Lesson 1: ***Introduction to The Golden Age***

Objectives:

- Students will be able to understand how scientist's inventions of The Golden Age have helped produce the technology we use today.
- Students will be able to understand how Ibn al-Haitham provided basic ideas about vital optical phenomena.
- Students will be able to construct and operate a pinhole camera.
- Students will be able to observe and make inferences as to how light enters a simple pinhole camera to produce an image.

Standards:

- *Indiana's Revised Academic Standards for Science, Process Standards, Nature of Science:*
    - Grade 4, 5: Perform investigations using appropriate tools and technology that will extend the senses.
    - Grade 4, 5, 6, and 7: Compare the results of an investigation with the prediction.
    - Grade 6, 7, and 8: Keep accurate records in a notebook during investigation.

(Retrieved on 1 February 2011 from: < http://www.in.gov/edroundtable/files/3-Draft_Revised_Science_Standards_02.02.10.pdf>)

Teacher Content Knowledge:

- The Golden Age is of Islamic origin and dates from approximately the mid-8th century to mid 13th century. The Golden Age harbored innovative ideas across numerous job occupations such as: artists, engineers, scholars, poets, philosophers, and geographers to advance aspects of agriculture, arts, economics, industry, law, literature, sciences, and technology. The Golden Age preserved early Islamic traditions but also produced new innovative inventions to contribute to the world's overall societal advancement.
    - *Islam and Islamic History in Arabia and The Middle East*. The Golden Age. Retrieved 1 February 2011 from: <http://www.islamicity.com/mosque/ihame/sec7.htm>
- Born in 965 CE in Basra, Iraq, famous Muslim scientist Abu Ali al-HasanIbn al Hiatham was credited for the invention of the Camera Obscure, or Pinhole Camera. He is regarded as the "Father of Optics" for his extensive research on light dispersment, lenses, refractions, and much more.
- He studied many things, physics, philosophy, and astronomy; however, it is said that his greatest invention was, in fact, the pinhole camera. Although some misconceptions exist about who was the first to prove light travels in a straight line, Ibn al-Haitham receives credit for this discovery. He helped future generations to

understand that light reflects off objects and enters our eyes in order to see things. He alone created hundreds of thousands pieces of work; deeming him the "First Real Scientist. Unfortunately, most of them were lost or destroyed. As of today, there are only 14 of his works still intact, many of which are in Arabic language.
    - Aslam, Syed. "Muslim Scientists and Thinkers – Abu Ali al Hasan ibn al-Haytham." *Muslim Observer* 03/13/2008: 10-12. Retrieved 1 February 2011 from: <http://muslimmedianetwork.com/mmn/?p=1886>.
    - "Abu 'Ali al-Hasan ibn al-Hasan ibn al-Haytham." *HighBeam Reasearch.* N.p., 01/01/2001. Retrieved 1 February 2011 from: <http://www.highbeam.com/doc/1G2-3408500782.html>.
- Famous Muslim scientist Abu Ali al-Hasan Ibn al-Haitham invented the first camera around a thousand years ago and contributed to revolutionary work regarding optical phenomena.
- The first type of camera invented is called a camera obscura, which means "dark room" in Latin. We now refer to this as a pinhole camera. When it was first invented, it was actually a dark room! The room had a tiny hole in the wall that allowed a narrow beam of light to enter. This beam produced a "real image" on the opposite wall of the hole. While it didn't actually take a picture, it did display the image upside down on the wall.
- The pinhole camera was used most commonly to capture the movement of the sun over a long period of time. This was called Solargraphy.
- Pinhole camera works by letting in straight light rays and having them blocked by a screen before being able to enter the eye. When the rays bounce off the object and hit the screen in the pinhole camera, the image appears upside down. Since the screen blocks the rays from getting to our lens, which turns images right side up again, we cannot process it and allow the lens to do its job.
- Citations:
    - Grepstad, Jone. "Pinhole Photography." *Photo.net*. NameMedia Inc., 12/18/2003. Retrieved 1 February 2011 from: <http://photo.net/learn/pinhole/pinhole>.
    - Chernewski, Anitairst. "Alternative Photography." Pinhole History. N.p., 2009. Retrieved 1 February 2011 from: <http://www.alternativephotography.com/wp/history/pinhole-history>.

