EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

RESCIF Réseau d'excellence des sciences de l'ingénieur de la Francophonie

Thermodynamique

Expériences : Potentiels thermodynamiques


Helmholtz

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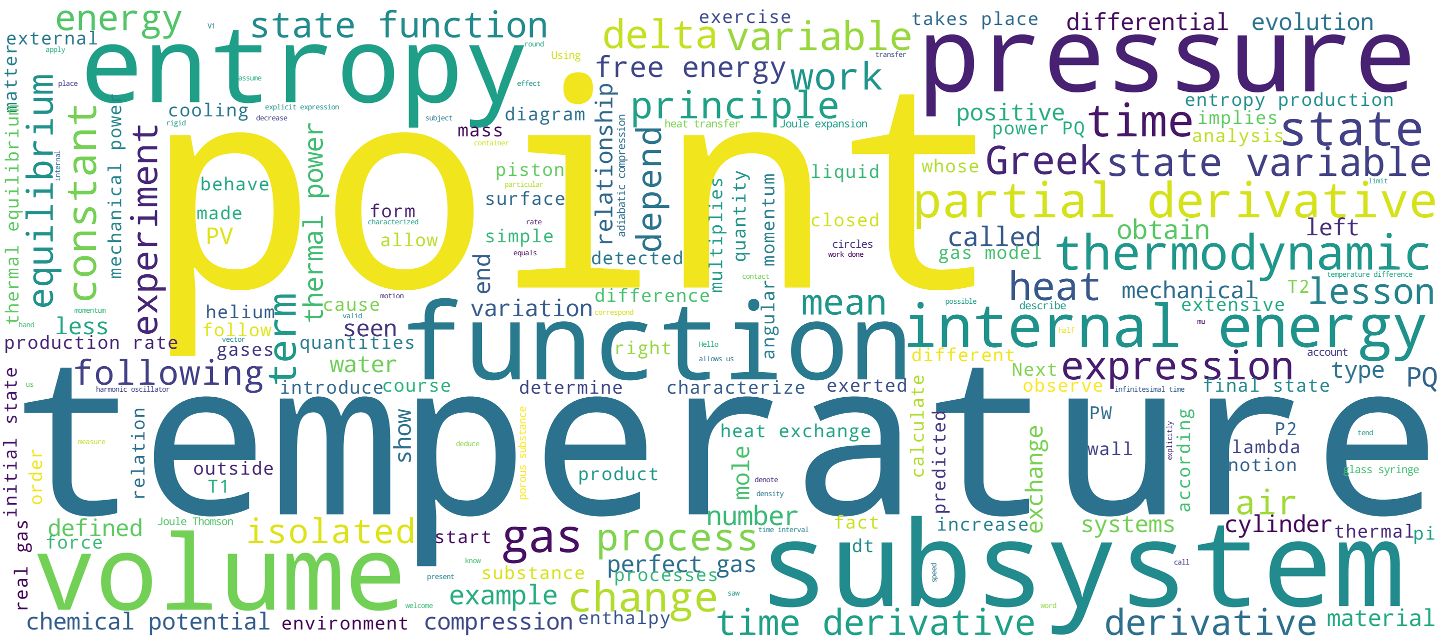
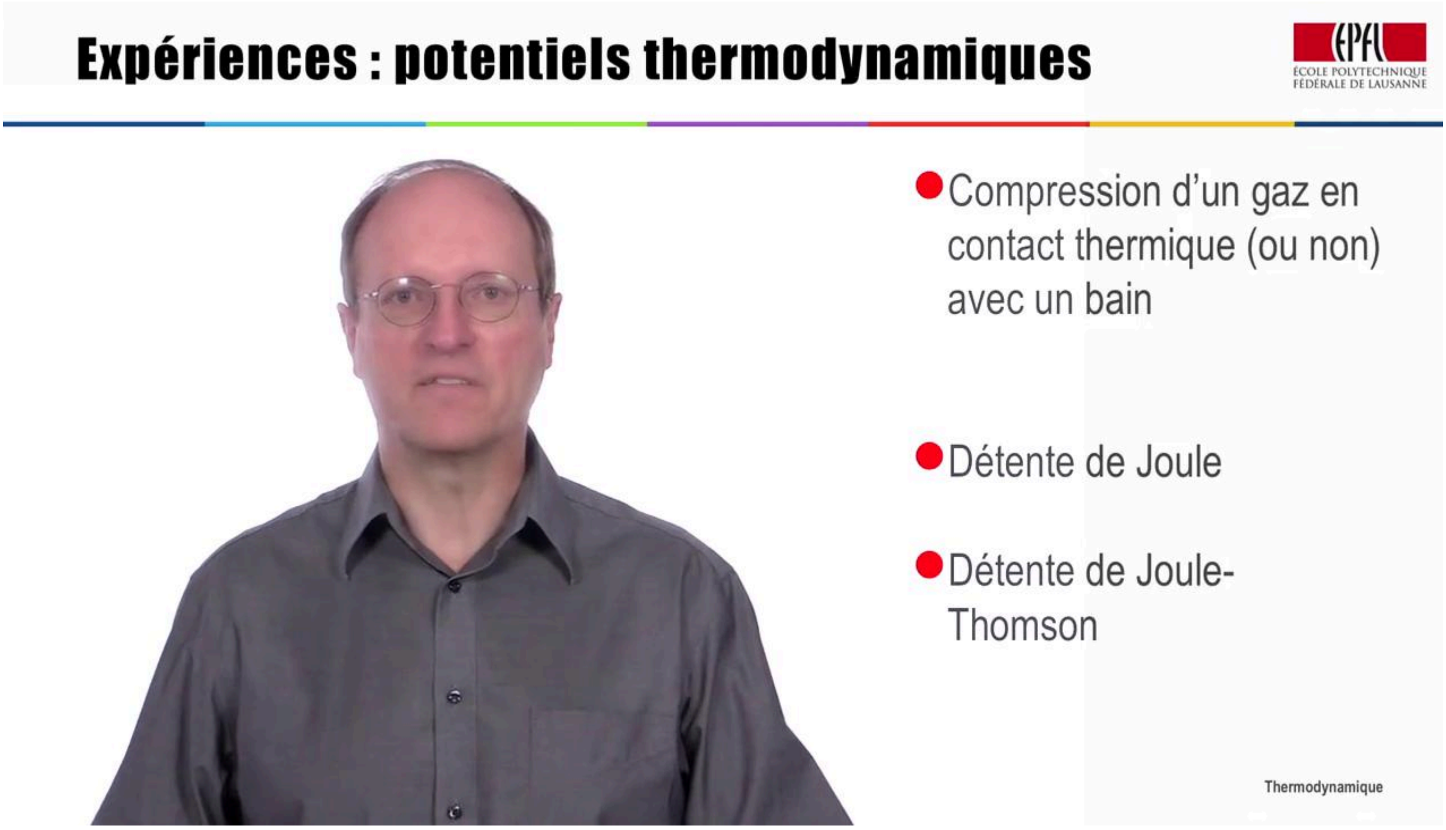


