The device is theoretical

1/ Goal:

Give an example with a pure theoretical mechanical device where the sum of energy is not conserved to break the law of the conservation of the energy.

2/ Method:

I study the sum of the energy during a deformation of a device, the device doesn’t return to the start position. Even during a deformation, the sum of energy must be kept constant. I give the calculations for a small and for a big angle.

3/ Simplifications:

- no mass, all components have a mass at 0
- no friction
- the force of the springs is constant, doesn’t depend of the length of the spring
- the springs have no volume
- no gravity

In theory, I’m not limited to the size of the atoms and I can take the walls thin like I want. With limits I can cancel some problems.

Sure, the device works with mass, gravity, and a realistic force for the springs but the calculations are more complex. The volume of the spring is a problem but it is possible to think with only a layer of spheres for the device and the springs outside.

4/ The device is unstable:

The device needs another external device to control it. All must be controlled: walls, spheres, springs, etc. That external device controls but measures in the same time all the energies out/in. That external device is not drew. In the description I didn’t speak about that external device, I suppose all is needed to do to deform the device is done by that external device.

5/ What the device needs :

- a gradient of pressure
- the source of the gradient must be on the device
- move out/in some parts and a rotation
- an white shape (an empty object) not attracted by the springs
- an arm in rotation that take the object not attracted with asymmetric position relatively to the axis of the arm
- buoyancy force must act on some objects

I need a gradient of pressure, for that, I use small spheres and springs. Small spheres are like molecules of water and the springs attract like gravity can do. I can't use the gravity and a fluid like water because the source of attraction must move in the device and it is not possible on Earth, I done calculations for a device with water under gravity and it doesn't work. Molecules of water have a mass but I don't need mass so like that can simplify the calculations I take the mass at 0 for the spheres. One end of the springs is fixed on the green line (the bottom wall) the other end is fixed in the center of each sphere. There are a lot of spheres like there is a lot of molecules of water in the glass of water. I gave the force of the springs in N/m^3 like that if I change the size of the spheres that doesn't change the results, the volume is the volume of the sphere attracted by a spring.

6/ Spheres packing:

I didn't take in account the spheres packing. In standard, the coefficient is 0.74 if there is only one size for the spheres. If I take only one size for the spheres, all the results I gave need to be multiplied by 0.74. But it is also possible in theory to filled the container with different diameters of the spheres. Like the force of the springs is in Newtons by a volume, the results are the same than mine.

7/ Springs:

Each spring has a potential energy, F*Lg with F the force of the spring, for example, F=1e-15N for a volume of a sphere of $1e\text{-}15m^3$, Lg is the length of the spring. The force of the spring is supposed constant. If I change the length of the spring I change the potential energy of the spring. If the length of the spring increases then the potential energy stored in the spring is increased. If the length is decreased then the potential energy is decreased. The springs pull.
The orientation of all the springs is the same at a time but change when the device is deformed. I symbolized the orientation of the springs with the red line in the drawings. Like that, I can use the law of pressure of a fluid in a gradient of pressure (like water under gravity for example), it is easy, I don't need to calculate all the forces for each sphere.

8/ White shape :

To be forced to move out and move in something, I use an object (white color). You could imagine the object like polystyrene, but I take the mass at 0. It is possible to imagine the object empty too.

9/ Buoyancy force:

Like an object in water under gravity has a buoyancy force (Archimedes), it is the same here. Especially for the spheres, each sphere has 2 forces on it. One force from the spring, the other from the others spheres all around (buoyancy force). The sum of forces on each sphere is 0 N. So when the springs change their length, it is impossible to recover that energy (or give an energy for that). The white shape has a buoyancy force too, it will give a counterclockwise torque on the black arm.

10/ Time:

Like there is no mass, the device is more unstable than with mass. All movements could be done with a duration of 0. So, the external device is there to cadence the movements. But at each time:

- the orientation of the springs is the same
- the orientation of the black arm is like the lateral walls
- the volume of the container is constant at 1m³
- the container is always filled at 1m³ (filled with the white shape and the spheres)

11/ The device is composed of:

- a container, the volume is 1m³, the walls are perfect, the depth (perpendicularly to the screen) is 1 m
- spheres: very small like molecules of water, but without mass nor friction, the spheres transmit pressure perfectly, in all direction
- springs: one spring for each sphere, no volume, no mass, the force is constant (doesn't depend of the length of the spring)
- white shape: empty, no mass, walls are perfect
- axes of rotation: no friction

12/ Geometry:

I used an arbitrary geometry: a parallelogram (side view) but it is possible to change it. I deform the parallelogram to a square (side view), again it is arbitrary. It is possible to use another shapes. In 3 dimensions, the device is a parallelepiped and it is deformed to a cube, the depth is perpendicularly to the screen. The white shape is an arbitrary geometry.

13/ Size of the elements:

No matter the size of the spheres :

The volume of the container is 1 m³
The volume of the white shape could be like example at 0.01 m³

First case: realistic dimensions

The radius of one sphere could be at 1e-5 m
The thickness of walls could be at 1e-7 m

Second case, like the device is theoretical it is possible to have:

The radius of one sphere could be at 1e-100 m
The thickness of walls could be at 1e-80 m

14/ Orientation of the springs:

To have the right to use the simplified formulas of a fluid under a gradient of pressure I need to have the same orientation of the springs. Like the white shape moves inside the container differently the blue spheres, I need to move out/in the blue spheres.

15/ The walls:

I supposed the walls perfect. No friction to modify the shape of the walls. The walls are perfectly waterproof, I mean nothing can pass through the walls. In theory, it is possible to take the thickness of walls at 1e-100 m if it is necessary.

16/ Create/destroy the energy:

The device I used destroys the energy, but it is possible to deform the device from end to start like that the energy is created.

