Problem Set 1 for Tuesday Sept. 14

Gather together the four theory handouts that have been created and distributed. You will need them. Also get clean 8½x11 paper, a pencil, and an eraser. High-quality work begins with assembling good tools, and taking pride in using them well.

} These are directions not suggestions

1. You are a 72 kg astronaut who has just landed on the Moon. The acceleration of gravity is $1.5 \frac{m}{s^2}$ You carefully lower yourself 0.50 m from the bottom rung of the lander's ladder to the surface.

If you had instead jumped from the bottom rung to the surface, how much energy would be released!

Carry through units carefully. Convert to common and convenient units. Feel free to round to two sig figs – or not.

} More directions

2. A 50g serving of Kitkat wafer bars has 259 kcal = 259,000 cal of energy

energy unit used by nutritionists — energy unit used by chemists in the 1800's

a. 1 cal ≡ 4.184 J ← exact, using today's defn of cal

Convert the energy in 50g of Kitkats to Joules. Round to three sig figs. (I chose these numbers to make the final result tidy.)

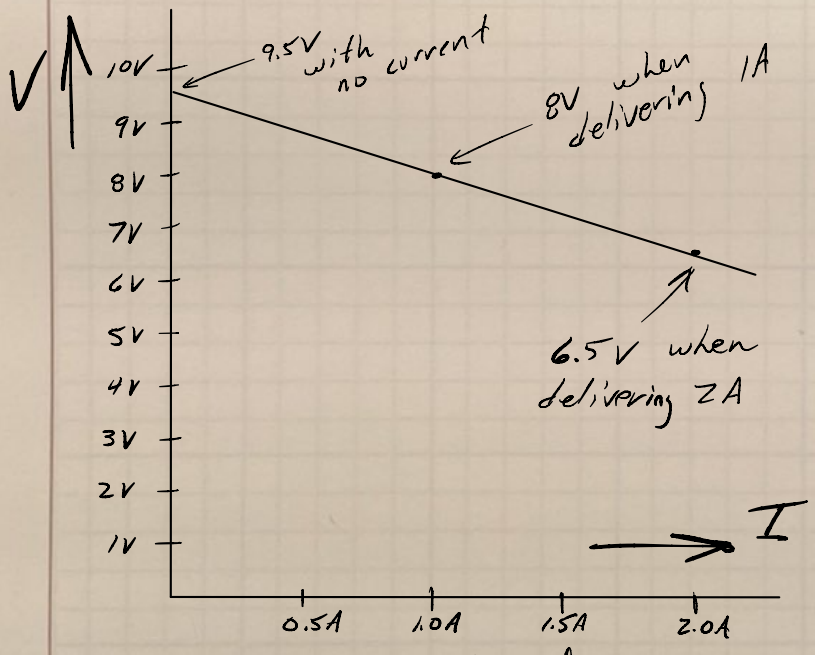
b. You are hiking and you have 50g of Kitkats every hour. If your body was perfectly efficient at turning Kitkats into muscular work, how much power could your muscles put out? HINT: You will need to convert hours to seconds to get to standard units. NOTE: The human body is far from perfectly efficient. Most humans can only do work at a rate of about 100W.

3 a. 5 Coulombs of charge "falls" through an electrical potential and releases 150 Joules of energy. What is the electrical potential?

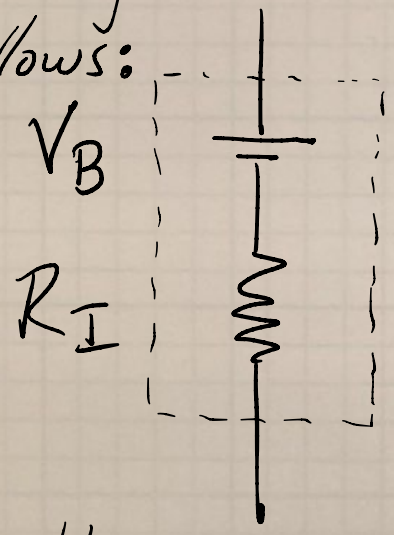
b. 20A of current "falls" through an electrical potential of 12V. What is the power being released?

4. A proton has charge of 1.6×10^{-19} C. The LHC (Large Hadron Collider) at CERN has a beam current of 0.58 A. How many protons pass by the particle detector in 1 second.

5. This is a more realistic I-V curve for a fresh 9V alkaline battery:



Model a 9V battery as follows:

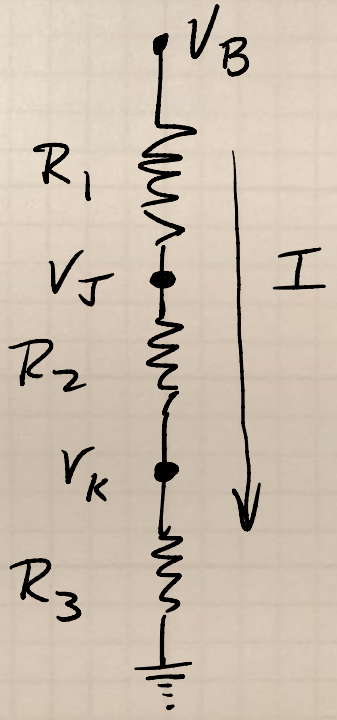


modeled as

The battery is a perfect voltage source with value V_B, in series with a resistor of value R_I.

From the y-intercept of the graph (where no current is flowing), and the slope of the graph, determine V_B and R_I

5a. Use the methods I used when deriving the formula for resistors in series to determine V_J and V_K in the following schematic:



5b. Your answers for V_J and V_K involved R_1, R_2, R_3 and V_B

Plug in $V_B = 10\,V$

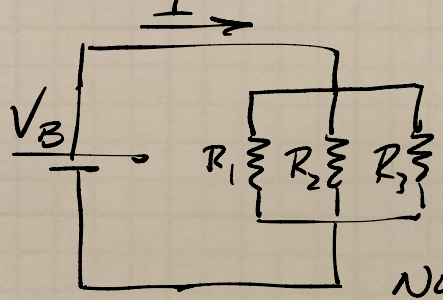
$R_1 = 800\,\Omega$ and

$R_2 = R_3 = 100\,\Omega$ and

get V_J and V_K.

NOTE: Such a circuit is called a voltage divider.

6a. Use the methods I used when deriving the formula for resistors in parallel to find I in this circuit.



6b. Rearrange your equation for I to solve for $\frac{V_B}{I}$.

NOTE: Your answer to 6b is the formula for the resistance of three resistors in parallel