Instrumental Analysis

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Spring 2014

1 Direct Current

1.1 Charge

- Can be positive or negative
- Depicted by the symbol "\mathrm{Q}"
- Measured in Columbs where \electron{1} = 1.6e-19\mathrm{C}
- All charges are multiples of the electron charge
- However, charge is often considered a continuous value for simplicity's sake
- Conserved in a closed system

1.2 Current

- Flow of electrical charge
- egin{equation}I = \dfrac{d \mathrm{Q}} {d \mathrm{t}}\end{equation}
- Where \mathrm{I} is current, \mathrm{Q} is charge, and \mathrm{t} is time
- Direction is conventionally flow of POSITIVE charge
- Measure in Amps where \mathrm{A} = \dfrac{\mathrm{C}}{\mathrm{s}} = \SI{6.25e18}{ rac{\electron}{\mathrm{s}}}
- Lower Power = 1-10 \mathrm{m}\mathrm{A}
- High Power = anything higher
- 2 Types
- Direct Current
- Direction of charge flow is ALWAYS the same
- Pulsating Direct Current has variable current magnitude
- Alternating Current
- Direction of charge flow is variable

1.3 Voltage

- Electric potential
- \mathrm{V} = \dfrac{\mathrm{W}}{\mathrm{Q}} =
  rac{Potential Energy}{Charge} =
  rac{Joules}{Columbs}
- Ground is the point at which the energy of all charges is zero
- Flows from high to low

1.4 Resistance

- With flow comes resistance
- \mathrm{R} = (\dfrac{\mathrm{V2} - \mathrm{V1}}{\mathrm{I}}) = \Omega = \dfrac{Volts}{Amps}
- Current in must equal current out
- Passive circuits: if no energy is given to the charge, then the charge loses energy
- \dfrac{{(\mathrm{{V2}} - \mathrm{{V1}})}}{{\mathrm{R}}} and \mathrm{V2}\gtr\mathrm{V1}
- Resistance is positive
- Dependent on length
- \mathrm{R} = ho * \dfrac{{\mathrm{l}}}{{\mathrm{A}}}
- where \mathrm{R} is resistance, ho is resistivity (ohm meters), \mathrm{l} is length, and \mathrm{A} is cross-sectional area
- Resistivity: the difficulty that an electron has in moving through a material due to the collisions it experiences with the atoms in the material
- Can be temperature dependent
- Increases 0.5% - 1% for a rise of 10C in carbon resistors
- Does NOT depend on size or shape, but on material properties
- Conductors have low resistivity
- Insulators have high resistivity
- Batteries have a negative resistance due to chemical energy contribution (\mathrm{V1} \gtr \mathrm{V2})
- \mathrm{R} =
  rac{{d\mathrm{V}}}{{d\mathrm{I}}}
- Resistors are a two terminal circuit element that has a consistent resistance
- Color code where \mathrm{R} = (1st)(2nd)*10^(3rd) and the (4th) is the tolerance