Phys2426 2017-08-01 Lec 17

Grade Calculator: goo.gl/ua3sXF

#3 Object Properties vs Environment

Mass of object
$\mathcal{E}$ of battery
R of resistor
C of capacitor
L of inductor
n of material
f of lens

#8 Pendulum - Longer = slower

$f = \frac{1}{2\pi}\sqrt{g/L}$

$T = 2\pi\sqrt{L/g} \propto \sqrt{L}$

Double L $\Rightarrow$ T factor of $\sqrt{2}$

#19 $I = \frac{P}{4\pi R^2}$ (Point Source)

R doubles $\Rightarrow$ I decrease 4 times

$\log_{10}(4) = -0.6$ $\quad 10^{-0.6} = \frac{1}{4}$

$-0.6 = \beta/10 \rightarrow \beta = -6$ dB

Series Circuit - same current everywhere

Given voltage: $28 \sin(377t)$

$V_{rms} = \frac{28}{\sqrt{2}} = 20V$ (#11) ← resistor V_{rms}.

$2\pi f = 377$

$f = 60$ Hz (#10)

Given ΔV was across resistor.

With ΔV_R, $I_{rms} = \frac{V_{R\,rms}}{R} = \frac{20V}{500\Omega}$

$= 40$ mA (#12)

Other components

$X_C = \frac{1}{2\pi f C} = \frac{1}{(377)(3.54 \times 10^{-6})} =$

$= 750\,\Omega$ (#13)

$X_L = 2\pi f L = (377)(0.663) = 250\,\Omega$

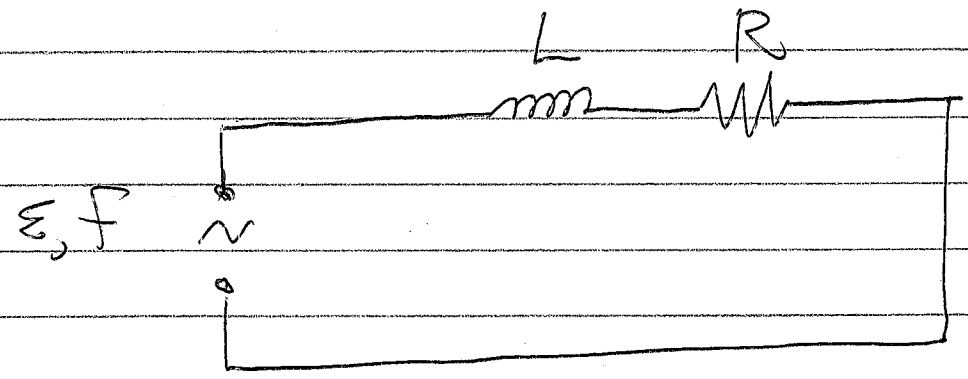
$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{500^2 + 500^2}$

$= 707\,\Omega$ (#14)

$P = I^2 R = V_R I$ (Use RMS)

$= (20V)(40\,mA) = 0.8\,W$ (#15)

(3)



What is Z if $f \to 0$?

$X_C = 0$ for "no capacitor"

