

# Some of my experiments

Károly Piláth dr.

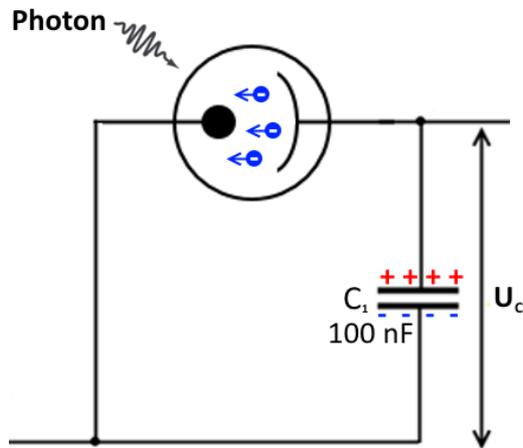
---

Physics lessons can be good, if the teacher feels good. So I chosed three experiments of my kit which are very nice for me, and I got good feedback from my students who are not interested in physics.



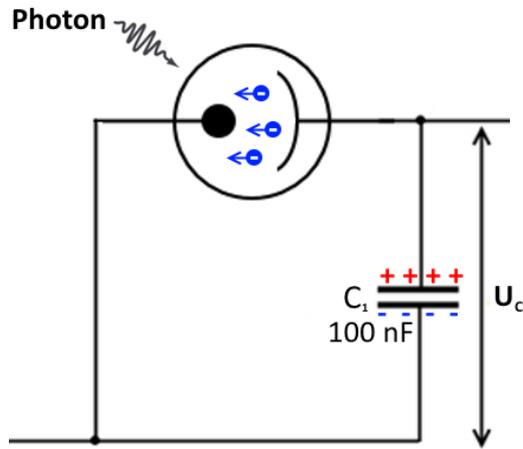
My first experiment is try to visualize the quantized behavior of light.





## Some Theory

When we shine light on the photocathode, we have some possibilities of detecting energy of the electrons which are emitted the photocathode. One of them if the electrons charge up the capacitor, then an electric field develops in the photocell which will stop the electrons.



If we use the Einstein equation, the result will be that the voltage measured at the terminals of the capacitor ( $U_C$ ) will be proportional to the frequency of the illuminating light.

