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| **Title** | Thermal Expansion Lab |
| **Introduction** | Through the use of lab activities and discussion, students will explore, discover, and then demonstrate their understanding of thermal expansion and specific heat. |
| **Curriculum Alignment** | Grade 6 Science:  Objective 1.01  Identify and create questions and hypotheses that can be answered through scientific investigations.  Objective 1.02  Develop appropriate experimental procedures for:   * Given questions. * Student generated questions.   Objective 1.03  Apply safety procedures in the laboratory and in field studies:   * Recognize potential hazards. * Manipulate materials and equipment. * Conduct appropriate procedures.   Objective 1.05  Analyze evidence to:   * Explain observations. * Make inferences and predictions. * Develop the relationship between evidence and explanation.   Objective 1.06  Use mathematics to gather, organize, and present quantitative data resulting from scientific investigations:   * Measurement. * Analysis of data. * Graphing. * Prediction models.   Objective 1.08  Use oral and written language to:   * Communicate findings. * Defend conclusions of scientific investigations.   Objective 6.01   * Determine how convection and radiation transfer energy.   Objective 6.02   * Analyze heat flow through materials or across space from warm objects to cooler objects until both objects are at equilibrium.   Objective 6.04  Evaluate data for qualitative and quantitative relationships associated with energy transfer and/or transformation. |
| **Learning Outcomes** | 1. Through the completion of several lab activities, recording their observations, analyzing their collected data, and communicating their findings, students will understand thermal expansion and specific heat. 2. Students will demonstrate their understanding thermal expansion and specific heat through diagramming and the written explanation of one or more experimental scenarios. |
| **Time Required and Location** | 1 class period |
| **Materials Needed** | Lab notebook (1 per student)  Lava lamp  Lab 1: (1 set per pair of students)   * Thermal ball and ring set * Propane micro burner * Beaker of water   Lab 2: (1 set per pair of student)   * 2 bi-metallic strips * Propane micro burner * Beaker of water   Lab 3: (1 set per pair of student)   * 4 premade tape strips * 2 tongs * Propane micro burner * Beaker of water   Lab 4: (1 set per pair of student)   * 1 conduct-o-meter * 5 small pieces of wax * Propane micro burner * Flat pan of water |
| **Safety** | Follow typical classroom safety procedures.  Be sure you go over lab safety procedures required when working with open flames. |
| **Participant Prior Knowledge** | Students should have completed the lab activities on energy transfer and have a basic understanding of the concepts of conduction, convection, convection currents and radiation. |
| **Facilitator Preparations** | Prepare lab stations ahead of time. |
| **Activities** | **HOOK:**  Focus students’ attention on the lava lamp plugged in at the front of the room. Have students make observations about what they see happening. Have them jot down their thoughts of how they think the lamp works.  **ACTIVITY: Lab Activities**  Lab Station 1: Ball and Ring  **Directions**:   * 1. Students should make observations (quantitative and qualitative) about the ball and ring set.   2. Students should try to fit ball though the ring prior to placing either in the flames. Record observations.   3. Make a hypothesis about what might happen when you place the ball only in the flame for 2 minutes.   4. Place ball in flame for 2 minutes, then try to fit ball through the ring. Record observations.   5. Cool off ball by slowly dipping it into the water.   6. Make a hypothesis about what might happen when you place the ring only in the flame for 2 minutes.   7. Place ring in flame for 2 minutes, then try to fit ball through the ring. Record observations.   8. Cool off ring by dipping it slowly into the water.   9. Make a hypothesis about what might happen when you place both the ring and the ball in the flame for 2 minutes.   10. Place both ring and ball in flame for 2 minutes, then try to fit ball through the ring. Record observations.   11. Cool off ring and ball by dipping them slowly into the water.   Questions:  Explain what you just observed in steps 1-11.  Why do you think this happened?  Lab Station 2: Tape Strips  **Directions**:   * + 1. Have students make observations about the tape strips.     2. Make a hypothesis about what is going to happen when the tape strips are held several inches above the flame.     3. Using tongs hold one end of the tape strip two inches ABOVE the flame and record what happens.     