Current,

Resistance,

and

Voltage

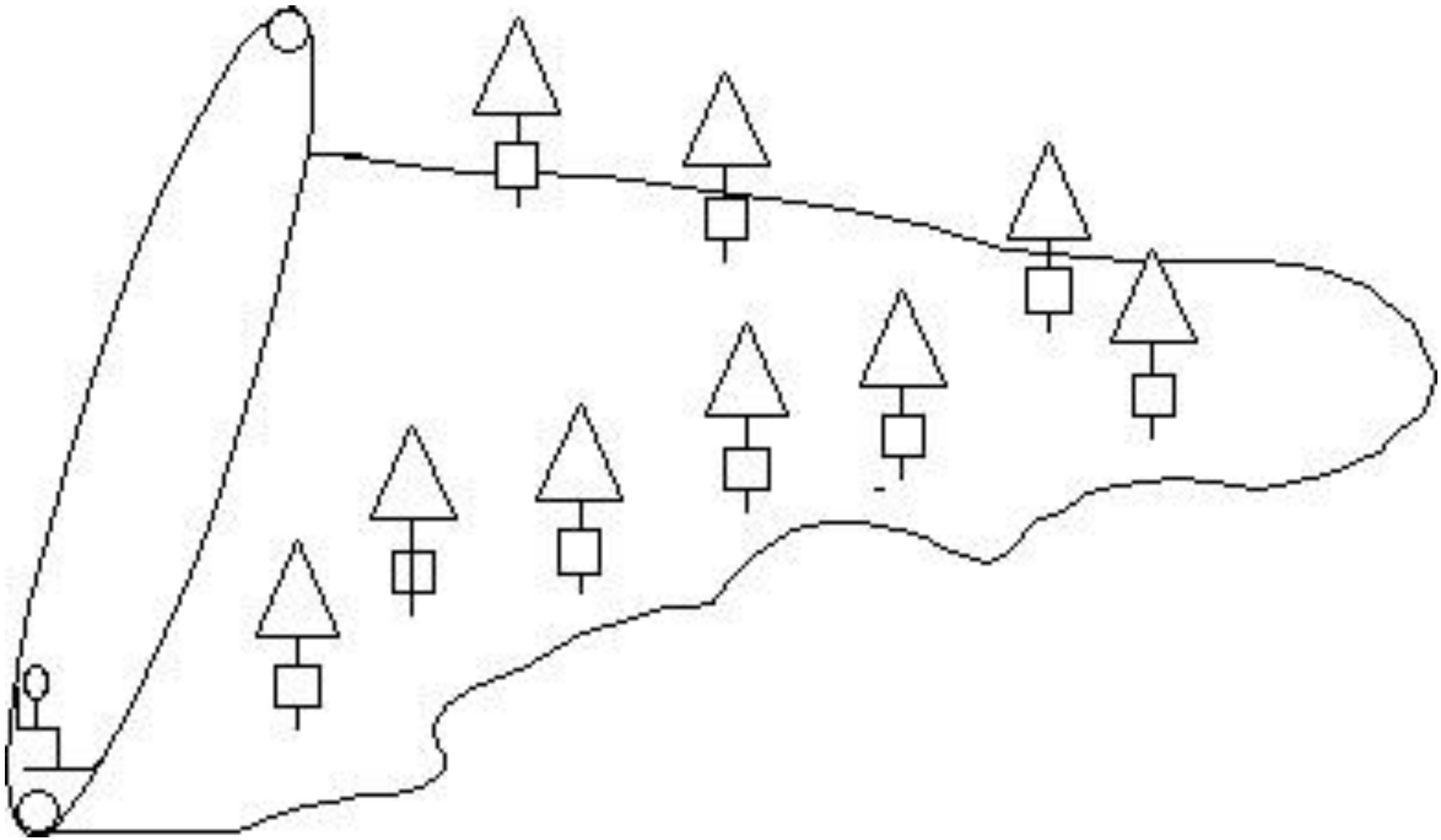
in a simple circuit

Part 1

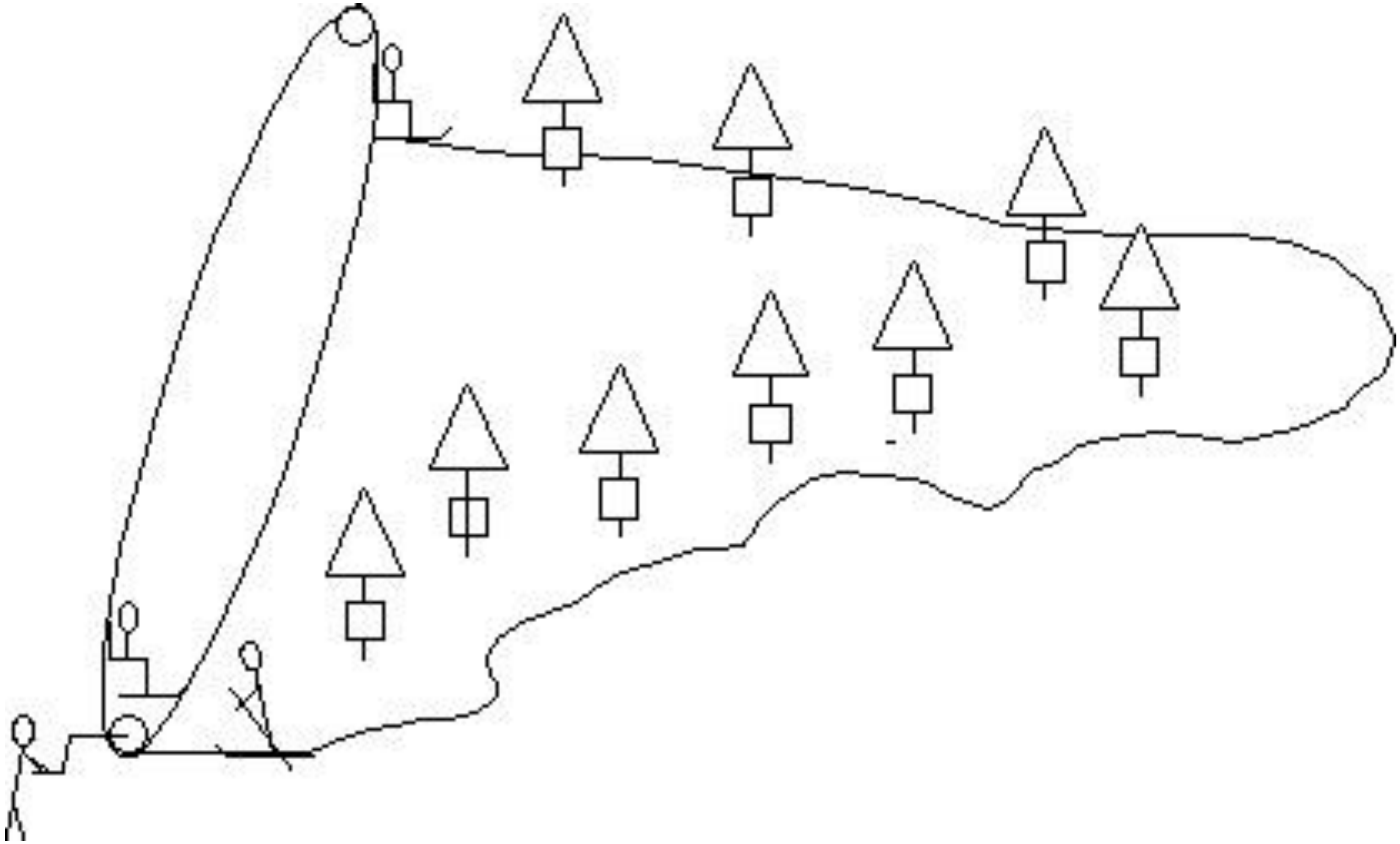
Sometime analogies, though they may limp, help our understanding of abstract concepts.

Here is a physical process analogous to what happens in a simple electrical circuit.

Imagine a skier on a lift (manually operated) at the bottom of a hill.