17/ Colors used:

- red : orientation of the springs
- blue: small spheres, so small I drew them like water, a full color, blue color
- green (bottom wall): wall where all the springs are attached
- purple: the external walls of the container (only in the first drawing)
- black: the arm that takes the white shape

18/ Writing conventions:

- I write ‘up’ or ‘down’ it is relatively to the screen because there is no gravity
- the depth is perpendicularly to the screen, it is the geometric depth !
- all views are side view (except if I wrote something else)
- units are SI
- angles are relatively from the horizontal
- I gave the integrals in positive values but I indicate if the energy is positive or negative

19/ Drawings conventions:

I needed to take choices. It is impossible to draw all spheres ! And even less the springs ! So I didn’t draw the springs, and I drew only a color for the spheres, like I could do for water.

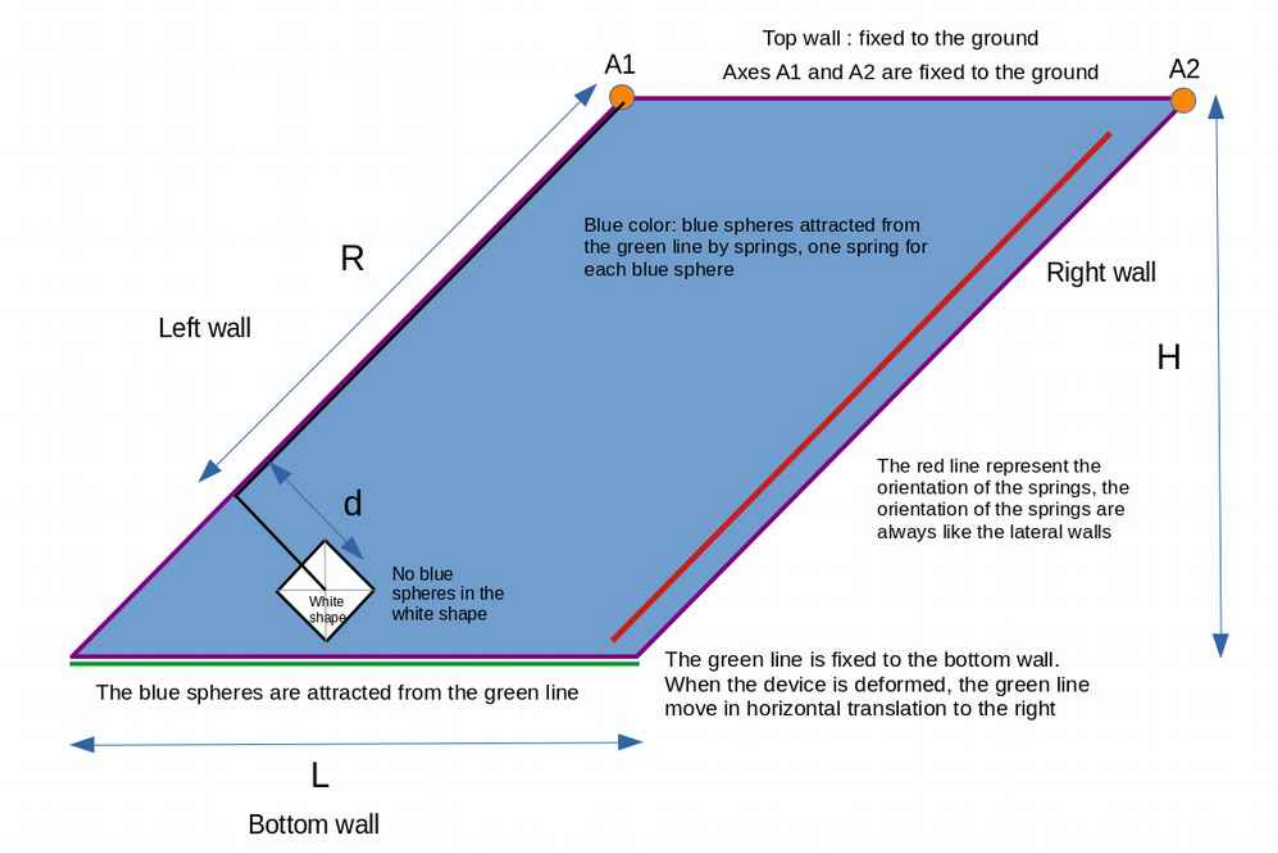
20/ Pressure:

Each sphere acts like a perfect molecule of water, and gives the pressure in all directions. I noted some pressures ‘p=’. Pressures are in Pascal, Pa. The pressure is directly linked to the length from the higher point relatively to the green line but with the orientation of the red line.

21/ Deformation:

