ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

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

Thermodynamique

Chaleur - Travail

James Joule,
1818-1889

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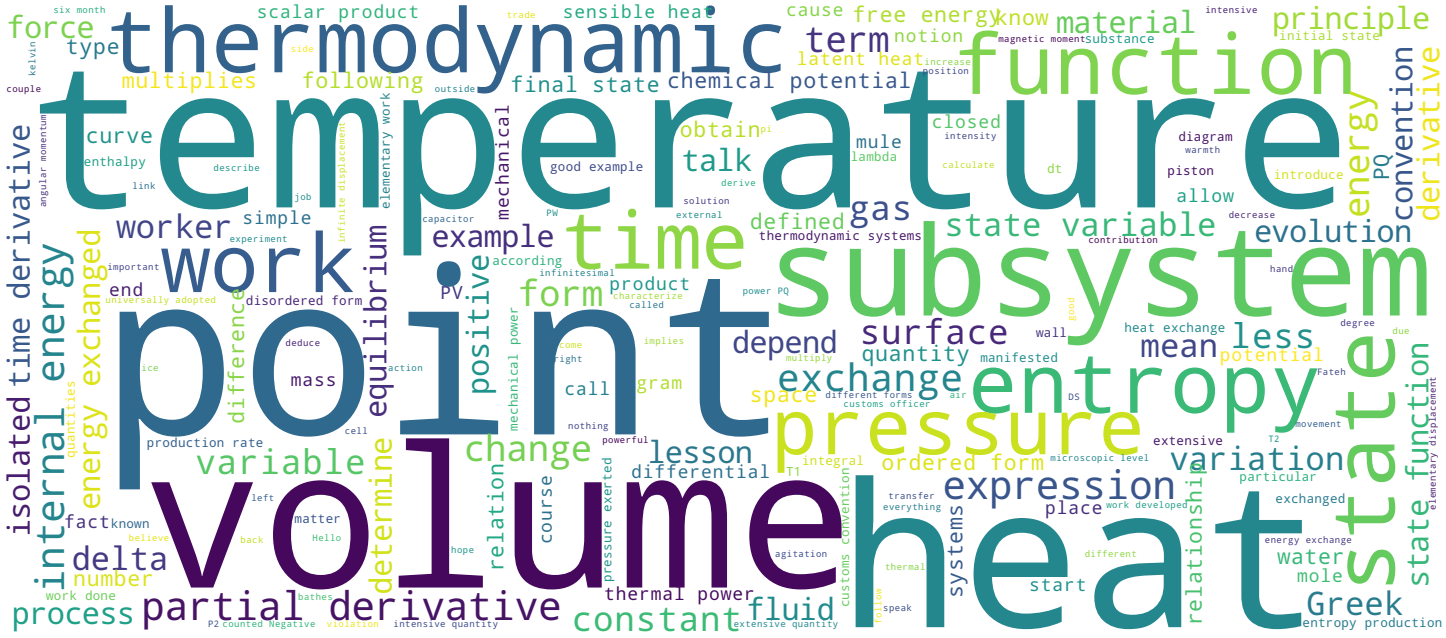

