IMHOTEP'S LEGACY ACADEMY

Making a Carousel Lantern

Grade 7 Activity Plan

Reviews and Updates

- Carousel Lanterns Activity added by Fola Akpan in July 2017

Making a Carousel Lantern

Objectives:

1. To compare two methods of heat transfer: conduction and convection
2. To understand that the physical characteristics of a surface have a powerful effect on the way that surface absorbs heat through radiation
3. To demonstrate how convection currents can be used to move a propeller
4. To identify good conductors of heat and good insulators

Keywords/concepts: density, conduction, convection, radiation, electromagnetic waves, heat transfer, conductor, insulator

Take-home product: Carousel Lantern

Segment	Details
African Proverb & Cultural Relevance (5 min.)	"What is inflated too much will burst into fragments." **Ethiopia**
Pre-test (10 min.)	Use students to demonstrate heat transfer. The students will represent particles. As the particles heat up they start to move farther away from one another and some will even move out of the circle completely. Explain the terms conduction, convection and radiation.
Activity 1 (5 min.)	Watch as an ice cube melts at the top of one cup of hot water, and at the bottom of another in order to compare convection and conduction.
Activity 2 (15 min.)	Explain to students how electromagnetic radiation works. Briefly discuss how dark colours absorb light rays and light colours reflect them. Make hypotheses about which substances will absorb more heat.
Activity 3 (30 min.)	Build a carousel lantern with students to demonstrate the power of convection. Give students lab worksheet with their hypothesis, observations and conclusion.
Activity 4 (15 min.)	Guide students through experimentation of various conductors.
Post-test (5 min.)	Memory Matching Game

Suggested interpretation of the proverb: In this activity, we will explore some of the properties of matter, and we will learn that as a substance heats up, the particles vibrate faster and expand. If the particles are contained, they will exert more and more pressure on the substance containing them, and it may eventually burst. On a deeper note, one who thinks very highly of him/herself is said to have a "big head". If you let your ego grow, and you boast all the time, eventually you will not be able to live up to it. Your ego will shatter, in a sense.

Cultural relevance:

Madame C.J. Walker (Sarah Breedlove) (1867-1919) invented a metal heating comb in 1904 and a conditioner for straightening hair in 1905. Some say her understand of this method of heat transfer helped her as she became the first self-made female millionaire.

BACKGROUND INFORMATION

All things are made up of molecules. When things get heated, they absorb heat energy. With more energy, molecules are able to move faster. When molecules move faster, the temperature rises.

Thermal Energy is energy resulting from the motion of particles. It is a form of kinetic energy and is transferred as heat. Thermal Energy Transfer can occur by three methods: Conduction, Convection and Radiation

Conduction is the transfer of thermal energy through direct contact between particles of a substance, without moving the particles to a new location. Conduction usually occurs in solids. When heat is supplied to one end, molecules at that end start to move more quickly. In the process, they bump into their neighbours, transferring the kinetic energy.

Convection is the transfer of thermal energy through movement of particles from one location to another. Convection usually occurs in fluids (liquids and gases). Example with boiling water: water at bottom of pan is heated first. Heated water expands and density decreases. Heated water begins to rise. Cooler water with higher density from the sides of the pan rush down to take its place. The cooler water gets heated and the cycle repeats. These are called Convection Currents.

Radiation is the emission of energy as waves or particles or rays. Radiation does not require a medium to transfer energy. Radiant energy is either reflected or absorbed by matter. Energy that is absorbed increases the kinetic energy of the object. This increases the temperature of the object. Example with frying pan on a stove top: Energy is radiated from the heat source and absorbed by the lower surface of the pan. Example with the sun: Sun radiates energy in form of solar radiation. When this energy reaches Earth, it is absorbed by matter (air, water, land). Absorbed radiant energy increases kinetic energy of the matter, raising its temperature. The sun is an emitter - It gives out heat. The Earth is an absorber - It takes in the heat.

Activity 1: Convection vs. Conduction Demo

Source: http://www.atmos.washington.edu/~durrand/demos/convection_conduction.htm

Purpose: *To compare two methods of heat transfer: conduction and convection*

Suggested format: *While waiting for the ice cubes to melt, set up Activity 1 to save time*

Item	**Quantity (for mentor)**
Metal chain	1
Ice cube tray	1
Tall glasses	2
Food colouring	1 colour

Procedure:

Night before activity:

1. Place a metal chain in one ice cube well. Fill two wells with water and food colouring, and place in freezer until frozen.

