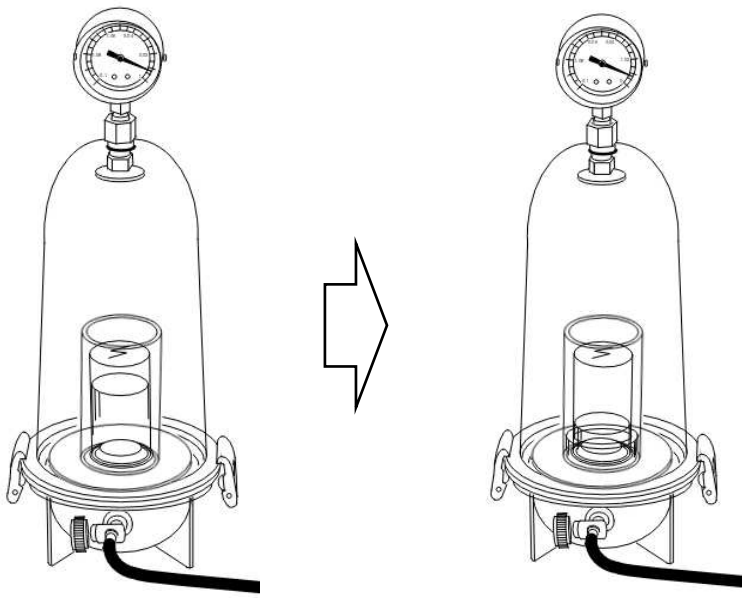
Portable Vacuum Chamber, Container, a sample container, an electric vacuum pump, a vacuum hose, some water

[Procedure]
1. Make a small hole (around 1 mm diameter) in a lid of a small container with a needle.
2. Pour some water (around 80% of the small container) into the small container, press the lid on the small container to close it, place it upside-down into the Container (the outer one), and place it on the base of the chamber.
3. Place the small container in the Container upside down.
4. Set the upper chamber on the base and fix them to seal the chamber with its buckles.
5. Join a nozzle of the chamber to a vacuum pump with a vacuum hose, open the nozzle, and start the pump to

draw the air in the chamber.
6. Pumping the air out from the chamber, the water in the sample container starts moving out through the small hole to the outer container.
7. When approximately 80% of the water moves from the sample container to the outer container, close the nozzle, remove the vacuum hose, then stop the vacuum pump.
8. Slowly opening the valve to fill air into the chamber, almost all water in the outer container moves to the sample container.

Water occupies approximately 80% volume of the small container. The air occupies the other, of which pressure is the same as the atmospheric one. When air pressure surrounding the container decreases than the atmospheric one, differential pressure occurs between the outside and inside of the container. The inside pressure becomes higher than the outside one. Consequently, the inside air presses the water to drain away through the small hole, and it results in the volume of air in the small container increasing.

Filling air into the chamber restores the pressure to the atmosphere, and differential pressure occurs between the small container and outside it again. Consequently, the outside air presses the water back into the small container through the small hole, and it goes back to the initial condition whose the volume of water in the container increase.



Atmospheric pressure　　Vacuum condition

5. Expanding and Shrinking a marshmallow

[Objective]
To observe the phenomenon of expanding and shrinking a marshmallow depending on the surrounding air pressure.

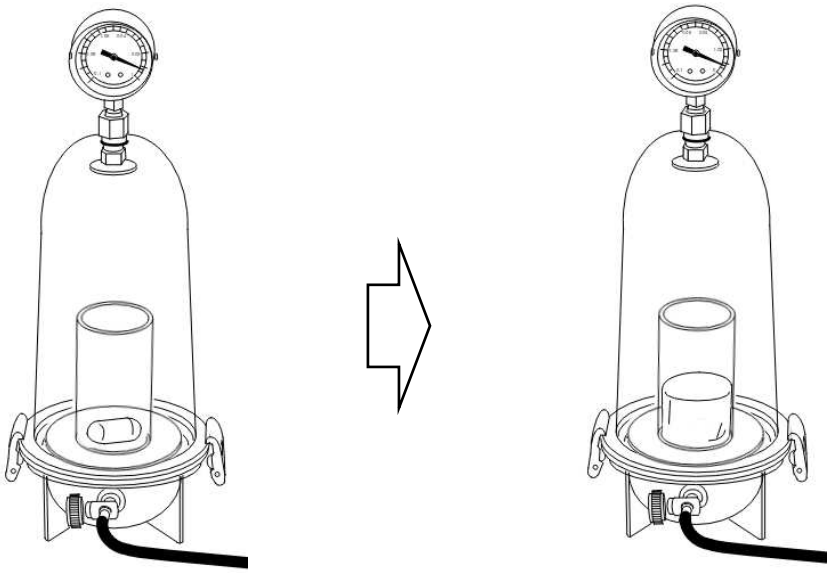
[Apparatus]
Portable Vacuum Chamber, Container, an electric vacuum pump, a vacuum hose, a marshmallow

[Procedure]

1. Place Container on the base of the chamber.
2. Put a marshmallow into Container.
3. Set the upper chamber on the base and fix them to seal the chamber with its buckles.
4. Join a nozzle of the chamber to a vacuum pump with a vacuum hose, open the nozzle, and start the pump to draw the air in the chamber.
5. Observe what the marshmallow happens.
6. Close the nozzle and remove the vacuum hose.
7. Slowly open the nozzle to inject air into the chamber and observe the marshmallow changing.

A marshmallow has an enormous number of micro-bubbles whose inside gas pressure is the atmospheric one. Pumping the air out from the chamber reduces the pressure of the inside air to be less than the atmospheric pressure. When air pressure surrounding the marshmallow decreases less than the atmospheric pressure, differential pressure expands the micro-bubbles as it occurs between the micro-bubbles of the marshmallow and its outside. Consequently, the whole marshmallow becomes bigger size.

Filling air into the chamber makes the inside pressure become the atmospheric pressure, and differential pressure occurs again. Although we expect the marshmallow will be back to its initial size, it becomes smaller than the initial size and also becomes hard like a candy. It is caused by the micro-bubbles bursting to release their gas when they expand.



Atmospheric pressure　　Vacuum condition