AIR PRESSURE

Manual

CONTENTS

USING THE VACUUM CHAMBER

- Put the blue seal ring (large) in the upper edge of the base of vacuum tank, check and lie steadily.

- Put the vacuum lid on the base, the flat side close to the seal ring and place symmetrically, not eccentrically.

- Check and put down the release valve (Open it after the experiment in order to make the same pressure between inside and outside) .

- Insert the blue tube into the trachea joint. There will be a small hinder, to make sure that insert in the end, please insert 3-4mm.

- Put the bigger side of red plastic connector on the syringe, and connect one side of blue tube to the other side of red plastic one.
- Hold the syringe by one hand, and hold the piston putter by the other hand.
- Keep the vacuum tube relax, so that the vacuum lid will not move at the beginning.

When push the piston, close the valve core in the bottom and the air will out from the valve core at the top.

When pull out the putter, through manometer, you can see the pressure decreases in the vacuum tank. The scale of manometer shows negative pressure.

- When you are pumping, the pressure will be lower and lower.

If necessary, the vacuum tube can be removed from trachea joint.

- Press blue plastic ring of the trachea joint by two fingers.
- At the same time, remove the vacuum tube by the other hand.

EVIDENCE OF AIR PRESSURE

Material:
Syringe plastics, 80ml-------------------------1
Manometer--------------------------------------1

With the syringe you can easily change the pressure – also evidencing this change is possible.

Experiment 1:

Position the piston somewhere between 30 and 40ml. Hold the syringe with one hand right handed shall either use the left hand) and close the hole with one finger. Press the piston slightly inside and finally remove it. You will feel over and under pressure directly on your finger.

Experiment 2:

You can prove and measure the generated pressure with a Manometer (in hecto pascal). The pointer position at zero indicates the normal air pressure of approx. 1000hPa
A pointer position at -1000hPa then means an actual pressure of 1000-1000=0hPa (vacuum), one of +1000hPa a pressure of 1000+1000=2000hPa, which means that the pressure has doubled.

Part 1:
Shift the piston fully inside the syringe and stick the Manometer on it. Try to remove the piston and read off the value on the Manometer.

Part 2:
Remove the piston a little bit (70-80ml) and stick the Manometer on the syringe.
Hold the syringe and also the Manometer with one hand (the left one) and press the piston with the grip inside···
a) by holding up the syringe with ring-and forefinger
b) by scheduling the grip on the stomach
Read off the value on the Manometer while pressing the piston inside!

Conclusion (fill in the gaps):
When removing the piston, the space for the gas particle and the pressure __________________ (declines／increases)
When pressing the piston inside, the space for the gas particles and the __________________ (declines／increases)

" MAGDEBURG HEMISPHERES"

Material:
Magdeburg Circler------------------------------1

Generally, huge forces are appearing when normal air pressure interacts single-edged. These forces shall be watched. In 1654 Otto Guericke, major of Magdeburg, was demonstrating the experiment with two hemispheres Now, experience by yourself the bughe power of air pressure on the earth's surface.

Preparations:
Take the Magdeburg circles and press them lightly together

Experiment:

Try to pull the circles apart by drawing on the grips
The circles easily diverge when letting air inside by softly bending the rand of one disk.

Conclusion (fill in the gaps):
If air pressure is acting ______________________________ (collateral/from everywhere in the same way/single-edged), huge forces are appearing.
The magnitude of the force depends on ____________________________ (the dimension of the circles/on the applied pressure) to press the circles together.

AIR PRESSURE MEASUREMENT

Material:

Syringe plastics, 80ml--------------------------------------1
Vacuum hose plastics, incl Connector---------------------1
Vacuum chamber complete, 1000ml-----------------------1

To act in time and also to avoid troubles simultaneously, you shall often watch and read off the values on the meters.
This can be the speed when driving as well as reading the temperature to diagnose whether there is a risk of frost existing. Another example would be to observe the pressure of liquids ／gases to ensure that nothing explodes or to guarantee that enough power gets generated at a specific pressure level (hydraulic power units).

Preparations:

Consider the instructions how to use the vacuum chamber.

Experiment:

If the chamber is ready prepared and the syringe and the syringe is connected, press the piston fully inside and finally extract it until 80ml is reached. As a result you have reduced the air volume by 2／27and pressure is reduced by 2／27, for 74hPa. The pressure in the chamber is now 1000hPa-74hPa

Now, continue with evacuating air from the chamber and watch the vacuummeter and the valves.

