On-level Physics
Optics

This unit will allow each student to:

a. gain a better understanding of the behavior and characteristics of light as it is reflected and refracted by mirrors and lenses
b. continue making proper scientific measurements and calculations
c. define and properly use all vocabulary
d. properly apply all terms and concepts in describing/explaining real world examples
e. continue making and interpreting scientific graphs
f. teach someone else the concepts discussed
g. practice proper laboratory safety

This will be accomplished by each student that is able to:

1. state the law of reflection; state the law of refraction
2. properly measure angles using a protractor
3. draw light as a ray; draw and identify incident and reflected rays striking flat and curved surfaces
4. identify angles of incidence, reflection, and refraction
5. properly draw a normal line (relative to flat and curved surfaces) to measure angle of incidence, angle of reflection, angle of refraction
6. use the law of reflection and a ray diagram to predict the image formed by a plane (flat) mirror
7. identify the following properties of an image relative to the object: type, orientation, size, and location
8. determine the focal point and center of curvature of a concave mirror
9. properly draw and label ray diagrams for light rays on concave and convex mirrors as well as convex and concave lenses
10. identify and draw the four easy rays for use with curved mirrors and lenses (2 easy rays)
11. use easy rays to find and describe (4 properties) images formed by curved mirrors and lenses
12. predict the properties of an image based on the object's relative location to the mirror or lens
13. compare/contrast mirrors and lenses

Textbook Reference – Physics: Principles and Problems

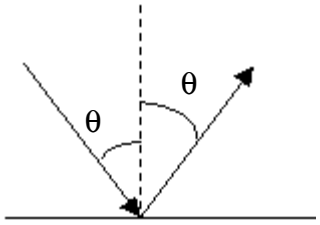
Chapter 17; Chapter 18

Key Terms

angle of incidence, normal line, angle of reflection, angle of refraction, concave, convex, center of curvature, focal point, apex, optical axis**,** optical center**,** virtual image, real image**, mirror, lens**

Mirrors and Lenses – Everyday reflection and refraction

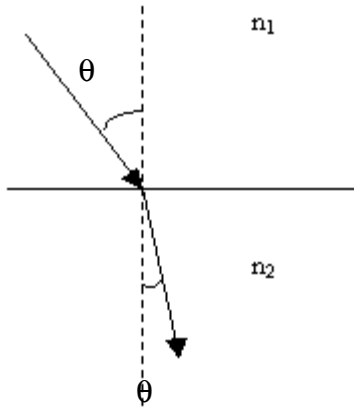
A mirror is basically a "smooth" surface that neither absorbs nor transmits most (at least 90%) of the electromagnetic radiation that strikes it, but instead most of the radiation bounces off according to the **law of reflection**. For this course we will stick with the **reflection** of visible light. Reflection is simply the light bouncing off a reflective surface and is a commonly observed behavior. For example: making a bounce pass in basketball, bouncing a ball off of a wall, playing tennis, making a bank shot in billiards (pool), etc. The **law of reflection** states the relationship between the **angle of incidence** (θ_i) and the **angle of reflection** (θ_r). These angles indicate how the light strikes (θ_i) and leaves (θ_r) the reflective surface. The light striking the surface is called incident light and the light leaving the surface is called the reflected light. An important tool used in analyzing this behavior is that the light waves can be represented by a ray. (⟶) This then gives us two rays: **incident ray** and **reflected ray**. Another very important reference line is the **normal line**. The **normal line** is drawn at a right angle to the reflective surface at the point of incidence. From the diagram you can see the **law of reflection** says that $\theta_i = \theta_r$.



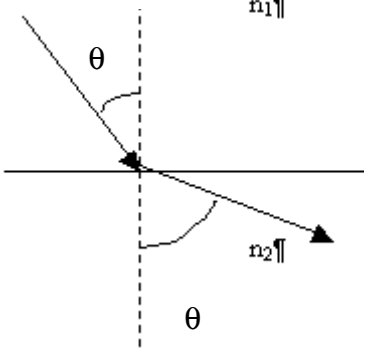
This also works exactly the same for a curved surface. The difference is drawing the normal to a curved surface. To do this either find the tangent line at the point of incidence and draw the normal perpendicular to it or find the center of curvature and connect it with the point of incidence. The second method, **easy rays**, is the easiest and the one we will use with concave and convex mirrors.
For details of curved mirrors, please see the tutorial at
http://theteterszone.net

A lens is an object/material that allows most (90%) of the light to pass through two surfaces (at least one curved) without being absorbed or reflected. When this happens the light will usually change speed because of the difference in the two media. For example, light in a vacuum travel at a speed of 3.0×10^8 m/s (a little slower than this in air), if it enters a piece of glass it will slow down tremendously ~ 2.0×10^8 m/s. This change in speed causes **refraction** as you might recall from the previous unit. The ratio of the speed of light in a vacuum to the speed of light in another medium is known as the **index of refraction (n)** of that medium; or by what factor does light slow down and bend as a result of the change in medium. The higher the index of refraction, the slower the speed of light and the more the light will bend. The lowest index of refraction is 1, in a vacuum. The **law of refraction** can be summarized as follows: **(1)** If $n_1 < n_2$, the light will bend towards the normal, $\theta_i > \theta_R$ **(2)** if $n_1 > n_2$, the light will bend away from the normal,
$\theta_i < \theta_R$ and **(3)** if $\theta_i = 0$, there is no observed bending but the light still changes speed. There are two basic types of simple lenses: **concave** (diverging) and **convex** (converging). Draw each type of lens below:

(1)

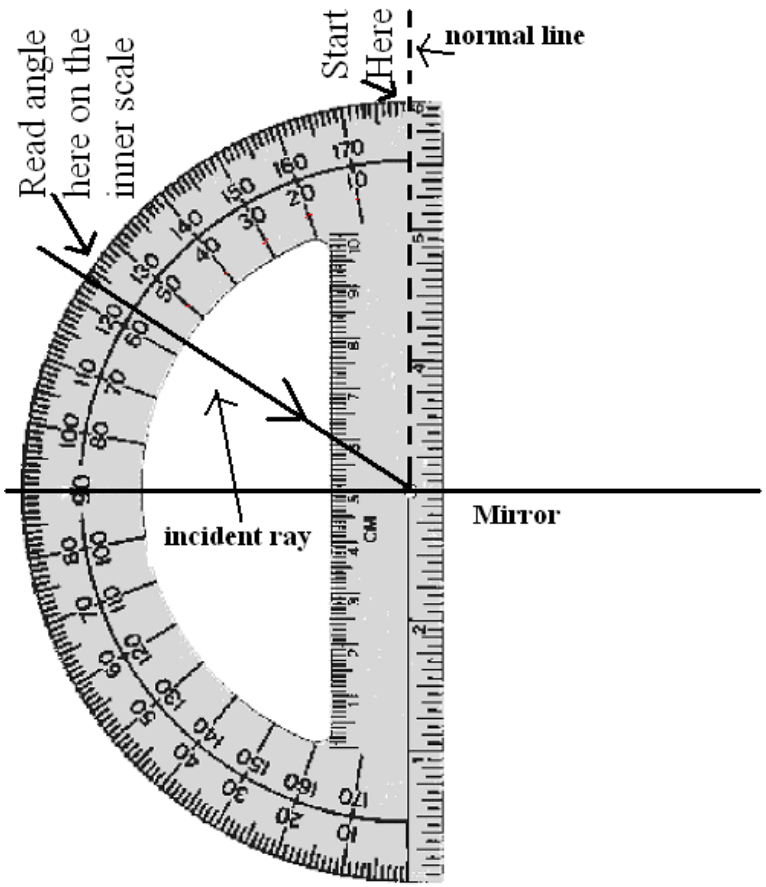


(2)



Optics Part B(1) - Law of Reflection notes

The following shows how to set up and use a protractor to measure the angle of incidence:



Follow the law of reflection video and draw all parts below.

Start at point P, which represents a point source of light. Draw a light ray leaving point P and striking the mirror surface at X.

P

•

mirror

X

Optics Chunk Plan | http://physics.scaseyjones.com

_____ A. (10 pts) Measuring Angles: (1) watch the video
(2) complete the Part A practice on the worksheet.

_____ B. (10 pts) Law of reflection: (1) watch the Law of Reflection Video and take notes, also follow along on the Law of Reflection notes page
(2) complete the Part B Practice Reflection

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_____ D. (15 pts) Plane (flat) mirror image formation:

Now view the Law of Reflection PowerPoint and take notes, just like it was in class. Slide 4 is important, you should copy it and describe what happened. You need to sketch the final diagram on that slide. Also keep in mind that you could replace the arrow with yourself (or anything else) and it would work the same, which is how you see your reflection in a normal mirror. Your notes will be checked for approval of this part.

_____ E. (35 pts) Complete the curved mirror tutorial. There are printed copies in the classroom and you can access it online at http://thetelterszone.net/tutorials/cavemirr/crvtut1.html
You will do your work on the Curved mirror diagram (front and back).

_____ F. (15 pts) Complete the curved mirror practice sheet. The back page will not give you any real images, but recall how a virtual image appears with a plane mirror and you can figure out what to do. The last mirror is a convex mirror, you will need to be creative with your easy rays. You can view the Curved Mirror PowerPoint to assist you if you get stuck.

_____ G. (10 pts) Complete the mirror image properties chart below. This chart simply lists the behavior of all types of mirrors together into one place. This chart should be completed based on the mirror ray diagrams you have completed up to this point. Basically is list the L.O.S.T. properties that you see when you look in a mirror.