Video

EPFL

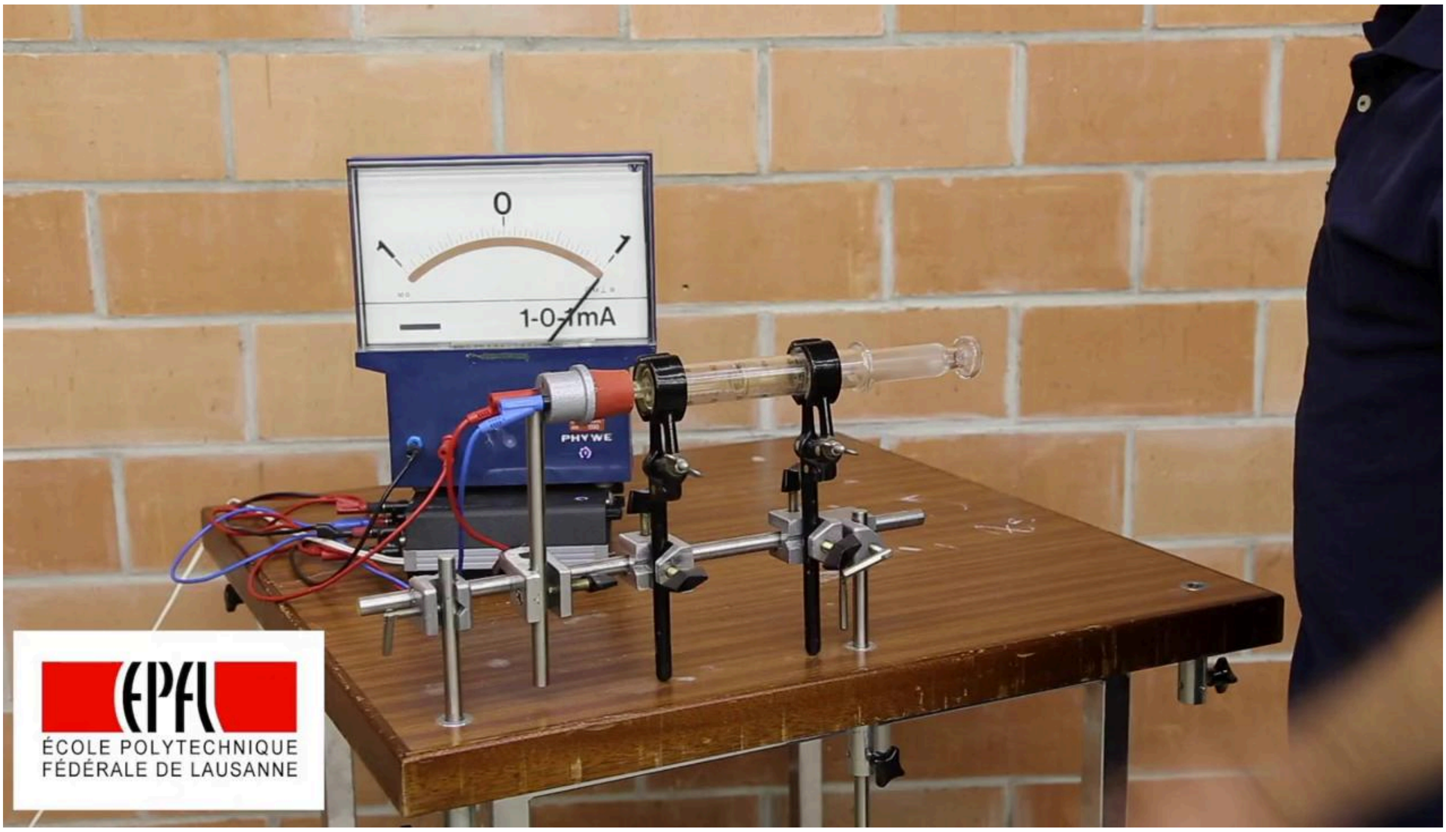


Here I am again to present you some experiences. Like we talked about thermal bath in this lesson, I would like to show you the compression of a gas for which we can suppose whether the thermal contact with the surrounding world is negligible or not. Next, I would like to show you two experiments. Joule's expansion, the Thomson Joule expansion which are the subject of two exercises in this lesson. You will see that with the relationships introduced in this lesson, you can calculate a change in temperature due to a change in pressure or volume according to the characteristic conditions of these two experiments.

