Formulas of Physics for ISP 209

Electricity and Magnetism

Electrostatics

Coulomb's Law. The magnitude of the electrostatic force between two charged particles is equal to the Coulomb constant K times the product of the charges Q_1 Q_2 divided by the square of the distance r between the centers;

$$F = \frac{KQ_1Q_2}{r^2} \ .$$

- The electric field **E(x)** is a physical entity which is created by electric charges and which exerts a force on electric charges. Quantitatively, **E(x)** is equal to the force per unit charge **F**/q on a small test charge *q* placed at **x**,
  $$\mathbf{E(x)} = \mathbf{F} / q \ .$$
- The electric potential *V(***x***)* is the electrostatic potential energy per unit charge *U(***x***)/q* on a small test charge *q* placed at **x**,
  $$V(\mathbf{x}) = U(\mathbf{x}) / q \ .$$
- The voltage drop across a capacitor, i.e., the difference in electrostatic potential between the conductors, is Q/C where +Q and –Q are the charges on the conductors and C = capacitance,
  $$V = Q / C \ .$$
  Or, if the potential drop is known, e.g., from the emf of a battery, then the charge on the capacitor plates is obtained from *Q = CV*.
- The energy stored in a capacitor is
  $$U = \tfrac{1}{2} QV \ .$$

Electric current

Power consumption. The power P used by an electrical device is equal to the voltage drop V across the device times the current I flowing through it,

$$P = IV \ .$$

Power production. The power P provided by an electrical device is equal to the voltage drop V across the device times the current I flowing through it,

$$P = IV \ .$$

Ohm's Law. The voltage drop *V* across a resistor is equal to the current *I* flowing through it times the electrical resistance *R*,

$$V = IR \ .$$

Or, if the potential drop is known, e.g., from the emf of a battery, the current is *I = V/R*.

Joule's Law. The power dissipated as heat in a resistor is I^2R, where I = current and R = resistance,

$$P = I^2 R \ .$$

Magnetic Force

- The magnetic force on a charged particle with charge *q* moving with velocity **v** through a magnetic field **B** is
  $$\mathbf{F} = q\mathbf{v} \times \mathbf{B} \ .$$
  The direction is determined by the right-hand rule for the cross product.
- If the velocity vector **v** is orthogonal to the magnetic field vector **B**, then the magnetic force **F** on the charge *q* is orthogonal to both **v** and **B**, in the direction given by the right-hand rule; and the magnitude of the force is
  $$F = qvB \ .$$