Materials:

- 12-13 clean tubes with tight fitting lid (eg Pringles cans we can help bring if needed)
- Tape
- 8-12 Scissors
- Thumbtacks
- 8-12 pencils

- 8-12 rulers
- Exacto knife for adult use
- 15 feet of aluminum foil
- 3 feet of wax paper
- 12-13 spiral notebooks or journals (loose leaf would work fine)

Engage:

- Students will enter the room and be prompted to answer the journal/driving question written on the board, "When scientists come up with an idea about the world around them, how do they go about exploring their ideas?"
- As an ice-breaker, students will be given a card to write and decorate their name, and share aloud with the rest of the class. They will quietly answer the following questions on their card:
    - Name
    - Grade and School
    - Favorite Color or food
    - Favorite part about science
    - Cool fact about yourself
- Establish a learning community and a set of classroom rules with the children. Invite them to contribute what rules they think are necessary for productive and safe learning and why. Type up the list for all to see using the Smart Board.
- Then transition the students into inquiry mode and ask them if they have heard of The Golden Age? Ask them why The Golden Age is important to science? What time in history it may have been?
- Play the *1001 Inventions and The Library of Secrets* video http://www.youtube.com/watch?v=JZDe9DCx7Wk (Retrieved 31 January 2011)
    - Instruct the students to discuss in pairs: What the students learned from the video? What they thought was interesting? What surprised them? What do they want to learn more about?
    - Then in a whole group discussion, form a list of 5 inventions or inventors of The Golden Age the students would like to further explore.
- Introduce the activity. Ask them how many have ever used a camera before? What did it look like? How did you use it? What did you see?
- Then ask them if they think the cameras they have used today were the same as people used long ago. Explain we are going to investigate today the first camera, the pinhole camera and learn about how we have the cameras we use in today's world.

Explore: This phase allows the students to construct a simple pinhole camera by following a set of given procedures with an opportunity to undergo a an inquiry portion of investigation: *(Pass out copies of the instructions to the children and project it on the screen as well.)*

1. Take the plastic lid off the clean Pringles can.

2. Draw a line with the marker all the way around the can about 2 inches from the metal bottom. A teacher will help you and your partner cut along the line so the tube is now in two pieces.
3. The shorter bottom piece has the metal end. A teacher will help you make a hole in the center of the metal bottom with a thumbtack. Raise your hand when you are ready for this step.
4. You will use the plastic lid as a screen. You will cut a piece of wax paper to cover the plastic lid to act as a translucent screen. Put the plastic lid onto a shorter piece of container. Put the longer piece back on top. Tape all the pieces together.
5. To keep light out of the tube, use a piece of aluminum foil that is about 1 foot long. Tape one end of the foil to the tube. Wrap the foil all the way around the tube twice, and tape the loose edge of the foil closed. Extra foil can be tucked nearly inside the tube along the inside.
6. Let a teacher know you are done making your pinhole camera. We will try it out after a short break!
7. With a teacher, go to a sunny window. Briefly predict in their journal what they think they will see when they first look through their pinhole camera with the original size hole.
8. Close one eye and hold the tube up to your other eye.
9. Look around outside to observe what you see. Make a simple sketch of what you see in your journal, did it match your prediction?

(SNACK TIME/ BATHROOM BREAK)

10. With a teacher, go to a sunny window. Have the students briefly predict in their journal what they think they will see when they first look through their pinhole camera with the original hole's size.
11. Close one eye and hold the tube up to your other eye.
12. Look around outside to observe what you see. Make a simple sketch of what you see in your journal, did it match your prediction?

Inquiry Investigation:

- Encourage them to position their camera different ways and move it different directions to note if what they see changes. Each time have the children predict in their journal what they think will happen before each manipulation. Then have them follow up in their journals, responding to the accuracy of their predictions.
- Bring some extra materials with you to the windows in order to undergo manipulations to the original pinhole camera.

SCIENTISTS, TRY THESE PROBLEMS OUT!

13. What can you guess (infer) would happen if you were to make the hole at the bottom of the can bigger? (Teacher will use the thumbtack for safely reasons).
14. How could we make a sharper image? Is it affected by the size of the hole? The placement of the shield?
15. What would happen if the screen were farther away from the pinhole?
16. What other kinds of materials would work for the screen?
17. What would happen if you allowed more/less light in when looking through the camera? How does cupping your hands around the tube's end by your eye allow more or light into the camera?
18. If time allows, try out any other ways to possibly change what you see in your camera!

(*Pringles Pinhole: Recycle a potato chip can into a simple camera!*.Owl Books, Henry Holt & Company, New York, 1996 & 1997. Retrieved on 31 January 2011from: <http://www.exploratorium.edu/science_explorer/pringles_pinhole.html>)

Explain: Students return to the classroom and discuss in small groups what they saw. As a whole group discuss what the students saw and use probing questions to help them infer why they saw what they did. Reference their original predictions compared to their actual results of what they saw and how objects appeared.