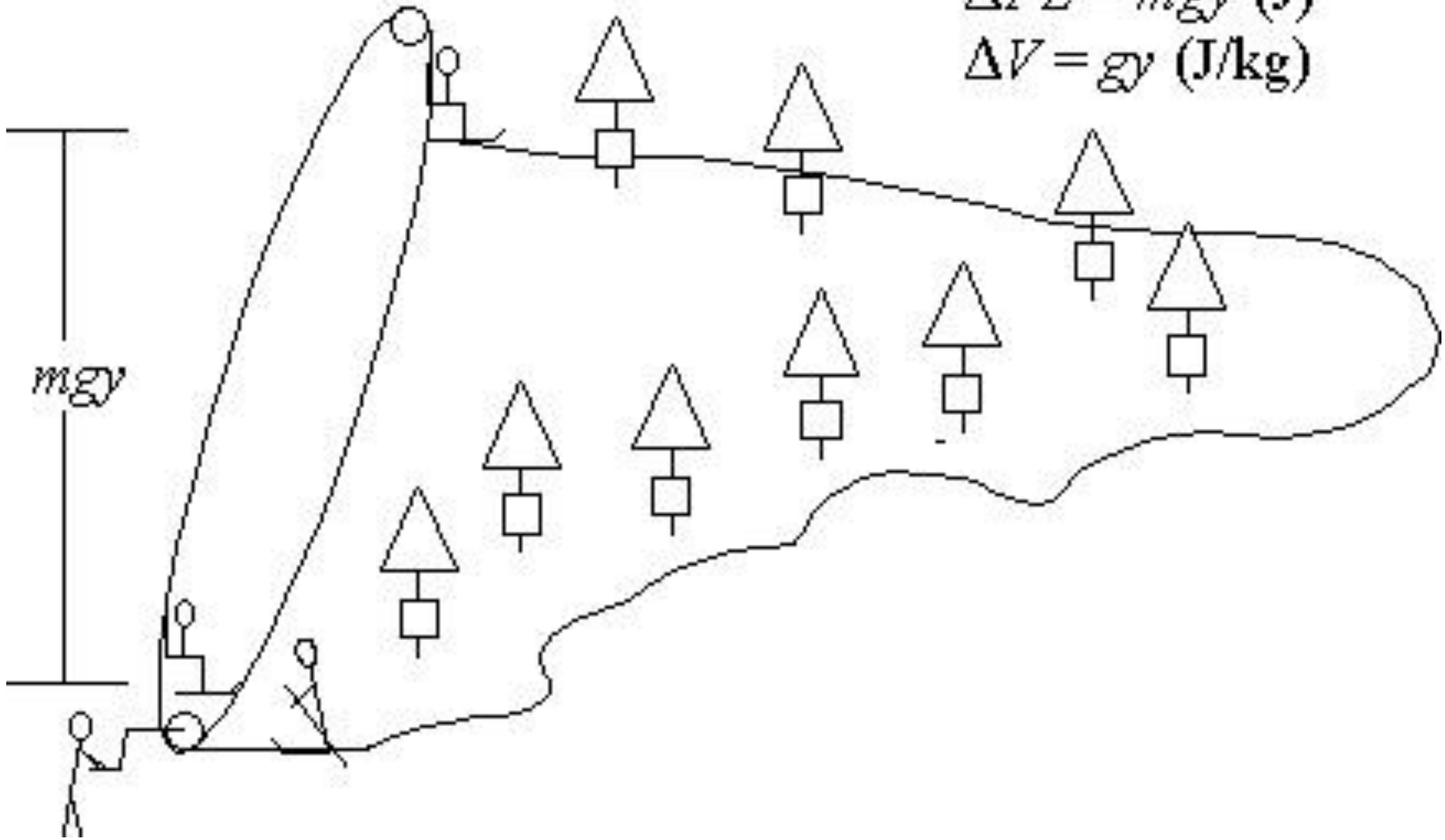


The lift operator can raise the skier to the top of the hill and gravity will eventually bring the skier back to the bottom.