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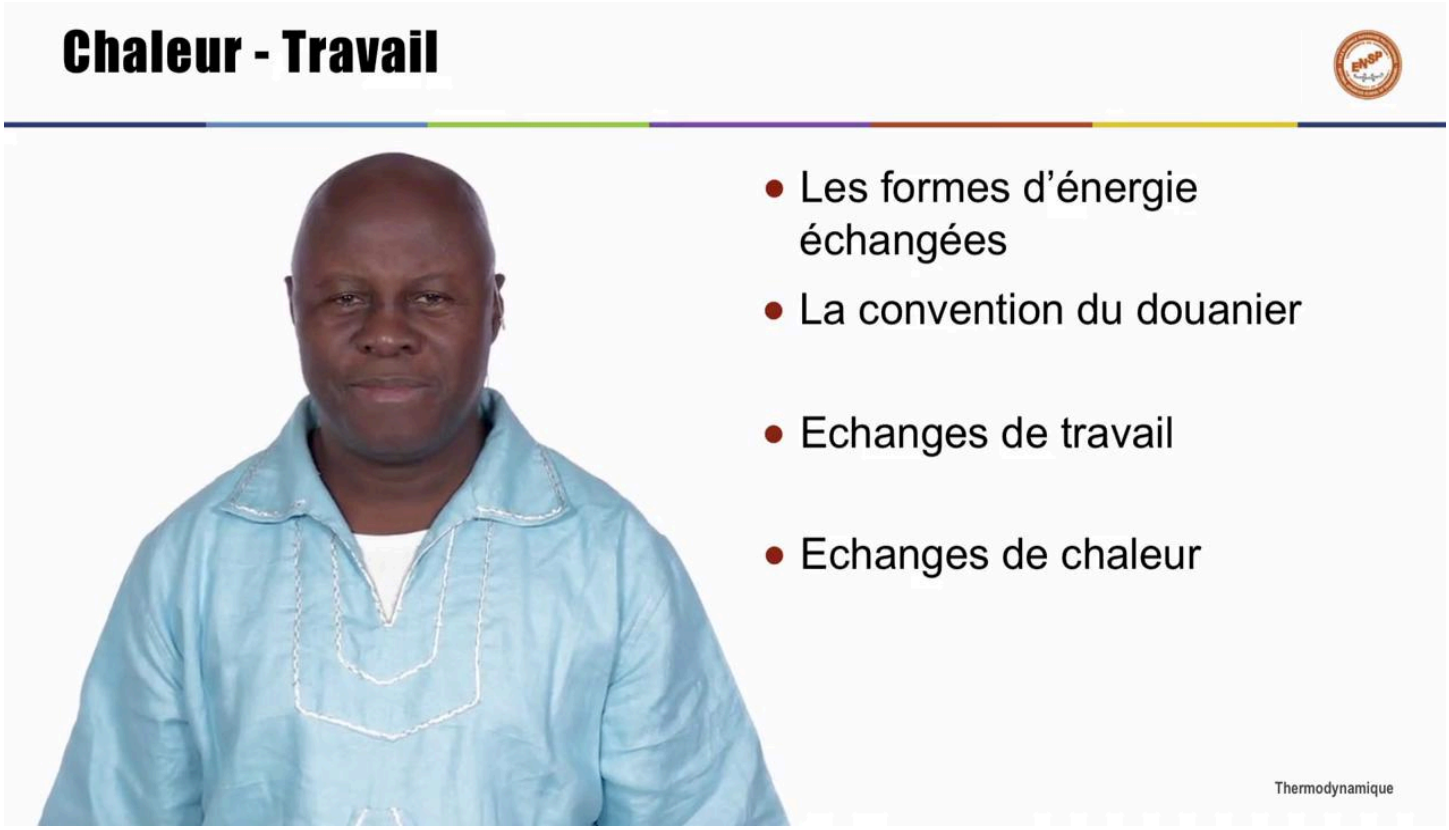


