Optics

Speed of light

$$c = 2.998 \times 10^8 \text{ m/s}$$

Law of refraction (Snell's law)

$$n_1 \sin \vartheta_1 = n_2 \sin \vartheta_2$$

Image formation for a converging lens

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f} \quad \text{and} \quad \frac{h_i}{h_o} = \frac{d_i}{d_o}$$

Atoms and Atomic Structure

$$N_{av} = 6.02 \times 10^{23}$$

$$\text{atomic radius} \approx 0.1\,\text{nm} = 10^{-10} \text{ m}$$

Nuclear Physics

Mass energy

$$E = mc^2$$

Nuclear reactions

$$\text{energy released} = M_i c^2 - M_f c^2$$

$$(1\,\text{u})c^2 = 931.5\,\text{MeV}$$

where u = atomic mass unit

Radioactivity

Half-life = τ

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{t/\tau}$$

$$\frac{t}{\tau} = \frac{\log(N_0/N)}{\log(2)}$$

Mechanics

Constant acceleration

$$v = at \quad \text{or} \quad v = v_0 + at$$

$$D = \frac{1}{2}at^2 \quad \text{or} \quad v_0 t + \frac{1}{2}at^2$$

$$g = 9.8 \text{ m/s}^2 \quad \text{(Earth's gravity)}$$

Newton's second law

$$F = ma \quad \text{where} \quad a = \frac{\Delta v}{\Delta t}$$

Energy

$$K = \frac{1}{2}mv^2$$

$$V = mgh \quad \text{(Earth's gravity)}$$

$$V = \frac{1}{2}kx^2 \quad \text{(spring force)}$$

Kepler's third law of planetary orbits

$$T^2 \propto a^3$$

where T = period and a = orbit radius (circle) or semi-major axis (ellipse)

Newton's law of universal gravitation

$$F = \frac{Gm_1m_2}{r^2}$$

Electricity and Magnetism

Coulomb force

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

where $K = 8.99 \times 10^9 \text{ Nm}^2/\text{C}^2$

The *electric field* is defined by **E** = **F**/q (force per unit charge on a test charge). The *magnetic field* is defined by **F** = q **v** × **B** (Lorentz force).

Magnetic field (Ampère's Law)

$$B = \frac{\mu_0 I}{2\pi r} \quad \text{(wire)}$$

$$B = \mu_0 nI \quad \text{(solenoid)}$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ Tm/A}$$

Faraday's law

$$emf = -\frac{\Delta\Phi}{\Delta t} \quad \text{where} \quad \Phi = BA$$