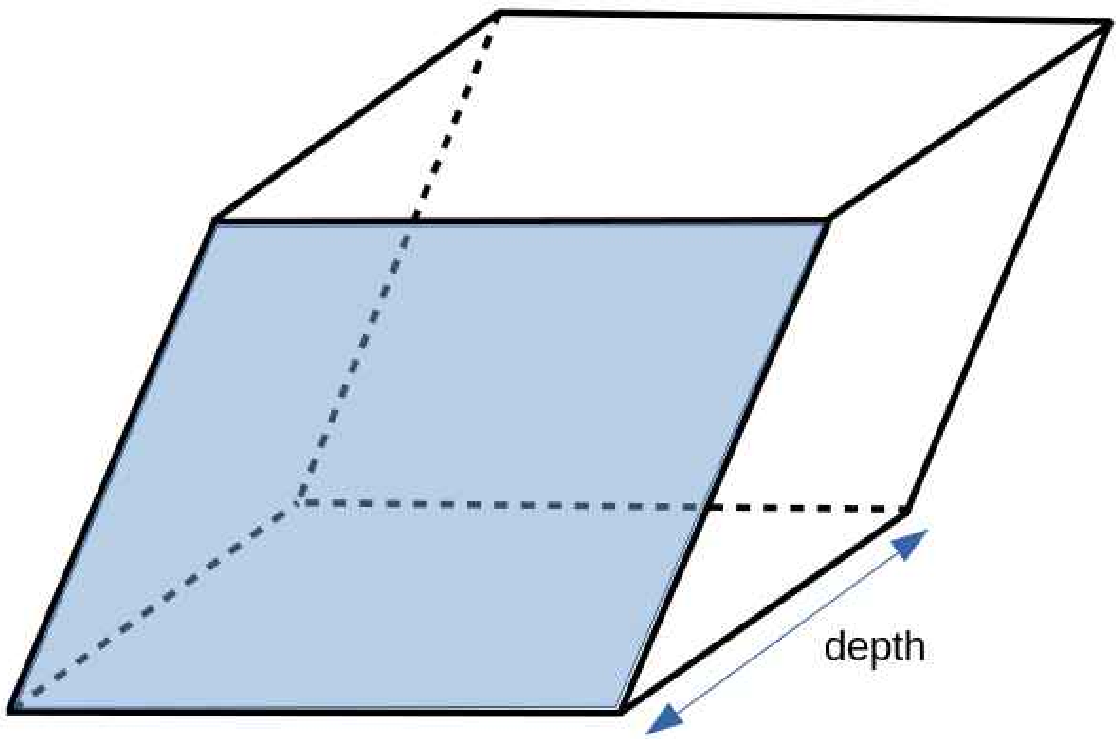
- The height ‘H’ is constant (1 m)
- The lengths I noted ‘L’ are constant (1 m)
- The depth is constant too (1 m)
- The volume of the container is constant at $1m^3$
- I deformed the container from a parallelepiped to a cube (parallelogram to a square in the side view).
- The volume is filled with $1m^3$ (white shape and spheres), from start to end the container is filled

I drew only the side view, but for all the depth the cutting view is like the side view (parallelepiped).



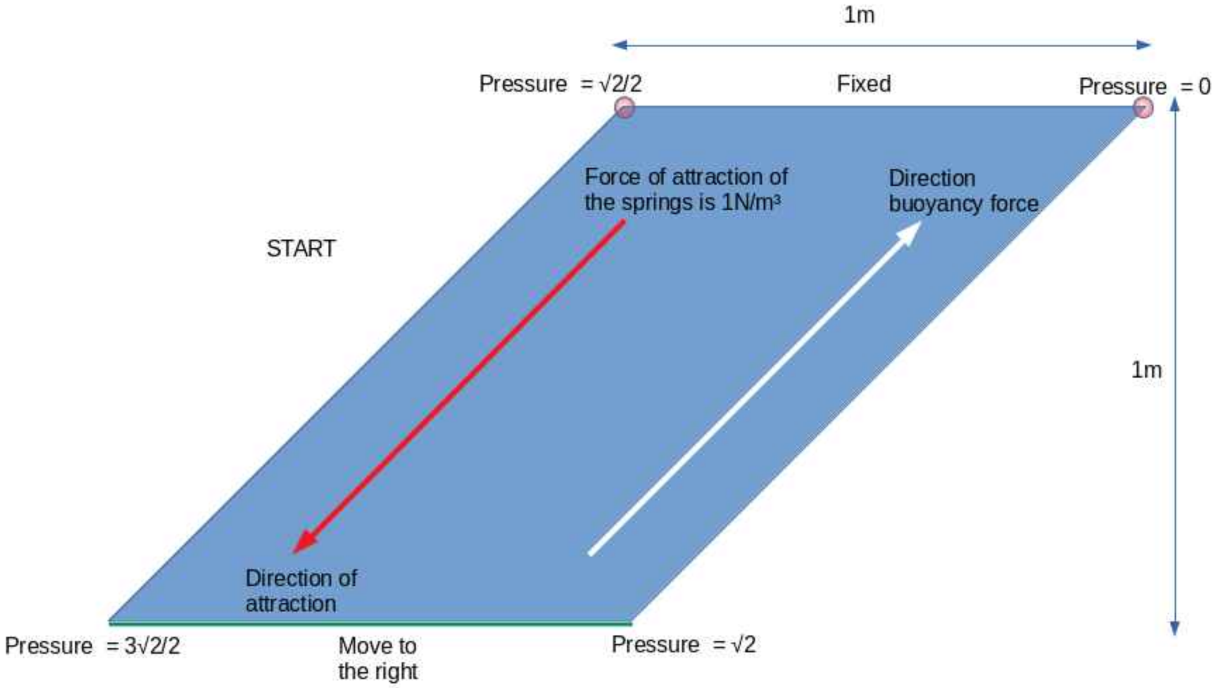
- The lengths H and L are constant
- The top of the container is fixed to the ground
- The lateral walls, left and right, turn respectively around A1 and A2, counterclockwise
- The green line shows where the springs are attached. The green line is the bottom wall of the container
- The red line shows the orientation of the springs. Springs pull.
- The force of attraction of the springs is 1 N/m^3 , the volume is the volume of each sphere.