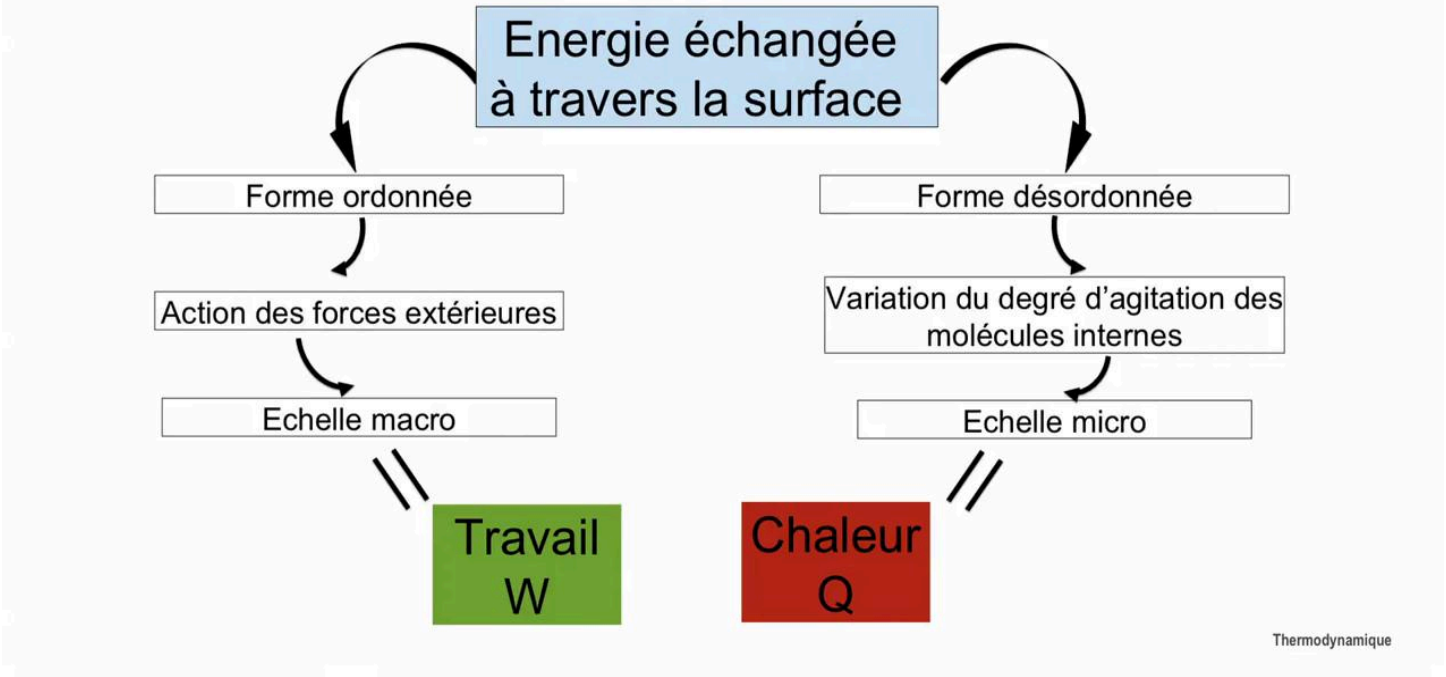
Hello. I have the privilege to bring a new contribution to the keyword thermodynamics thread coordinated by the Swiss Federal Institute of Technology in Lausanne, Switzerland. I am the ingenious Dr. Paul Salomon and as a teacher at the School National Polytechnic University of Yaoundé in Cameroon. If you maintain this faith under the theme. Work and warmth in this lesson. So, we will first talk about form of energy and exchange, as we have already seen across the boundary of thermodynamic systems. We can have material exchanges, but also energy chains whose meaning is the same. Let's talk about the energy exchanges that can take place at the border. Of a thermodynamic system. After presenting the different forms of energy that can take place, we will then introduce the customs convention. A convention that is universally adopted. Who did the assessment? As far as energy fields are concerned, we will then go into detail to describe the exchanges energy in the form of work, including seeing how this form of energy exchange can be evaluated and analyzed. We will talk about of the fields released in the form of heat and give some methods and determination of quantities of energy exchanged in the form of heat.