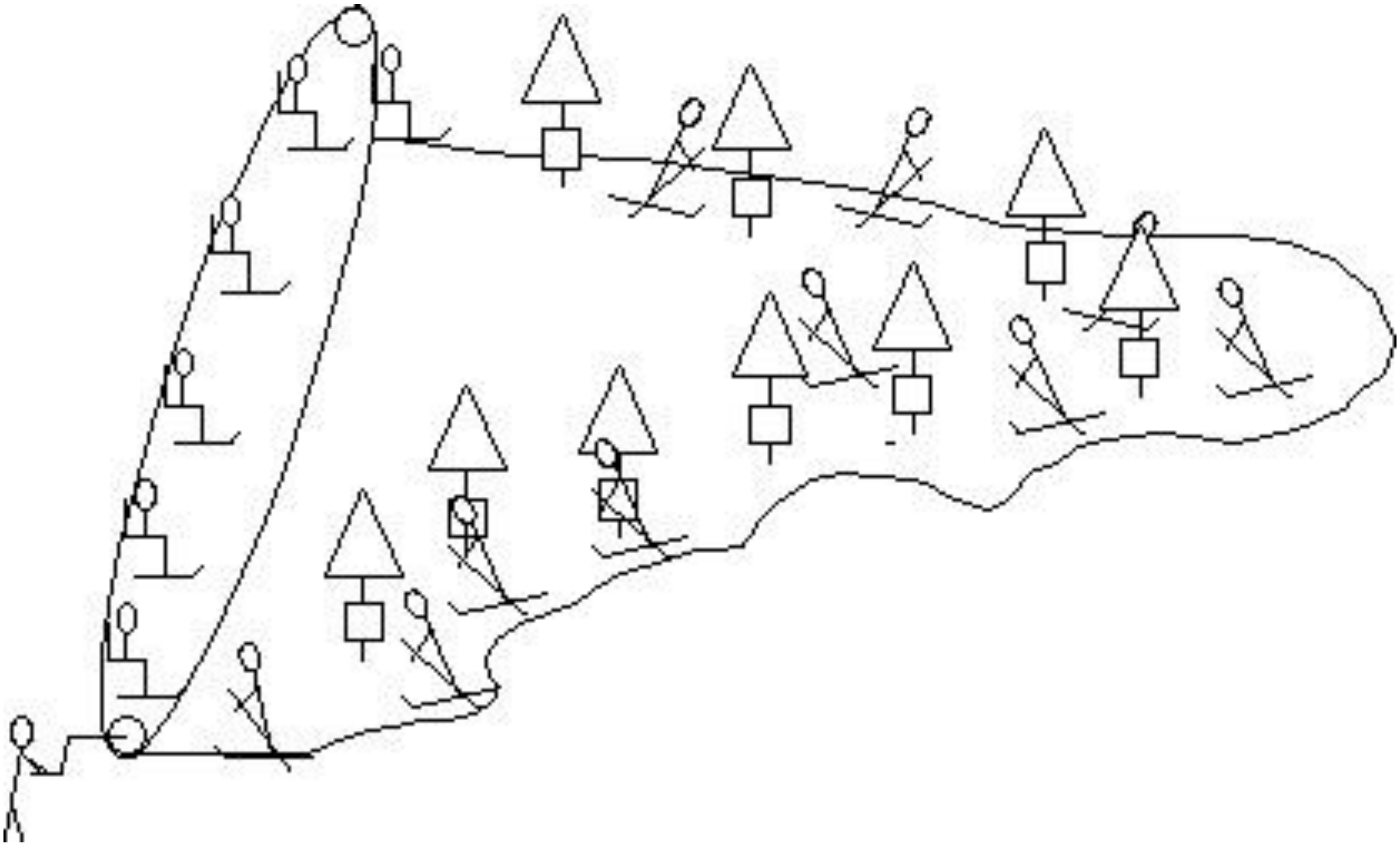


Of course, this will require the expenditure of *work* that will change both the gravitational potential energy (*mgy*) and the gravitational potential (*gy*) of the skier-earth system.

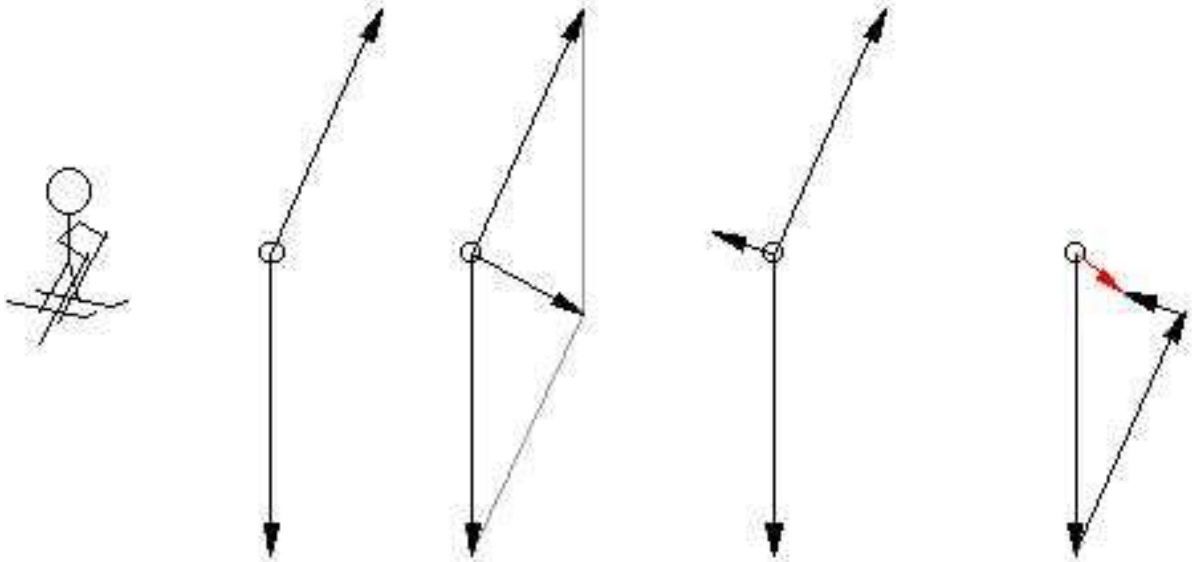
$$\Delta PE = mgy \text{ (J)}$$
$$\Delta V = gy \text{ (J/kg)}$$



We could even image a continuous movement of skiers, a "current" of skiers.



Let's focus on an individual skier.

