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

Atoms and Atomic Structure
\[ N_{\text{av}} = 6.02 \times 10^{23} \]
atomic radius \( \approx 0.1 \text{ nm} = 10^{-10} \text{ m} \)

Nuclear Physics

Mass energy
\[ E = mc^2 \]

Nuclear reactions
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 = \( \tau \)
\[ \frac{N}{N_0} = \left( \frac{1}{2} \right)^{t/\tau} \]

\[ t = \frac{\log(N_0 / N)}{\log(2)} \]

Mechanics

Constant acceleration
\[ \mathbf{v} = \mathbf{a} t \quad \text{or} \quad \mathbf{v} = \mathbf{v}_0 + \mathbf{a} t \]
\[ D = \frac{1}{2} \mathbf{a} t^2 \quad \text{or} \quad \mathbf{v}_0 t + \frac{1}{2} \mathbf{a} t^2 \]
\[ g = 9.8 \text{ m/s}^2 \quad \text{(Earth's gravity)} \]

Newton's second law
\[ \mathbf{F} = \mathbf{ma} \quad \text{where} \quad \mathbf{a} = \frac{\Delta \mathbf{v}}{\Delta t} \]

Energy
\[ K = \frac{1}{2} m \mathbf{v}^2 \]
\[ V = mgh \quad \text{(Earth's gravity)} \]
\[ V = \frac{1}{2} k \mathbf{x}^2 \quad \text{(spring force)} \]

Radioactivity

Half-life = \( \tau \)
\[ \frac{N}{N_0} = \left( \frac{1}{2} \right)^{t/\tau} \]

\[ t = \frac{\log(N_0 / N)}{\log(2)} \]

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 \( \mathbf{E} = \mathbf{F}/q \) (force per unit charge on a test charge). The magnetic field is defined by \( \mathbf{F} = q \mathbf{v} \times \mathbf{B} \) (Lorentz force).

Magnetic field (Ampère's Law)
\[ \mathbf{B} = \frac{\mu_0 I}{2\pi r} \quad \text{(wire)} \]
\[ \mathbf{B} = \mu_0 \eta l \quad \text{(solenoid)} \]
\( \mu_0 = 4\pi \times 10^{-7} \text{ Tm/A} \)

Faraday's law
\[ \epsilon = -\frac{\Delta \Phi}{\Delta t} \quad \text{where} \quad \Phi = BA \]