Notes

Summary

0m 05s

Les formes d'énergie échangées

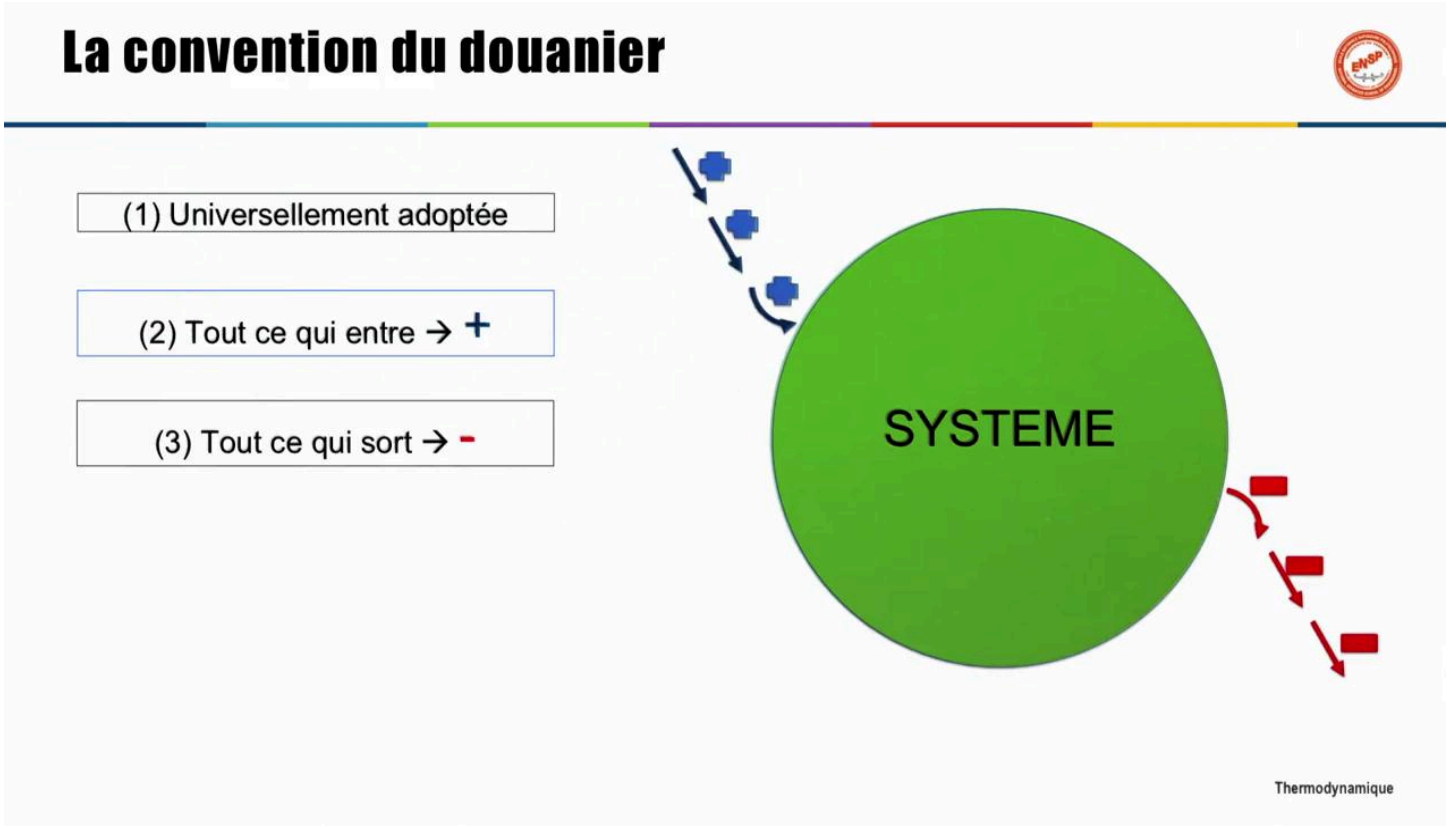


Let's start by exchanging them on the surface of a thermodynamic system. There are two different forms of energy exchanged between the medium and the system, and this through the surface of the system. First, we have an ordered form of energy. Obviously, on the other side, we have a disordered form of energy. The ordered shape is due to the action of the forces R0, the system. While the disordered form comes from the violation of the degree of agitation of the molecules internal to the system. For the ordered form, we will mainly talk about the action at the macroscopic level. While the disordered form simulates effects that take place at the microscopic level. The ordered form is therefore called work and the ordered form heat. We recall this and we saw it in a later lesson. The thermodynamic system does not have work, the thermodynamic system does not have heat, but work and heat are energies that arise when an exchange between the system and the middle gives way leading to the convention of the customs officer.

Notes

Summary

1m 51s



Remember that this is a convention that is universally adopted. This is how it is done in all customs and this is the case in all thermodynamic systems. So what does this agreement say? Firstly. When we have a system here. Everything that enters the system is counted, positive. And everything that comes out is counted. Negative. This is the convention of the customs officers and this convention is applied for any good year system. When people plowed after Yola, the system, that's where we are positive. But when it is known that the systems, it is that counted, negative, it will be the same if there is a contribution of material or a transfer of material to the system. Afterwards, in the customs convention, we will move on to work exchanges through the surface of the thermodynamic system.

Notes

Summary

3m 20s

Echanges de travail

- Définition du travail

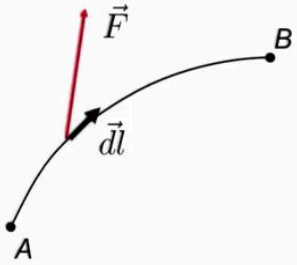
Travail élémentaire : $\delta W = \vec{F} \cdot \vec{dl}$

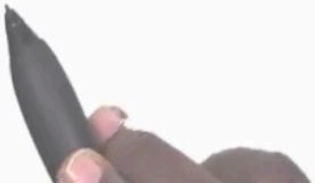
Travail pour un déplacement fini : $W = \int_{AB} \vec{F} \cdot \vec{dl}$