$$h \cdot f = \frac{1}{2} \cdot m_e \cdot v^2 + W = U_C \cdot e + W$$

$$U_C \cdot e = h \cdot f - W$$

$$U_C = \frac{h}{e} \cdot f - \frac{W}{e}$$

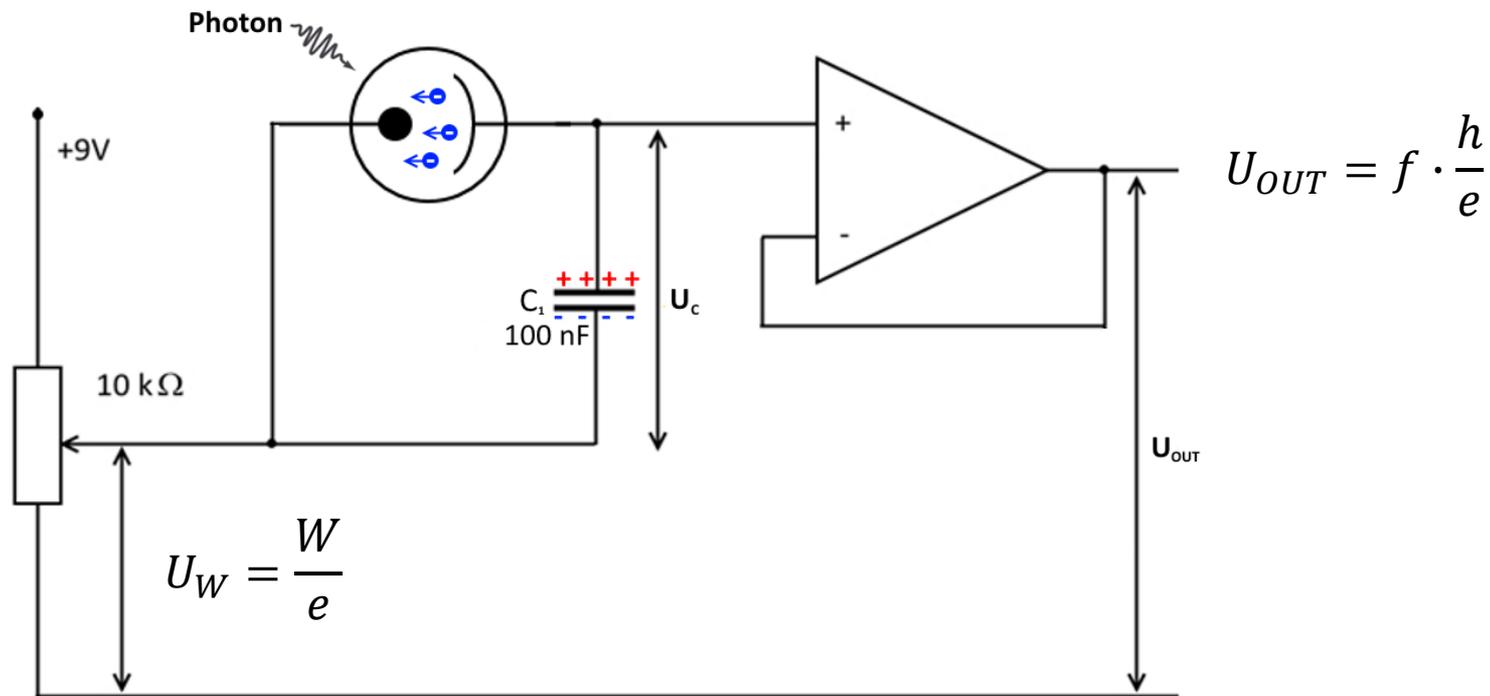
Where

$W$  is the binding energy

$f$  is frequency of the illuminating light

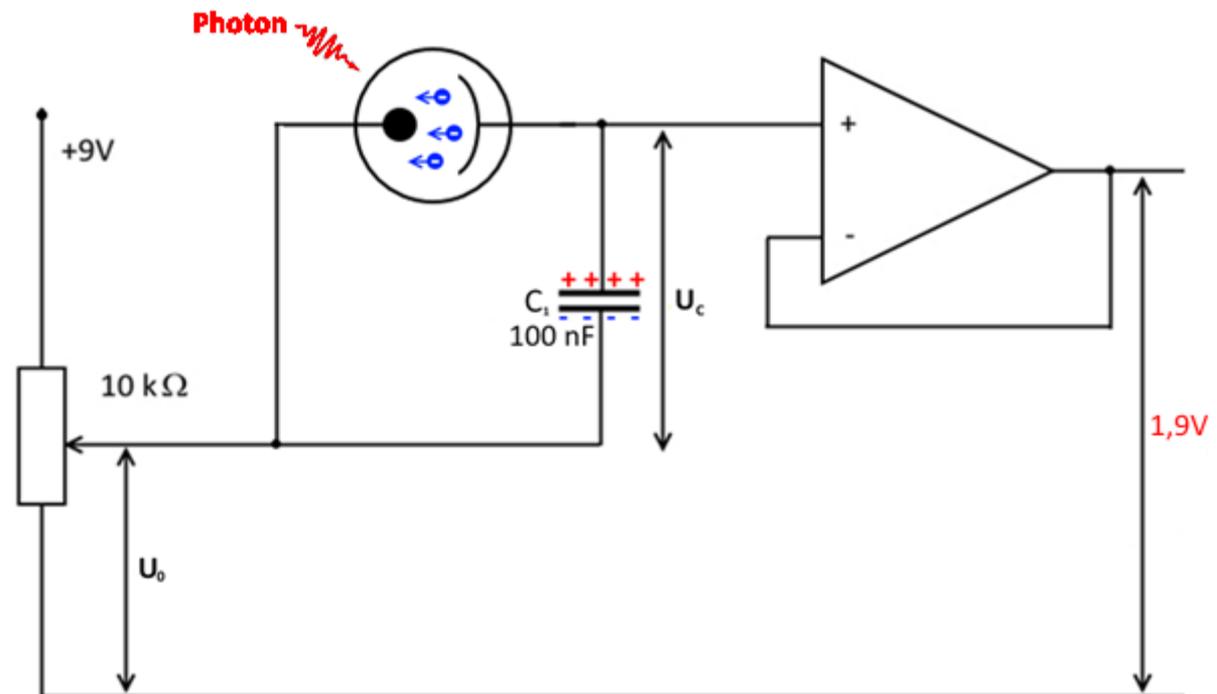
