

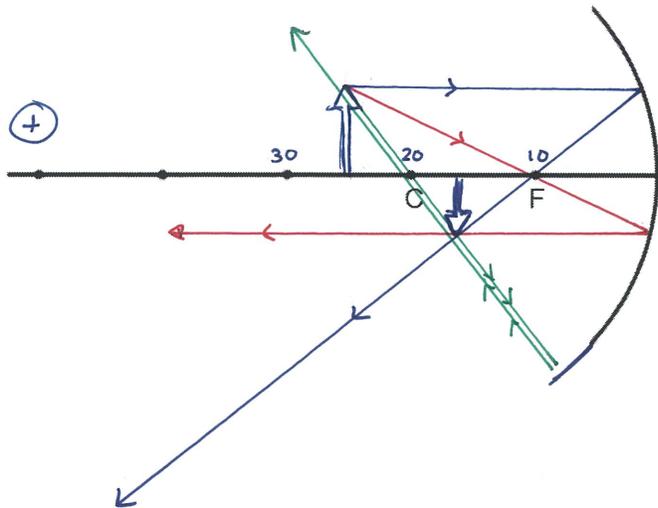
First Name: _____

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106 - Worksheet - Refraction Lenses

Basic Concepts

Q1: An 8.0cm tall object is placed 25.0cm from the vertex of a concave mirror with focal length 10.0cm. Using both (a) a Ray Diagram, and (b) Equations, determine the image position and attributes (real/virtual, erect/inverted, enlarged/diminished).



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

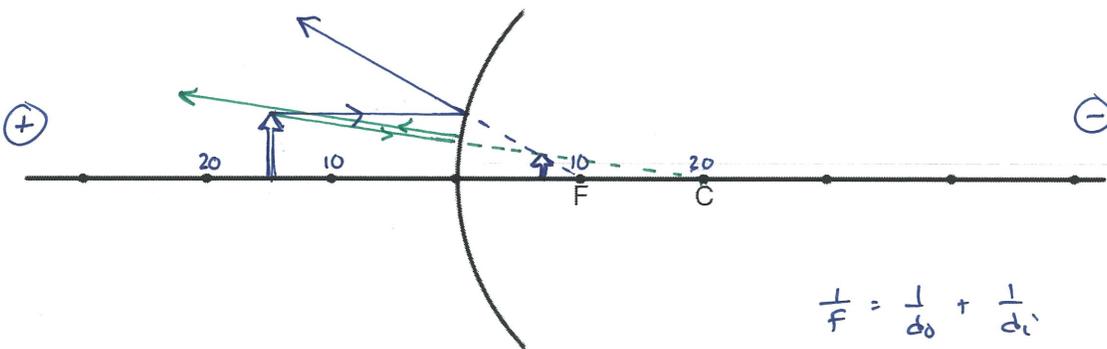
$$\frac{1}{10} = \frac{1}{25} + \frac{1}{d_i}$$

$$d_i = 16.6 \text{ cm}$$

$$m = \frac{-d_i}{d_o} = \frac{-16.6}{25} = -0.6$$

Real, Inverted, Diminished

Q2: An 8.0cm tall object is placed 15.0cm from the vertex of a concave mirror with focal length 10.0cm. Using both (a) a Ray Diagram, and (b) Equations, determine the image position and attributes (real/virtual, erect/inverted, enlarged/diminished).



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

$$\frac{1}{-10} = \frac{1}{15} + \frac{1}{d_i}$$

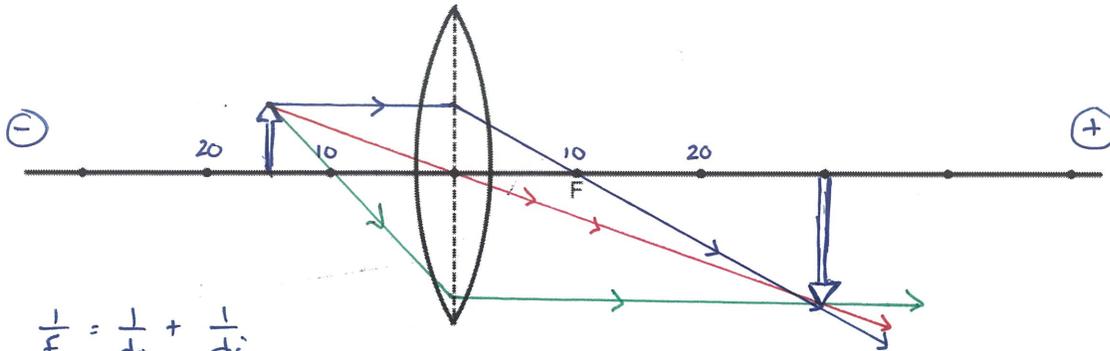
$$d_i = -6.0 \text{ cm}$$

$$m = \frac{-d_i}{d_o} = \frac{-(-6)}{15} = +0.4$$

Virtual, Erect, Diminished

■ KEY ■

Q3: An 8.0cm tall object is placed 15.0cm from the vertex of a converging lens with focal length 10.0cm. Using both (a) a Ray Diagram, and (b) Equations, determine the image position and attributes (real/virtual, erect/inverted, enlarged/diminished).