Cas de force dérivant d'un potentiel Φ: $\vec{F} = -\overrightarrow{grad}\ \Phi$

$$\Rightarrow \delta W = \vec{F} \cdot \vec{dl} = -\overrightarrow{grad}\ \Phi \cdot \vec{dl} = -d\Phi$$

$$\Rightarrow W = \int_{AB} -d\Phi = [-\Phi]_{\Phi_A}^{\Phi_B}$$





Thermodynamique

First, let's define work. Let's consider a path, an origin curve, one of these trades B and which bathes in a space where reigns a SandForce SF. This means that each point of this curve. We can define a force F. It depends of course on its position on the curve. Now suppose that this force performs an elementary displacement dl. So by definition, the basic work developed by the fork for these elementary displacements is given by d w and f scalar dl a scalar product. Now, if we want to determine the work done by the force during an infinite displacement in the curve from A, B is the work for these infinite displacements and W equal to the integral G ab of the elementary work escalation DN1. Now, if we consider the case of a force which derives from a potential FI, well, the relation which links the force F with the potential and F is equal to less than. In fact, if we use in this expression of F in the elementary work, we have. The term element tw which is equal to FDN is equal to less than fiscal, editor's note. We recognize all that is scalar product and nothing else that the wire differential had left six months which is the opposite. We have therefore d w to less challenge in the work.

Notes

Summary

4m 22s

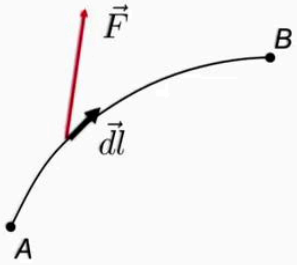
Echanges de travail

- Définition du travail

Travail élémentaire : $\delta W = \vec{F} \cdot \vec{dl}$

Travail pour un déplacement fini : $W = \int_{AB} \vec{F} \cdot \vec{dl}$

Cas de force dérivant d'un potentiel Φ: $\vec{F} = -\overrightarrow{grad}\ \Phi$



$$\Rightarrow \delta W = \vec{F} \cdot \vec{dl} = -\overrightarrow{grad}\ \Phi \cdot \vec{dl} = -d\Phi$$

$$\Rightarrow W = \int_{AB} -d\Phi = [-\Phi]_{\Phi_A}^{\Phi_B}$$

$$W = \Phi_A - \Phi_B$$

Thermodynamique

Along A.B is the integral on AB is less the challenge. This is what the lesser made learn between them. A and B entrusts one of its affiliates whose potential work is given by W, a, B and K. The potential in less potential a B. We will now determine in a particular case, the work done during the expansion of a gas.

Notes

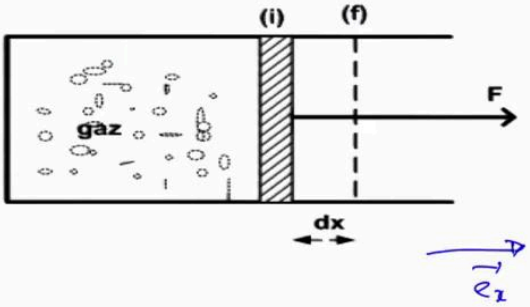
Summary

6m 05s

Echanges de travail

$\delta W = \vec{F} \cdot \vec{dl}$
$= F \vec{e_x} \cdot dx \, \vec{e_x}$
$= F \, dx$

- Travail de détente de gaz



$$\delta W = -P_{ext} \, dV$$

Thermodynamique

We will consider whether a gas that is in an old smoke. And whose orifice is closed with a mobile piston. Obviously, we will consider that the volume of this gas varies thanks to the action exerted on the piston by a worker, a technician, a physicist, a manipulator. This is the. Good. The powerful will not reach the state initial state or is currently in a final state f, et cetera. A shift of X's from the initial to the final state. Go back for these infinitesimal displacements dx work and change a little the system which is the gas and the mixture. That is to say what worker and form BDW there is less serious PR BV or PS? And the pressure exerted by the worker is dv and the volume value of our system is. So it's work. Developed by the worker or the work exchanged between the worker and the environment. The system is given by. W's. There is the F. D.L. This was the initial definition of elementary work. Well if we orient the space, not the X in movements. In this sense, if we have the F which is equal to a module f carried by x and the scalar product with dl which is nothing but x for the start x. I had the material in the form f, everything multiplies X.

