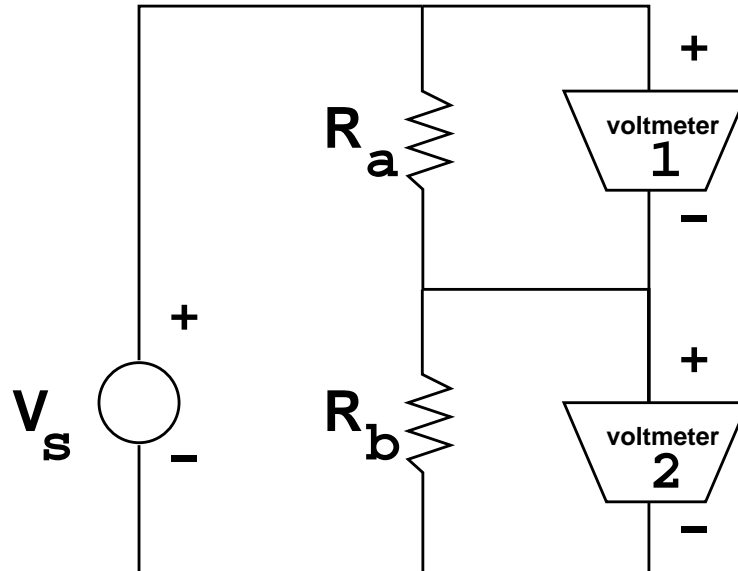


## Physics 122: Practice Problem of the Day

### Problem #07: A “Voltage Divider”

Wednesday, 28 Jan 2008



A circuit is constructed as shown above. Assume the values  $V_s$ ,  $R_a$  and  $R_b$  correspond to given known parameters. Two voltmeters measure voltages  $V_1$  and  $V_2$ . Assume that these are ideal voltmeters.

**Part a)** Calculate the values  $V_1$  and  $V_2$ . Do this from “First Principles.” In other words do this without referencing the concept of “equivalent voltage”. this.

**Part b)** This circuit is called a “Voltage Divider” where  $V_s$  corresponds to the “input” voltage and  $V_2$  corresponds to the “output” voltage. Explain why this circuit has this name.

**Part c)** Suppose we put a “load” on the “voltage divider”. In other words, suppose we replace voltmeter number 2 with one or more components that correspond to some device or circuit or something that has an equivalent resistance  $R_L$ .

One of the drawbacks of a voltage divider is that unless the equivalent resistance of the load is large compared to the divider resistances, the actual output voltage will “sag” relative to the design output voltage. To show this, calculate from first principles the output voltage of the divider as a function of the input voltage and the value of each resistor and the load resistance. Show that in the limit that  $R_L \gg R_a$  and  $R_L \gg R_b$  that  $V_{out}$  approaches the design output. Show also that in the case that  $R_L = R_a = R_b$  that the output voltage is expected to sag by more than 30% of the design voltage.