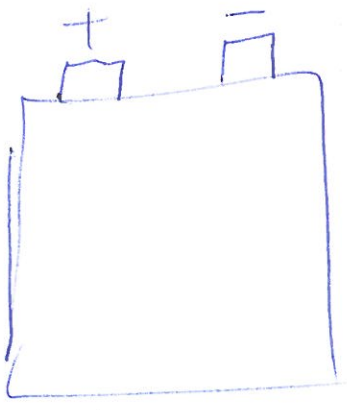
About Batteries

(1) What is a basic property of batteries?

Well what is marked on every commercial battery?

A voltage, e.g. 1.5 V, 9 V, etc.

Voltage is actually the potential difference between the terminals.



Ideally, it is a constant no matter what current

2) is drawn from the battery

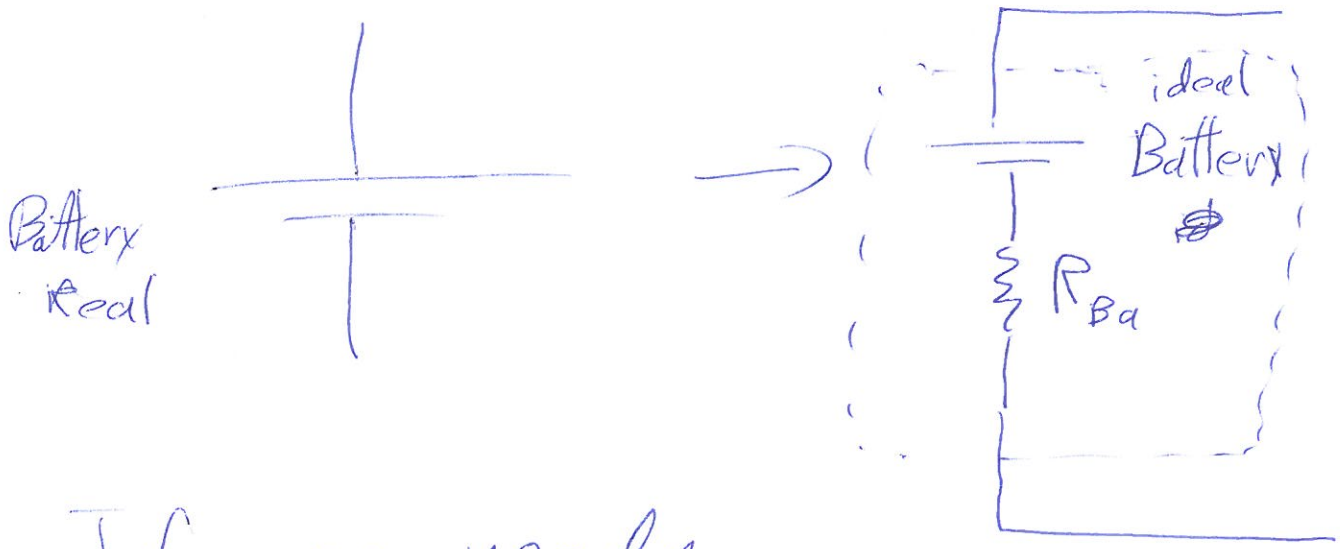
$P = I V_{Ba}$ is the power output of a batter.

- Ideally it only depends on I since V_{Ba} is constant.

(2) In Reality Batteries do have an internal resistance R_{Ba} that can be approximated as ohmic for currents NOT too large.

- R_{Ba} is usually pretty small in a circuit with

a good battery
and can be neglected
to 1st order

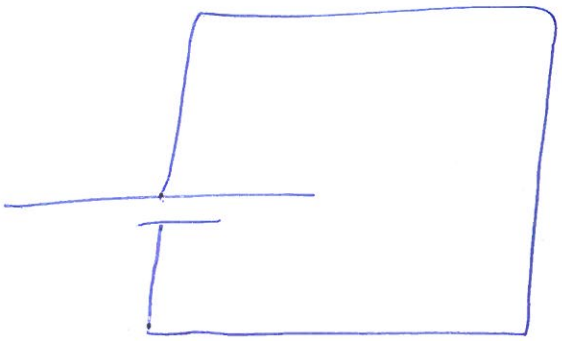


If one needs
to, one can model
a real battery as
an ideal battery in series
with ~~bat~~ an ohmic battery
resistance R_{Ba}