# Setup the $U_{OUT}$

If we add  $U_W$  to the voltage of the capacitor and we use the operational amplifier as a voltage follower, the output voltage of the amplifier is equal  $f \cdot \frac{h}{e}$



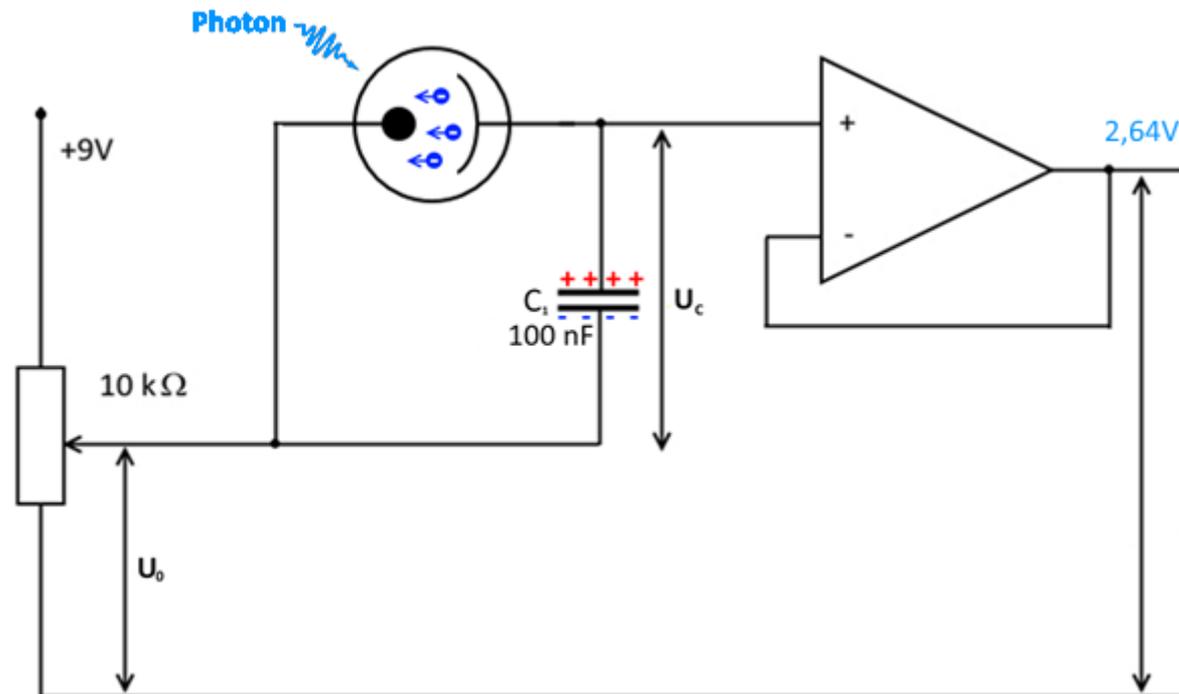
# An example

If the wavelength of the illuminating light is **650 nm**, then  $U_{OUT} = 1,9V$

