Physics 112 Formulae

Waves: Sound and Diffraction

$frequency = \frac{cycles}{time}$	$T = \frac{1}{f}$	$f = \frac{1}{T}$	$period = \frac{time}{cycles}$

$v = f\lambda$ $v = \frac{\lambda}{T}$ v = wave speed λ = wavelength T = period	*Speed of Sound in air* $v_{air} = 331 + 0.590T_{air}$ T_{air} = temp in degrees Celsius	*Diffraction:* $n\lambda = \frac{dW_n}{L}$ or $n\lambda = dtan\theta$ n = maximum # λ = wavelength d = separation of slits W_n = Distance of maximum from centre L = Distance from screen θ = angle in degrees

Doppler Shift Approaching: $f_o = f_s\left(\frac{v + v_o}{v - v_s}\right)$	Doppler Shift Receding: $f_o = f_s\left(\frac{v - v_o}{v + v_s}\right)$	*Doppler Shift Variables* f_o = observed (heard) frequency f_s = source frequency v_o = observer's velocity v_s = velocity of the source v = speed of sound in medium.	Wave Speed in a String $v = \sqrt{\frac{T}{\mu}}$ T = Tension μ = kg/m

Refraction

$n = \frac{c}{v},\ n = \frac{\lambda_{vac}}{\lambda_{medium}}$ n = index of refraction c = speed of light v = slower speed of light	$n_1 \sin\theta_1 = n_2 \sin\theta_2$ n_1 = 1st medium n_2 = 2nd medium θ_1 = angle of incidence θ_2= angle of refraction	$n_1 \sin\theta_c = n_2$ $n_1 = n_2 \sin\theta_{\max}$ θc= critical angle θmax= maximum angle of refraction

Mirrors and Lenses

$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$ d_o = object distance d_i = image distance f = focal length	$M = \frac{h_i}{h_o},\ M = \frac{-d_i}{d_o}$ $\frac{h_i}{h_o} = \frac{-d_i}{d_o}$ M = magnification	$\frac{1}{f} = \left(\frac{n_{lens}}{n_o} - 1\right)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$ n_o = index for surrounding medium R_1, R_2 = Radii of curvature

Sign Convention

di & f: + = real, − = virtual **M, hi, & ho**: + = upright, − = inverted

Radii of a lens (as if light is hitting the outside of the lens): + = convex, − = concave

Kinematics (Displacement & Velocity)

Displacement – Time Graph	**Velocity – Time Graph**
Instantaneous Velocity = slope at a specific time $V_{avg} = \frac{disp}{time}$ $Speed_{avg} = \frac{dist}{time}$ *The formulae above also apply to Velocity – Time graphs.	Instantaneous Acceleration = slope at a specific time Displacement = Top area – Bottom area Distance = Top area + Bottom area *Areas refer to the area between the graph and the time axis. Use all positive numbers for area calculations

General Mathematical Relationships

Circle

$Cicumference = 2\pi R$

$Area = \pi R^2$

1 revolution = 360°

Triangle

$$A = \frac{1}{2} base \times height$$

Sphere

$Area = 4\pi R^2$

$$Volume = \frac{4}{3}\pi R^3$$

Pythagorean Thrm

$$hyp^2 = a^2 + b^2$$

Quadratic Formula

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Slope

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

Trig

$$\sin = \frac{opp}{hyp}$$

$$\cos = \frac{adj}{hyp}$$

$$\tan = \frac{opp}{adj}$$

Constants & Other Useful Information

Indices of Refraction	
Substance	Index of Refraction (*n*)
Vacuum	1.0000
Air (0°C, 101 kPa)	1.0003
Water	1.33
Ethyl alcohol	1.36
Quartz (fused)	1.46
Glycerin	1.47
Lucite or Plexiglas	1.51
Glass (crown)	1.52
Sodium chloride	1.53
Glass (crystal)	1.54
Ruby	1.54
Glass (flint)	1.65
Zircon	1.92
Diamond	2.42

Speed of Light in a vacuum:

$$c = 3.00 \times 10^8\ m/s$$

n = nano = 10^{-9}
m = milli = 10^{-3}
μ = micro = 10^{-6}
k = kilo = 10^3
g_{Earth} = 9.81 m/s^2 (downwards)
m/s × 3.6 ⇨ km/h
km/h ÷ 3.6 ⇨ m/s

Types of Lenses