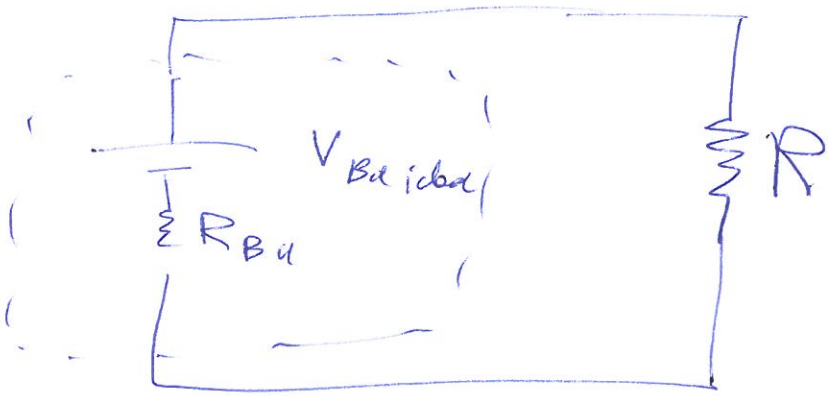
We don't need to that
in our lab.

4

i) What would this circuit be called?



ANS. a Short circuit of the battery.



ii) Solve for current I

$$I = \frac{V_{Bi}}{R_{Bi} + R}$$

Solve $P_{output\ of\ battery}$ in terms of V_{Bi}, R_{Bi}, R

ANS. $P = I V_{Bi} = \frac{V_{Bi}^2}{R_{Bi} + R}$

As $R \to 0$ (i.e. one goes to a short circuit)

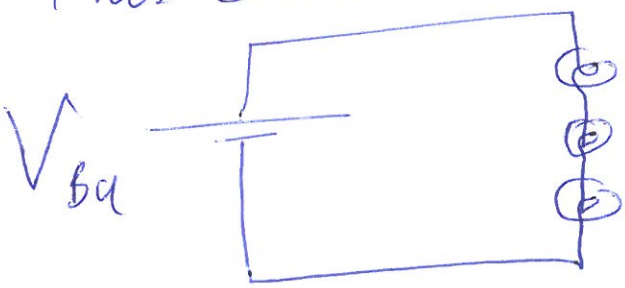
What happens to P?

Where does this power end up?

Is this safe?

(3) I_u in this lab (see Task 1)

This circuit defines

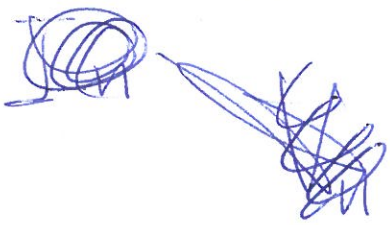


I_u unit current

V_u unit potential

R_u unit resistance

— The battery is assumed ideal (a good assumption as always in this lab)



and the bulbs identical (a so-so assumption)

V_u is the potential drop across a single bulb.

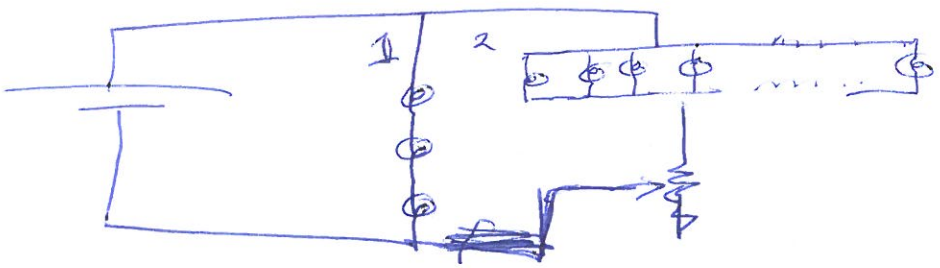
What is V_u in terms of V_{Bu}?