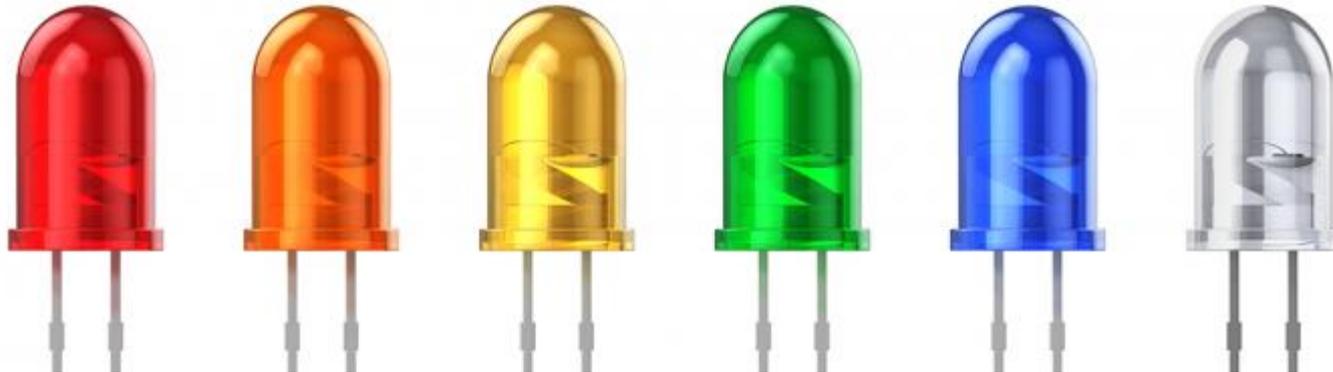


# The next example

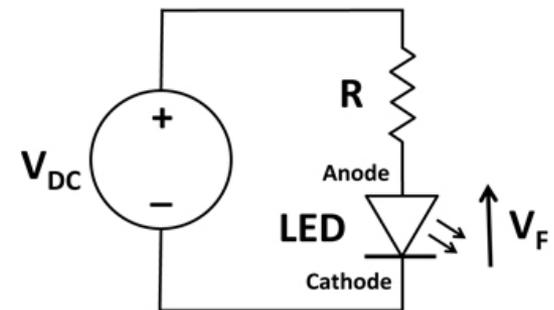
If the wavelength of the illuminating light is  $470 \text{ nm}$ , then  $U_{OUT} = 2.64 \text{ V}$