Notes

Summary

0m 05s

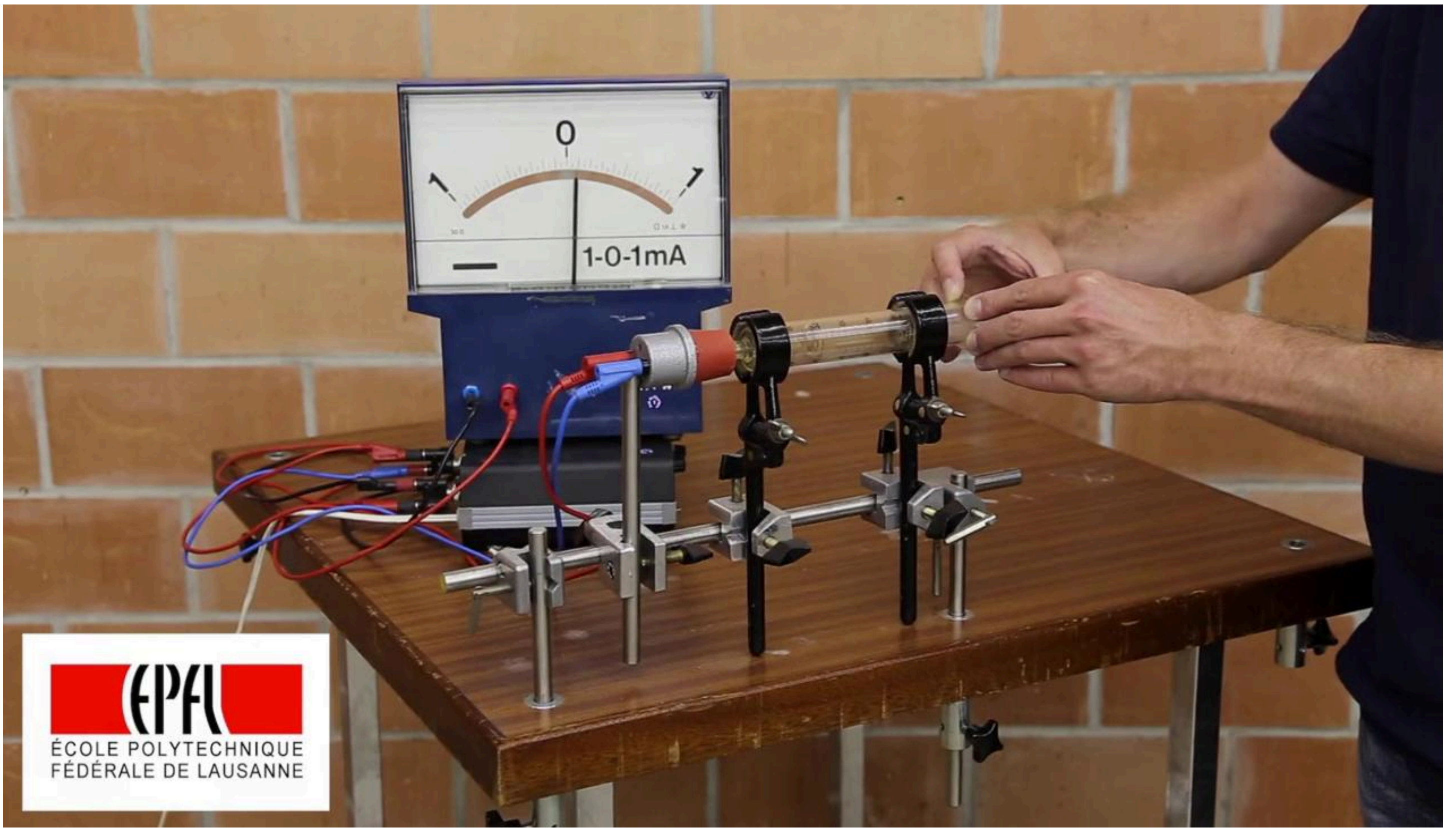


Let's start with adiabatic compression of a gas, i.e. a compression that takes place with. No heat exchange. Zero thermal power observing of air is contained in a glass syringe. Any change in temperature is detected by a thermocouple mounted at the end of the syringe. At first, compression is carried out very quickly, so that no heat transfer is possible. can take place between the compressed gases and the outside world. We can clearly see an increase in temperature.

