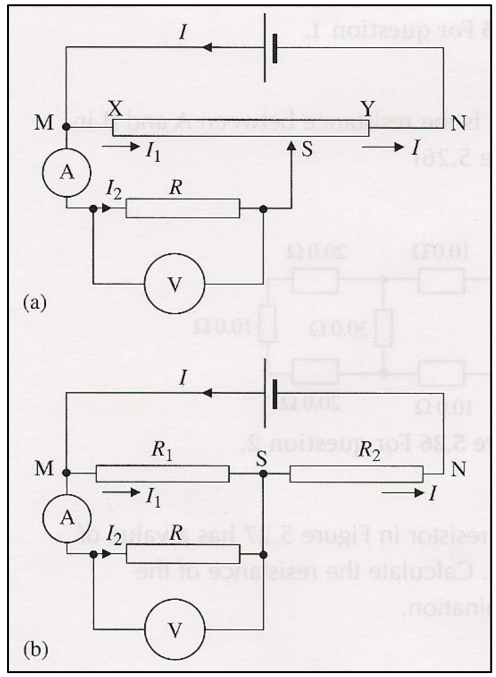
DEVIL PHYSICS
BADDEST CLASS ON CAMPUS
IB PHYSICS

**IB PHYSICS - 1**

Name: ______________________________

Period: ________ Date: ____________________

# Potential Divider Exercise
# (5pt Open Book Quiz, Individual Effort)




1. Read the description of the potential divider on the reverse side of this page.
2. In figure (a) to the right, assign a value to the emf (power source), the XY resistor, and resistance in the "device" R.

   a. emf ____________ V

   b. XY ____________ Ω

   c. Device (R) ____________ Ω

3. Figure (b) shows how the potential divider, in effect, works. The placement of the slider, S, divides the XY resistor into two resistors: one in parallel with the device, R, and one in series with the parallel circuit. Create three cases: 1. Put the slider in the middle of your XY resistor dividing it into two equal resistances, 2. Put the slider close to the left side of your XY resistor which gives a small resistance in parallel with your device and a large resistance in series, and 3. Put the slider toward the right side of your XY resistor which gives you a large resistance in parallel with your device and a small one in series. For each case, record the values of your $R_1$ and $R_2$ (remember that $XY = R_1 + R_2$), and calculate the total resistance ($R_T$) for ***the circuit***, the current (I), the voltage potential across your device ($V_D$), current ($I_1$) through your $R_1$, and the current through your device ($I_2$). Do your work on a separate piece of paper and attach it to this page.

| **Case 1** | | | **Case 2** | | | **Case 3** | | |
|---|---|---|---|---|---|---|---|---|
| $R_1$ | ____________ | Ω | $R_1$ | ____________ | Ω | $R_1$ | ____________ | Ω |
| $R_2$ | ____________ | Ω | $R_2$ | ____________ | Ω | $R_2$ | ____________ | Ω |
| $R_T$ | ____________ | Ω | $R_T$ | ____________ | Ω | $R_T$ | ____________ | Ω |
| I | ____________ | A | I | ____________ | A | I | ____________ | A |
| $V_D$ | ____________ | V | $V_D$ | ____________ | V | $V_D$ | ____________ | V |
| $I_1$ | ____________ | A | $I_1$ | ____________ | A | $I_1$ | ____________ | A |
| $I_2$ | ____________ | A | $I_2$ | ____________ | A | $I_2$ | ____________ | A |

4. Given what you have found above and learned from the back, what could this type of device be used for?

______________________________________________________________

______________________________________________________________

______________________________________________________________

# Sensors based on the potential divider

## The potential divider

The circuit in Figure 5.22(a) shows a potential divider. It can be used to investigate, for example, the current–voltage characteristic of some device denoted by resistance $R$. This complicated-looking circuit is simply equivalent to the circuit in Figure 5.22(b). In this circuit, the resistance $R_1$ is the resistance of the variable resistor XY from end X to the slider S, and $R_2$ is the resistance of the variable resistor from S to end Y. The current that leaves the battery splits at point M. Part of the current goes from M to N, and the rest goes into the device with resistance $R$. The right end of the resistance $R$ can be connected to a point S on the variable resistor XY.

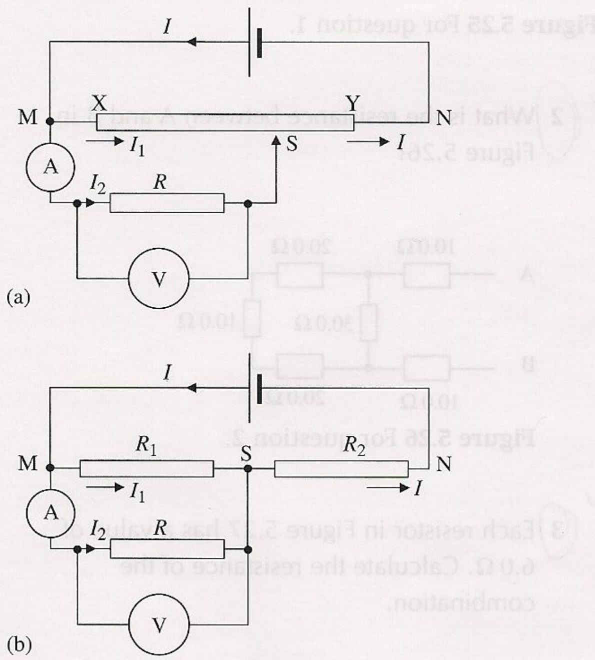



**Figure 5.22** (a) This circuit uses a potential divider. The voltage and current in the device with resistance $R$ can be varied by varying the point where the slider S is attached to the variable resistor. (b) The potential divider circuit is equivalent to this simpler-looking circuit.

By varying where the slider S connects to XY, different potential differences and currents are obtained for the device $R$. The variable resistor XY could also be just a wire of uniform diameter. One advantage of the potential divider over the conventional circuit arrangement (Figure 5.20) is that now the potential difference across the resistor can be varied from a minimum of zero volts, when the slider S is placed at X, to a maximum of $\mathcal{E}$, the emf of the battery (assuming zero internal resistance), by connecting the slider S to point Y. In the conventional arrangement of Figure 5.20, the voltage can be varied from zero volts up to some maximum value *less than* the emf.

**Example question**

**Q12**

In the circuit in Figure 5.23, the battery has emf $\mathcal{E}$ and negligible internal resistance. Derive an expression for the potential difference $V$ across resistor $R_1$.

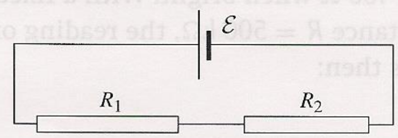



**Figure 5.23.**

**Answer**

Since $V = IR_1$ and $I = \frac{\mathcal{E}}{R_1+R_2}$,

we have that

$$V = \frac{R_1}{R_1 + R_2}\mathcal{E}$$

## Using sensors

This section includes a use of a particular sensor, a light-dependent resistor in a circuit. Other examples using the potential divider circuit discussed earlier can also be used with various other types of sensor, for example strain gauges and temperature-dependent resistors. A few examples are given in the questions at the end of the chapter.

Consider the circuit in Figure 5.24 that contains a light-dependent resistor (LDR). An LDR is a resistor whose resistance decreases as the light falling on the resistor increases. Typically, the resistance is 100 Ω in bright light and more than 1.0 MΩ in the dark. A voltmeter is connected across the LDR. Because the resistance of the LDR