"My Hydraulic Lift Experiment"

Figure: The structure of hydraulic lift

Main Requirements:

1. Two hypodermic syringe; one is small and another is big.
2. Cardboard
3. A kind of pipe use in medical cases
4. A kind of glue that can shoot like a gun

Preparation Method (Step by Step)

Step1. Build the cardboard into a rectangle shape.

Step2. Just a rectangle shape is not enough to be a perfect design. If we put more weights onto it, it can easily deform. So, as a next stage, build cardboard as pillars between them to be firmer.

Step3. What is next: perforating two holes on the surface of the cardboard, one is small and another is big.

Step4. Let the small hypodermic syringe be at small hole and the large one is at big hole.

Step5. Build cardboard as cups that the things can be put at the top of both hypodermic syringes.

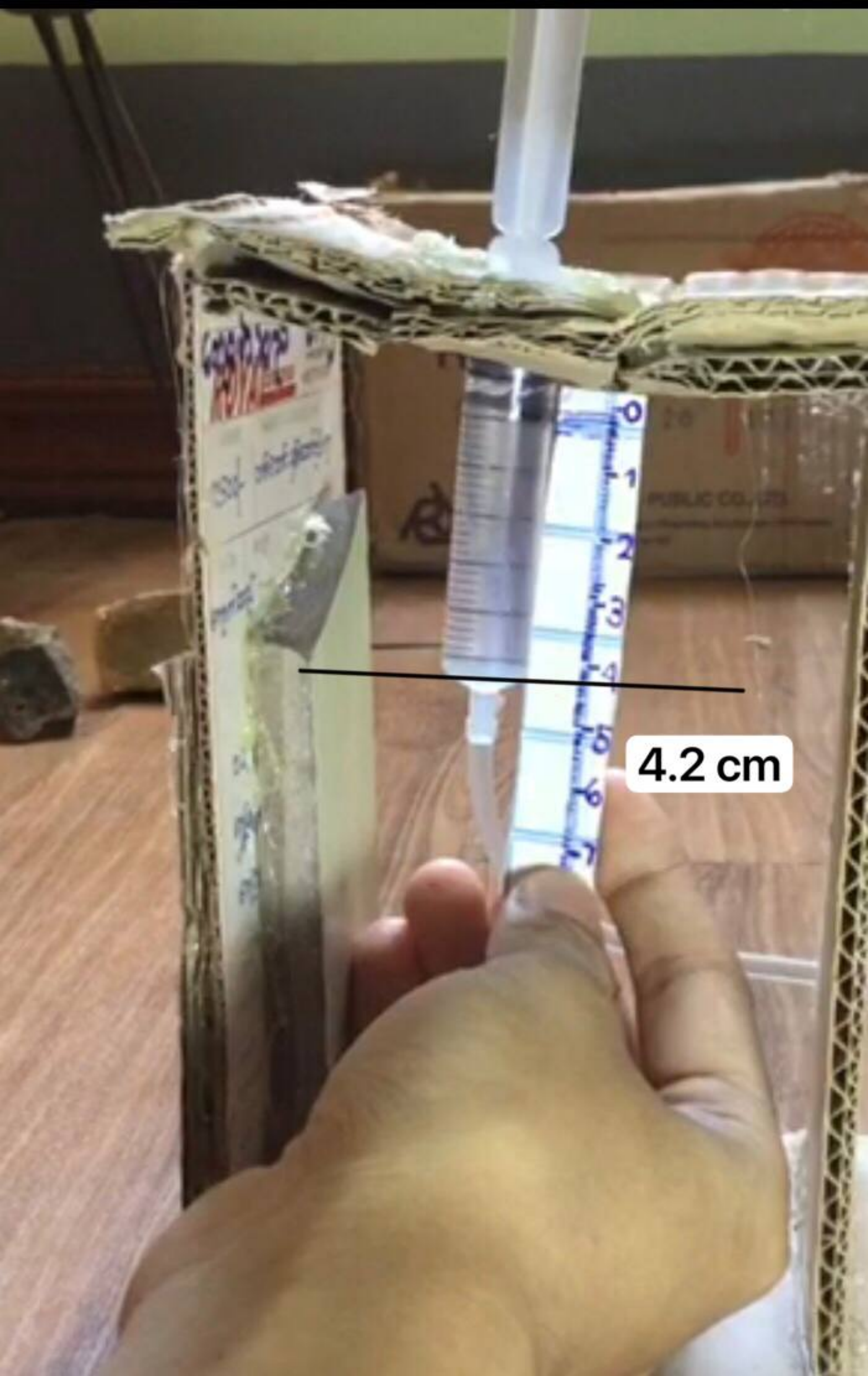
Step6. Lastly, contact your pipe from small syringe to big.