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

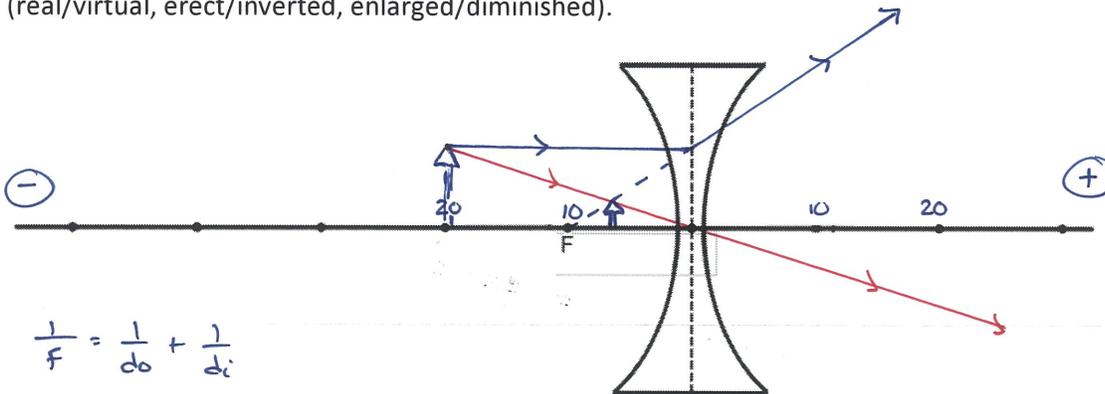
$$\frac{1}{10} = \frac{1}{15} + \frac{1}{d_i}$$

$$d_i = 30\text{cm}$$

$$m = \frac{-d_i}{d_o} = \frac{-(30)}{15} = -2.0$$

Real, Inverted, Enlarged

Q4: An 8.0cm tall object is placed 20.0cm from the vertex of a converging lens with focal length 10.0cm. Using both (a) a Ray Diagram, and (b) Equations, determine the image position and attributes (real/virtual, erect/inverted, enlarged/diminished).



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

$$\frac{1}{-10} = \frac{1}{20} + \frac{1}{d_i}$$

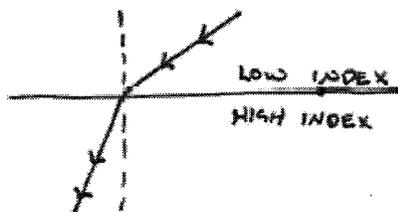
$$d_i = -6.6\text{cm}$$

$$m = \frac{-d_i}{d_o} = \frac{-(-6.6)}{20} = 0.3$$

Virtual, Erect, Diminished

Textbook Questions

Pg 683 #1: Is light bent toward or away from the normal line when it passes from a low-index medium to a high-index medium?



Toward normal (perpendicular) line.

Pg 683 #2: How is the index of refraction measured for a particular medium?

It is defined as $n = \frac{c}{v}$, or the ratio of the speed of light in a vacuum (c) to the measured speed of light in the medium (v). Realistically it is probably calculated by measuring the critical angle necessary for total internal reflection, then using Snell's law ($n_1 \sin \theta_1 = n_2 \sin \theta_2$), where $\theta_2 = 90^\circ$.