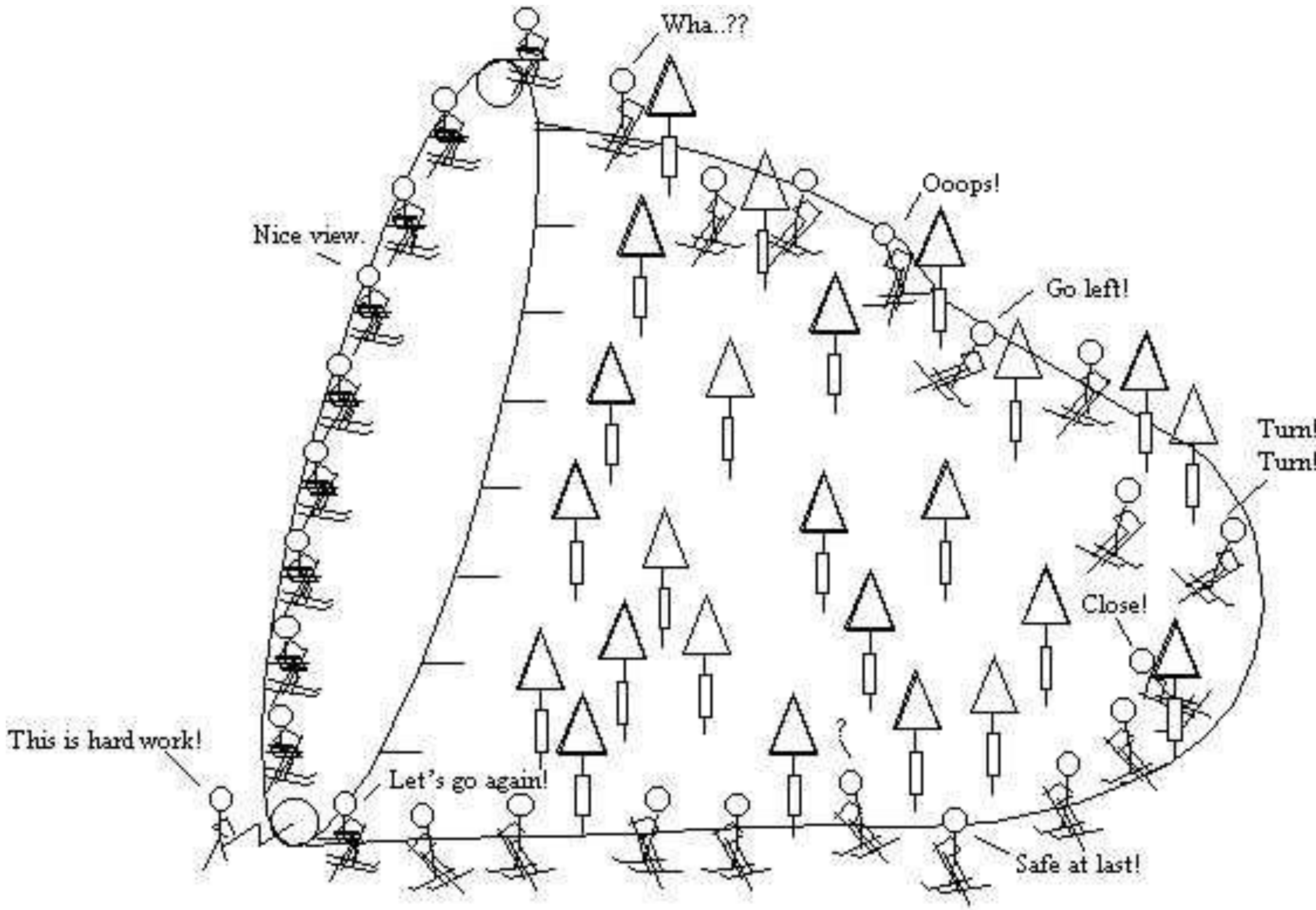


At any instant the forces on theskier will be:

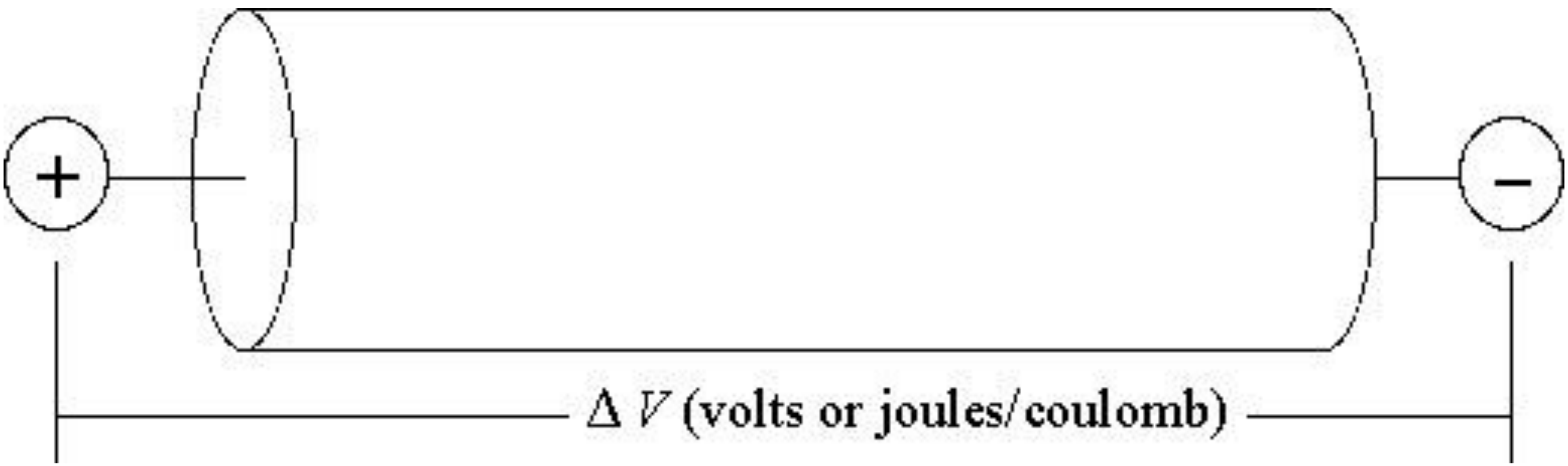
1. The weight (gravity force)
2. The normal force
3. Some combination of retarding forces
   a. Air friction
   b. Friction between skis and snow
   c. A push/collision force (perhaps) of a tree against the skier

Over the entire motion down the slope, then, there is some average retarding force and the result is an average drift speed down the slope equal to the rate at which skiers are being lifted to the top.