Notes

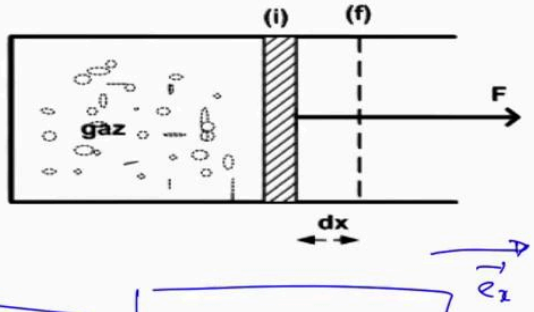
Summary

6m 36s

Echanges de travail

$\delta W' = \vec{F} \cdot d\vec{\ell}$
$= F \vec{e_x} \cdot dx \vec{e_x}$
$= F\, dx$
$P_{ext} = \frac{F}{S} \rightarrow F = P_{ext} \cdot S$
$\delta W' = P_{ext} S \cdot dx$
$= P_{ext} \cdot dV$
$\delta W' = P_{ext}\, dV$

- Travail de détente de gaz



$$\delta W = -P_{ext}\, dV$$

Thermodynamique

We will now involve the external pressure exerted by the worker. We know that the pressure exerted by the outside worker. Is related to the force F and at the surface of the piston by the solution of write equal to f on S, we deduce. In a ditch, it does not know the worker outside. What multiplies s. And back to the expression of work elemental which is of a large F, that is to say external. Does it multiply X's? Remember that this is the work of the UMP in Louviers. If we want to have the work received by the system, so we will have less wind well in the developed work, not the worker we have at STX. Now, if we consider this diagram, the surface of the piston multiplied by its movements will give him the variation of the volume. On the other hand, the GAS system. In this space, it becomes clear that multiplies the violation of the elementary volume of the volume. W's. He doesn't know. Louviers and the outdoor water glass couch is on the side of the system. The motor work being equal to the existing work. So we have the W system. Less. This one, we can say that we can call this w pim in the work of the worker in the d w to less d w feather in less time. In this expression, work is generalized. Whether the system is gaseous, whether it is linear or volumetric-surface.

Notes

Summary

8m 32s

Echanges de travail

- Généralisation de l'expression du travail échangé : quelques applications

Déformation ou évolution	Travail élémentaire
Linéaire	$\delta W = \vec{F} \cdot \vec{dl}$
Surface	$\delta W = A \; dS$
Fluide (Volume)	$\delta W = -P \; dV$

We will thus speak about the deformation of the evolution to which we will find the elementary value of the extensive quantity. And. We will give the expression of the work more than to these linear displacements. Good example is a strength. In the time those great leaders who perform. A displacement of the wings. The very definition of humanitarian work made us aware that the FDLR, whose size we tried to intensive, these are the French of extensive grandeur. If we consider any surface. Which undergoes a glenda surface tension. The tension has grown in intensity. The surface s. Indeed, this, under the effect of this tension, sees its dimensions evolve. So the club will exchange this surface and to mix it in his eyes to this evening of the Formula one DS. In the case of a plow fire set up while on time for work and turn off a gas. We have the impression of the fluid that causes the volume of fluid and we know that. After that, the volume will go in the opposite direction. If we increase the pressure on the fluid, only the pressure against the fluid, the volume will decrease. But if we relax, the fluid and therefore we drop impulse, or we pull the powerful in the direction of lowering the pressure.

Notes

Summary

10m 28s

Echanges de travail

- Généralisation de l'expression du travail échangé : quelques applications

Déformation ou évolution	Travail élémentaire
Linéaire	$\delta W = \vec{F} \cdot \vec{dl}$
Surface	$\delta W = A\ dS$
Fluide (Volume)	$\delta W = -P\ dV$
Angulaire (couple)	$\delta W = c\ d\theta$
Electrique (modification de la charge)	$\delta W = \Phi\ dq$
Magnétique (modification du moment)	$\delta W = B\ dM$

