NOTES FROM AUGUST 31

(Mechanical) Energy and (Mechanical) Power

We are going to start with water molecules and pipes instead of electrons and wires. The movement of water is much easier to visualize.

We have at least three choices for how to measure an amount of water molecules:

usual units are mols

- We could count them $1 \text{ mol} = 6.02 \times 10^{23}$ molecules
- We could measure their volume
- We could weigh them

usual units are cubic meters

usual units are kilograms

Because of gravity, mass falls downward. The rate of acceleration is $9.8 \frac{m}{s^2}$

meters

seconds

If you let 1kg of water fall 1m gravitational <u>energy</u> is released. How much?

$$1\,kg \cdot 1\,m \cdot \frac{9.8\,m}{s^2} = 9.8 \frac{kg\ m^2}{s^2}$$

$\frac{kg\,m^2}{s^2}$ is the usual unit of energy. It is clumsy to always be writing it out so

$$\boxed{1\text{ Joule} = 1\,J \equiv \frac{1\,kg\,m^2}{s^2}}$$

If we let 2kg fall 1m then

$$2kg \cdot \frac{9.8\,m}{s^2} \cdot 1m = 19.6\,J \text{ is released}$$

What if we let 1kg fall 1m <u>every second</u>?

How much energy is released in 5 seconds?

$$\frac{1kg}{s} \cdot 5\,s = 5kg$$

$$5kg \cdot \frac{9.8\,m}{s^2} \cdot 1m = 49\,J$$

How much in 10 seconds? 98 J

There is a <u>rate of energy release</u> in this example. It is: $9.8\,\frac{J}{s}$

$\frac{J}{s}$ comes up so often it has a name too:

$$\boxed{1\text{ Watt} = 1\,W \equiv \frac{1\,J}{s}}$$

in other circumstances instead of release, it can be transfer, or absorbtion — it is still called power and measured in watts

<u>Rate of energy release</u> is <u>power</u>

There was also a rate of water movement. Each second 1kg moved. The rate is

$$\frac{1kg}{s}$$

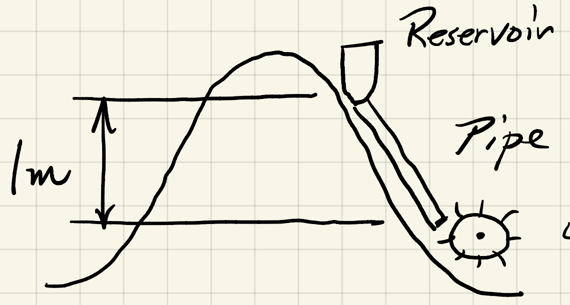
That combination of units doesn't have a name. There is a concept associated with it though and that is current.

For water, current is usually measured in cubic meters/second. If you measure current in cubic meters/second and you want to convert to kg/s, you have to know that 1 cubic meter of water weighs 1000kg.

One more concept: Potential

If one kg of water dropped one meter releases 9.8 J and 2kg releases 19.6 J, there is another ratio we can create: $\frac{9.8\,J}{kg}$ ← each kg that falls releases 9.8J

We could say that the reservoir is $\frac{9.8J}{kg}$ higher in potential than the water wheel.



We of course usually just say it is 1m higher