...so the real "skier current" will be more irregular.


This is hard work!
Nice view.
Wha..??
Ooops!
Go left!
Turn!
Turn!
Close!
?
Let's go again!
Safe at last!

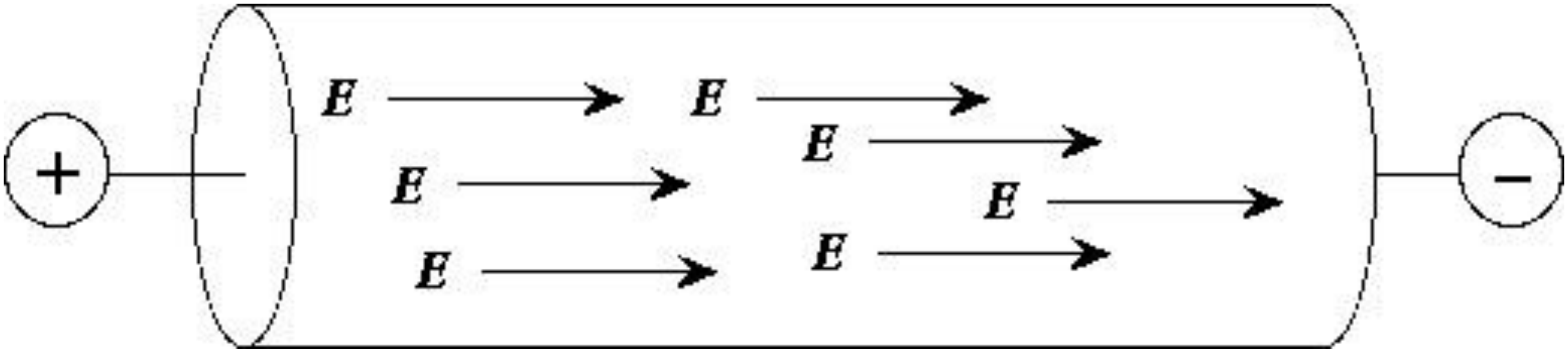
Now, to apply the analogy, connect a battery to a conducting wire.



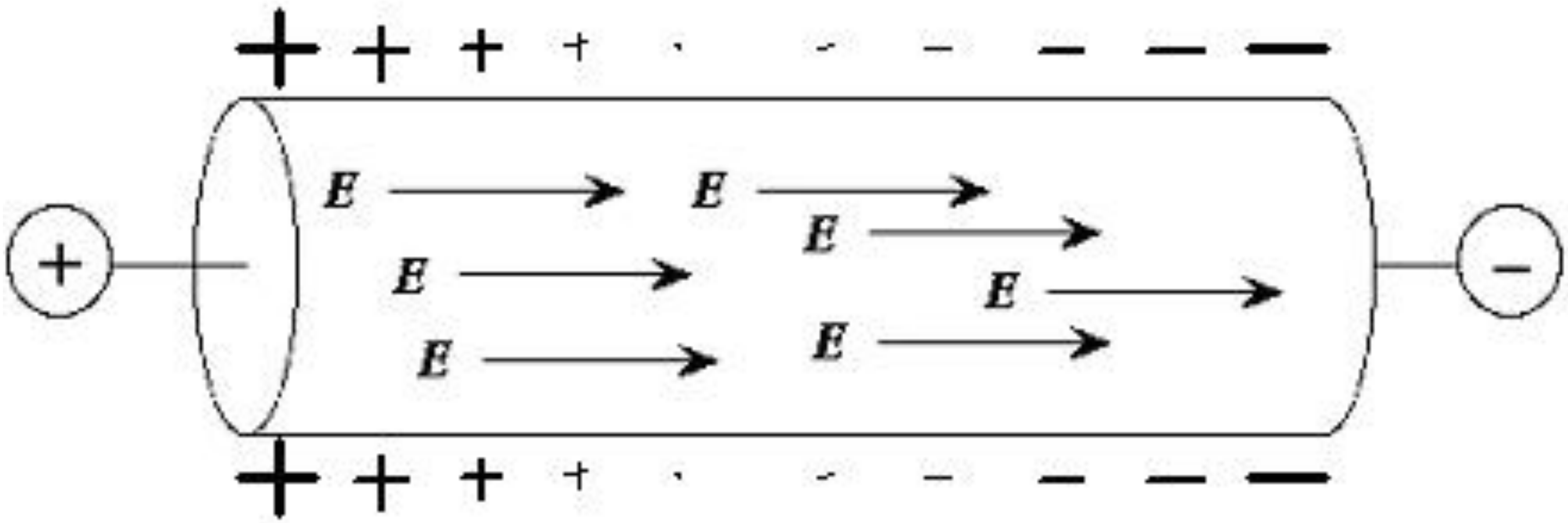
ΔV is the potential difference between the terminals of the battery.

