Important Lenses and Refraction Formulas PDF

Formulas
Examples
with Units

List of 24
Important Lenses and Refraction Formulas

1) Lenses Formulas

1.1) Focal Length of Concave Lens given Image and Object Distance Formula

Evaluate Formula

Formula

$$f_{\text{concave lens}} = \frac{u \cdot v}{v + u}$$

Example with Units

$$0.2077\,\text{m} = \frac{0.90\,\text{m} \cdot 0.27\,\text{m}}{0.27\,\text{m} + 0.90\,\text{m}}$$

1.2) Focal Length of Concave Lens given Radius Formula

Evaluate Formula

Formula

$$f_{\text{concave lens}} = \frac{r_{\text{curve}}}{n - 1}$$

Example with Units

$$0.2429\,\text{m} = \frac{0.068\,\text{m}}{1.280 - 1}$$

1.3) Focal Length of Convex Lens given Object and Image Distance Formula

Evaluate Formula

Formula

$$f_{\text{convex lens}} = -\frac{u \cdot v}{u + v}$$

Example with Units

$$-0.2077\,\text{m} = -\frac{0.90\,\text{m} \cdot 0.27\,\text{m}}{0.90\,\text{m} + 0.27\,\text{m}}$$

1.4) Focal Length of Convex Lens given Radius Formula

Evaluate Formula

Formula

$$f_{\text{convex lens}} = -\frac{r_{\text{curve}}}{n - 1}$$

Example with Units

$$-0.2429\,\text{m} = -\frac{0.068\,\text{m}}{1.280 - 1}$$

1.5) Focal Length using Distance Formula Formula

Evaluate Formula

Formula

$$f = \frac{f_1 + f_2 - w}{f_1 \cdot f_2}$$

Example with Units

$$2.2396\,\text{m} = \frac{0.40\,\text{m} + 0.48\,\text{m} - 0.45\,\text{m}}{0.40\,\text{m} \cdot 0.48\,\text{m}}$$

1.6) Lens Makers Equation Formula

Evaluate Formula

Formula

$$f_{\text{thinlens}} = \frac{1}{\left(\mu_l - 1\right) \cdot \left(\frac{1}{R_1} - \frac{1}{R_2}\right)}$$

Example with Units

$$0.2345\,\text{m} = \frac{1}{\left(10 - 1\right) \cdot \left(\frac{1}{1.67\,\text{m}} - \frac{1}{8\,\text{m}}\right)}$$

1.7) Magnification of Concave Lens Formula

Evaluate Formula

Formula

$$m_{concave} = \frac{v}{u}$$

Example with Units

$$0.3 = \frac{0.27\,m}{0.90\,m}$$

1.8) Magnification of Convex Lens Formula

Evaluate Formula

Formula

$$m_{convex} = -\frac{v}{u}$$

Example with Units

$$-0.3 = -\frac{0.27\,m}{0.90\,m}$$

1.9) Object Distance in Concave Lens Formula

Evaluate Formula

Formula

$$u_{concave} = \frac{v \cdot f_{concave\ lens}}{v - f_{concave\ lens}}$$

Example with Units

$$0.7714\,m = \frac{0.27\,m \cdot 0.20\,m}{0.27\,m - 0.20\,m}$$

1.10) Object Distance in Convex Lens Formula

Evaluate Formula

Formula

$$u_{convex} = \frac{v \cdot f_{convex\ lens}}{v - \left(f_{convex\ lens}\right)}$$