Notes

Summary

0m 59s

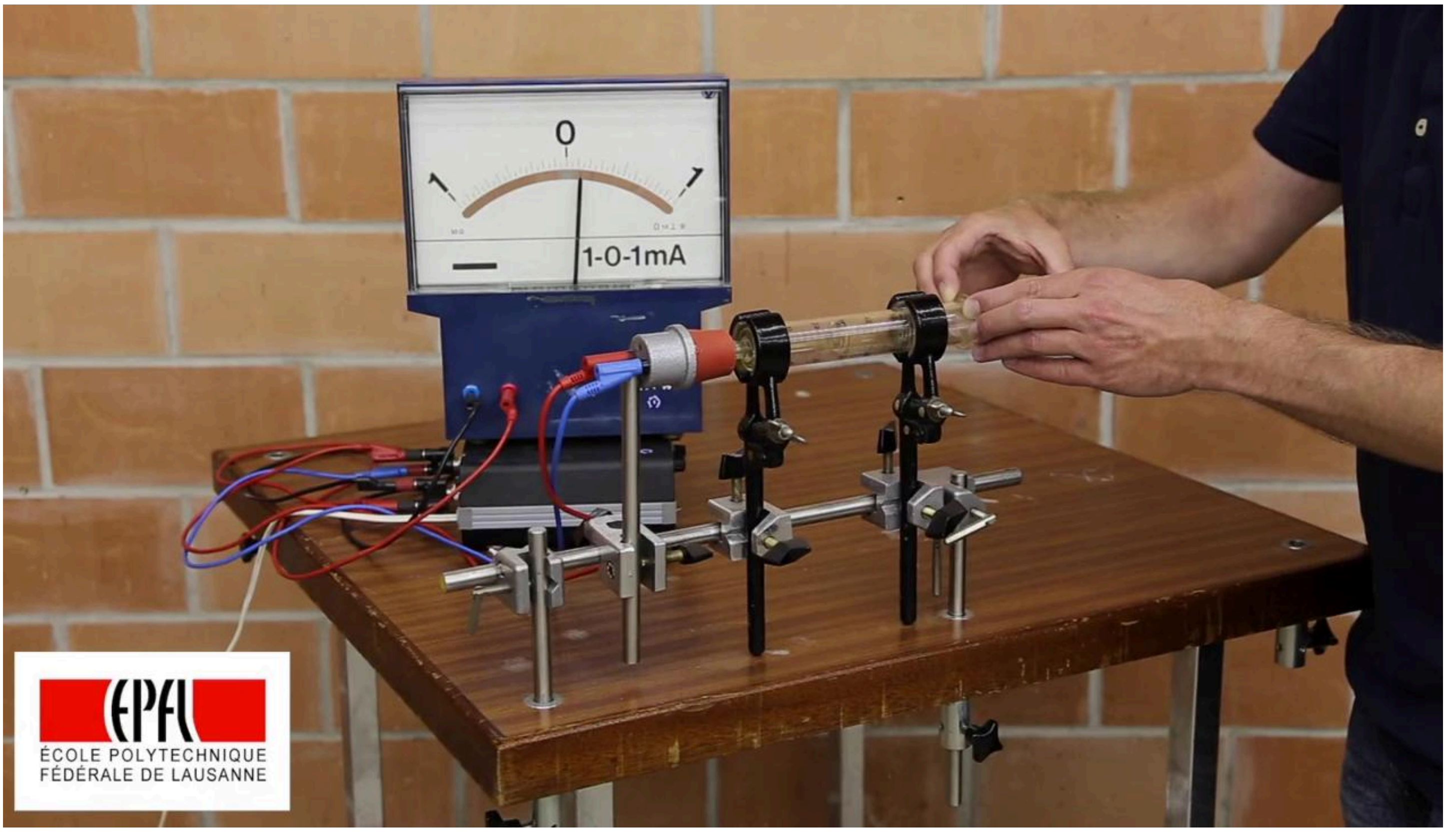


If we compress the gas and leave the piston fixed. What's going on? Observing, we see that the gas heats up under the effect of the compression, then gradually returns to the temperature it had at the beginning, i.e. the temperature of the room. Given enough time, the system will thermally adjust to its environment.