The battery has done work (from stored chemical energy) to separate charges.

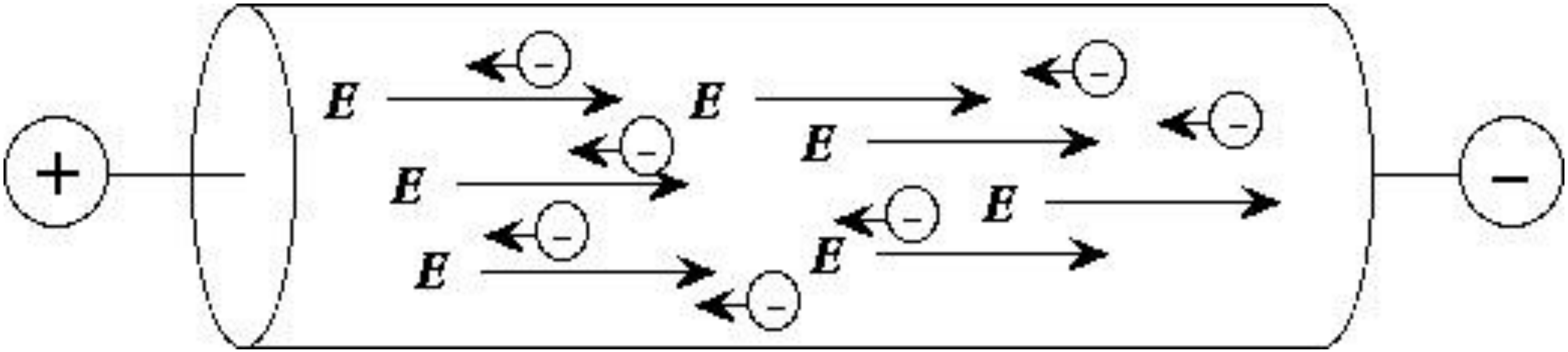
A uniform electric field is present in the wire...



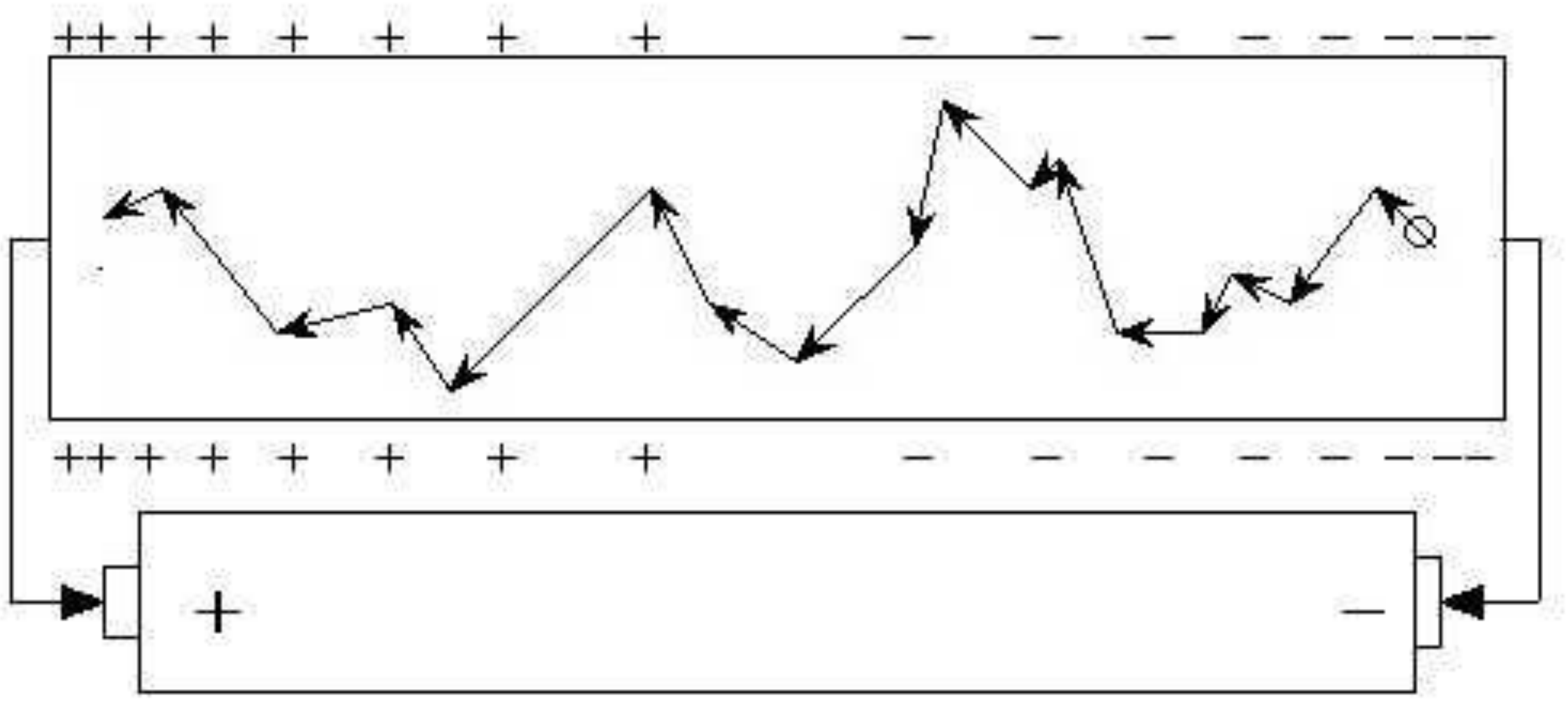
…because there is a charge distribution along the (*outside*) of the wire.



