## Optics

*Speed of light*

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

*Law of refraction (Snell's law)*

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

*Image formation for a converging lens*

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

## Atoms and Atomic Structure

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

atomic radius $\approx 0.1\,\text{nm} = 10^{-10}$ 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 $\text{u} = \text{a.m.u.} = 1.67 \times 10^{-27}$ kg

*Radioactivity*

Half-life = $\tau$

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

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

## Mechanics

*Constant acceleration*

$v = at$ or $v = v_0 + at$

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

$g = 9.8$ m/s$^2$ (Earth's gravity)

*Newton's second law*

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

*Energy*

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

$V = mgh$ (Earth's gravity)

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

*Equation of motion for circular motion*

$$m\frac{v^2}{r} = \frac{GMm}{r^2}$$

*Newton's law of universal gravitation*

$$F = \frac{Gm_1 m_2}{r^2}$$

## Electricity and Magnetism

*Coulomb force*

$$F = \frac{KQ_1 Q_2}{r^2}$$

where $K = 8.99 \times 10^9$ Nm$^2$/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)*

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

$B = \mu_0 nI$ (solenoid)

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

*Faraday's law*

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