

## Circuits

**Ohm's Law:**  $V = IR$

voltage = current  $\times$  resistance

**Power Dissipated in a DC Circuit:**  $P = IV$

power = current  $\times$  voltage

**Equivalent Resistance for Resistors in Series:**

$$R = R_1 + R_2 + R_3 + \dots$$

resistance = resistance<sub>1</sub> + resistance<sub>2</sub> + resistance<sub>3</sub> + ...

**Equivalent Resistance for Resistors in Parallel:**

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$$

$$\frac{1}{\text{resistance}} = \frac{1}{\text{resistance}_1} + \frac{1}{\text{resistance}_2} + \frac{1}{\text{resistance}_3} + \dots$$

## Experimental Design

$$\text{Percent Error} = \frac{|\text{accepted value} - \text{experimental value}|}{\text{accepted value}} \cdot 100\%$$

$$\text{Percent Yield} = \left( \frac{\text{actual yield}}{\text{theoretical yield}} \right) \cdot 100\%$$

## Force and Energy

**Newton's Second Law:**  $F = ma$

force = mass  $\times$  acceleration

$$\text{Power: } P = \frac{W}{t}$$

$$\text{power} = \frac{\text{work}}{\text{time}}$$

**Work:**  $W = Fd$

work = force  $\times$  distance

**Force Due to Gravity:**  $F = w = mg$

force = weight = mass  $\times$  acceleration due to gravity

$$\text{Coulomb's Law: } F = k_e \left( \frac{q_1 q_2}{r^2} \right)$$

$$\text{force} = \text{Coulomb's constant} \left( \frac{\text{charge}_1 \times \text{charge}_2}{\text{distance}^2} \right)$$

## Force and Energy (continued)

**Law of Universal Gravitation:**  $F_g = G \left( \frac{m_1 m_2}{d^2} \right)$

force = gravitational constant  $\left( \frac{\text{mass}_1 \times \text{mass}_2}{\text{distance}^2} \right)$

**Gravitational Potential Energy:**  $PE_{\text{gravitational}} = mgh$

gravitational potential energy = mass  $\times$  gravity  $\times$  height

**Kinetic Energy:**  $KE = \frac{1}{2} mv^2$

kinetic energy =  $\frac{1}{2}$  mass  $\times$  velocity<sup>2</sup>

**Work:**  $W = \Delta KE$

work = change in kinetic energy

**Impulse:**  $J = F\Delta t = m\Delta v$

impulse = force  $\times$  change in time = mass  $\times$  change in velocity

## Gas Laws

**Ideal Gas Law:**  $PV = nRT$

pressure  $\times$  volume = moles  $\times$  ideal gas constant  $\times$  temperature

**Combined Gas Law:**  $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

$\frac{\text{pressure}_1 \times \text{volume}_1}{\text{temperature}_1} = \frac{\text{pressure}_2 \times \text{volume}_2}{\text{temperature}_2}$

## Motion

**Average Velocity:**  $v = \frac{\Delta d}{\Delta t}$

velocity =  $\frac{\text{change in distance}}{\text{change in time}}$

**Accelerated Motion:**  $x = x_o + v_o t + \frac{1}{2} at^2$

distance = distance<sub>o</sub> + velocity<sub>o</sub>  $\times$  time +  $\frac{1}{2}$  acceleration  $\times$  time<sup>2</sup>

**Accelerated Motion:**  $v = v_o + at$

velocity = velocity<sub>o</sub> + acceleration  $\times$  time

**Momentum:**  $p = mv$

momentum = mass  $\times$  velocity

**Conservation of Momentum:**  $m_1 v_{1,i} + m_2 v_{2,i} = m_1 v_{1,f} + m_2 v_{2,f}$

mass<sub>1</sub>  $\times$  initial velocity<sub>1</sub> + mass<sub>2</sub>  $\times$  initial velocity<sub>2</sub> = mass<sub>1</sub>  $\times$  final velocity<sub>1</sub> + mass<sub>2</sub>  $\times$  final velocity<sub>2</sub>

## Radioactive Decay

**Radioactive Decay:**  $A = A_o \times \left(\frac{1}{2}\right)^n$

amount remaining = initial amount  $\times \left(\frac{1}{2}\right)^{\text{number of half-lives}}$

**Half-life:**  $n = \frac{t}{t_{\frac{1}{2}}}$

number of half-lives =  $\frac{\text{elapsed time}}{\text{half-life}}$

## Solutions

**Molarity:**  $M = \frac{n}{V}$

molarity =  $\frac{\text{moles}}{\text{volume}}$

**Dilution:**  $V_1M_1 = V_2M_2$

volume<sub>1</sub>  $\times$  molarity<sub>1</sub> = volume<sub>2</sub>  $\times$  molarity<sub>2</sub>

**pH:**  $pH = -\log[H^+]$

pH =  $-\log(\text{hydrogen ion concentration})$

## Thermodynamics

**Heat of Fusion:**  $Q = m\Delta H_{fus}$

heat = mass  $\times$  heat of fusion

**Heat of Vaporization:**  $Q = m\Delta H_{vap}$

heat = mass  $\times$  heat of vaporization

**Change in Enthalpy (Heat):**  $Q = m(\Delta T)C_p$

heat = mass  $\times$  change in temperature  $\times$  specific heat capacity

## Waves

**Energy of a Photon:**  $E = hf$

energy = Planck's constant  $\times$  frequency

**Speed of Light:**  $c = f\lambda$

speed of light = frequency  $\times$  wavelength

## Constants

**Acceleration Due to Gravity:**  $g = 9.8 \frac{\text{m}}{\text{s}^2}$

**Avogadro's Number:**  $N_A = 6.02 \times 10^{23} \frac{\text{particles}}{\text{mol}}$

**Coulomb's Constant:**  $k_e = 8.99 \times 10^9 \frac{\text{N} \cdot \text{m}^2}{\text{C}^2}$

**Gravitational Constant:**  $G = 6.67 \times 10^{-11} \frac{\text{N} \cdot \text{m}^2}{\text{kg}^2}$

**Mass of Earth:**  $M_E = 5.97 \times 10^{24} \text{ kg}$

**Planck's Constant:**  $h = 6.63 \times 10^{-34} \text{ J} \cdot \text{s}$

**Radius of Earth:**  $R_E = 6.37 \times 10^6 \text{ m}$

**Speed of Light in a Vacuum:**  $c = 3.00 \times 10^8 \frac{\text{m}}{\text{s}}$

**Volume of a Gas at 0°C and 100 kPa:**  $V_m = 22.4 \frac{\text{L}}{\text{mol}}$

## Conversions

**Calorie to Joule:**  $1 \text{ cal} = 4.184 \text{ J}$

**Temperature:**  $\text{K} = ^\circ\text{C} + 273$

**Pressure:**  $1 \text{ atm} = 760 \text{ Torr} = 101.3 \text{ kPa}$

**Temperature:**  $^\circ\text{F} = \left(\frac{9}{5}\right)^\circ\text{C} + 32$

## Units

**Energy:**  $1 \text{ J} = 1 \text{ N} \cdot \text{m}$

**Frequency:**  $1 \text{ Hz} = 1 \frac{\text{cycle}}{\text{s}}$

**Force:**  $1 \text{ N} = 1 \frac{\text{kg} \cdot \text{m}}{\text{s}^2}$

**Power:**  $1 \text{ W} = 1 \frac{\text{J}}{\text{s}}$