Physics Fourth Marking Period Review Sheet

Spring, Mr. Wicks

Chapter 14: Reflection

A. Characteristics of Light
- I can describe the regions of the electromagnetic spectrum and their relative order with wavelength or frequency in mind (radio waves, microwaves, infrared (IR) waves, visible light, ultraviolet (UV) light, X-rays, gamma rays).
- I understand that all electromagnetic waves move at the speed of light.
- I can calculate wavelength and frequency using the wave-speed equation $c = f\lambda$ where c = speed of light (3.00 x 10^8 m/s), f = frequency in Hertz, and λ = wavelength in meters.
- I can represent waves of light as rays in ray diagrams and illustrate where images form for mirrors (Chapter 14) and lenses (Chapter 15).
- I understand that brightness decreases by the square of the distance from the source.

B. Flat Mirrors
- I can describe the characteristics of flat mirrors.
  - Angle of incidence = angle of reflection
  - Object distance = image distance
  - Object height = image height
  - The image is always virtual, upright, and the same size as the object.
  - The image is reversed compared to the object.

C. Curved Mirrors
- I can compare and contrast the characteristics of concave and convex mirrors given in Table 1.
- Using ray diagrams, I can distinguish between the six cases for a concave mirror to give the image characteristics shown in Table 2.
- Using the instructions in Table 3, I can draw ray diagrams for mirrors showing the focal point, center of curvature, location of the object, location of the image, image size, and image orientation.
- Using the mirror and magnification equations given in Table 4, I can calculate image distance, object distance, focal length, magnification, and image height.
- Using Table 5, I can interpret the ***signs*** of optical quantities like focal length, f, image distance, q, and magnification, M. Using Table 5, I can also interpret the ***size*** of the magnification, M.
- I understand that parabolic mirrors are superior to concave spherical mirrors. Parabolic mirrors eliminate spherical aberration by having the rays converge at a single point.

Table 1: Curved Mirrors

Quantity	***Concave Mirror***	***Convex Mirror***
Focal Length:	f is positive	f is negative
Number of Cases:	6 (See ray diagram handout)	1
Image is: • ***Real or Virtual?*** • ***Inverted or Upright?*** • ***Larger, Smaller, or Same Size as Object?***	The answers to these questions depend on the case number in the ray diagram handout.	Virtual Upright Smaller than Object

Table 2: Description of Cases 1-6 for a Concave Mirror

Case #	***Object Position***	***Image Type***	***Image Orientation***	***Image Size Compared to Object***
1	***Object is at infinity:***	Real	Inverted	Smaller (Focal Point)
2	***Object distance is greater than C:***	Real	Inverted	Smaller
3	***Object is at C:***	Real	Inverted	Same Size
4	***Object is between C and F:***	Real	Inverted	Larger
5	***Object is at F:***	No image exists for case 5 because parallel rays cannot intersect as shown in the corresponding ray diagram.		
6	***Object is between F and the lens:***	Virtual	Upright	Larger

Table 3: Drawing Ray Diagrams for Mirrors

Ray	***Before Mirror***	***After Mirror***
Parallel Ray (P-Ray):	Ray is parallel to principal axis	Ray passes through the focal point, F
Focal-Point Ray (F-Ray):	Ray passes through the focal point, F	Ray is parallel to the principal axis
Center of Curvature Ray (C-Ray):	Ray passes through C	

Table 4: Equations for Mirrors

Calculation	***Equation***	***Comments***
Mirror Equation:	$\frac{1}{p}+\frac{1}{q}=\frac{1}{f}$	p = object distance, q = image distance, and f = focal length
Magnification:	$M=\frac{-q}{p}=\frac{h'}{h}$	M = magnification, h' = image height, and h = object height

Table 5: Interpreting Signs and Sizes for Various Optical Quantities

Quantities		
Sign of focal length, f ***:***	f is positive, Concave mirror or a Convex (converging) lens	f is negative, Convex mirror or a Concave (diverging) lens
Sign of Image Distance, q***:***	q is positive, Real image	q is negative, Virtual image
Sign of Magnification, M ***:***	M is positive, Upright image	M is negative, Inverted image
Size of Magnification, M ***:***	$M > 1$, Image is larger than object	$M < 1$, Image is smaller than object

D. Color
- I can use the triangle diagram given during class to predict colors when various lights or various pigments are combined.
  - The primary colors for light are red, blue, and green.
  - Additive primary colors produce white light when combined.
  - The primary colors for pigments are yellow, magenta, and cyan.
  - Subtractive primary colors produce black pigment when combined.