4. Take the tape strip away from the heat and allow it to cool. Straighten it out and flip it over. Place the tape strip back over the flame and record what happens.   Questions:  Explain what occurred with the tape strip when you did your experiment.  Why do you think the tape strips acted the way that they did?  Lab Station 3: Bi-metallic Strips  **Directions**:   1. Have students make observations about the bimetallic strips. 2. Make a hypothesis about what is going to happen when the bimetallic strips are held over the flame. 3. Using the handle hold the bimetallic strip close to the flame and record what happens. 4. Take the bimetallic strip away from the heat and dip it into the water. 5. Flip the strip over and place bimetallic strip back over the flame and record what happens.   Questions:  Explain what you saw occur in this experiment.  How are the tape strip different and the bimetallic strip similar?  Why do you suppose this happened in both experiments?  Lab Station 4: Heat Conduct-o-Meter  **Directions**:   * 1. Place a small piece of wax in the dimple at the end of each rod. (The wax pieces should be equal in size.)   2. Lay out a piece of paper towel on your station but away from the flame.   3. Make a hypothesis about what you think is going to happen with the conduct-o-meter.   4. Hold the hub of the conduct-o-meter over the flame until the wax begins to melt.   5. Once the wax begins to melt, remove the conduct-o-meter from the flame and hold it over the paper towel.   6. Record the order in which the wax melts.   7. Cool conduct-o-meter by placing it in the pan of water.   8. Repeat a second time.   Questions:  Explain what happened in the experiment.  How is it that the wax at the ends of each rod was able to melt?  By what process did the rods get hot?  Why did the all the wax not start melting at the same time?    **CONTENT WRAP-UP**:  After all groups have completed all stations, bring the students back into the whole group and discuss their observations and answers to the questions. At this time, through this discussion, correct terminology and definitions can be imparted to clear up misunderstandings and to clarify the processes they just examined. Additional aid for students can come in the form of a close guided notes sheet.  **GUIDED PRACTICE:**  Have students explain how, and through what processes, the lava lamp at the front of the room works. They should be able to use correct vocabulary and processes to describe and/or diagram what is occurring in each instance.  During completion or immediately after completion teacher can check in with, or check over student understanding and allow for correction and clarification. |
| **Assessment** | Have students explain though words and diagrams how the bimetallic strip in an air conditioner thermostat turns the AC and heat on and off. |
| **Critical Vocabulary** | **Specific Heat –** The amount of heat required to raise the temperature of one kilogram of a material by 1 degree Kelvin.  **Temperature** – The measure of the average kinetic energy of the individual particles of matter in an object.  **Fahrenheit Scale** – The temperature scale where the freezing point of water is 32 degrees and the boiling for water is 212 degrees.  **Celsius Scale** - The temperature scale where the freezing point of water is 0 degrees and the boiling for water is 100 degrees.  **Kelvin Scale** – The temperature scale where the freezing point of water is 273 degrees and the boiling for water is 373 degrees.  **Absolute Zero** – The lowest temperature possible -273 degrees Celsius or 0 degrees Kelvin.  **Thermal Energy** – The total amount of energy, of all the particles in an object.  **Heat** – Thermal energy moving from a warmer object to a cooler object.  **Thermal Expansion** – The spreading out of a matter’s particles as it is heated. |
| **References** | Cooperative Learning - <http://edtech.kennesaw.edu/intech/cooperativelearning.htm> |
| **Supplemental Information** | Assigning or setting up of lab groups or [Cooperative](http://edtech.kennesaw.edu/intech/cooperativelearning.htm) grouping is critical as you need to put students together that can work together and support each other’s learning. |
| **Comments** | The Comments section contains anything you think facilitators should know or consider that doesn’t fit into the other parts of the project plan. They may include:   * an explanation of how you developed the plan, or why you wrote it in a particular way * possible extensions or ways to shorten the plan * reflections on the experience of leading this project * participants’ comments or reactions |
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