In classroom:

2. Fill two tall glasses, A and B with hot water (3/4 full only).
3. Take out your ice cubes and place them in tall glasses; the ice with chain in Beaker A; the ice without chain in Beaker B. Let the ice cubes melt, and observe the results.
4. Which method of heat transfer occurs in Beaker A? Beaker B? Which method transfers heat across a greater area?

The science:

Warm water is more buoyant than cold water. Since warm water is below the ice and cold water in Beaker B, the warm water rises, whereas the cold water sinks. This is convection in action!

In Beaker A, on the other hand, the warm buoyant water overlays the cold ice. This is a very stable arrangement, and convection does not occur. Heat transfer only occurs through conduction in this case.

Additional resources:

http://spaceplace.nasa.gov/en/kids/st8/thermal_loop/#
Kid friendly, interactive site about heat and how heat is transferred. "Beat the Heat" game familiarizes player with vocabulary of each type of heat transfer.

http://www.wisc-online.com/Objects/ViewObject.aspx?ID=SCE304
Simple definition of heat transfer, conduction, convection and radiation, with examples.

http://www.bbc.co.uk/schools/gcsebitesize/science/aqa_pre_2011/energy/heatrev1.shtml
Section "Heat transfer and efficiency" contains useful background information to brush up on knowledge. Students can also complete an online activity here.

Activity 2: Radiation and absorption

Purpose: To understand that the physical characteristics of a surface have a powerful effect on the way that surface absorbs heat through radiation

Suggested format: Divide students into three groups. If it is a nice sunny day, it would be great to take the students outside in a contained, bright area. If the weather is not cooperative, use incandescent lamps to shine on jars.

Item	**Quantity (10 Students)**
Disposable pie pans	9
Thermometer	9
Dark soil	1kg
Light sand	1kg
Stop watch/timer	1
Tap Water	2 L
Incandescent lamp with 200W bulb	3

Procedure:

1. Hand out charts for students to record their observations. Sample:

Heating Cycle											
Surface Material	Start time	Start temp.	Temperature each minute									
			1	2	3	4	5	6	7	8	9	10

2. Fill the pie pans to the same level, one with dark soil, one with light sand, and one with water.
3. Place the pie pans on a table or desk and position the lamp about 12 inches above them.
4. Place a thermometer into each pie pan, securing it so it measures the temperature just under the surface of the substance in the pan.
5. Record the starting temperatures on the data table.
6. Turn on the lamp and record the temperature of each substance every minute for ten minutes.

Note: Feel free to vary the materials in the pie pans. Use different colour soils, dry and wet soils, grass, green or dry leaves, or different types of coverings such as plastic or aluminum foil.

Adapted from: http://www.ucar.edu/learn/1_1_2_5t.htm
Follow the link for more background information, and excellent follow-up questions.

Activity 3: Making a Carousel Lantern

Source: http://www.instructables.com/id/DIY-Carousel-Lartern/

Purpose: To demonstrate how convection currents can be used to spin a propeller

Suggested Format: Create a demo to show the students

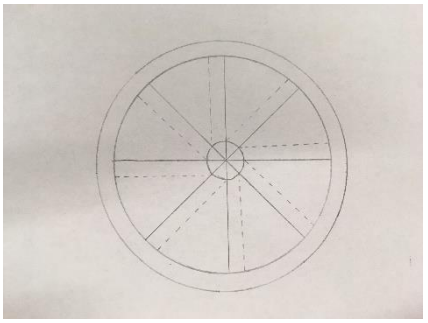
Item	**Quantity (10 students and 1 Demo)**
Straight Mason Jar	11
Candle	11
Wire	11 ft
Exacto Knife	1
Foil Pie Plate	11
Math Set (compass, ruler, protractor etc.)	10
Paper	11
Coloured Pencils	4 sets
Tape	1
Scissors	10
Pliers/ Wire Cutters	1

NOTE: The template for an 8 oz., straight sided Mason jar lantern and propeller is located at the end of this document

Procedure:

(To be done by the mentor beforehand)

1. Cut out a foil circle
    a. Using a compass, draw 3 circles on a piece of paper. The first should be the diameter of the jar, the second 5mm small than the jar and the central circle with a 5mm radius.
    b. Divide the circle into 8 parts and draw 8 dotted lines to create a fan shape