Thermodynamique

Fluids, but the volume will increase every six months. In the case. Of a couple, therefore it provokes. A variation of the angular orientation. For example, of a twisting wire jams slightly. The couple is the intensity factor. The more you cut the whites, the more the fire will twist. And lots of them including English and French. Tensions in the workplace. In this case, a stopwatch is not the product of the intensive quantity with the variation of the extensive quantity. If we now consider the case of athletic work, in particular the modification of the mixing passages in a capacitor which is subject to a potential fit the chase evolving from DQ. The work or energy accumulated in this capacitor is a code of the form PHI that multiplies DQ and last cases. This is the case of a work due to the variation of a magnetic moment. We have thus that magnetic which bathes in a field of intensity B. The presence of this field causes the magnetic moment to change by a magnitude DM. Such as the energy associated with this magnetic field or this evolution. Only the form. B times DMB. The Fateh and the Fateh of the stations. Well after the exchanges or the exchange, We will now talk about heat exchange.

Notes

Summary

12m 08s

Echanges de chaleur

- Définition de la chaleur:

Energie échangée entre le système et le milieu extérieur due à leur différence de température

Transmission, au niveau microscopique, de l'énergie d'agitation (E_c) des molécules du corps plus chaud vers celles du corps moins chaud

- Condition d'existence :

Si et seulement il y d'échange d'énergie

- Remarque:

Le système ne possède ni chaleur, ni travail

Le milieu extérieur non plus ! ! !

Thermodynamique

First, let's define what we mean by heat or warmth. We have said that the system does not have heat of work. When an exchange between the system and the cell environment. Well, the heat, it is this energy exchanged between the system, its serious because of a temperature difference between the two. It's intuitive and very simple. Well, we specify that this heat exchange, which is due to the difference between the two bodies, is manifested at the microscopic level by the agitation of the kinetic molecular energy of the different molecules of the hottest body. In the hollow bone, a body has a greater agitation and more important in the molecules of the most excited body. From the microscopic point of view, therefore, transmit new energy to the strongest body, and it is this energy exchanged in the whole in the form of heat, water specifying that heat only exists. When there is a difference in temperature between the two streams, between the scrum system and other GTMs. The system has no heat. The system doesn't even have a job and the mule doesn't have a job. It is Laval, they say. What during the exchanges between the system and the mule, it is very good. This definition of the notion of heat romana brings a precision. On the typology related to heat.

Notes

Summary

13m 50s

Echanges de chaleur

- Typologie des chaleurs :

* Chaleur sensible :

Variation de T

Ex. : 1g d'eau qui se refroidit

* Chaleur latente :

Changement d'état

Ex. : 1g de glace qui fond

$$\delta Q = mcdT$$

c en $J.kg^{-1}.K^{-1}$

Thermodynamique

But in terms of typology, we distinguish two heat centers, a sensible heat. Which is manifested by the waltz of the temperatures. And this is the case, for example when one gram of water has to cool down and 50 grams of water. Well the heat mixed with and the temperature of this water range varies. Here we have a sensible heat. The second type of heat is latent heat. This one is the system, the mule, the cell without temperature variations. This is manifested by a change in the state of the system. A good example is a gram of ice that melts. It is known that the range of ice melts present at zero degrees that it has its melting temperature during the entire melting process. During the entire change of state, the temperature remains constant, the temperature is constant and the system changes state instead, from a solid state to a liquid state for this which is the case of the ice of the sensible heat. We have time. We had the comedy equation for summer innovation. System temperatures. The solution given by mc dt or mc. The mass of the system is its heat capacity. This calorific capacity is given one day per kilogram and per kelvin. This is the expression of the elementary sensible heat exchanged between the cell system.

Notes

Summary

15m 37s

Echanges de chaleur

- Typologie des chaleurs :

* Chaleur sensible :

Variation de T

Ex. : 1g d'eau qui se refroidit

$$\delta Q = mcdT$$

c en J.kg^{-1}.K^{-1}

* Chaleur latente :

