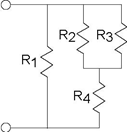
**Example 3.1**



**Figure 3.14 Example 3.1**

We want to find the total resistance of the example circuit. To apply the series and parallel combination rules, it is best to first determine the circuit's structure: What is in series with what and what is in parallel with what at both small-and large-scale views. We have **R2** in parallel with **R3**; this combination is in series with **R4**. This series combination is in parallel with **R1**. Note that in determining this structure, we started away from the terminals, and worked toward them. In most cases, this approach works well; try it first. The total resistance expression mimics the structure:

Such complicated expressions typify circuit "simplifications." A simple check for accuracy is the units: Each component of the numerator should have the same units (here Ω3) as well as in the denominator (Ω2). The entire expression is to have units of resistance; thus, the ratio of the numerator's and denominator's units should be ohms. Checking units does not guarantee accuracy, but can catch many errors.

Another valuable lesson emerges from this example concerning the diference between cascading systems and cascading circuits. In system theory, systems can be cascaded without changing the input-output relation of intermediate systems. In cascading circuits, this ideal is rarely true **unless** the circuits are so **designed**. Design is in the hands of the engineer; he or she must recognize what have come to be known as loading efects. In our simple circuit, you might think that making the resistance ***RL*** large enough would do the trick. Because the resistors ***R*1** and ***R*2** can have virtually any value, you can never make the resistance of your voltage measurement device big enough. Said another way, **a circuit cannot be designed in isolation that will work in cascade with all other circuits**. Electrical engineers deal with this situation through the notion of **specifcations**: Under what conditions will the circuit perform as designed? Thus, you will fnd that oscilloscopes and voltmeters have their internal resistances clearly stated, enabling you to determine whether the