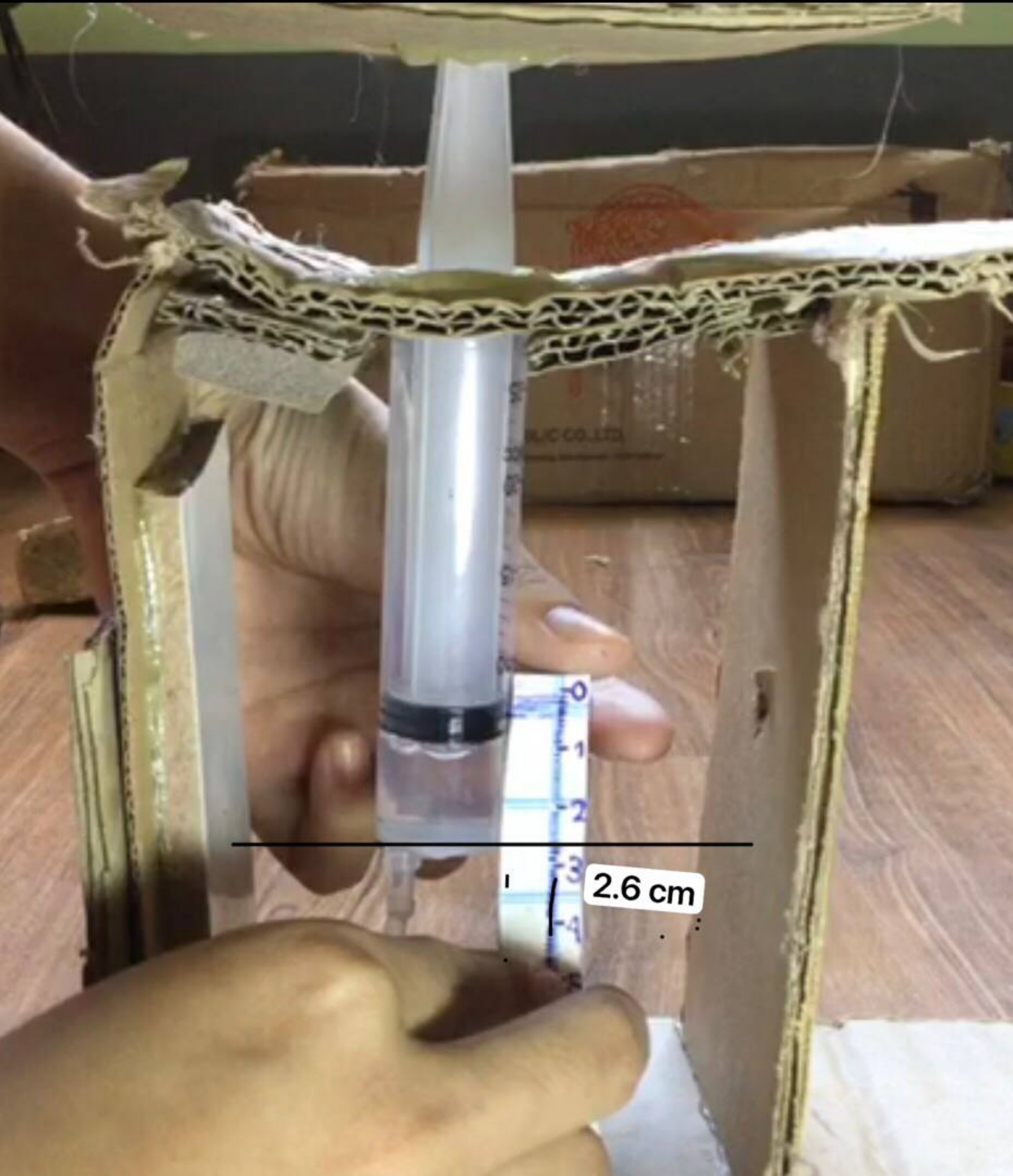
> **Note:** Don't forget to use glue during the entire experiment. The firmer you build, the more specific your calculation is. And don't forget to add in compressible fluid into your syringes.