# A few words about the LED's



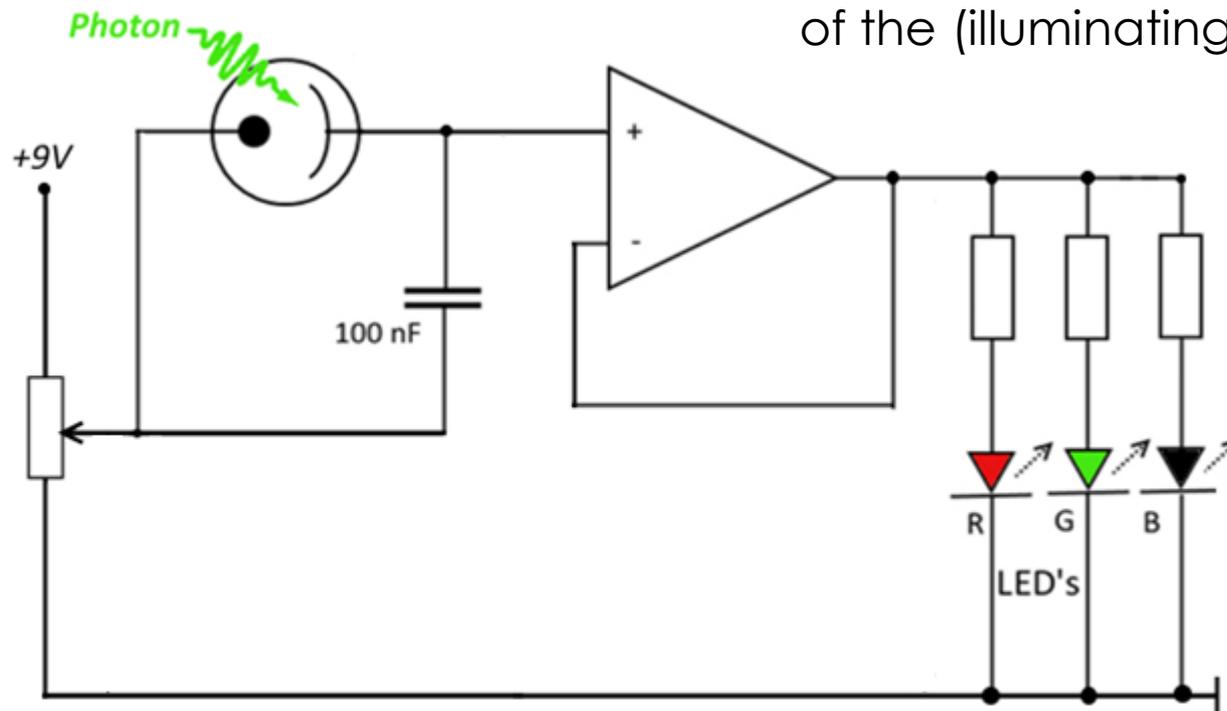
A LED only starts to emitting photons if the voltage of the current source is higher than forward voltage ( $V_f$ ) of the given color of LED.