Pg 683 #9: What is the speed of light in water ($n = 1.33$)?

$$n_w = 1.33$$

$$v_w = ?$$

$$n_{\text{vacuum}} = 1.00$$

$$v_{\text{vacuum}} = 3.0 \times 10^8 \text{ m/s}$$

$$n_1 v_1 = n_2 v_2$$

$$(1.33)v_w = (1.00)(3.0 \times 10^8 \text{ m/s})$$

$$v_w = 2.26 \times 10^8 \text{ m/s}$$

Pg 683 #10: A light ray is incident on a block of quartz glass ($n = 1.47$) at an angle of 35.0° . Determine the angle of refraction.

$$n_1 = 1.0003 \text{ (assuming air)}$$

$$\theta_1 = 35.0^\circ$$

$$n_2 = 1.47 \text{ (Pg 667)}$$

$$\theta_2 = ?$$

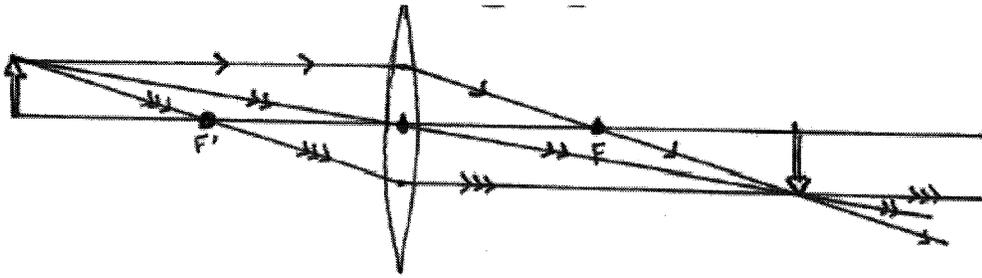
$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$(1.0003) \sin 35^\circ = (1.47) \sin \theta_2$$

$$\theta_2 = 22.97^\circ$$

■ KEY ■

Pg 683 #15: Using a ray diagram, determine the image attributes of an object located at $2F'$ relative to a converging lens.



Real, inverted image, located at $2F$.

Pg 683 #16: A camera with a converging lens ($f = 4.50$ cm) is used to take a picture of a 25.0-m-high tree that is 50.0 m from the camera. How tall is the image? Is it erect or inverted?

683 #16

$$f = 4.50 \text{ cm or } 0.0450 \text{ m}$$

$$h_o = 25.0 \text{ m}$$

$$d_o = 50.0 \text{ m}$$

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

$$\frac{1}{0.0450} = \frac{1}{50} + \frac{1}{d_i}$$

$$d_i = 0.04504 \text{ m}$$

or 4.504 cm (REAL)

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

$$\frac{h_i}{25} = \frac{-0.04504}{50.0}$$

$$h_i = -2.252 \times 10^{-2} \text{ m}$$

(REDUCED, INVERTED)

Diploma Questions – Refraction (Basic Concepts)

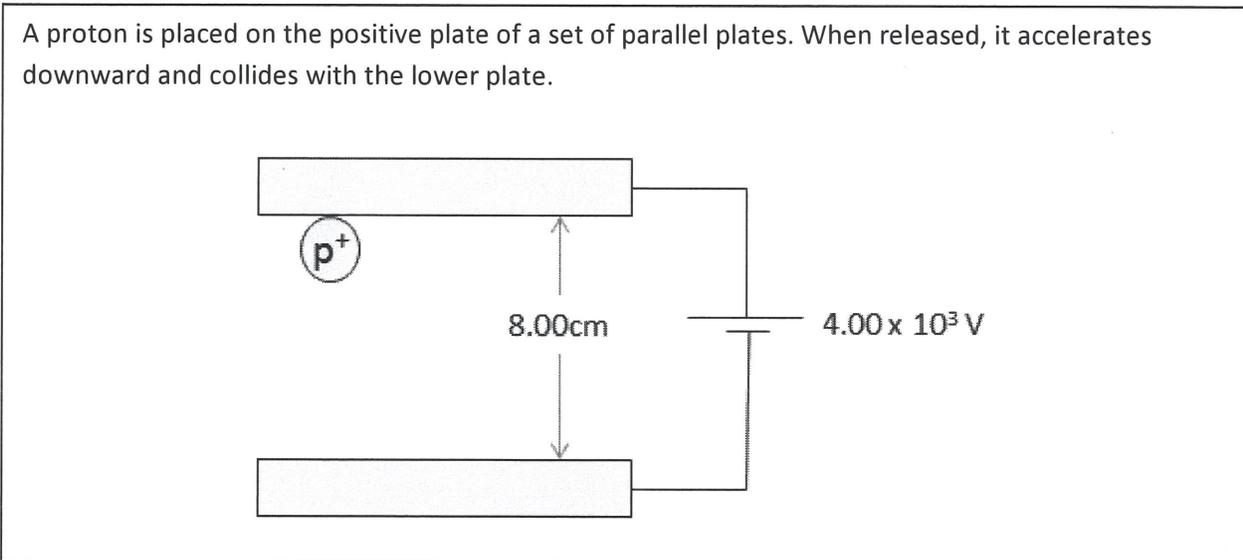
None

Challenge Questions

None

Cumulative Review from Previous Units

Use the following information to answer Q1:



Q1: The proton has a speed of $a.bc \times 10^d \text{ m/s}$ when it collides with the lower plate, where a , b , c , and d are __, __, __, and __.