$X_L = 2\pi f L$

$Z = \sqrt{R^2 + X^2} = R$

$\because X = X_L - X_C$

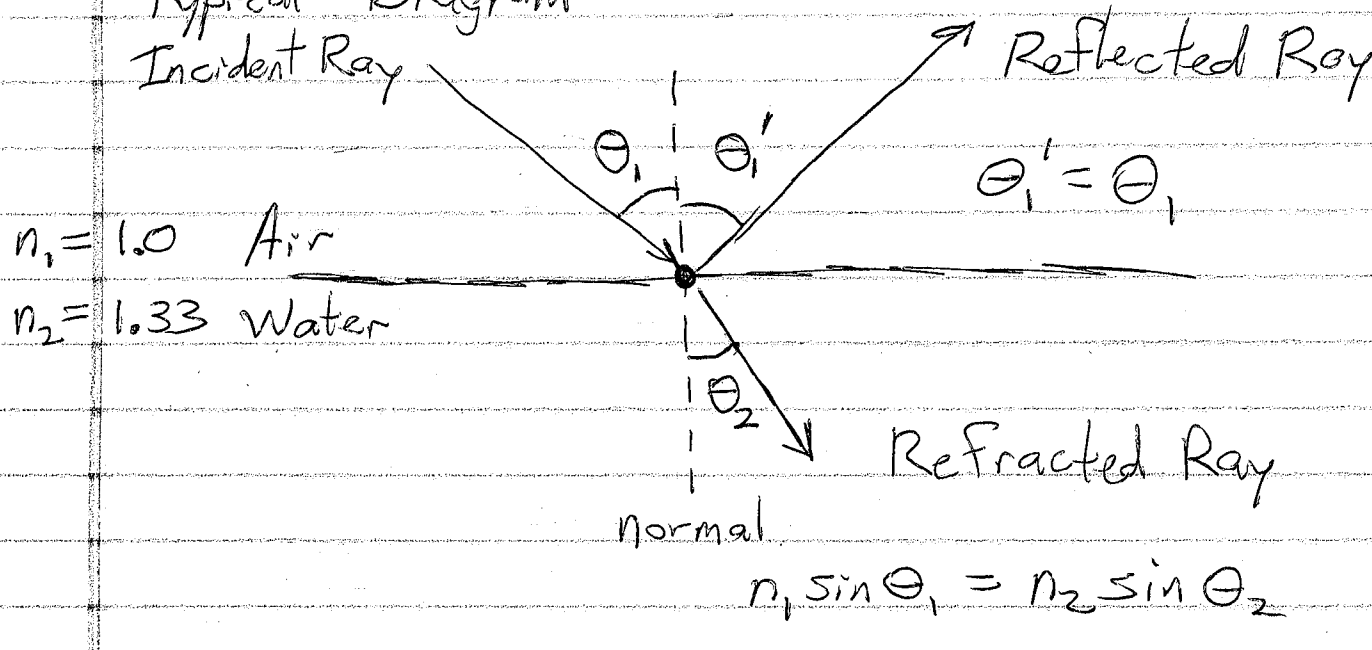
What is Z if $f \to \infty$?

$Z = \sqrt{R^2 + \infty^2} = \infty$

Geometric Optics – Redirecting Light with the macroscopic shape of materials.

Two main Effects
- Reflection – Bouncing Light off surface
- Refraction – Deflection of Light when changing materials.

Typical Diagram



$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

When $n_2 > n_1 \rightarrow \theta_2 < \theta_1$

Ex: $\sin\theta_2 = \frac{n_1 \sin\theta_1}{n_2} = \frac{(1)\sin(45^\circ)}{1.33} = 0.532$

$\theta_2 = 32^\circ$

What if $\sin\theta_2 = 1.1$ as a middle step?
No valid θ_2. No refraction.

(5)

If $n_1 > n_2$, only some θ_1 are valid.

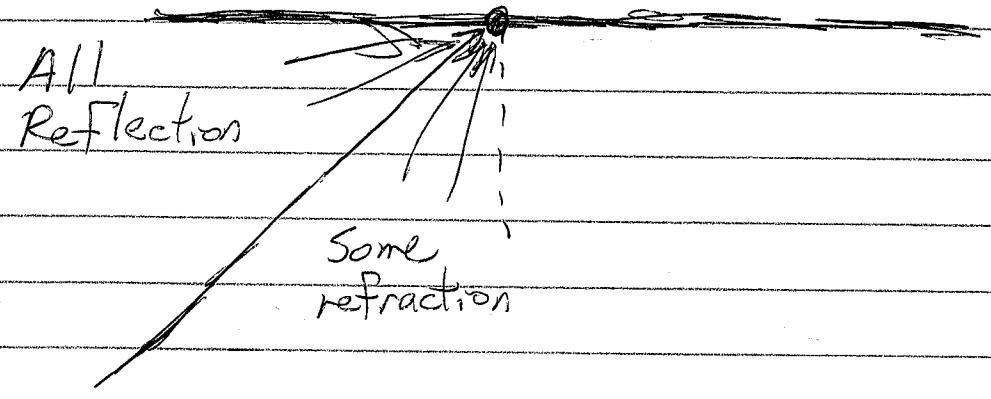
Threshold when $\sin\theta_2 = 1$

$$n_1 \sin\theta_1 = n_2$$

$$\sin\theta_1 = \frac{n_2}{n_1}$$ Threshold for Total Internal Reflection

For water $\Rightarrow$ air

$$\sin\theta_1 = \frac{1.0}{1.33} = 0.75 \qquad \theta_1 = 48.7^\circ$$



n affects speed of waves

In a vacuum, $v = c = 3 \times 10^8 \ m/s$

In a material, $v = \frac{c}{n}$

n = slowdown factor

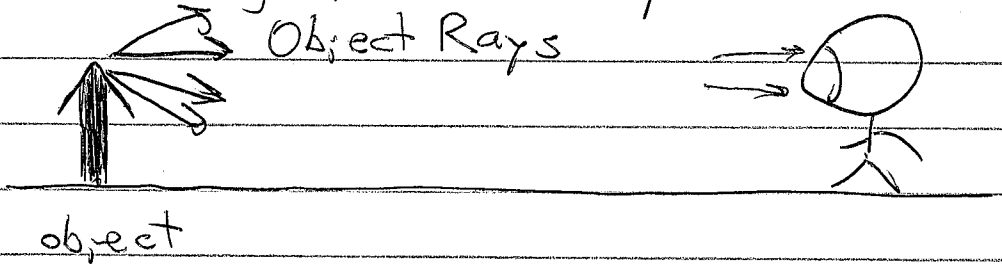
$n_{air} = 1.0003$

$n_{water} = 1.33$

$n_{glass} = 1.5$

$n_{diamond} = 2.4$

Next Level of complexity: many Rays all coming from one point.