<u>The device is at start a parallelepiped and at final it is a cube:</u>

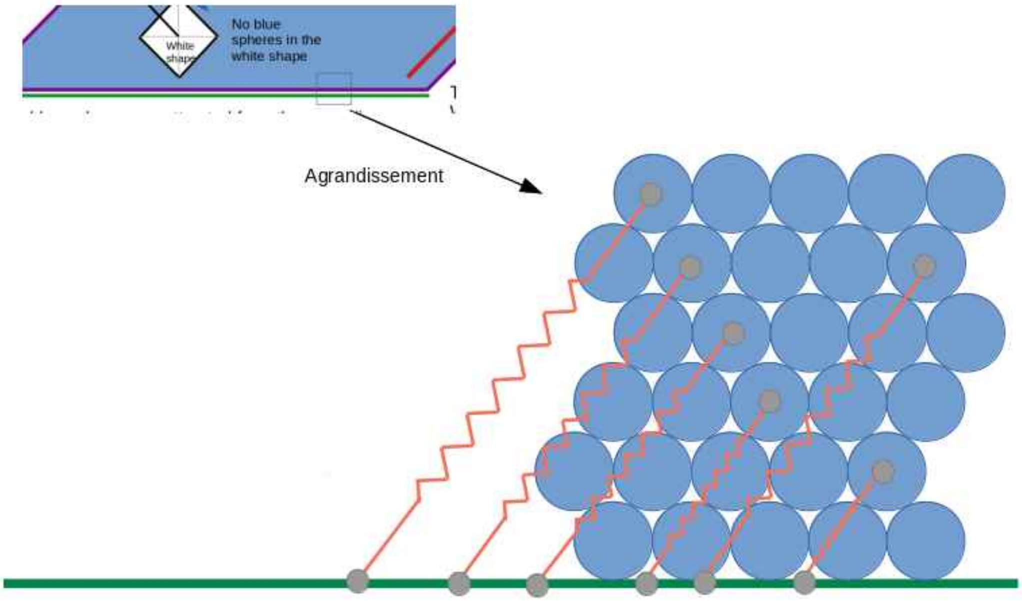


I drew only the blue face (2 dimensions) in that document.

<u>The direction of the attraction and the direction of the buoyancy force:</u>



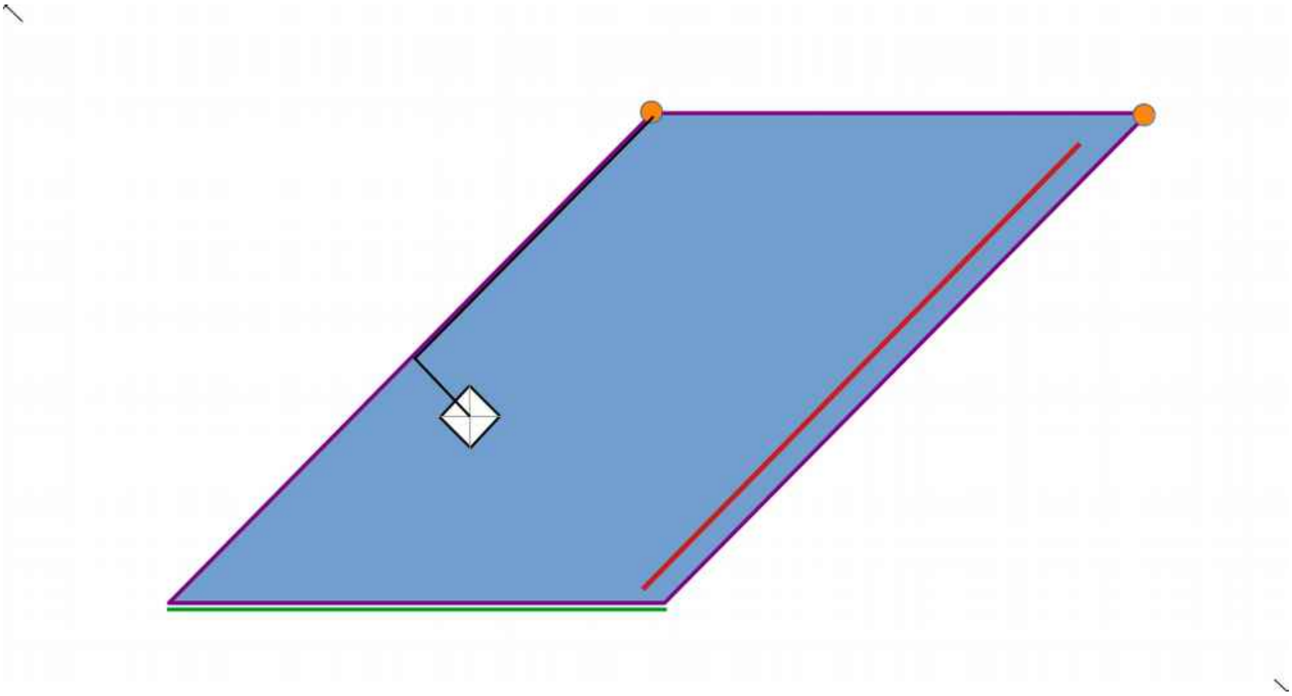
I drew more details at the angle 53°:



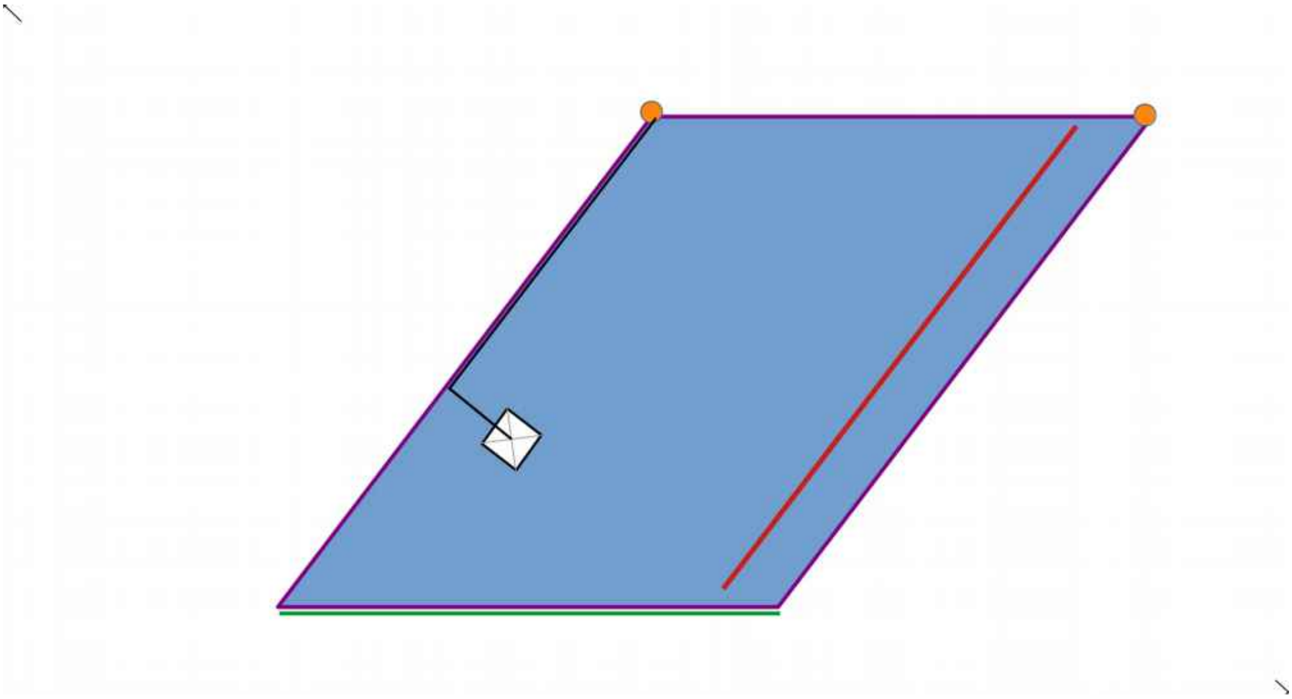
- I drew only few spheres, imagine the volume of each sphere like 1e-15m³ or less
- I drew few springs, EACH SPHERE HAS A SPRING
- It is possible to watch where the springs are attached: the gray dots. Note, the gray dots are fixed on the green line when the device is deformed and each spring is always on the same sphere.
- The orientation of the springs follows the orientation of the lateral walls