Changement d'état

Ex. : 1g de glace qui fond

$$\delta Q = Ldm$$

L en J.kg^{-1}

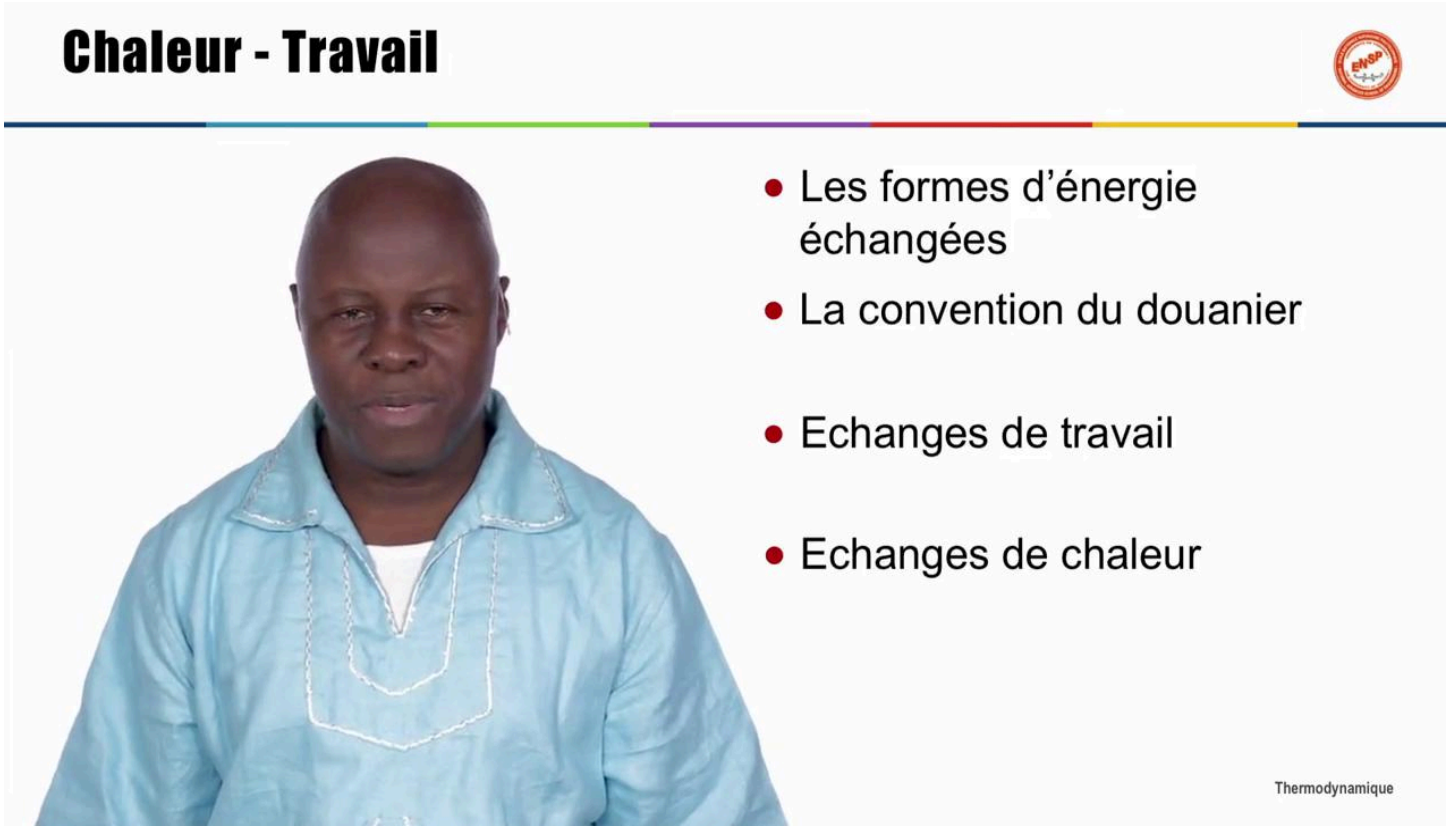
Thermodynamique

As for the latent heat. We have. The expression DQ equals LD M. Grinding wheels show the elementary quantity of material of the CCM that changed the state and it represents the heat, the mass heat of change of state. This heat so slightly called latent heat. Of state change to call it, although we speak of latent heat, is sensitive. The latent warmth in the details gave a nice step you'll get.

Notes

Summary

17m 17s



At the end of this lesson. We hope you have mastered the form of energy that can be exchanged. Between these according to us. Let's also hope that you master now the customs convention, very useful in the calculation of trade but also and above all in energy balances. Not only for thermodynamics, but in general for the physical system. We also believe that you have had clues to help you calculate or determine the quantity of energy exchanged in the form of of cell intercellular, but also the amount of energy exchanged in the form of heat through the surface of thermodynamic systems. I thank you for your patience and your attention throughout this lesson and I believe I can count on you for the following lessons. Thank you.

Notes

Summary

17m 56s