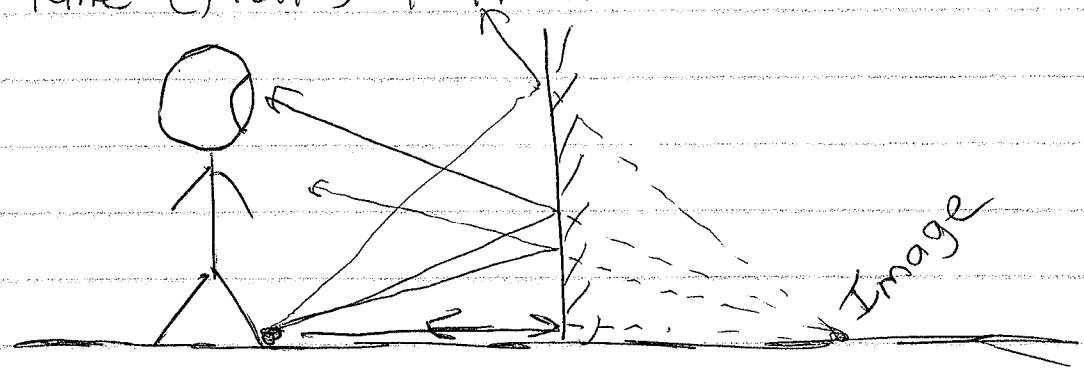


Observer sees rays diverging from a common point.

Can we emulate an object?

- Mirrors
- Lenses
- Holograms

Plane (Flat) Mirror



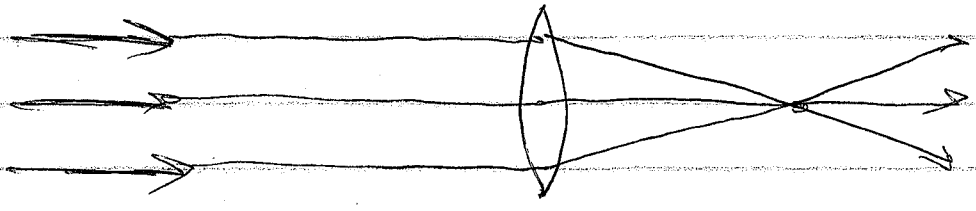
"Image" is the common origin of the reflected rays.

Since these image rays don't touch the image, it is only a virtual source, "Virtual Image" = negative d_i

$$d_o = -d_i \qquad \text{(Plane mirror)}$$

$$(20\text{ cm}) = -(-20\text{ cm})$$

A Converging Lens makes* rays converge.



Parallel Rays Focus on the focal point.

What if the incoming rays aren't parallel?

* It tries to but only has so much power.

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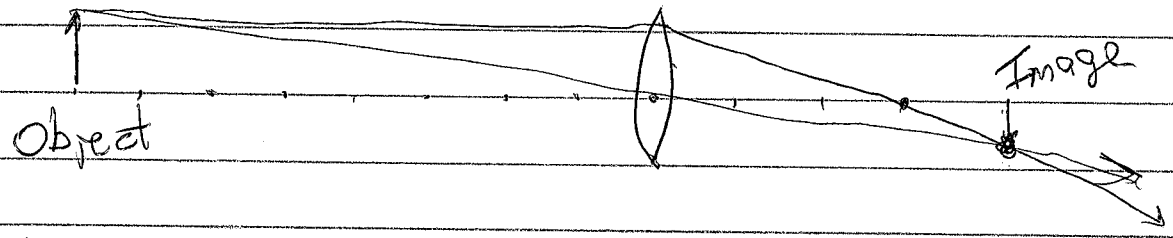

$d_o = 8$ cm
$f = 3$ cm

① Central ray goes straight
② Horizontal ray goes thru f.

Rays actually cross ⇒ real image

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$$

$$\frac{h_i}{h_o} = M = -\frac{d_i}{d_o}$$

$d_i = 4.8$ cm

$$M = -\frac{4.8}{8} = 0.6$$