I drew different positions of the device for 45°, I took R lower than 1 m. It is for understand the deformation of the device, I don't to deformate the device so much, I studied the sum of energy for a small angle, here the deformation is 45°:

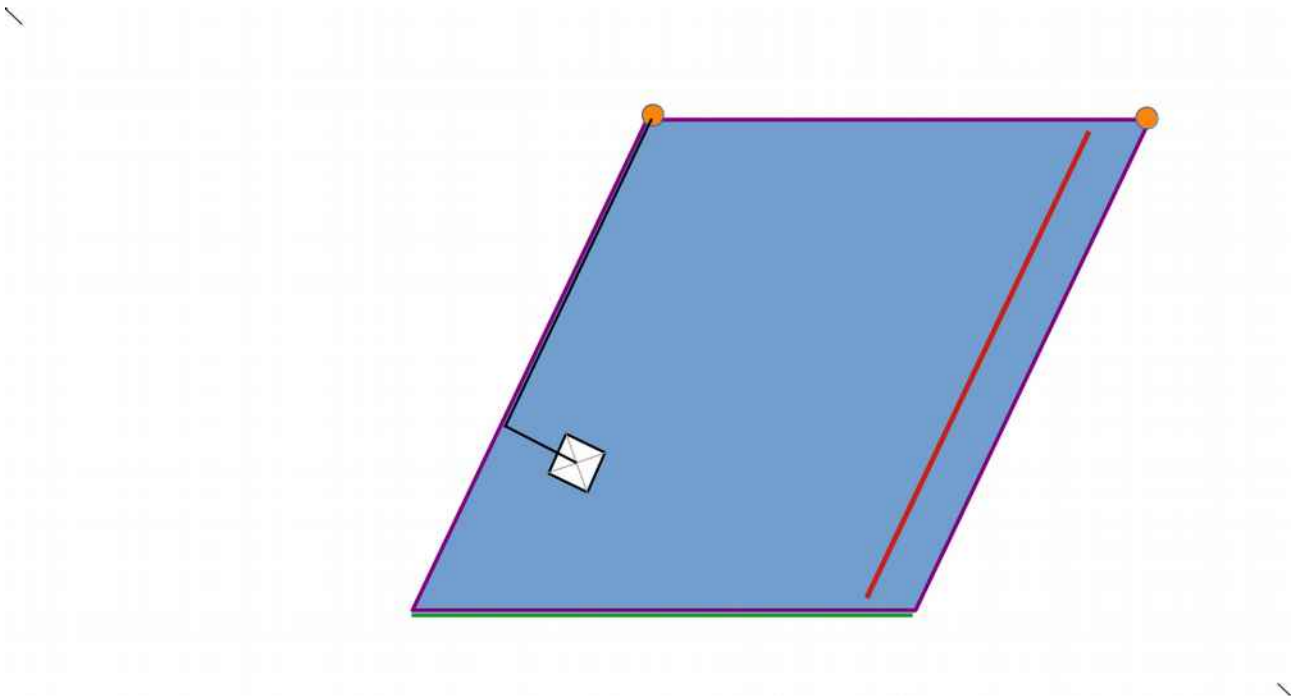
At start, time = 0:



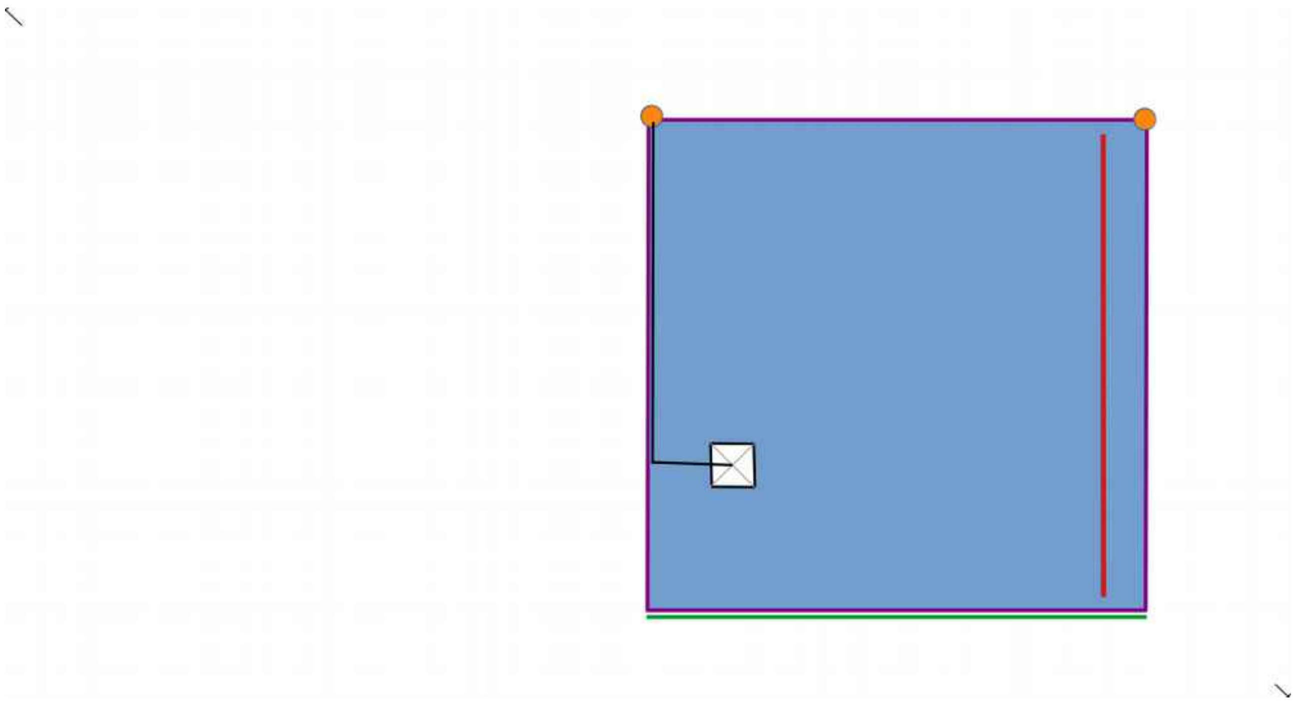
Time = 1



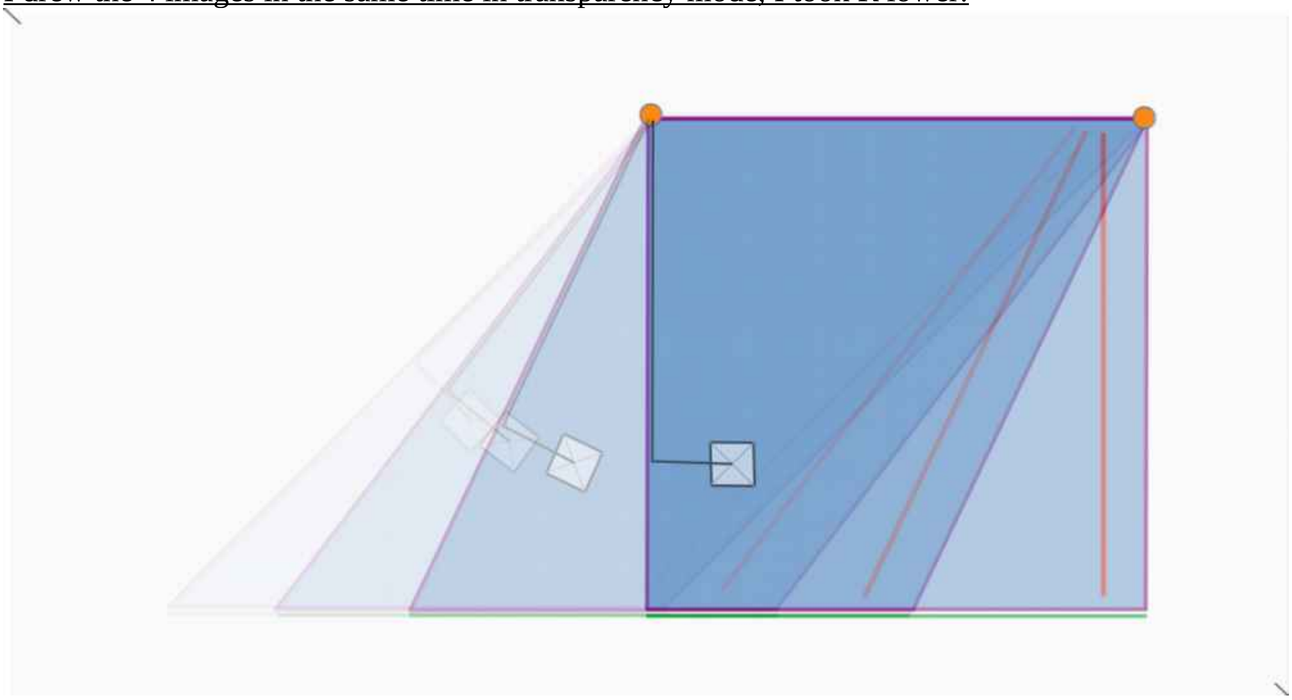
Time = 2



At final, time = 3

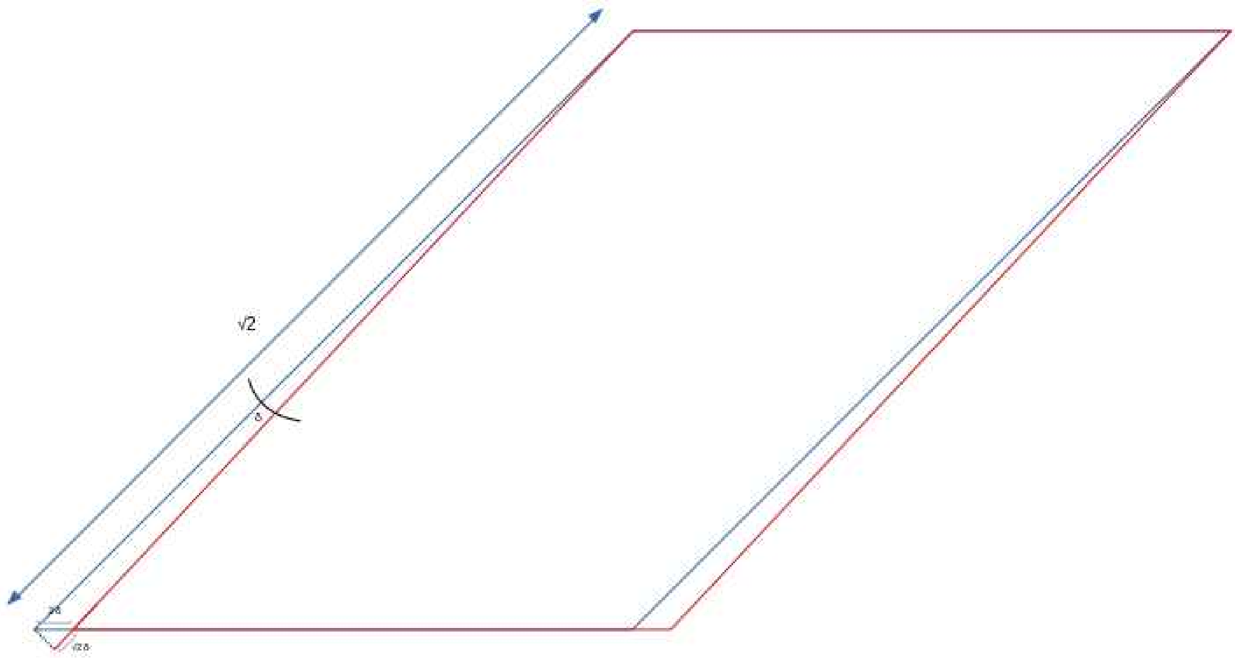


I drew the 4 images in the same time in transparency mode, I took R lower:



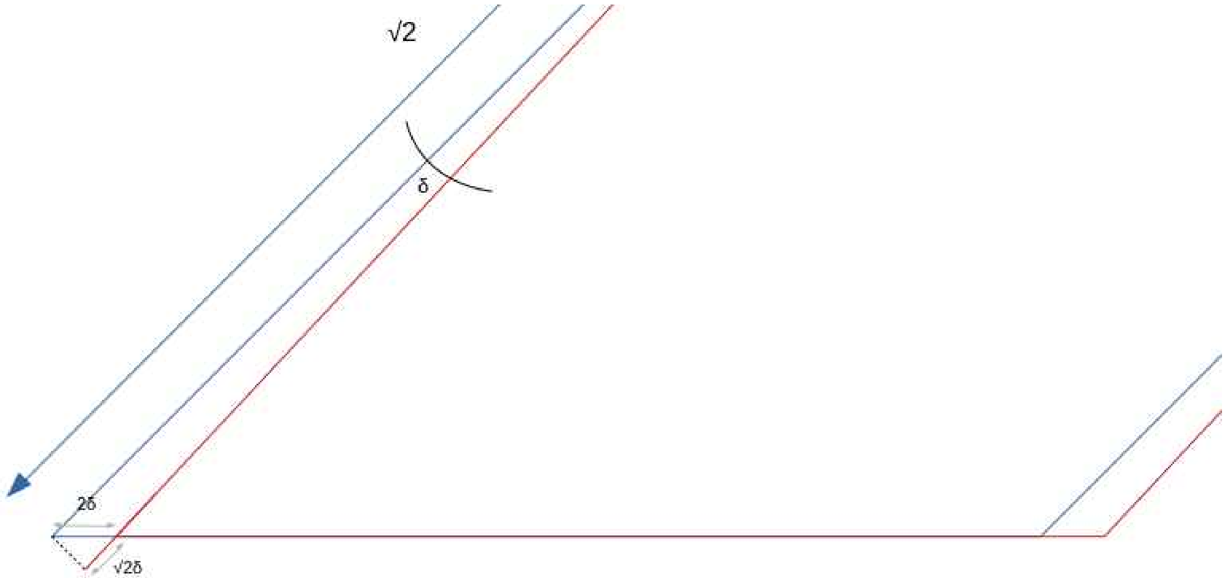
A/ Calculations for a small angle δ of rotation around the position Θ:

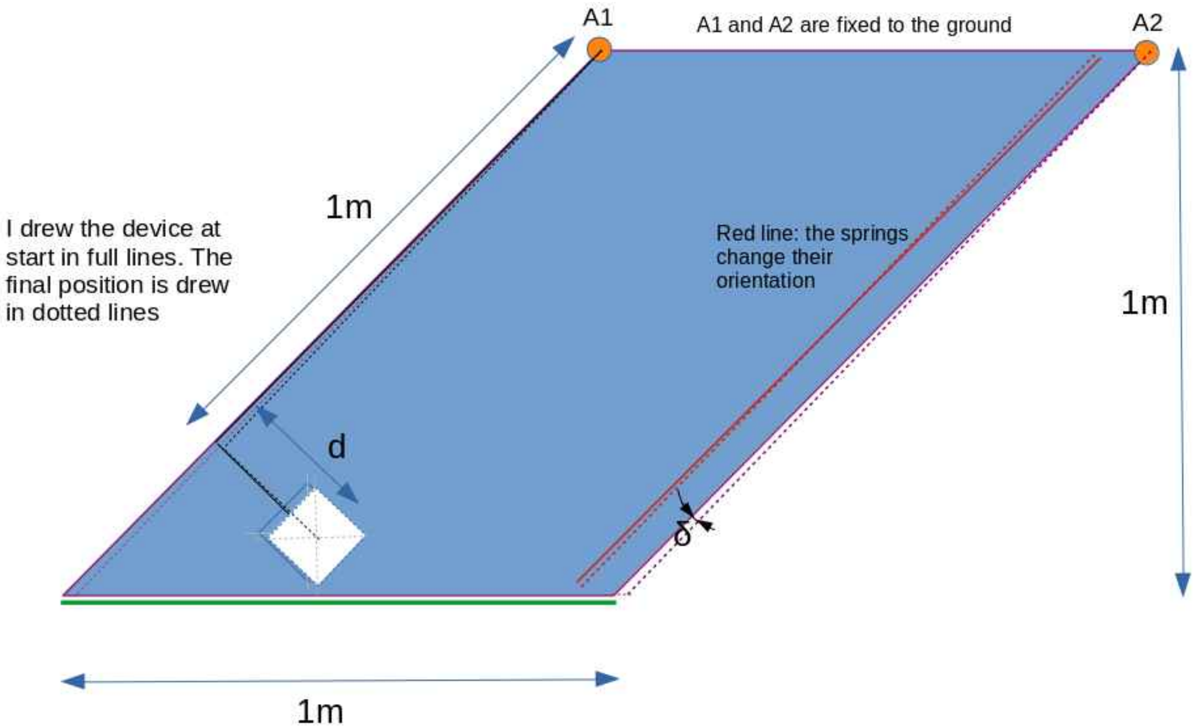
An example, the device from 45° to 46°:



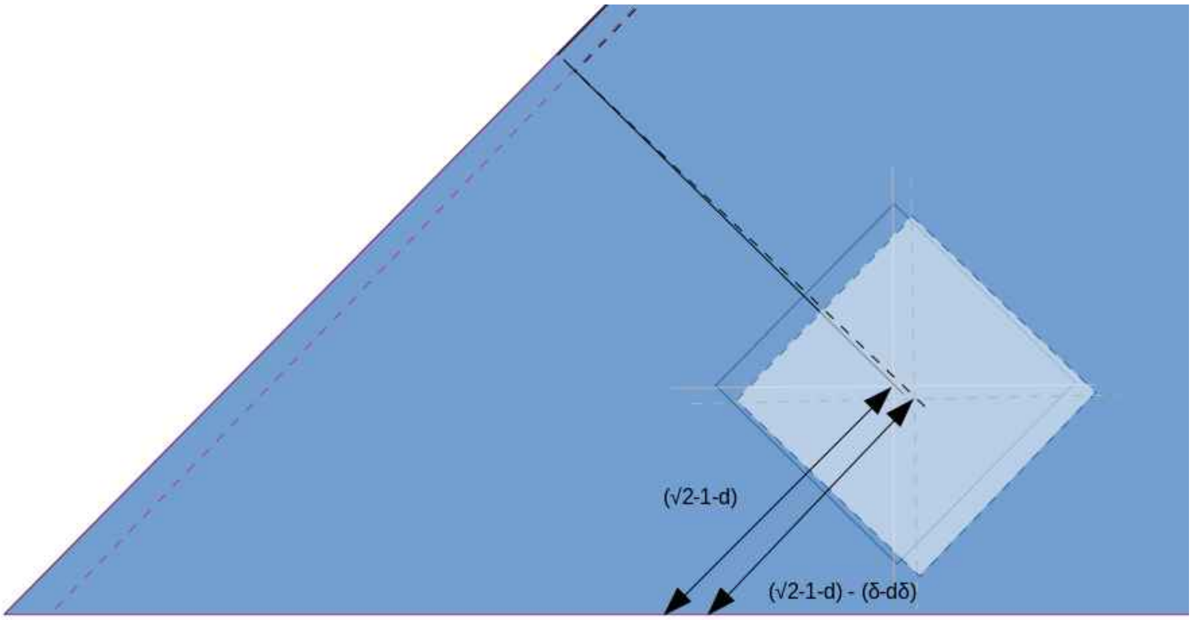
I drew for $\delta = 1°$ but it could be smaller

Details:


√2
δ
2δ
√2δ


A1
A1 and A2 are fixed to the ground
A2
1m
I drew the device at start in full lines. The final position is drew in dotted lines
Red line: the springs change their orientation
1m
d
δ
1m

With an angle of 1.2°:



Calculations: with the depth of the device = 1 m, ‘S’ the surface of the white shape, ‘δ’ an infitisimal angle of rotation for the lateral walls, the black arm and the orientation of the springs:

Work to rotate the lateral walls:

$-\sqrt{2}/2*\delta$

Work from the black arm:

$+Sd\delta$

Work recovered to move out the white parts and move in the blue spheres:

The energy lost by the move out/in of the blue spheres is $-\delta S-\delta dS*\sqrt{S}\sqrt{2}$, note the move out/in in the direction of the attraction don't give/need energy what I lost in difference of pressure I win in difference of the length of the springs, the move out/in perpendicularly to the attraction have no difference of pressure but I need to increase the length of the springs

Potential energy lost by springs:

The difference of potential energy of the springs is

- potential energy at start: $-\sqrt{2}/2+(\sqrt{2}-1-d)S$
- potential energy at final: $+\sqrt{2}/2-\sqrt{2}/2*\delta-((\sqrt{2}-1-d)S - (S\delta-Sd\delta)/\sqrt{2})$
- the sum of potential energy of the springs is: $-\sqrt{2}/2*\delta+(S\delta-Sd\delta)/\sqrt{2}$

The work won by the green line:

$\sqrt{2}*\delta-\sqrt{2}\delta S$ with S the surface of the white shape

The laterals walls rotate, so I need to move out/in :

I need to move out/in the volume $(1+d+\delta/2)*\delta*\sqrt{2}*\sqrt{2}*\sqrt{S}$
The mean of difference of pressure is $\sqrt{S}/2$

The energy recovered is $(1+d+\delta/2/\sqrt{2})*\delta*S$ the term '$\delta/2/\sqrt{2}*\delta*S$' is very small compared to the others

Sum of energy:

The sum is $\delta Sd*(2-1/\sqrt{2}) – \delta S*(1/\sqrt{2}) - \delta dS*\sqrt{S}\sqrt{2} +\delta/2/\sqrt{2}*\delta*S$

so it is near $\delta Sd*(2-1/\sqrt{2}) – \delta S*(1/\sqrt{2})$

Practical considerations:

1/ Volume of the springs:

I can change the manner to attract the spheres. I can attract one sphere from the previous. The springs near the green line are stronger than at top, but it doesn't change the potential energy.

2/ The gradient of pressure in reality:

The device is mechanical but in reality to create the energy you need to use something else than mechanics to have the gradient of pressure, like electromagnetism for example or a composition of two acceleration like rotation and tangential.