	Object location	**Image Location**	**Image Orientation**	**Image Size**	**Image Type**
1	**Plane (flat) mirror**				
2	**Concave mirror Beyond C**				
3	**Concave mirror *@* C**				
4	**Concave mirror C←→ f**				
5	**Concave mirror *@* f**				
6	**Concave mirror f ←→ apex**				
7	**Convex mirror**				

H. OMIT

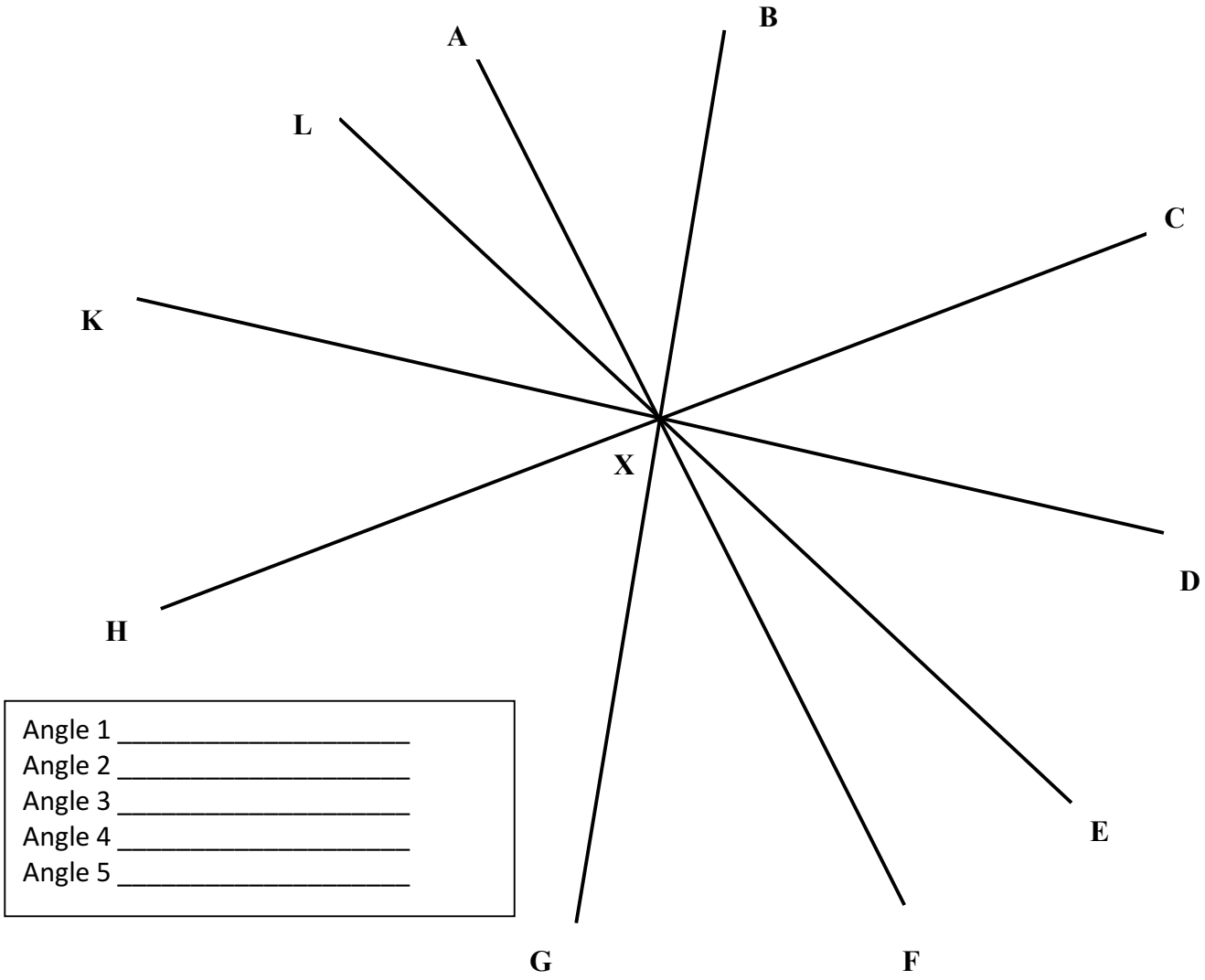
_____ I. OMIT

_____ J. (10 pts) Optics Quiz - This will be given at the end and you may use all the work you have completed at that point. This will cover all parts listed above.

All of the work you complete is the summative assessment for this chunk. All work should be approved as you work through the Optics Chunk. You will only turn in this paper at the end of the chunk. This means you must get your work approved as you complete it on a daily basis.

There are 105 points available…you must complete the first seven parts and take the quiz at the end…your final summative score will be based on a maximum score of 100 points.

Part A - Measuring angles practice: Use the diagram below to practice measuring angles using a protractor. Identify and measure at least 5 angles to the nearest 0.1°. For example angle CXE is 63.8°. All angles should have **X** as the vertex.



Angle 1 _____
Angle 2 _____
Angle 3 _____
Angle 4 _____
Angle 5 _____

Part B(2) - Law of Reflection practice: Follow the law of reflection with light from point **Z** to the mirror below. Draw the incident light from the dot to the dash on the mirror. Label all 5 parts of the law of reflection.

Z

Mirror