Notes

Summary

1m 36s

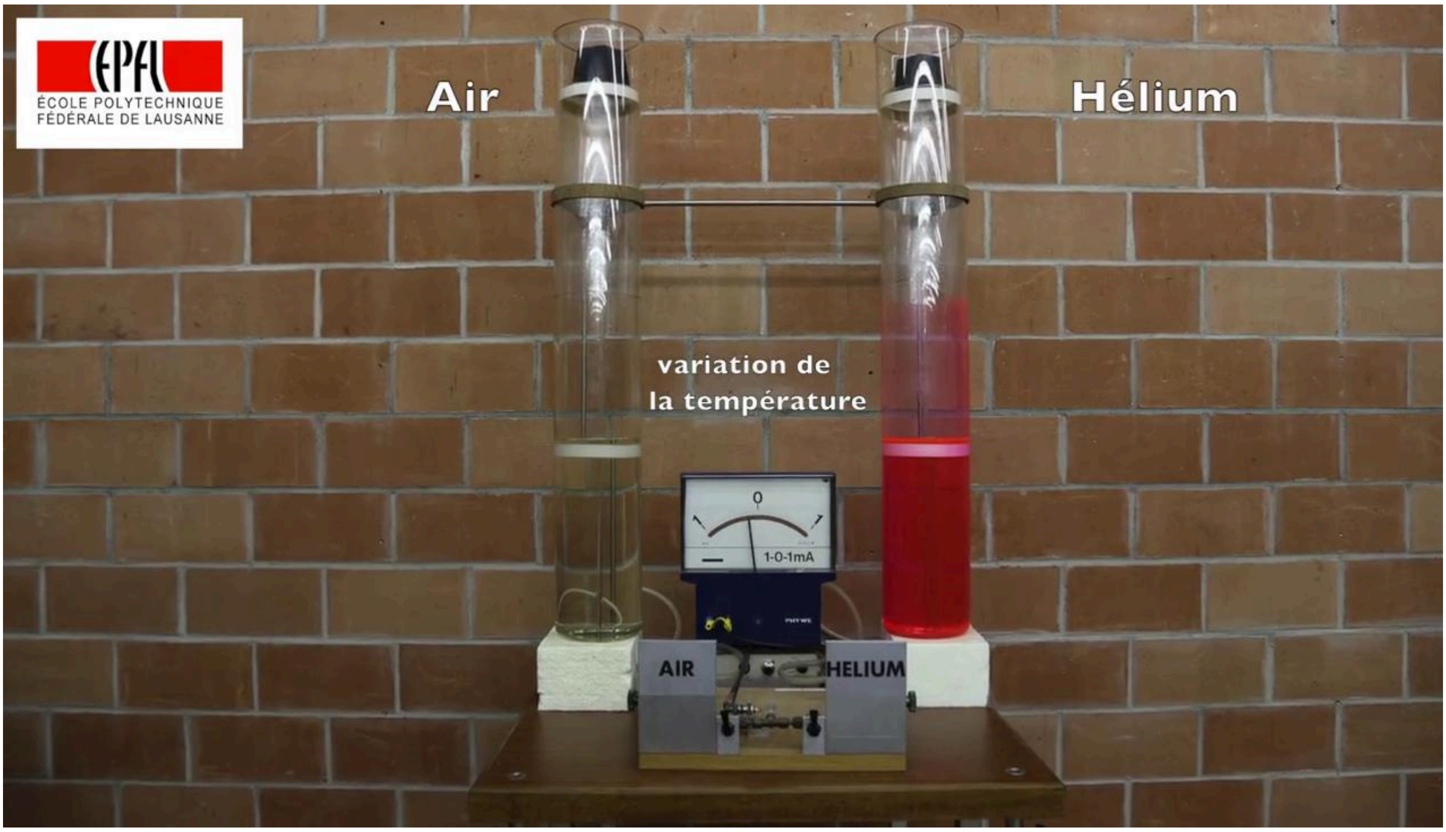


We can therefore envisage a process that takes place so slowly that in At all times the gas is in thermal equilibrium with its environment. The temperature is constant and such a process is called an ISO term process. You will have noticed that after the flow, the piston has advanced and yet the temperature has not changed.