Example with Units

$$-0.1149\,m = \frac{0.27\,m \cdot -0.20\,m}{0.27\,m - \left(-0.20\,m\right)}$$

1.11) Power of Lens Formula

Evaluate Formula

Formula

$$P = \frac{1}{f}$$

Example with Units

$$0.4484 = \frac{1}{2.23\,m}$$

1.12) Power of Lens using Distance Rule Formula

Evaluate Formula

Formula

$$P = P_1 + P_2 - w \cdot P_1 \cdot P_2$$

Example with Units

$$0.4484 = 0.15 + 0.32 - 0.45\,m \cdot 0.15 \cdot 0.32$$

1.13) Total Magnification Formula

Evaluate Formula

Formula

$$m_t = m^2$$

Example

$$0.25 = 0.5^2$$

2) Refraction Formulas

2.1) Angle of Deviation Formula

Evaluate Formula

Formula

$$D = i + e - A$$

Example with Units

$$9° = 40° + 4° - 35°$$

2.2) Angle of Deviation in Dispersion Formula

Evaluate Formula

Formula	Example with Units
$D = (\mu - 1) \cdot A$	$9.8° = (1.28 - 1) \cdot 35°$

2.3) Angle of Emergence Formula

Evaluate Formula

Formula	Example with Units
$e = A + D - i$	$4° = 35° + 9° - 40°$

2.4) Angle of Incidence Formula

Evaluate Formula

Formula	Example with Units
$i = D + A - e$	$40° = 9° + 35° - 4°$

2.5) Angle of Prism Formula

Evaluate Formula

Formula	Example with Units
$A = i + e - D$	$35° = 40° + 4° - 9°$

2.6) Coefficient of Refraction using Boundary Angles Formula

Evaluate Formula

Formula	Example with Units
$\mu = \frac{\sin(i)}{\sin(r)}$	$1.2802 = \frac{\sin(40°)}{\sin(30.14°)}$

2.7) Coefficient of Refraction using Critical Angle Formula

Evaluate Formula

Formula	Example with Units
$\mu = cosec(i)$	$1.5557 = cosec(40°)$

2.8) Coefficient of Refraction using Depth Formula

Evaluate Formula

Formula	Example with Units
$\mu = \frac{d_{real}}{d_{apparent}}$	$1.281 = \frac{1.5\,m}{1.171\,m}$

2.9) Coefficient of Refraction using Velocity Formula

Evaluate Formula

Formula	Example with Units
$\mu = \frac{[c]}{v_m}$	$1.2806 = \frac{3E+8\,m/s}{234100000\,m/s}$

2.10) Number of Images in Kaleidoscope Formula

Evaluate Formula

Formula

$$N = \left(\frac{2 \cdot \pi}{A_m}\right) - 1$$

Example with Units

$$5 = \left(\frac{2 \cdot 3.1416}{60°}\right) - 1$$

2.11) Refractive Index Formula

Evaluate Formula

Formula

$$n = \frac{\sin(i)}{\sin(r)}$$

Example with Units

$$1.2802 = \frac{\sin(40°)}{\sin(30.14°)}$$

Variables used in list of Lenses and Refraction Formulas above

- **A** Angle of Prism *(Degree)*
- A_m Angle between Mirrors *(Degree)*
- **D** Angle of Deviation *(Degree)*
- $d_{apparent}$ Apparent Depth *(Meter)*
- d_{real} Real Depth *(Meter)*
- **e** Angle of Emergence *(Degree)*
- **f** Focal Length of Lens *(Meter)*
- f_1 Focal Length 1 *(Meter)*
- f_2 Focal Length 2 *(Meter)*
- $f_{concave\ lens}$ Focal Length of Concave Lens *(Meter)*
- $f_{convex\ lens}$ Focal Length of Convex Lens *(Meter)*
- $f_{thinlens}$ Focal Length of Thin Lens *(Meter)*
- **i** Angle of Incidence *(Degree)*
- **m** Magnification
- $m_{concave}$ Magnification of Concave Lens
- m_{convex} Magnification of Convex Lens
- m_t Total Magnification
- **n** Refractive Index
- **N** Number of Images
- **P** Power of Lens
- P_1 Power of First Lens
- P_2 Power of Second Lens
- **r** Angle of Refraction *(Degree)*
- R_1 Radius of Curvature at Section 1 *(Meter)*
- R_2 Radius of Curvature at Section 2 *(Meter)*
- r_{curve} Radius *(Meter)*
- **u** Object Distance *(Meter)*
- $u_{concave}$ Object Distance of Concave Lens *(Meter)*
- u_{convex} Object Distance of Convex Lens *(Meter)*
- **v** Image Distance *(Meter)*

Constants, Functions, Measurements used in list of Lenses and Refraction Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- constant(s): **[c]**, 299792458.0 *Light speed in vacuum*
- Functions: **cosec**, cosec(Angle) *The cosecant function is a trigonometric function that is the reciprocal of the sine function.*
- Functions: **sec**, sec(Angle) *Secant is a trigonometric function that is defined ratio of the hypotenuse to the shorter side adjacent to an acute angle (in a right-angled triangle); the reciprocal of a cosine.*
- Functions: **sin**, sin(Angle) *Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.*
- Measurement: **Length** in Meter (m) *Length Unit Conversion*
- Measurement: **Speed** in Meter per Second (m/s) *Speed Unit Conversion*
- Measurement: **Angle** in Degree (°) *Angle Unit Conversion*

- v_m Velocity of Light in Medium *(Meter per Second)*
- **w** Width of Lens *(Meter)*
- **μ** Coefficient of Refraction
- μ_l Lens Refractive Index

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