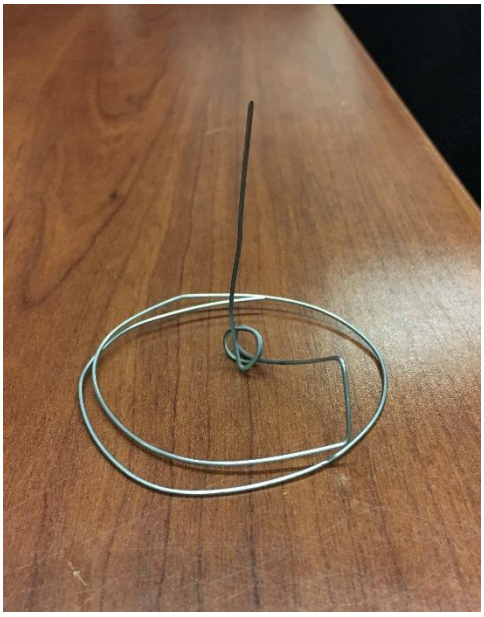
c. Trace steps 1 & 2 onto the foil pie plate using either the compass or divider
d. Cut out the largest circle on the pie plate and cut out the fan blades (the solid 8th lines) with the exacto knife
e. Mark the **exact** center of the circle and indent it with the tip of the compass (The entire activity rests on this so be precise)

2. Draw out a lantern pattern onto a piece of paper

Optional: Add a design on the main body of the lanterns

3. Cut out the lantern carve out the 2nd circle to form a lip that will hold the foil propeller
4. Tape the sides of the lantern together
5. Put the foil propeller into the lantern
6. Cut out 1 ft. of wire and manipulate the end of the wire so that the end that will hold the propeller is point
7. Wrap the wire around the mason jar to create the lantern stand
8. Place a candle into the bottom of the mason jar
9. Light the candle and place the propeller lantern onto the lantern stand
10. The lantern should spin when placed corrected on the wire

NOTE: A template for an 8 oz. straight sided Mason jar is located at the end of this document



Additional Information

https://www.youtube.com/watch?v=3RpevU9FzVM

https://www.youtube.com/watch?v=iHsZs8BuEtE

Examples of how the spinning action that should occur in the experiment

Activity 4: Conductors and Insulators

Source: http://scienceonline.tki.org.nz/Nature-of-science/Nature-of-Science-Teaching-Activities/Investigating-heat-transfer-by-conduction

Purpose: To identify good conductors of heat and good insulators

Suggested format: Students should work in groups of 2 or 3

Item	**Quantity (10 students)**
Materials to test:	
Wood	1 thin, flat piece
Tin Foil	1 roll
Glass	1 flat sample
Cereal box (cardboard)	1
Ceramics	1
Plastic	1 flat sample
Materials to use:	
Thermometer	4
Hot Water bottle	4
Kettle (optional)	1

Procedure:

1. Have students **hypothesize** what materials will be the best and worst conductors. In other words, what material(s) will become the hottest and what material(s) will increase in temperature the least.
2. **Pour very hot water** (boiled or tap) into bottle and seal it.
3. Have students **take two materials** at a time. **Hold them against the bottle** on either side
4. Then determine out of the pair which is the better conductor and insulator
5. Rank the list of materials from best to worst conductors (as in what heats up fastest)

Sample observation table:

Material	**Better Conductor** (out of pair)	**Best-to-Worst Conductors** (out of all)

Post-Test

Item	Quantity (10 students)
Deck of Cards with terms	1

Use the following words. Print and paste onto playing cards. Students can play individually or in groups. It is your basic memory matching game. Student turns over two cards, if they match they pick those cards up and get another turn. If the cards do not match, they flip cards back (face down) and their turn is over. Each term will match with either: radiation, conduction or convection. For example, ray and sunburn cannot be matched together. The student or group that has the most matches at the end wins.

The acceptable matches are:
Radiation with: Ray, Sunburn, Lamp, Beam, Sun, Fire (with arrows to the side)
Convection with: Fluid, Current, Liquid, Hot Air Balloon, Gas, Fire (with arrows up)
Conduction with: Conductor, Insulator, Copper, Solid, Friction, Tin Foil

Radiation	Radiation	Ray
Sunburn	Lamp	Radiation
Radiation	Radiation	Beam
Sun	Fire	Radiation
Convection	Fluid	Convection
Convection	Liquid	Current
Fire	Gas	Convection
Convection	Conduction	Hot Air
Balloon	Insulator	Convection
Conductor	Conduction	Conduction
Conduction	Friction	Copper

Solid		Conduction
		Tin Foil