Notes

Summary

2m 04s

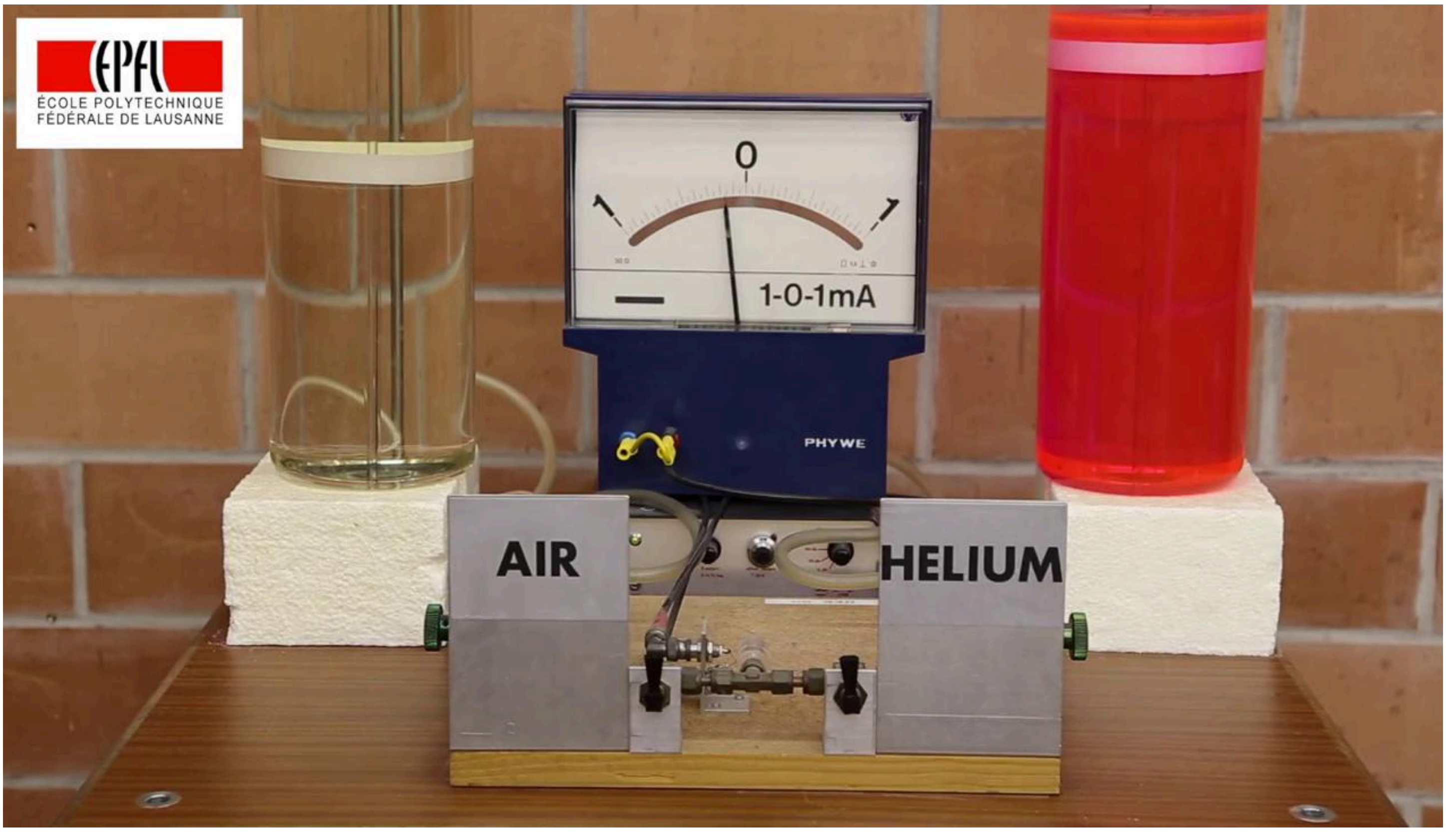


Here is the Joule relaxation experiment. We have here a cylinder in which we will put air at ambient pressure in the upper part. In the lower part, we will make the vacuum. We will then release the ball which will break the glass that separates the two halves of this cylinder and we will record the average value of the temperature detected with the two thermometers on the left. Since the cylinder is assumed to be rigid, no work is exerted on the gas. We will assume that the gas is thermally isolated, then its internal energy cannot change. We observe. That the temperature of the gas does not change when the glass breaks. This is what the perfect gas model predicts. If the objective is to demonstrate that a real gas does not behave exactly as predicted by the gas model perfect, Joule's experiment only allows us to see it with great difficulty. A cooling of the gas of the order of 0.01 per 100 should be detected. The experiment, as it is conceived here, does not allow such precision. On the other hand, the Joule Thomson expansion allows easily to show that a real gas is not does not behave as predicted by the perfect gas model. Here is the principle of the experiment.

