Name: _____

Kirchoff's Rules for Circuitry

Mr. Forrest *AP Physics*

Loop Rule (Conservation of voltage): The algebraic sum of the potential differences around a closed conducting loop must be zero volts.

Current Rule (Conservation of current): The net current entering into any junction (or node) must be zero: so the current entering a junction must exactly equal the current leaving a junction.

When figuring out circuits using Kirchoff's rules, there are some guidelines to follow. It is VERY important to make sure you use correct algebraic signs [(+) and (-)] when determining these circuits.

GUIDELINES TO KNOW AND L♥VE:

I) The potential difference is +V (or + $\mathcal{E}$ for an EMF) when a voltage source is traversed in the forward direction of the EMF. So crossing a battery from (-) to (+) would result in a gain in voltage, or + V.

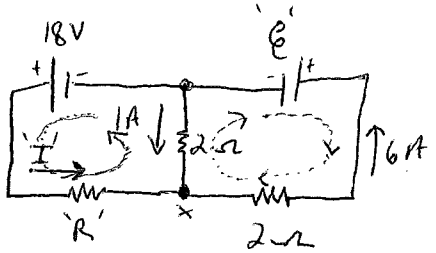
II) The potential difference is -V (or - $\mathcal{E}$ for an EMF) when a voltage source is traversed in the backward direction of the EMF. So crossing a battery from (+) to (-) would result in a loss in voltage, or - V.

III) The potential difference is - IR when a resistor is traversed in the direction of current. Why negative? That's because crossing a resistor in the direction of current causes a drop in potential, as electrical potential energy is 'lost' as heat.

IV) The potential difference is + IR when a resistor is traversed opposite the direction of current. Why positive? That's because crossing a resistor opposite the direction of current would take a 'push', thus causing an increase in electrical potential energy.

NOTE FOR RULES (III) and (IV). These rules apply even if you have initially 'guessed' that the current is going the opposite direction compared to the direction it is really traveling. Make sure to apply the algebra consistently as stated in these rules. If you did guess wrong, you'll just end up with a negative value for current, which means it's traveling the other way.

SAMPLE



Note: I randomly chose the direction of my loops.

FIND THE UNKNOWN CURRENT 'I', the RESISTANCE 'R', and the EMF '$\mathcal{E}$'.

(I) At the junction 'X', $I + 1\text{Amp} = 6\text{amps}$. So... $\boxed{I = +5\text{ Amps}}$

(II) To find 'R', use the loop rule on the left side: $0 = 18V - 5\text{Amps}(R) + 1\text{Amp}(2\Omega)$

$0 = 18 - 5R + 2 \Rightarrow 0 = 20 - 5R$

$-20 = -5R$; $\boxed{R = 4\Omega}$

(III) To find '$\mathcal{E}$', use the loop rule on the right side.

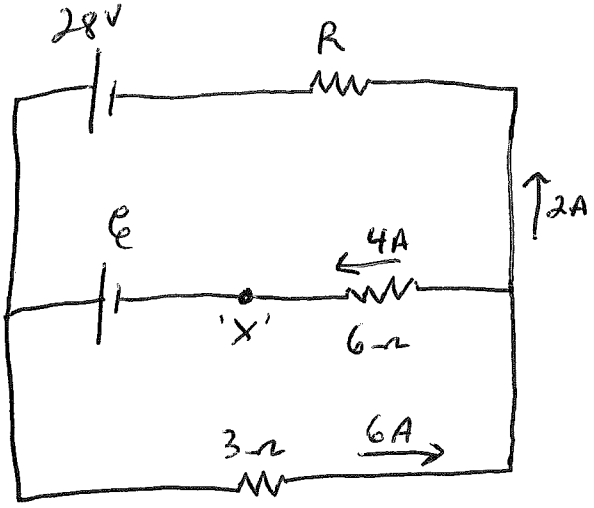
$0 = \mathcal{E} + (6A)(2\Omega) + (1A)(2\Omega)$

$0 = \mathcal{E} + 12V + 2V$

$\boxed{\mathcal{E} = -14\text{Volts!}} \Rightarrow$ ∴ The polarity of $\mathcal{E}$ is actually the reverse of what's shown.

[So the (+) terminal is actually on the left.]

Kirchoff's Problem #1



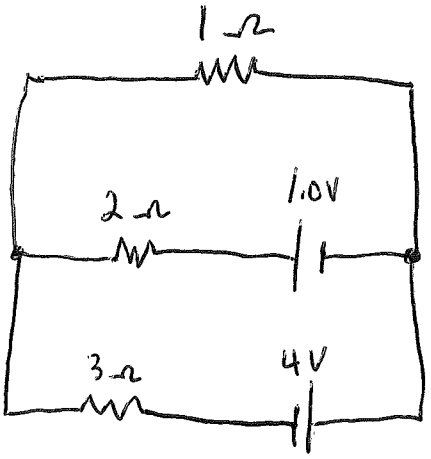
Find the following

1) 'R'

2) ℰ

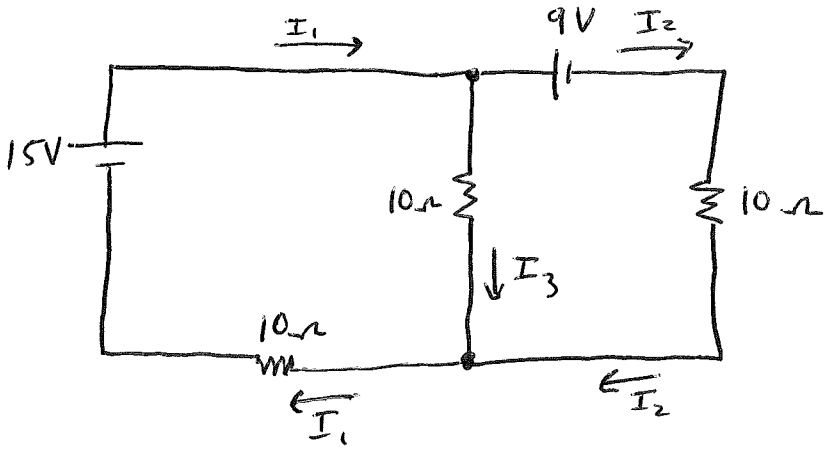
3.) Find the current through 'R' if the circuit is cut at 'X'.

KIRCHOFF'S PROBLEM #2



Find the magnitude and direction of current through <u>each</u> resistor.

KIRCHOFF'S PROBLEM #3



Find each of the three currents in the circuit.