You actually need to measure I_u.

What is R_u in terms of V_u and I_u?

(4) In Task 2

In task 2, you build circuits of form



You adjust R_{wire} so that all the bulbs are equally bright.

What is the resistance of the N bulbs in parallel?

$$I = \sum_i I_i$$

and $R \equiv \frac{V}{I}$ for any IV device

$$\therefore \quad \frac{V}{R} = \sum_i \frac{V}{R_i}$$

$$\frac{1}{R} = \sum_i \frac{1}{R_i}$$

$$\frac{1}{R} \geq \text{Max}\left(\frac{1}{R_i}\right)$$

$$R \leq \text{Min}(R_i)$$

The resistances are NOT ohmic in general

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If all R_i are equal

$R = ?$

If all bulbs are equally bright, what current flows through each bulb?

What potential drop occurs across each bulb?

Remember the bulbs are IV devices

$I = I(V)$ or $V = V(I)$

If all bulbs are equally bright,

~~what is power output~~

How do their power outputs compare?

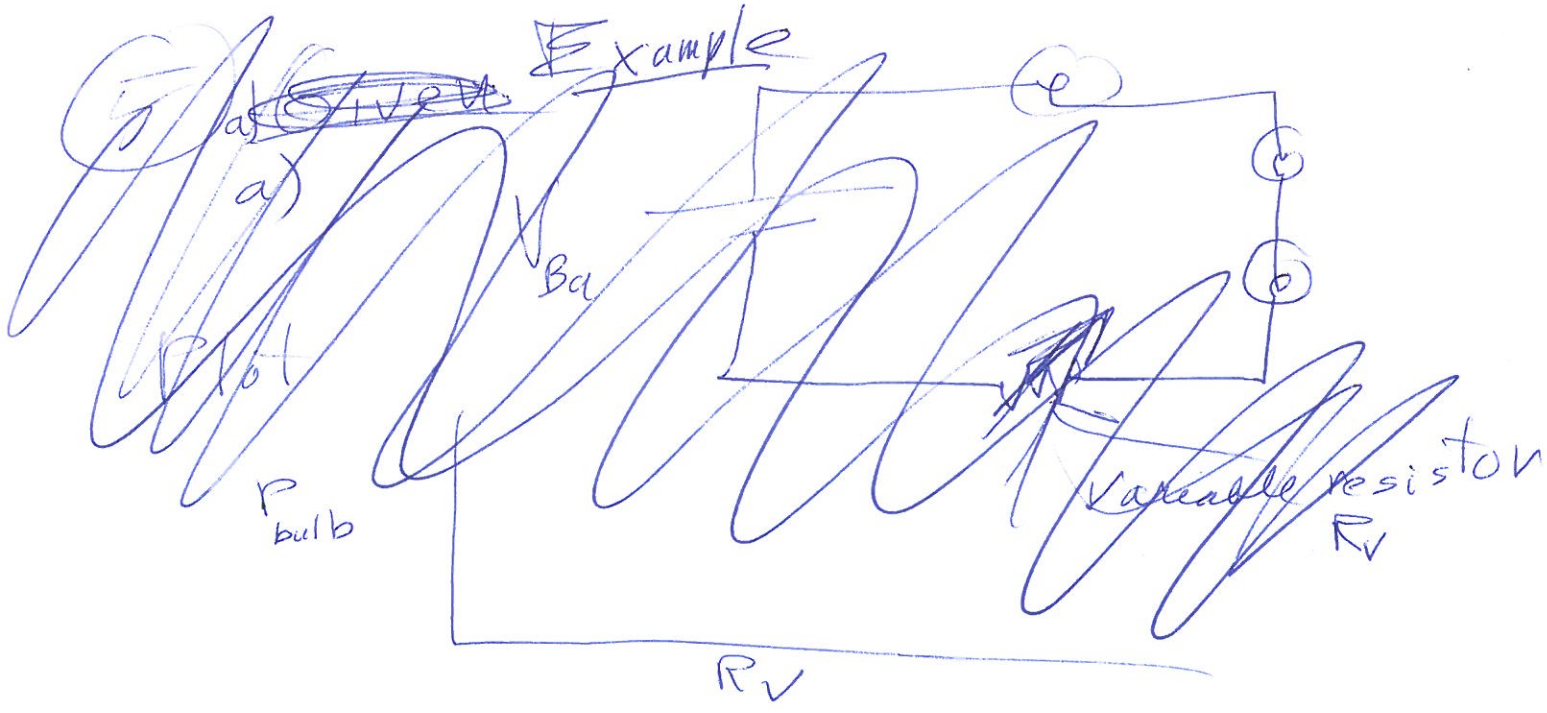
their currents?

