NAME:_____**DATE:**_____

AE-231: Basic Electronics and Studio Maintenance **Lesson-2:** Voltage Division

Variable Resistors come in two basic forms, as rotary potentiometers (pots) and linear faders. Both are perfect examples of how variable resistors can be used to divide voltages. The resistive element is the white-on-black vertical zig-zag shown in the example. The wiper is the part that turns or slides - it's the yellow arrow - it divides the resistive element into two parts. The equivalent circuit would be two resistors in series, the junction of which being the wiper.

The voltage source can be Direct Current (DC) - battery or power supply - or an Alternating Current (AC), power or audio signal. The "signal" is applied across the total resistance, which in this variable resistor example would be IN and GROUND (gnd). Not all variable resistors have one side connected to ground, but it is the reference and makes division possible. Think of the resistance as a bungee cord stretched from ceiling to floor.

The variable output would appear between OUT and GROUND. Keep in mind that the taper of variable resistors is application specific. Two taper types (and their examples) are Linear (PAN and EQ boost / cut) and Logarithmic (Level and Gain controls). Linear devices have equal resistance on either side of the wiper when positioned at mechanical center. If the source is 10 volts, the output (from wiper to ground) would be 5-volts or 6dB down. As **Figure-1** shows, this physically linear, log fader is 6dB down a very short distance from the top (wide open or full up).

You don't have to know Ohm's Law to predict the output at the wiper (referenced to ground). The formula is given in **Figure-1** (last page), where the voltage at the wiper can be calculated by multiplying the Voltage in ($\mathbf{V}_{total}$) by the ***ratio*** - of the resistance from wiper to bottom / gnd ($\mathbf{R}_{bot}$) to the total resistance ($\mathbf{R}_{total}$).
NOTE: For ALL exercises, draw the equivalent circuits, for each problem, in the margin to the left. Be sure to indicate the "quantity" as shown in the first exercise.

EXERCISE-1:
The wiper-to-ground output is 37-volts and the total resistance is 50k**Ω.** The resistance from wiper-to-ground is 1/3 the total resistance. Calculate the resistance from wiper-to-ground, wiper-to-top and the original input voltage.

1. Wiper-to-ground:_____**Ω**

2. Wiper-to-top:_____ **Ω**

3. Voltage In:_____***volts***

Exercise-2:

The total resistance is 22kΩ. The voltage out is 11-volts when the resistance on either side of the wiper is 11kΩ. What is the original voltage?

4. _____

_____

Exercise-3:

The resistance from input to wiper is 2kΩ and from wiper-to-ground is 3kΩ. The voltage in is 50.1 volts.

5. What is the total resistance?_____

6. What is the voltage out?_____

_____

7. If a 1MΩ resistor were connected ***in series*** with the wiper, what would the approximate voltage be at the other side of the 1MΩ resistor to ground? (draw example).

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8. If the external 1MΩ resistor was connected from the wiper to ground, how would it move the original wiper-to-ground voltage (the output from the wiper) up or down? (draw example)

_____

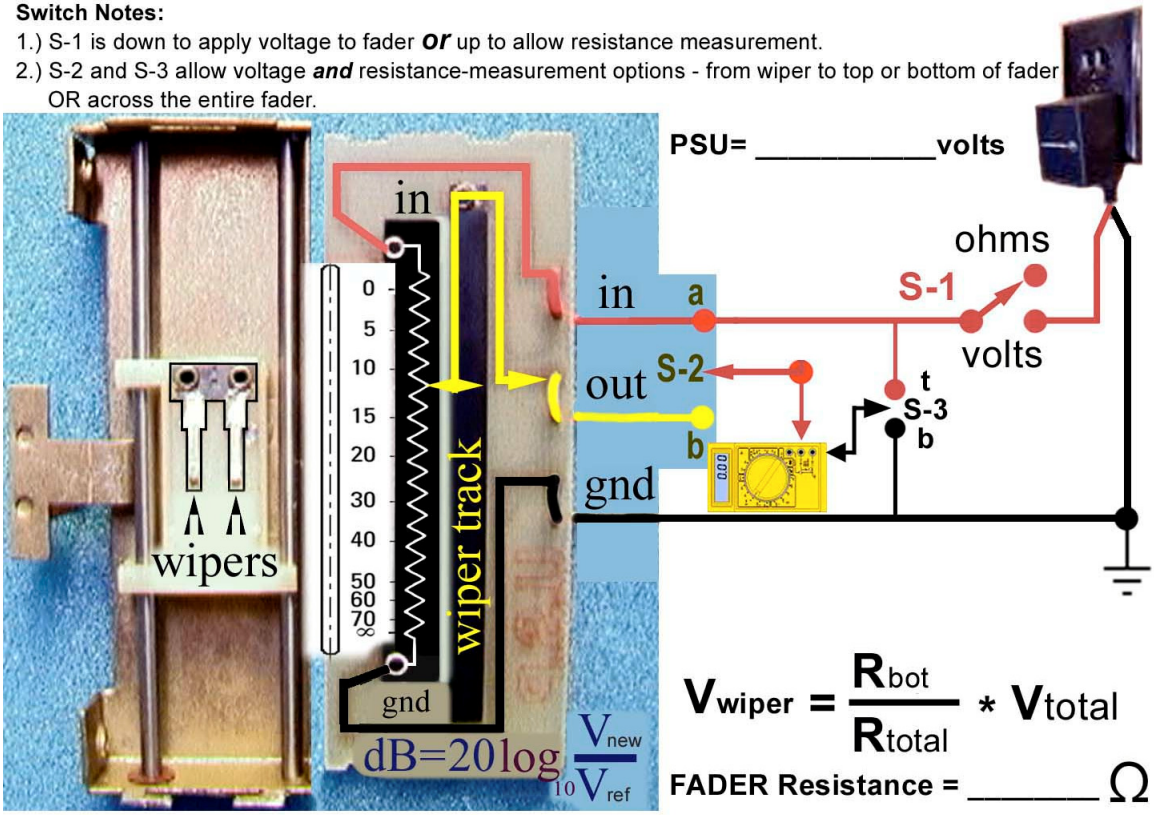
9. Would the change be significant or not. Give your reasons for either.

_____

Switch Notes:

1.) S-1 is down to apply voltage to fader ***or*** up to allow resistance measurement.

2.) S-2 and S-3 allow voltage ***and*** resistance-measurement options - from wiper to top or bottom of fader OR across the entire fader.



3.) S-2 is down and S-3 is up for ***wiper-to-top*** measurements.

4.) S-2 is down an S-3 is down for w***iper-to-bottom*** measurements.

5.) S-2 is up and S-3 is down to measure either the volts across the fader or total resistancs.

FIGURE-1: the mother of all resistive reference