$$e \cdot V_f = h \cdot f_{LED}$$

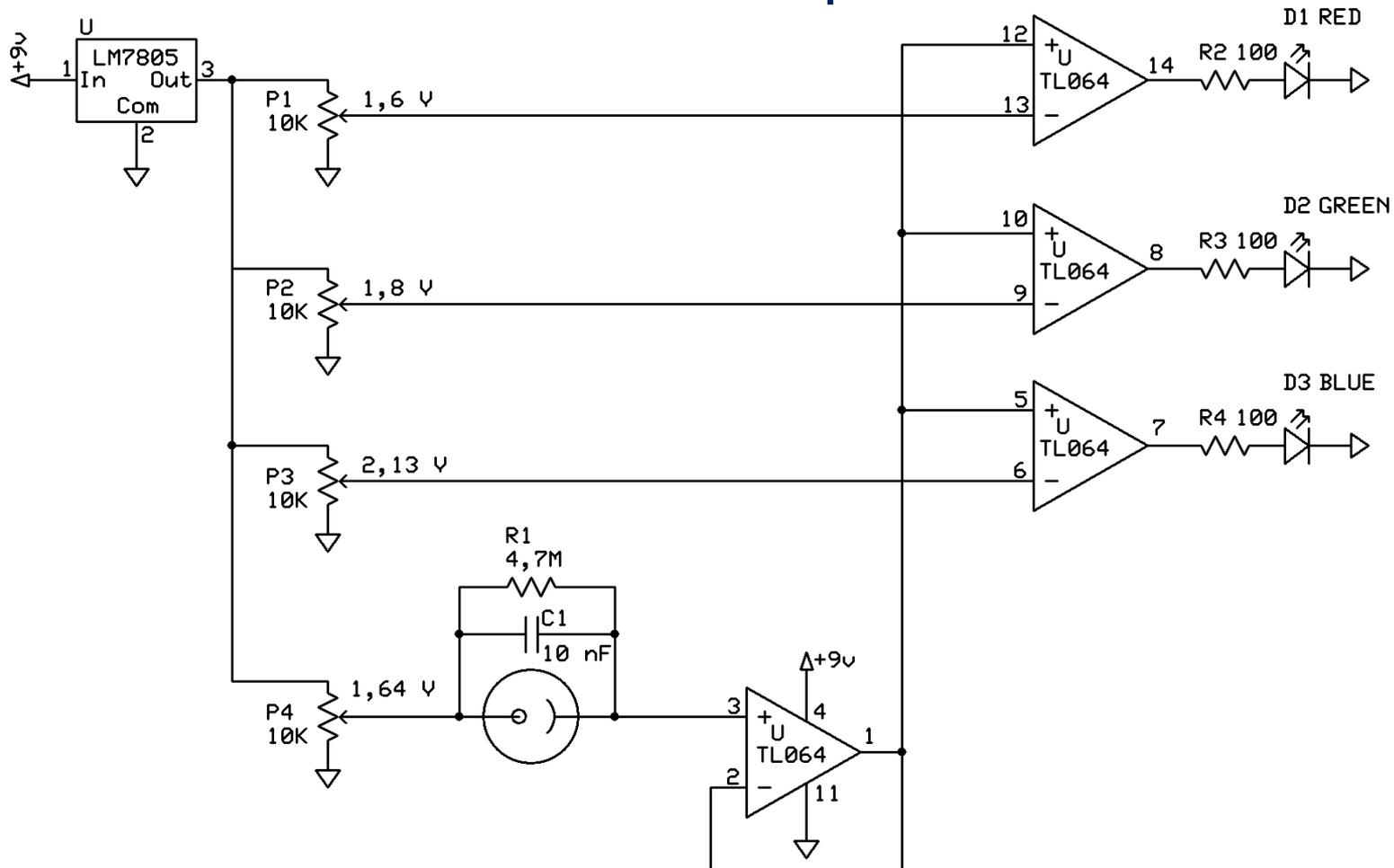
# The complete theoretical circuit

😊 😊 😊 We constructed a device which is able to recognize the color of the (illuminating) light!