- *(REMEMBER: Probe discussion accordingly to the children's thoughts and comments without necessarily critiquing the accuracy of their statements. Try to challenge their thinking or redirect it appropriately.)*

Elaborate: After students now understand how the pinhole camera works and why, we will lead a whole-group discussion of parts of the scientific process they thought they used while conducting this investigation. Use appropriate probing questions to help them explain:

- If they felt like scientists? Why?
- What did they do that other scientists do in an investigation? Why is this important to inquiry?
- What part of the day's activity was inquiry and which part was not? Why?

→ Ask the students if they have ever heard of Abu Ali al-Hassan Ibn al-Haitham before. Have them predict why he is important to our activity today. Invite the children to use the computers in the classroom for about 10 minutes to explore who Abu Ali al-Hassan was and to take notes on their findings for we will have a whole class discussion when they are done investigating him!

Discussion Questions:

- Who was Abu Ali al-Hasan Ibn al Hiatham?
- When and where did he live?
- What was his contribution to photography?

- What other important things did he discover or do?
- Why is he important to The Golden Age?
- What would have happened if Ibn al-Haitham had not invented the pinhole camera?

Websites:

- http://muslimheritage.com/topics/default.cfm?articleid=382
- http://philosophyofscienceportal.blogspot.com/2009/01/abu-ali-al-hassan-ibn-al-haytham.html
- http://www.ehow.com/about_5104664_history-pinhole-cameras.html

→ Revisit the original journal/driving question on the board, "When scientists come up with an idea about the world around them, how do they go about exploring their ideas?" Have their ideas changed? How so? Are they the same? How so? Invite them to revise their original statements.

→ Play video: *Pinhole Photography for Kids* http://www.meetmeatthecorner.org/episodes/pinhole-photography-for-kids To further elaborate the importance of how pinhole cameras have allowed the current technology of cameras we use today.

- Ask the children to share what they learned from the video. Do you think the information is relevant to the activity we did today? Why or why not?

(*Pinhole Photography for Kids*. Meet Me at the Corner: New Earth Marketing. Colorado Springs, CO. Retrieved on 31 January 2011 from: <http://www.meetmeatthecorner.org/episodes/pinhole-photography-for-kids>)

Evaluate/Assessments: Project the pinhole vs. digital-comparing cameras worksheet and discuss through the questions with the class. This provides a closing discussion for students to demonstrate their understanding of the learning objectives.

(Reference the Seeing in the Dark Activity below)

Copy of Handouts/Journal Entry:

http://www.muslimheritage.com/feedbackuploads/TPActivity1.pdf Pg, 13

(*Seeing in The Dark: Activity 1*. Muslim Heritage: 1001 Inventions. Retrieved on 31 January 2011 from: <http://www.muslimheritage.com/feedbackuploads/TPActivity1.pdf>)

-Directions on how to make pinhole camera and the inquiry activity are below!

HOW TO MAKE A PINHOLE CAMERA

1. Take the plastic lid off the clean Pringles can.
2. Draw a line with the marker all the way around the can about 2 inches from the metal bottom. A teacher will help you and your partner cut along the line so the tube is now in two pieces.
3. The shorter bottom piece has the metal end. A teacher will help you make a hole in the center of the metal bottom with a thumbtack. Raise your hand when you are ready for this step.
4. You will use the plastic lid as a screen. You will cut a piece of wax paper to cover the plastic lid to act as a translucent screen. Put the plastic lid onto a shorter piece of container. Put the longer piece back on top. Tape all the pieces together.
5. To keep light out of the tube, use a piece of aluminum foil that is about 1 foot long. Tape one end of the foil to the tube. Wrap the foil all the way around the tube twice, and tape the loose edge of the foil closed. Extra foil can be tucked nearly inside the tube along the inside.
6. Let a teacher know you are done making your pinhole camera. We will try it out after a short break!
7. With a teacher, go to a sunny window. Briefly predict in your journal what they think they will see when they first look through their pinhole camera with the original size hole.
8. Close one eye and hold the tube up to your other eye.
9. Look around outside to observe what you see. Make a simple sketch of what you see in your journal, did it match your prediction?

INQUIRY INVESTIGATION: BE A SCIENTIST!!

- Here you will position your camera different ways and move it different directions to note changes in the images you will see.
- Remember to make a prediction in your journal about what you think will happen each time you manipulate your camera.
- Then revisit your journal after testing out your changes to explain if your predictions were right or not.

1. What can you guess (infer) would happen if you were to make the hole at the bottom of the can bigger? (Teacher will use the thumbtack for safely reasons).
2. How could we make a sharper image? Is it affected by the size of the hole? The placement of the shield?
3. What would happen if the screen were farther away from the pinhole?
4. What other kinds of materials would work for the screen?
5. What would happen if you allowed more/less light in when looking through the camera? How does cupping your hands around the tube's end by your eye allow more or light into the camera?
6. If time allows, try out any other ways to possibly change what you see in your camera!