Note: the more the pressure inside the chamber decreases, the more the outer air pressure becomes noticeable and exertion gets higher. At a pressure level of 200hPa=1000hPa-200hPa it gets higher and harder to pull out the flask

Task:

At which pressure level is it still possible to remove the cover more or less easily ?

☐500 hPa ☐700 hPa ☐900 hPa

Conclusion (fill in the gaps):

With a Manometer (in this case a Vacuummeter, as only small pressure gets measured) you can measure air pressure.

Advice:

When the pressure in the chamber e.g. has halved, then in the course of one stroke only halve of air volume gets transported outside. Consequently, the pressure declines by 37hPa.
Generally speaking, with every stroke the pressure inside the chamber declines by 2／27 of the existing inner level.

AIR PRESSURE EFFECT –
EXTERAL PRESSURE DIMINISHED

Material:

Syringe plastics, 80ml-----------------------------------1
Vacuum hose plastics, incl Connector------------------1
Vacuum chamber complete, 1000ml--------------------1
Balloons---1
Clamp for balloons---------------------------------------1
Magdeburg circler---1

You shall have experienced during the "Magdeburg Hemispheres" experiment that forces are appearing when there is a difference between the outer and inner pressure level. In this experiment the effect pressure was higher than the inner one. With the help of the vacuum chamber the effect can be neutralized or reversed. When pumping up a tire or a paste is doughing the inner pressure gets higher than the outer one. This effect is equal when than inner pressure stays unchanged while the outer pressure is declining.

Preparations:

Put 1、the connected Magdeburg circles, 2、the locked ballon
Consider the Manual how to use the vacuum chamber (screw in the ventilation screw !)

Experiment 1: connected "Magdeburg circles"

Reduce the pressure in the chamber and read off the value on the vacuummeter when inner pressure = outer pressure
Result: the circles fall apart.

Experiment 2: balloon

Seal an unused balloon with the clamp and put it into the vacuum chamber
Reduce the pressure and watch the effect of the increasing outer pressure

Task (fill in the gaps):

When the ballon would not get sealed in experiment 2 then ____________________, as ____________________ Pressure is always existing in and around the balloon.

Conclusion (fill in the gaps):

Force action at different pressure level always acts from the _________ (lower/higher) to the _________ (lower/higher) pressure level.

AIR PRESSURE EFFECT – WATER BOILS AT 60 DEGREES

Material:

Syringe plastics, 80ml----------------------------------1
Vacuum hose plastics, incl Connector-----------------1
Vacuum chamber complete, 1000ml-------------------1
Beaker, 100ml --1
Thermometer---1
Black rubber ring--1

When meat, potatoes, rice etc. shall become soft, one has to add water and heater it.
The dishes become soft in a faster way when the water temperature is higher. In a locked cooking pot, the pressure increases because of the steam and the gas bubbles emerging at a higher temperature level – as a result cooking time gets shortened.
If a liquid is exposed to a lower pressure level there shall be a reverse action – this has now to be examined by you !

Preparations:

Fill hot water (circa 60℃) into the Beaker and position it in the vacuum chamber Consider the Manual how to use the vacuum chamber (screw in the ventilation screw !)

Experiment:

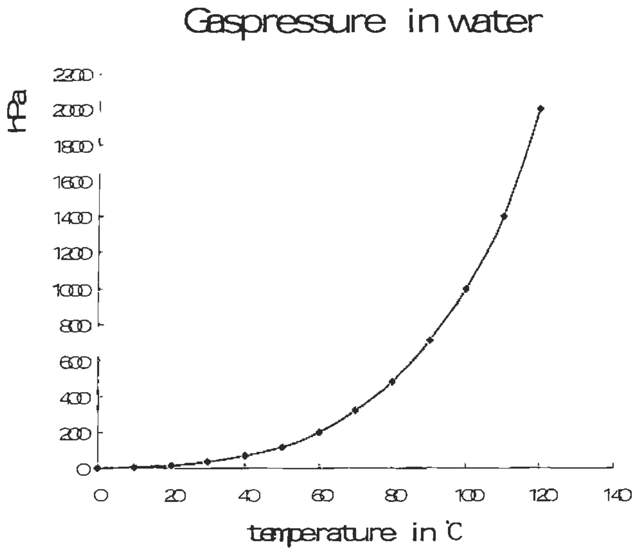
Reduce the pressure in the chamber and watch the liquid bubbling.

Task:

At which pressure level did the water start boiling ? ____________

With regards to above question, which temperature can be read off from the adjoining diagram ? ______________

Note: A pressure of 200hPa relates to –800hPa on the vacuummeter.