Notes

Summary

2m 40s

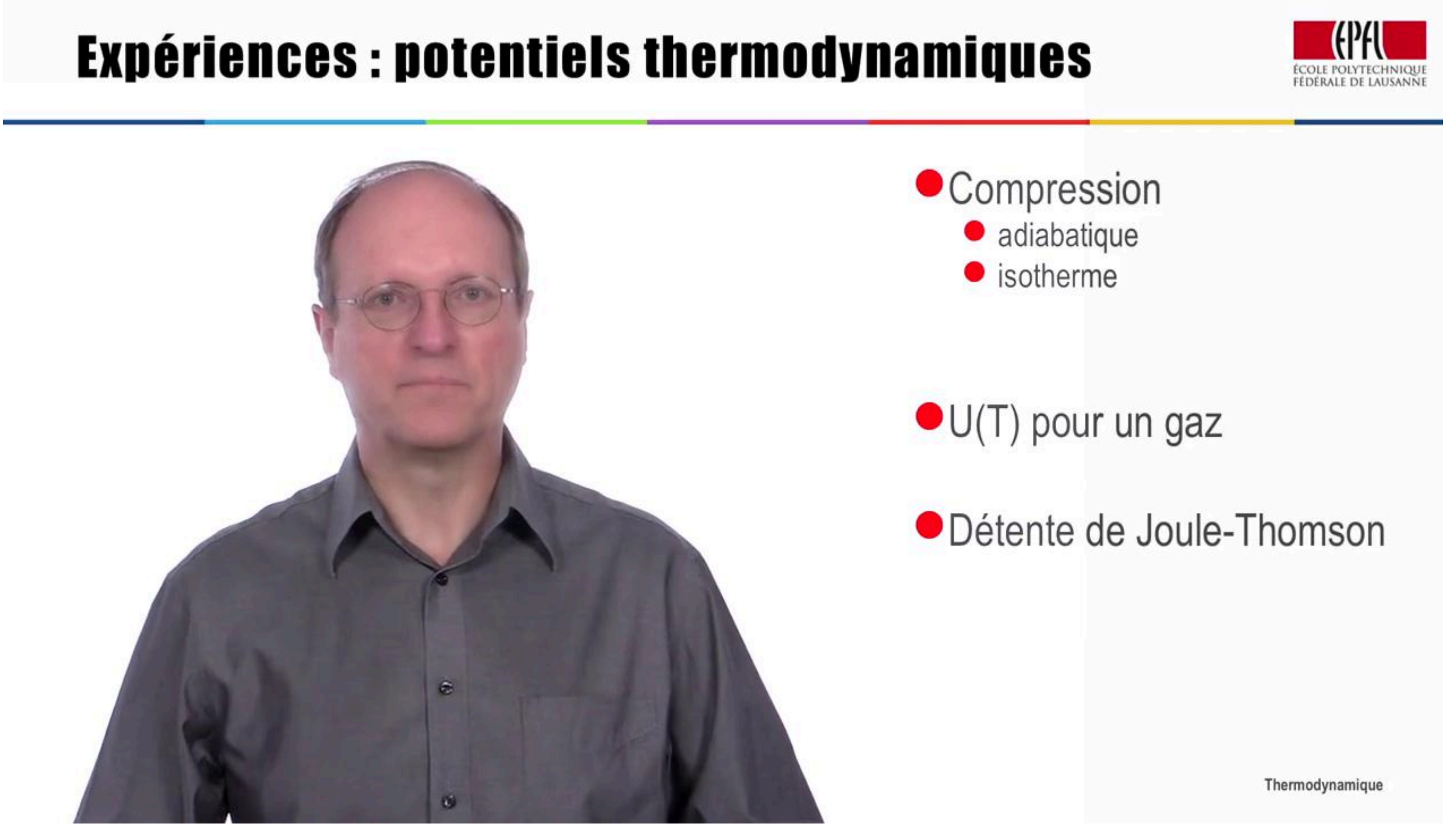


We have here two gases, air and helium. Each one is enclosed in a cylinder turned upside down on a liquid. A steel tube allows access to the trapped gases. We let it diffuse slowly, therefore as much as possible, reversibly, one or the other of these gases through a porous substance. And we measure the temperature difference between the gas just before and just after this expansion. The analysis of the Joule Thomson experiment will be given as an exercise. Here, it is enough to remember an important point if the air or helium is behave like a perfect gas, nothing would happen. What we observe, on the contrary, it is a heating of the helium and a cooling of the air.

Notes

Summary

4m 30s



In summary, we have seen three experiments. In the first one, we made an adiabatic compression or isolated, term of a gas enclosed in a glass syringe. In the second one, we saw that in first approximation. The internal energy of a gas depends only on its temperature. In the third experiment, we have seen that if we receive a real gas passes through a porous substance, you can have either a warm-up or a cooling of this gas and that it depends on the composition of this gas.

Notes

Summary

5m 26s