E. Polarization
- I can describe three types of polarization
  - Transmission—ex. Polaroid sunglasses can remove the glare of light polarized perpendicular to the glasses.
  - Reflection—ex. light becomes polarized by reflecting off of a lake.
  - Scattering—ex. light becomes polarized by reflecting off of atmospheric gas molecules.
- I understand that when high quality polarized lenses are oriented perpendicular to each other, this blocks the light from passing through both lenses.

Chapter 15: Refraction

A. Refraction
- I understand that refraction is the bending of light as it travels from one medium into another.
- I can compare and contrast the two general cases for refraction shown in Table 6.
- I can use the Law of Refraction and Snell's Law, which are given in Table 7.
- When the index of refraction for the first medium is greater than the index of refraction for the second medium ($n_i > n_r$), total internal reflection is possible (ex. fiber optic cables).
- I can calculate the critical angle at which total internal reflection occurs from the corresponding equation given in Table 7.

B. Curved Lenses
- I can compare and contrast the characteristics of concave and convex lenses given in Table 8.
- Using ray diagrams, I can distinguish between the six cases for a converging (double convex) lens to give the image characteristics shown in Table 9.
- Using the instructions in Table 10, I can draw ray diagrams for lenses showing the focal point F, 2F, the location of the object, location of the image, image size, and image orientation.
- Using the thin-lens and magnification equations given in Table 11, I can calculate image distance, object distance, focal length, magnification, and image height.
- Using Table 5, I can interpret the ***signs*** of optical quantities like focal length, f , image distance, q , and magnification, M . Using Table 5, I can also interpret the ***size*** of the magnification, M . The interpretation is the ***same*** for both mirrors and lenses.

Table 6: Refraction

Quantity	***Case 1***	***Case 2***
Sketch:	Ex. Ray passes from air into water or glass.	Ex. Ray passes from water or glass into air.
Index of Refraction, n:	$n_i < n_r$	$n_i > n_r$
Speed of Light, v:	$v_i > v_r$	$v_i < v_r$
Result:	Ray is bent ***toward*** the normal. ($\theta_i > \theta_r$)	Ray is bent ***away from*** the normal. ($\theta_i < \theta_r$)

Table 7: Equations for Refraction

Calculation	***Equation***	***Comments***
Law of Refraction:	$n = \frac{c}{v}$	n = index of refraction, c = speed of light in a vacuum (3.00×10^8 m/s), v = speed of light in the medium of interest
Snell's Law:	$n_i(\sin\theta_i) = n_r(\sin\theta_r)$	n_i = index of refraction for the first medium, θ_i = angle of incidence, n_r = index of refraction for the second medium, θ_r = angle of refraction
Critical Angle:	$\sin\theta_C = \frac{n_r}{n_i}$ for $n_i > n_r$	θ_C = critical angle at which total internal reflection begins to occur

Table 8: Curved Lenses

Quantity	***Convex Lens***	***Concave Lens***
Shape and Type of Lens:	Converging Lens	Diverging Lens
Focal Length:	f is positive	f is negative
Number of Cases:	6 (See ray diagram handout)	1
Image is: • ***Real or Virtual?*** • ***Inverted or Upright?*** • ***Larger, Smaller, or Same Size as Object?***	The answers to these questions depend on the case number in the ray diagram handout.	Virtual Upright Smaller than Object

Table 9: Description of Cases 1-6 for a Convex (Converging) Lens

Case #	*Object Position*	*Image Type*	*Image Orientation*	*Image Size Compared to Object*
1	*Object is at infinity:*	Real	Inverted	Smaller (Focal Point)
2	*Object distance is greater than 2F:*	Real	Inverted	Smaller
3	*Object is at 2F:*	Real	Inverted	Same Size
4	*Object is between 2F and F:*	Real	Inverted	Larger
5	*Object is at F:*	No image exists for case 5 because parallel rays cannot intersect as shown in the corresponding ray diagram.		
6	*Object is between F and the lens:*	Virtual	Upright	Larger