Conclusion (fill in the gaps):

The boiling temperature of water is ______________ (lower／higher) at a lower outer pressure level as then a ______________ (lower／higher) steam pressure in water is enough to generate bubbles.

AIR PRESSURE EFFECT –
INTERNAL PRESSURE DIMINISHED

Material:

Bubble burster--1
Black rubber ring---1
Plastic film for bubble burster---------------------------1
Syringe plastics, 80ml------------------------------------1
Vacuum hose plastics, incl Connector-----------------1
Vacuum chamber cover----------------------------------1

If you stick your finger into you mouth, clasp it closely with lips and finally bend it in that way that you can remove it fastly off your mouth – then you can hear a " plop" . When fastly remove a cork from a bottle, the " plop" is much louder. If the difference between inner and outer pressure level is very big, the pressure settlement can be done very quickly. In the event the " plop" changes into a bang, this action is called " implosion"

Preparations:

Tighten the plastic film on the recessed side (for the Black rubber ring) with the Black rubber ring over the bubble burster and fix it.

After you have screwed in the ventilation screw and the hose is connected, turn the cover of the vacuum chamber around – a second person holds the cover
Stick the syringe on the hose.
Position the bubble burster on the rounded depression／cut

Experiment:

As the bubble burster clasps a smaller space than the vacuum chamber, less flask movements are necessary to reduce the pressure inside the bubble burster. Stadely watch the vacuummeter !

You can watch the force of the outer pressure which is introversive directioned from the ouside. The plastic film introverts the same way cellophane plastic film on a jamglas reacts – then the plastic film tores loudly – bang !

Conclusion (fill in the gaps):

Due to the impact of outer air pressure vessels in which a lower pressure level is existing can be crushed. At the moment of demolition, air is infiltrating (= Implosion). The suddenly appearing air interchange (like the reverse action mentioned above) also generates a loud bang.

Advice:

Underpressure also emerges when watersteam gets condensated in a locked cooking pot. This effect of air pressure was also used in the very first existing steam engines.

FREE FALL – FREE FALL TUBE

Material:
Free fall tube, incl falling bodies-----------------------1
Syringe plastics, 80ml-----------------------------------1
Vacuum hose plastics, incl Connector-----------------1
Vacuum chamber cover----------------------------------1

A ski jumper is not interested in simply falling down when doing his jump – this more applies to a diver who tries to make his fall more interesting by showing some screws and salti. The ski jumper is better able to make use of the aerodynamic forces because of the high speed at the jump. You can gather that the frictional forces, appearing when a body is falling, make it very difficult to explain the fall – movement mathematically.

For this reason the naturally unexisting free fall – the fall without breaking air – was created. With the help of an optimally evacuated free fall tube, it is possible to create nearly those conditions which are necessary to simulate the free fall.

Preparations:
Put the feather and the red ball into the fall tube and position the tube on the cover of the vacuum chamber

Experiment:

Turn around the fall tube together with the cover and watch the fall of the feather and the ball.
Re-position the fall tube again and fix the hose and the syringe at the valve on the cover, Finally, reduce the pressure in the tube as good as possible.
Now, when removing the syringe and the hose, you can execute the fall experiment without breaking air again.

Conclusion (fill in the gaps):
When speaking about the" free fall" ________________ (own／the same)laws are valid for every body（plastic ball、lead ball、…）

Task:
If an astronaut would clamp his umbrella after he had left the spaceship, would he then lag behind the spaceship ?

TRANSMISSION OF SOUND IN A VACUUM

Material:
Syringe plastics, 80ml------------------------------------1
Vacuum hose plastics, incl Connector-------------------1
Vacuum chamber complete, 1000ml---------------------1
Alarm annunciator--1
Sound – absorbing pad-------------------------------------1

The purpose of a signaler is to hear it. At night one is not interested in hearing loud noises. But what is the relation to air pressure now ? You will be informed immediately ! Sound gets generally transmitted in air because of the movement of air particles. (see Implosion, Explosion).
But what happens if there are less or no particles existing ? Righ now, listen what happens or to say it in another words: don't hear what happens !

Preparations:
Put the sound absorbing pad into the vacuum chamber
Prepare the cover of the vacuum chamber (screw in the ventilation screw)
Switch on the Alarm annunciator and put it on the sound – absorbing pad

Experiment 1:

Position the cover slowly on the vacuum chamber and watch how the noise level reduces slowly.
Pump out as much air as possible from the chamber while watching the audibility of the alarm.
Let the air slowly inflow again and retrace your impressions.