SF-400A
475
背光
計數
開關
單位
Electronic Compact Scale
Friction

Mass at small syringe


Mass at large syringe
SF-400A
144
背光
計數
開關
單位
Electronic Compact Scale


4.2 cm



0
1
2
3
4
2.6 cm

Let me drop my calculation concerning with this hydraulic lift

W test=771 gram(including friction)

Friction=475 gram

g=gravitational accelaration

F=mg

F1=7555.8gram F2=7301gram

F'1=4655gram

F1net=F1-F'1

F1net=7555.6-4655

F1net=2900.8gram

F2/F1net=7301/ 2900.8=2.516=2.52

V1=6ml=6cm^3(1ml=1cm^3) h1=4.6

V1=A1.h1

6=A1.4.6

6/4.6=A1

1.304=A1

A1=1.3cm^2

V2=25ml=25cm^3(1ml=1cm^3) h2=7.7cm

V2=A2.h2

25=A2.7.7

25/7.7=A2

3.246=A2

A2=3.25cm^2

A2/A1=3.25/1.3=2.5

P1=P2

F1net/A1=F2/A2

296.g/1.3=745.g/3.25

2231.4 gram/cm^2= 2246.5 gram/cm^2(error 15.1)

The distance when it is not compressed at small area=h1=4.2cm

The rising distance at large area after pressing at small area=h2=2.6cm

h2/h1=2.6/4.2=0.62 (0.6)

Why is the distance at large piston smaller than the distance at small piston (h2/h1<1)?

My answer is:

Pascal's law states that the pressure of incompressible fluid will be same at all the point. The pressure change can be transmitted fully.

Concerning with work done, it will be same on both cylinders for a given operating pressure.

Here is the theory when **w** is constant.

W=F.d

F=P.A

Remember, we have to apply more force at larger piston since its area is more. As the work done is constant, the displacement will be small.

The force is less for small piston since its area is less. As the work done is constant, the displacement will be more.

Thus, the larger piston has less displacement than the smaller one.

Let me drive some calculations.

$F1$= force at small area, $F2$= force at large area

$F1 = 2N$, $F2 = 5N$, $W = 10J$

$W = F1.d1$, $W = F2.d2$

$10 = 2.d1$ $10 = 5.d2$

$d1 = 5m$ $d2 = 2m$

$h2/h1 = 2/5 = 0.4$

$0.4 < 1$

As I mention above is just a simple derivation. I just put numbers to show clearly how distance at large area is smaller than the distance at small. But, this time, I will show you that my idea is correct as in theoretical side.

d_1 = the distance at small, d_2 = the distance at large

As in volume, it raises the same on both side.