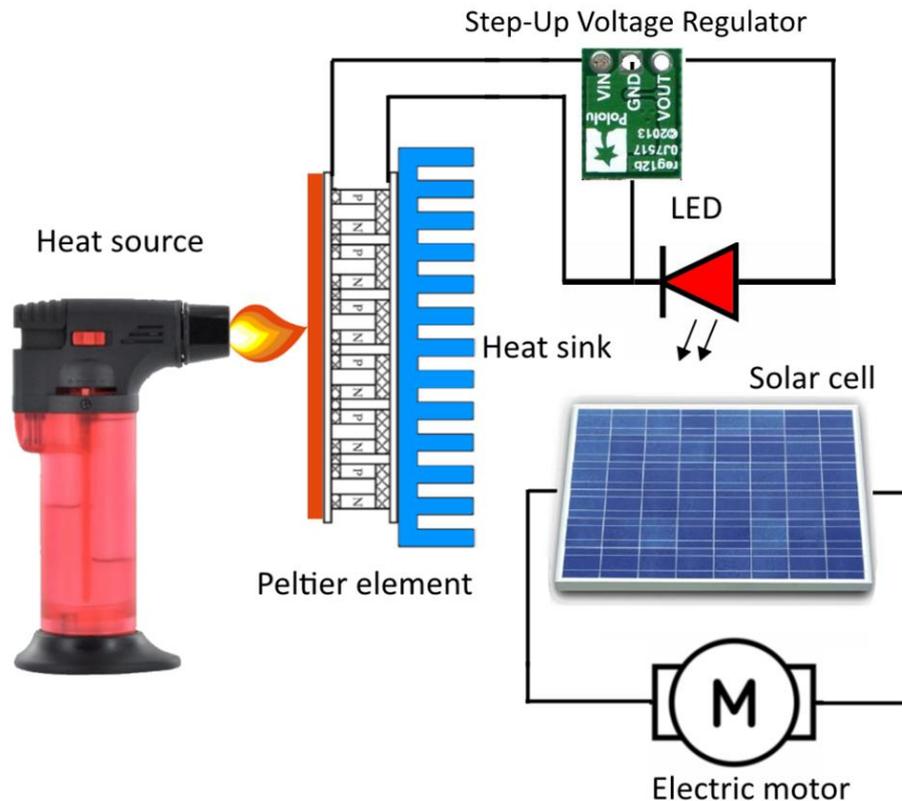


*Electric circuit to demonstrate the quantized nature of light.*

# Schematic of the circuit is a little bit complex



# The next experiment is a simple applied energy transformation



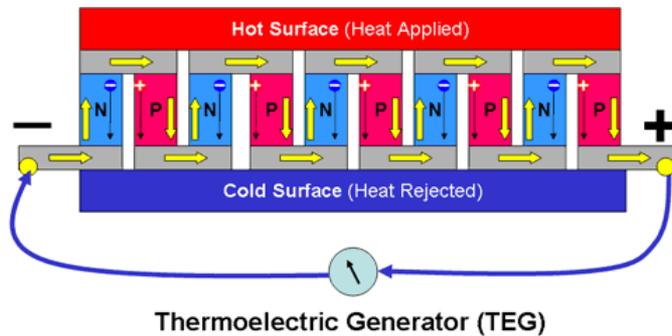
The goal of this experiment is to show that energy can be neither created nor be destroyed, but it transforms from one form to another.

Heat source



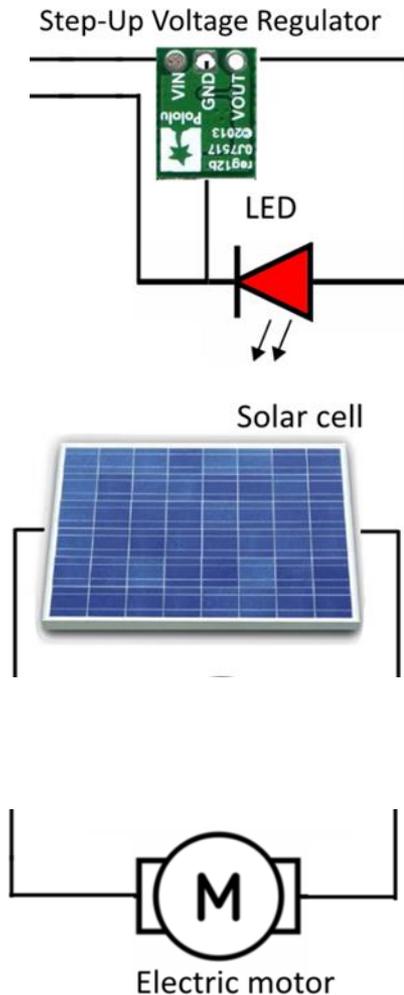
The chemical energy of the gas can be converted into heat energy. The converter is a simple gas lighter. The type of lighter is BelFlam Jet.

The heat energy can be converted directly into electric energy. The converter is a Peltier element with a heat sink.



Thermoelectric Generator (TEG)





The electric energy can be converted into light energy. The converter is a power LED.