Experiment 2:

Execute the experiment again – but without sound-absorbing pad (See left-hand picture)

Conclusion (fill in the gaps):
In a vacuum ____________________ (there is no／there is a good) sound transmission !
The air tightened isolation of the sound source reduces the outward transmission of the sound ____________________ (hardly ever／relative intensively／fully).
In case the sound source is connected with the bottom (without absorbing layer) the sound will be transmitted ____________________ (only when air is existing／ever).

BOYLE – MARIOTT LAW

Material:
Syringe plastics, 80ml-------------------------1
Manometer--------------------------------------1

If you have found a law you can not only say what the final result will be but also prognose what might happen when you change different factors – in this special case: In what way will the pressure in the air change when changing the volume ?
In 1662 the British physicist and cemist Robert Boyle and the French physicist Edme Mariotte have autonomously worked out the Boyle – Mariott Law which is dealing with gas pressure.

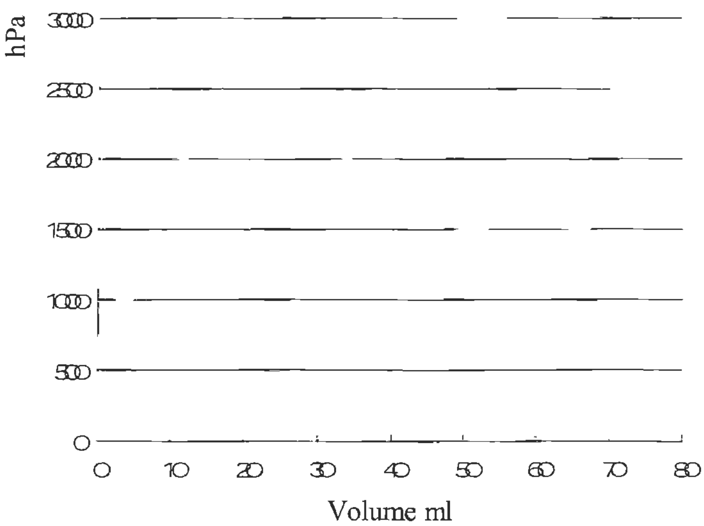
Preparations:
Fix the flask of the syringe at 40ml (frontal black rand) and stick theManometer on the top of the syringe

Experiment:

Hold the Manometer and the grip tightly, pull the piston slowly inside and read off the volume and the pressure.
Fill in the values in belows chart and also mark them in the diagram

Volume ml	pressure hPa
20	
30	
40	1000
50	
60	
70	
80	

Volume - pressure



Conclusion(fill in the gaps):
The higher the volume, ____________________ (the higher / the smaller) the pressure.
The pressure is reacting ____________________ (the reverse way / the same way) the volume does.
It is said: (with constant temperature) p.V=const

DETERMINATION OF THE WEIGHT OF AIR

Material:

Syringe plastics, 80ml--1
Vacuum hose plastics, incl Connector----------------------1
Vacuum chamber complete, 1000ml-----------------------1

Additionally required

Precise digital balance
Weighing range: at least 500g
Resolution: 0.1g

From where is the air pressure coming ? You already know the water pressure – you feel it when you are diving.

The water pressure emerges because of the mass of water. At a water level of more than 1 meter per m , a mass of 1000kg is pressing on 1 m =10 000N／m . At a 10m water column It is already 100 000N／m or 1000hPa.

The air pressure results from the mass of the air. Which mass then have 1 litre (=1dm air) ca.?

Preparations:

Consider the manual how to use the vacuum chamber (screw in the ventilation screw !) Prepare the balance ready for use