their potential drops across?

What is the current

in branch 1?

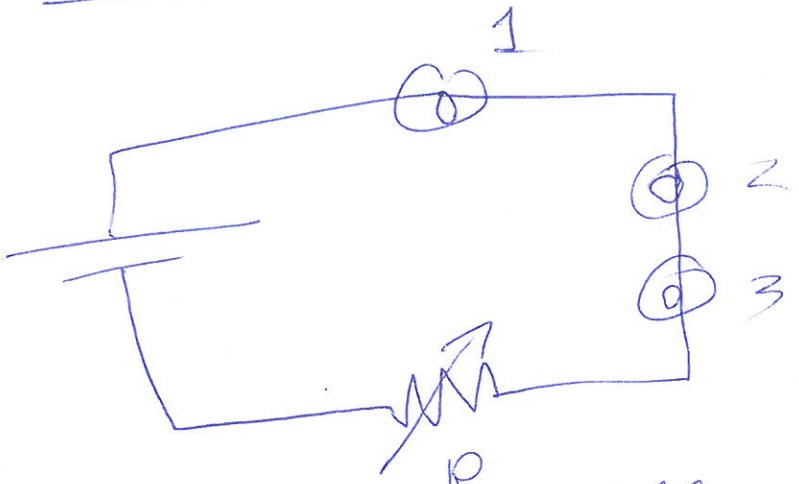
in branch 2?



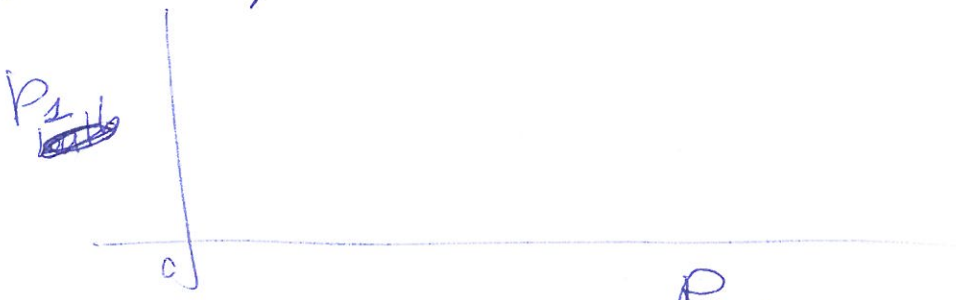
10)

(5) Example Circuits to test your know how

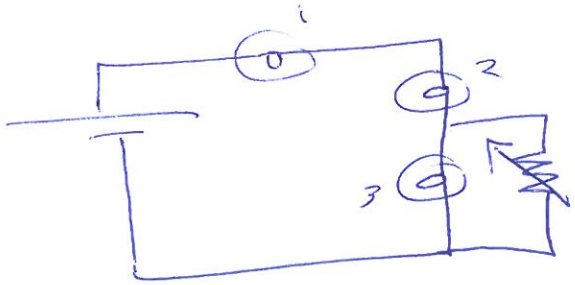
a)



Plot schematically a variable resistor.