Table 10: Drawing Ray Diagrams for Lenses

Ray	*Before Lens*	*After Lens*
Parallel Ray (P-Ray):	Ray is parallel to principal axis	Ray passes through the focal point, F
Focal-Point Ray (F-Ray):	Ray passes through the focal point, F	Ray is parallel to the principal axis
Midpoint Ray (M-Ray):	Ray passes through the midpoint of the lens	

Table 11: Equations for Lenses		
Calculation	***Equation***	***Comments***
Thin-lens Equation:	$\frac{1}{p}+\frac{1}{q}=\frac{1}{f}$	p = object distance, q = image distance, and f = focal length
Magnification:	$M=\frac{-q}{p}=\frac{h'}{h}$	M = magnification, h' = image height, and h = object height

C. Other Optical Phenomena
- I can give an example of atmospheric refraction—ex. refracted light can produce mirages.
- I can give an example of dispersion—ex. rainbows are created by the dispersion of light in water droplets. Note that the sun has to be behind a person for the rainbow to be observed.
- I can identify types of lens aberration:
  - Chromatic aberration—color fuzziness.
  - Spherical aberration—optical fuzziness.

<u>Chapter 17: Electric Forces and Fields</u>

A. Electric Charge
- I can describe types of charges
- I can give examples of charge conservation
- I understand charge quantization; e = 1.60 x 10^{-19} C; recall that you can use this as a conversion factor with units 1.60 x 10^{-19} C/electron, for example.
- I can give everyday examples of charge transfer:
  1. Charging through contact (walking across a carpet)
  2. Charging by induction (electroscope demonstrations, balloon demonstration)
- I can distinguish between conductors, insulators, and semiconductors

B. Electric Force
- I can compare and contrast electric force with gravitational force of attraction:
  1. Both are field forces
  2. Both are inverse square laws; recall that $F_g = Gm_1m_2/r^2$ where G = 6.67 x 10^{-11} Nm^2/kg^2
  3. Electric force is significantly stronger than gravitational force
  4. Electric force can be attractive or repulsive whereas gravitational force is only attractive.
- I can calculate electric force using Coulomb's Law: $F_{electric} = k_cq_1q_2/r^2$ where k_c = 8.99 x 10^9 Nm^2/C^2 = Coulomb Constant

C. Electric Field
- I understand that electric field strength depends on charge and distance
- I understand that electric fields can be represented by electric field lines (analogous to lines representing altitude on a geographical contour map for hiking)
- I can clearly describe why a person's hair stands on end when the person is insulated from the ground and he or she touches a van de Graaff generator. (Recall that a van de Graaff generator collects electric charge.)

Chapter 19: Current and Resistance

A. Electric Current
- I understand that current is the rate of charge movement, and I can calculate current using $I = \Delta Q/\Delta t$ where current, I, is in Amps (A), charge passing through a given area, ΔQ, is in Coulombs (C), and change in time, Δt, is in seconds (s).
- I understand conventional current is defined in terms of positive charge movement.
- I understand that drift velocity, which is the net velocity of charge carriers, is relatively small: 68 min. on average for an electron to travel 1.0 m.
- I can compare and contrast two current sources:
  1. Batteries—change chemical energy into electrical energy
  2. Generators—change mechanical energy into electrical energy
- I can describe two current types:
  1. Direct current (DC)
  2. Alternating current (AC)

B. Resistance
- I can explain how these four factors affect resistance:
  1. Length of conductor
  2. Cross-sectional area of conductor
  3. Conductor material
  4. Temperature
- I am an expert at using Ohm's Law: $\Delta V = IR$, where potential difference, ΔV, is in Volts (V), current, I, is in Amps (A), and resistance, R, is in Ohms (Ω).
- I can distinguish between ohmic and nonohmic materials:
  1. Ohmic materials have a constant resistance over a wide range of potential differences (ex. most metals)
  2. Nonohmic materials do not have a constant resistance over a wide range of potential differences. (ex. diodes, which are analogous to check valves in plumbing)
- I understand that resistors can be used to control the amount of current in a conductor.
- I understand that salt water and perspiration lower the body's resistance.