(Record your **four digit** answer in the Numerical Response boxes below)

8	7	5	5
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$$E_p \rightarrow E_k$$

$$q\Delta V \rightarrow \frac{1}{2}mv^2$$

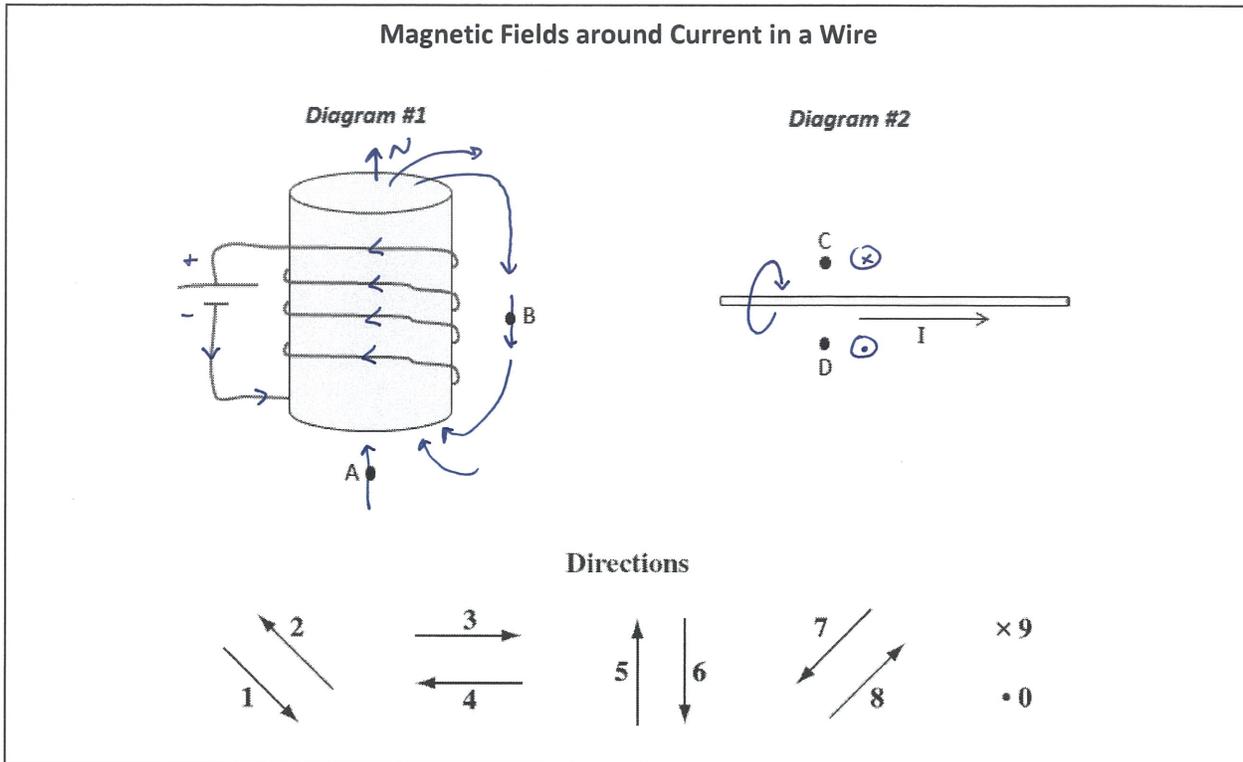
$$(1.60 \times 10^{-19})(4.00 \times 10^3) = \frac{1}{2}(1.67 \times 10^{-27})v^2$$

$$v^2 = 7.66467... \times 10^{11}$$

$$v = 8.75481... \times 10^5 \text{ m/s}$$

$$v \approx 8.75 \times 10^5 \text{ m/s}$$

Use the following information to answer Q2:



Q2: The directions of magnetic fields at various locations can be described using the numbers given above.

Direction:	<u>↑ 5</u>	<u>↓ 6</u>	<u>⊗ 9</u>	<u>⊙ ∅</u>
Field:	Direction of magnetic field at <i>Position A</i>	Direction of magnetic field at <i>Position B</i>	Direction of magnetic field at <i>Position C</i>	Direction of magnetic field at <i>Position D</i>

(Record your **four digit** answer in the Numerical Response boxes below)

5	6	9	∅
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