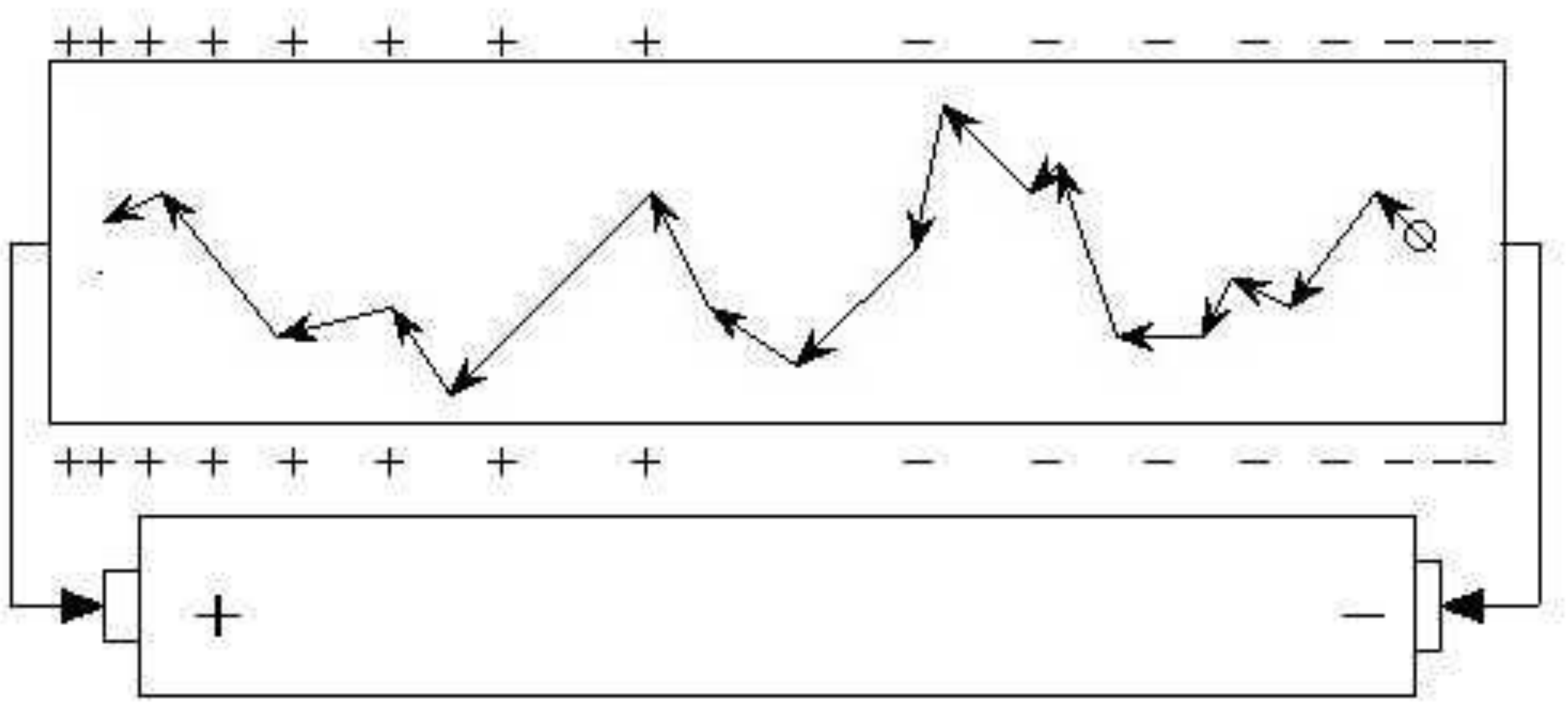
The field accelerates the conduction electrons in the metal.



The electrons move down the wire, accelerating and then colliding with impurity atoms, grain boundaries and vibrating ion cores, then accelerating again.



The result is an erratic drift of electrons between the terminals.



The result is an erratic drift of electrons between the terminals with an average drift velocity of magnitude υ_d.