C. Electric Power
- I understand that electric power, P, is the rate at which electrical energy is converted to other forms of energy, and I can calculate power using $P = I\Delta V$ where power, P, is in Watts (W), current, I, is in Amps (A), and potential difference, ΔV, is in Volts (V).
- By combining the power formula, $P = I\Delta V$, with Ohm's law, $\Delta V = IR$, I can derive two additional ways to calculate power: $P = I^2R$ and $P = (\Delta V)^2/R$.
- I understand that the amount of heat and light given off by a light bulb is related to the electric power rating. Most light bulbs are labeled with a power rating in Watts.
- By using a three-step method ((1) get power, (2) get kWh, (3) get cost), I can determine the electrical power cost to operate an electrical appliance for a given length of time.
- I understand that electric companies measure energy consumed in kilowatt hours ($1 \text{ kWh} = 3.6 \times 10^6 \text{ J}$)
- I understand that electrical energy is transferred at high potential differences (high voltages) to minimize energy loss.

Chapter 20: Circuits and Circuit Elements

A. Schematic Diagrams
- I can read, understand, and draw simple schematic diagrams.
- I can interpret the symbols for a wire, resistor, bulb, plug, battery, open and closed switch, and capacitor.
- I can identify open circuits, closed circuits, and short circuits
- I understand that short circuits occur when there is little or no resistance to the movement of charges; the increase in current may cause the wire to overheat and start a fire.
- When a light bulb is screwed in, I understand that charges can enter through the base, move along the wire to the filament, and exit the bulb through the threads.
- I understand that light bulbs emit light because the filament is a resistor, which converts some of its electrical energy to light energy and heat energy.
- I understand that the electromotive force (emf) is the source of a circuit's potential difference (voltage) and electrical energy.
- I understand that batteries have a small internal resistance, which is usually ignored in problem solving.

B. Series and Parallel Circuits
- I can compare and contrast series and parallel circuits using Table 12, and I can calculate equivalent resistance, R_{eq}, using the equations in Table 12.
- I can use Ohm's law on a large scale to calculate information about an entire circuit: $\Delta V_{battery} = I_{circuit}R_{eq}$ where $\Delta V_{battery}$ is the voltage of the battery, $I_{circuit}$ is the current in the circuit, and R_{eq} is the equivalent resistance.
- I can use Ohm's law on a small scale to calculate information about a particular resistor: $\Delta V = IR$ where ΔV is the voltage for the resistor, I is the current through the resistor, and R is the resistance of the resistor.

Table 12: Series and Parallel Circuits

Quantity	***Series Circuit***	***Parallel Circuit***
Schematic Diagram:		
Current, I : ***(Amps, A)***	$I = I_1 = I_2 = I_3 = \ldots$	$I_{total} = I_1 + I_2 + I_3 + \ldots$
Potential Difference, ΔV: ***(Voltage, V)***	$V_{total} = V_1 + V_2 + V_3 + \ldots$	$V = V_1 = V_2 = V_3 = \ldots$
Equivalent Resistance, R_{eq} : ***(Ohms, Ω)***	$R_{eq} = R_1 + R_2 + R_3 + \ldots$	$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$

Equations Available on Physics Fourth Marking Period Test

$c = f\lambda$	$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$	$M = \frac{-q}{p} = \frac{h'}{h}$
$n = \frac{c}{v}$	$n_i(\sin\theta_i) = n_r(\sin\theta_r)$	$\sin\theta_C = \frac{n_r}{n_i}$ for $n_i > n_r$
c = 3.00 x 10^8 m/s	$F_{Gravitational} = G\frac{m_1 m_2}{r^2}$	G = 6.67 x 10^{-11} Nm^2/kg^2
	$F_{Electric} = k_C\frac{q_1 q_2}{r^2}$	k_C = 8.99 x 10^9 Nm^2/C^2
e = 1.60 x 10^{-19} C	$I = \frac{\Delta Q}{\Delta t}$	$\Delta V = IR$
$R_{eq} = R_1 + R_2 + R_3 + \ldots$	$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$	$\Delta V_{Battery} = I_{Circuit} R_{eq}$
$P = I\Delta V$	$P = I^2 R$	$P = \frac{(\Delta V)^2}{R}$

Cost calculations: (1) get power (2) get kilowatt-hours (3) get cost

- This list of equations will be provided on the test.
- You are not allowed to use note cards, review sheets, textbooks, or any other aids during the test.
- You may use a calculator. However, you are not allowed to use any other electronic devices (*i*-Pods, *i*-Phones, smart phones, netbooks, laptop computers etc.) until the last person is finished with the test.
- Calculator sharing is not allowed.
- It is to your advantage to check your work.
- All test materials including scratch paper must be returned at the end of the test.