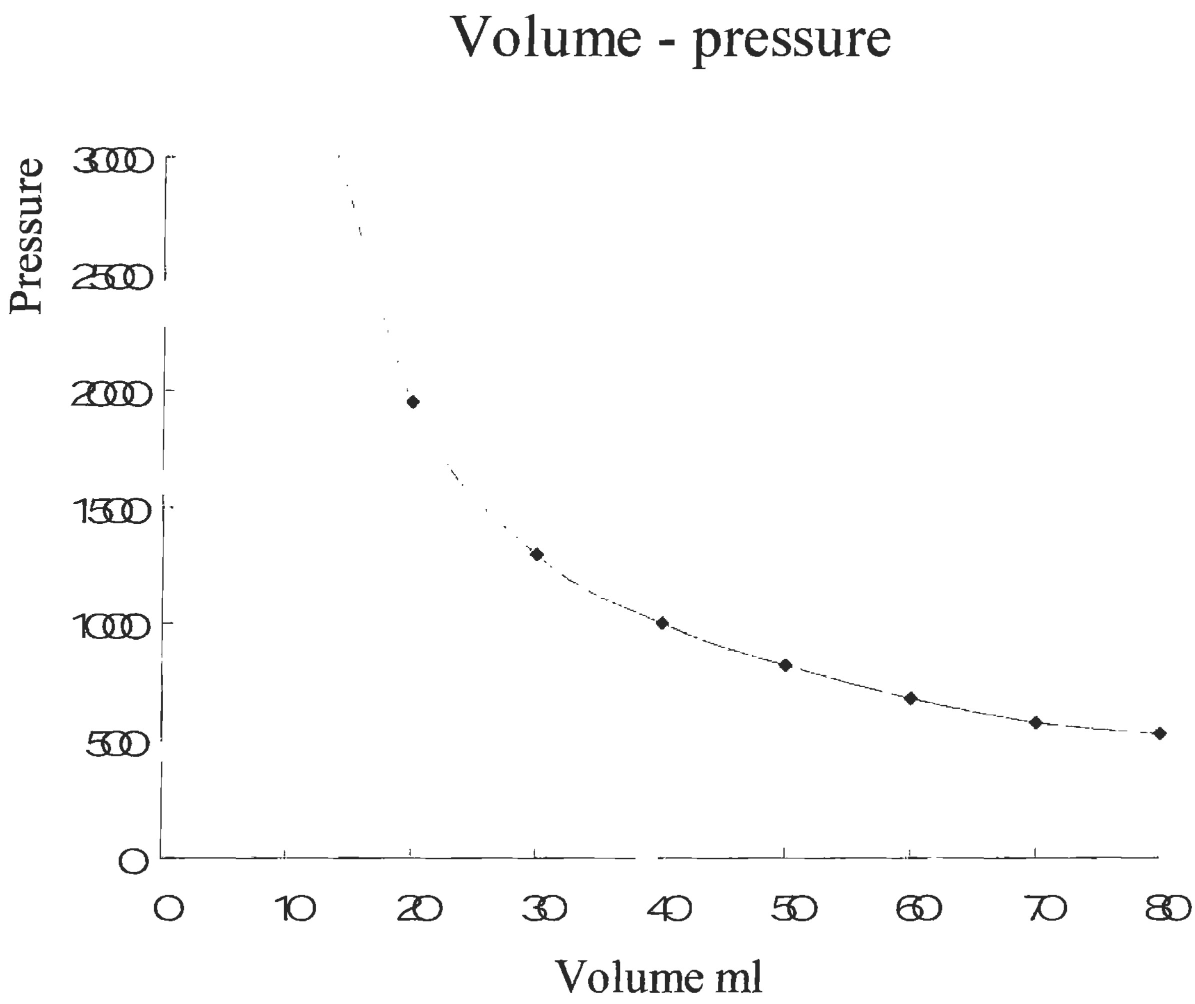
Experiment:

Position the vacuum chamber with attached cover – but without hose – on the blance and read off the mass (also the tare button can be pressed). This is shown on the left picture.

Remove the chamber from the balance, connect the hose and the syringe with the vacuum chamber and evacuate. Finally remove the hose and position the chamber on thebalance again. Read off the mass again – the deviation of the measurements then is the weight of 1dm air. (when having used the tare button before, the indicated value is the weight of air). This is shown on the right picture.

Advice:
Because of the existing air in the Manometer beyond the syringe, the doubled pressure is setting up at 29 – 28ml.

Real measurement example:



Conclusion (fill in the gaps):
The air pressure is based on the weight of air pressing on our earth. 1dm air has roughly a mass of 1g (weight: 0.01N) 1m a mass of 1 kg (weight: 10N).

Advice:
Just like the water pressure, pressure decreases from the buttom to the top. This is the same with the air pressure. But air pressure does not constantly decrease like water for the reason that air can easily be compressed. The mass of 1dm water is nearly ever 1kg, whereas the mass of air scarcely over the earth ground is 1g.

At a residual pressure of 150hPa only 85% of air is evacuated and as a consequence one measures a mass of 0,85 litre of air. A marked chart-value of 1,29g/dm then cannot be achieved in the majority of cases, as one does not execute the experiments at an earth level of 0 m and the temperature is not really 0℃.