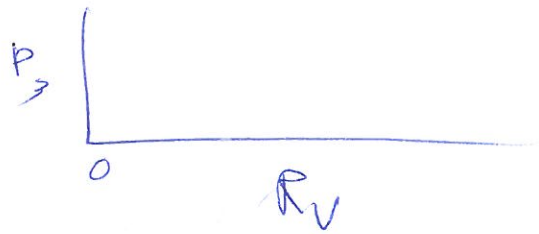


b)

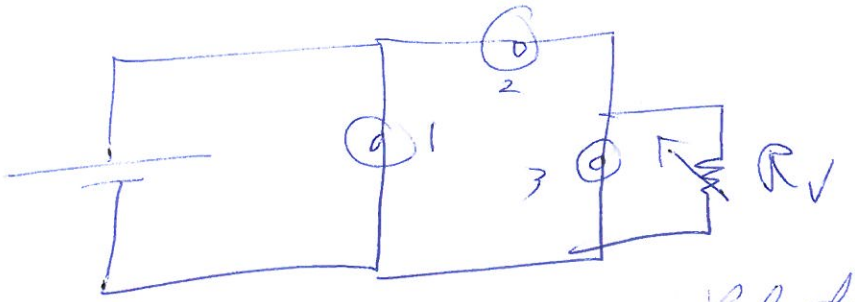


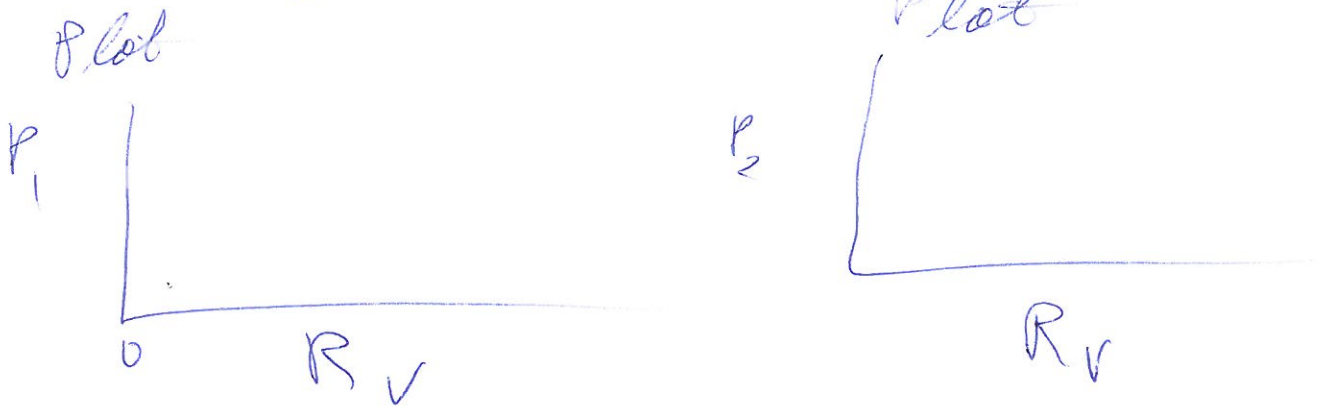
Plot

Plot



c)





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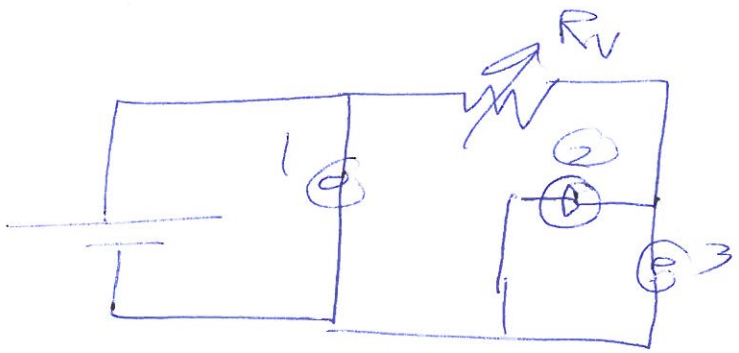
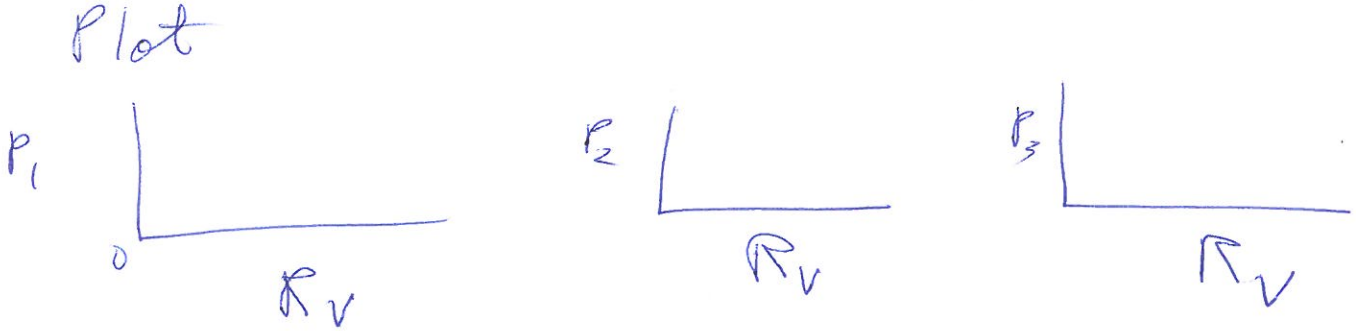


