

## Light reflection and refraction

- Spherical Mirror :  $f = \frac{1}{2}R$  (Concave mirror  $R > 0$  ; convex  $R < 0$ )
- Mirror Equation :  $\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$       Variants:  $f = \frac{d_o d_i}{d_o + d_i}$        $d_o = \frac{d_i f}{d_i - f}$        $d_i = \frac{d_o f}{d_o - f}$
- Magnification :  $m = h_i/h_o = -d_i/d_o$

Indices of Refraction	
Material	$n = c/v$
Vacuum	1.0000...
Air (STP)	1.0003
Water	1.33
Ethyl alcohol	1.36
Glass (fused quartz)	1.46
Glass (crown glass)	1.52
Glass (light flint)	1.58
Lucite, plexiglas	1.51
Sodium chloride	1.52
Diamond	2.42

## Snell's Law

- general :  $\frac{\sin \theta_1}{v_1} = \frac{\sin \theta_2}{v_2}$
- EM waves :  $n \equiv c/v$  so  $n_1 \sin \theta_1 = n_2 \sin \theta_2$

**Total Internal Reflection** (ray moving from higher  $n$  to lower  $n$ )       $\sin \theta_c = n_{lower}/n_{higher}$

## Lenses and Optical Instruments

Lens Equation  $\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$       Variants:  $f = \frac{d_o d_i}{d_o + d_i}$        $d_o = \frac{d_i f}{d_i - f}$        $d_i = \frac{d_o f}{d_o - f}$

Magnification  $m = h_i/h_o = -d_i/d_o$

Lens power (diopters) :  $P = 1/f$  (with  $f$  measured in meters)

Lensmaker's equation : lens material  $n$       surrounding material  $n_o$

- $\frac{1}{f} = \frac{n-n_o}{n_o} \left( \frac{1}{R_1} + \frac{1}{R_2} \right)$
- in air (  $n_o = 1.000..$  ) :  $\frac{1}{f} = (n-1) \left( \frac{1}{R_1} + \frac{1}{R_2} \right)$

Angular size :  $\theta \approx (size)/(distance)$  (from  $s = r\theta$ , with  $\theta$  in radians)

Apparent, or angular magnification :  $M = \theta_{image}/\theta_{object}$

## Random bits

$$v = \lambda/T = \lambda f = \omega/k \quad k = 2\pi/\lambda \quad \omega = 2\pi/T$$

Speed of light (in vacuum) :  $3 \times 10^8 \text{ m/s}$

Speed of sound in air (STP) :  $343 \text{ m/s}$

Speed of sound in pure water (STP) :  $1500 \text{ m/s}$

**NOTE: you'll need to know about ray diagrams and sign rules. See book.**