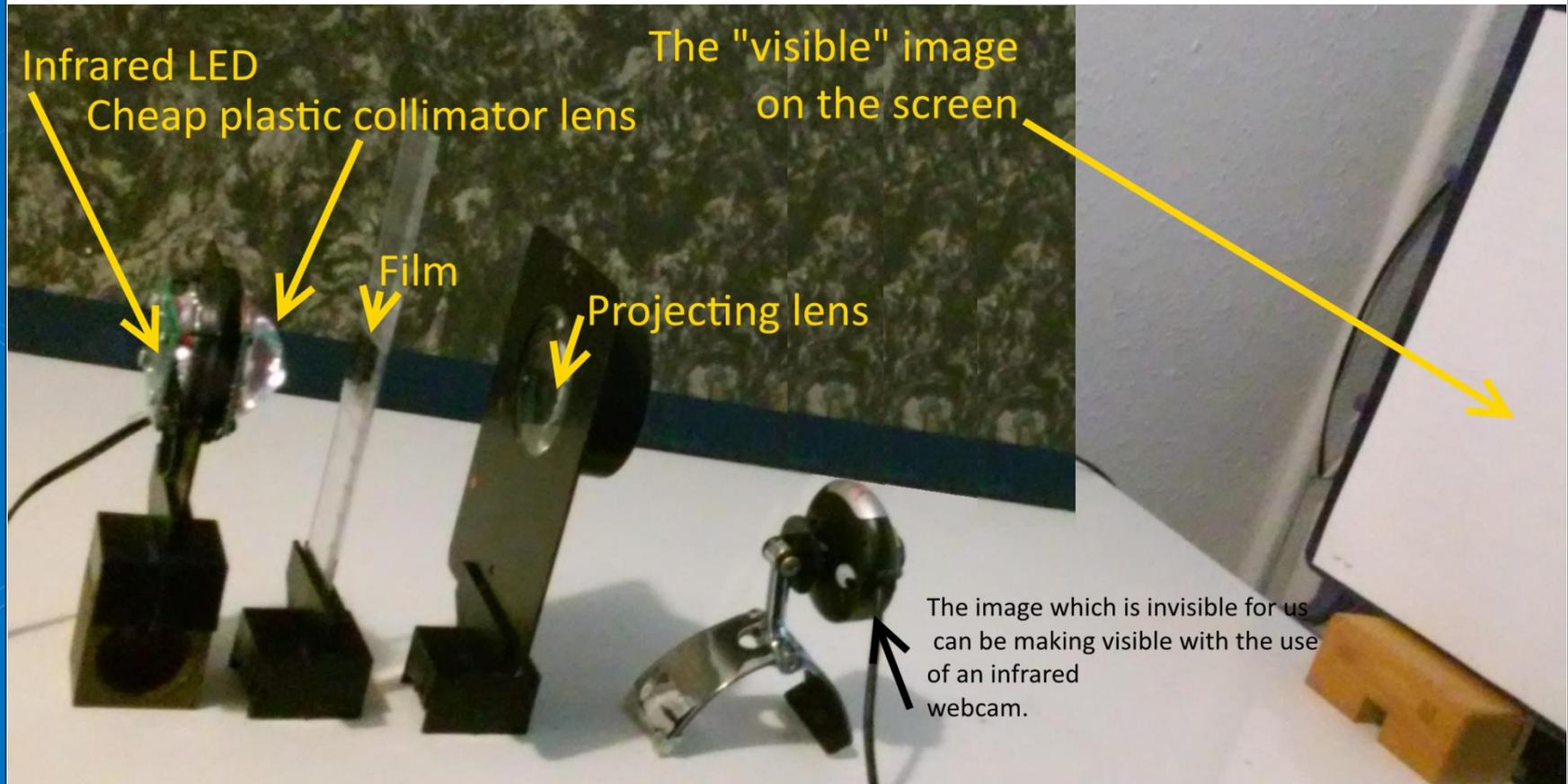
The light energy can be converted directly into electric energy. The converter is a solar cell.

The electric energy can be converted into mechanic energy. The converter is a simple electric motor.

# In the classroom



# The last experiment is an „Infrared cinema”



# In this experiment I make a special projector in infrared range.



I use an infrared LED with a cheap, plastic collimator lens (eBay) as a light source



The parallel light of the light source goes through the **film**, which is printed on a clear film and bonded onto a plastic ruler

# The projecting lens



The projecting lens can be traditional



Or a ball-shaped bottle filled with some liquor also can do.

Place the projector lens before the film.  
The projector lens projects the image on the screen.  
The real inverted infrared image is on the screen.



The image which is invisible for us can be visible with the use of an infrared webcam.