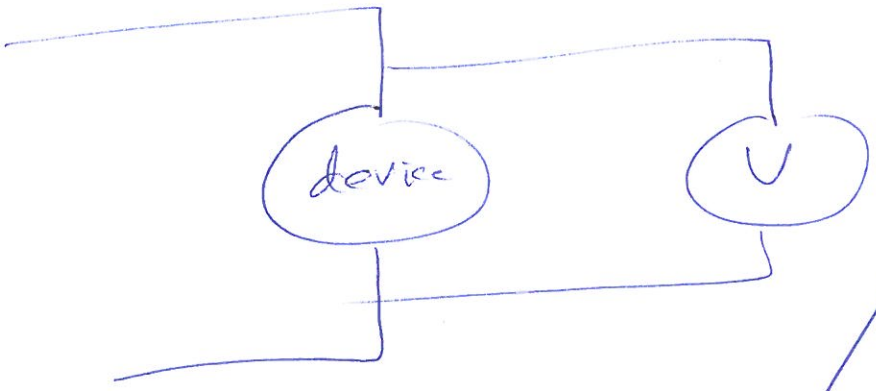


You may be asked in the lab to be build one of those circuits and test its behavior.

6 Practicalities

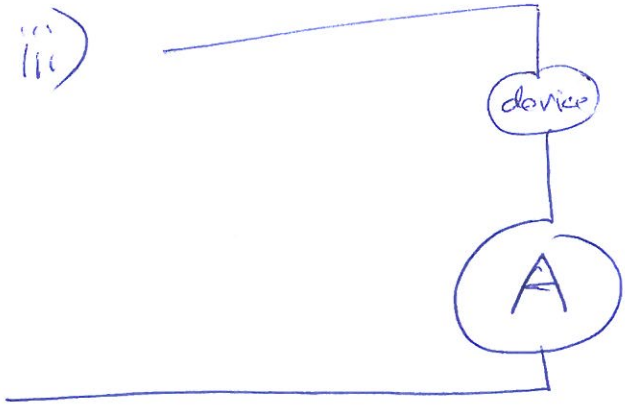
i) Use two batteries in a holder to get $V_{Ba} = 3V$.

ii) Voltage is measured across a component.



Voltmeter measure V across device. The voltmeter has a very high resistance so as to minimally perturb the circuit.

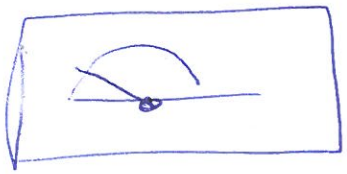
iii)



An ammeter must be in current path to measure current.

An ammeter has small resistance so as to minimally perturb the circuit.

In this lab we will use galvanometers as ~~ohmmeters~~ ammeters



- analog devices, not digital nor electronic.

NOT multimeter ~~ohmmeters~~ ammeters

These blow their fuses if $I \geq .4\,A$ and the fuses are tedious to replace.

There's too much chance of blowing fuses in this lab.