So, $V_1 = V_2$

- $A_1 d_1 = A_2 d_2$

(I will write height in term of distance)

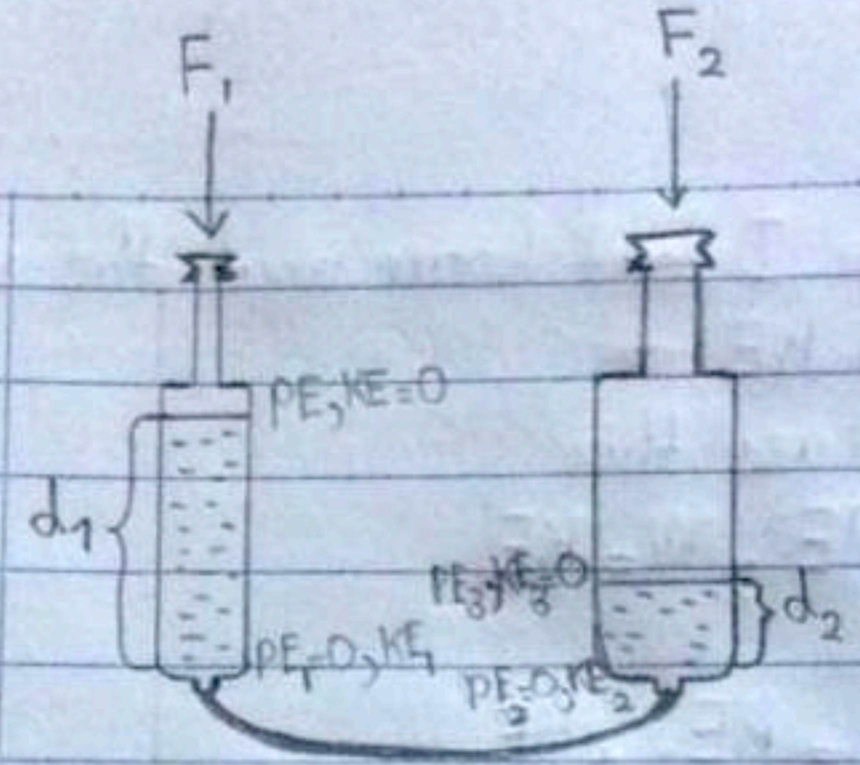
- $$\frac{A_2}{A_1} = \frac{d_1}{d_2}$$

As Pascal's law

- $$\frac{F_2}{F_1} = \frac{A_2}{A_1}$$

$$\frac{F_2}{F_1} = \frac{d_1}{d_2} \quad \left(\because \frac{A_2}{A_1} = \frac{d_1}{d_2}\right)$$

- $F_2 d_2 = F_1 d_1$



See when the side which more force has to apply has small distance. But not the other side which has less force has large distance.

- $F_2 d_2 = F_1 d_1$

As the derivative, Fd show W (work done)

- $W_2 = W_1$

Since work done is constant, as well as the energy gains on large area and the energy loses on small area is the same.

- That is called law of conservation of energy. This hydraulic lift is one of the the example that follows conservation of energy.

At top of the small syringe + At bottom of the small syringe = At bottom of the large syringe + At top of the large syringe

- $PE + \cancel{KE}^{0} + \cancel{PE_1}^{0} + KE_1 = \cancel{PE_2} + KE_2 + PE_3 + \cancel{KE_3}^{0}$

$$PE + KE_1 = PE_3 + KE_2$$

In this case, I don't know what the values of PE and KE are.

So, I will use this.

- $-W = PE$, $W = KE$

- $PE_{} + KE_1 = PE_3 + KE_2$

  $-W + W = -W + W$

  $0 = 0$

- This is how I prove without adding numbers.

That is just the idea of mine. In reality, physically, the girth of the small hypodermic syringe is less but not the large one. For instance, changing water from a small glass to a big bottle, how the distance on both can be the same. So, I think that it is also concerned with volume.

Thus, it is least to equal with 1 and greater than 1 but you can approach almost 1(not literally the same).