

Is Your Building Well-Insulated?

Students will complete a lab activity / STEM challenge to study what materials make the best insulators, then go outside to investigate the school building – what is warmest, walls, windows or doors? The less well insulated a building is, the more heat it is letting out and the warmer the outside of the building will be. Are older buildings or parts of buildings less well insulated than newer ones? Where would you recommend the school to invest in insulation?

This is a good activity for a cold winter day when the sun is not shining. Bundle up!!

Time Required: approximately 3 x 40min. class periods

Grade level: 6-8, 9-12

Materials needed:

- IR Thermometers - **WARNING - these have a laser pointer that you may want to cover.**
- Hot water - approximately 1 L per group; hot but not scalding or boiling
- Containers or cups made of various materials and approximately the same size - paper, plastic, metal (empty soup cans work well), glass (beakers), styrofoam - 1 of each per group.
- Cardboard circles or squares to cover the tops of the containers - 5 per group.

5 E's Lesson layout

- Engage - have students find temps of building surfaces & learn to use the IR thermometers
- Explain - discuss insulators vs. conductors and have students answer the pre-lab questions
-----End class period 1
- Explore - students conduct an experiment to find the best insulating material
-----End class period 2
- Elaborate / Engineer - students research & make recommendations for building insulation
- Evaluate - Have students (or student groups) share & discuss what are the best options.
-----End class period 3

NGSS Standards:

[MS-PS3-3](#), [MS-PS3-4](#), [MS-PS3-5](#) [HS-PS2-6](#), [HS-PS3-4](#),

PA Science & Technology Standards:

3.2.7.B6, 3.2.8.B3, 3.2.8.B4, 3.2.8.B6,

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In this lab, you will use an infrared (IR) thermometer to find out what parts of your school are losing heat, then investigate which materials make the best insulators. Finally you will use this information to make design recommendations to improve the school's insulation and reduce the heating bill.

NOTE → Follow your teacher's directions for using the IR thermometer!

Part I: Is Your Building Well-Insulated?

This is a good activity for a cold winter day when the sun is not shining. Bundle up!! You will need to take the IR thermometers outside and measure the temperature of different building surfaces (walls, windows, doors, etc. If the building has an addition it might be interesting to compare the old part to the new part). If they are losing heat they will be warmer than the outside temperature. Those losing the most heat will be the warmest! Record your information in the table below:

Data Table I: Temperature of Building surfaces

Portion of building	Material (brick, glass, wood, etc.	Temperature (° _____)

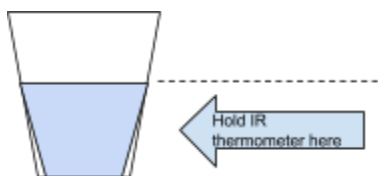
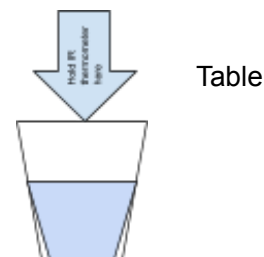
Notes: (Any additional observations)

Part II: Insulating Material**Pre-lab:**

- 1) What is the definition of an insulator?
- 2) What materials do you know of that are used as insulation?
- 3) If you are measuring the ability to insulate heated water by measuring the temperature of the outside of the container, which will indicate a better insulator, a lower temperature or a higher temperature?

Procedure:

- Obtain 5 containers of approximately the same size but made of different materials. Put ~ 200 mL (one cup) of hot water into each container. It is not crucial that the measurement is exact, but all of your containers should be filled to the same level, about half-full.
- Place the containers on a flat surface. With the IR thermometer pointed down at the water from above the container, measure the temperature of the water in each container and record it in Data II. Cover the containers with cardboard pieces and start a timer.



- After 5 minutes, take the temperature of the outside of each container, below the level of the water inside. Record the temperatures. Repeat at 10 and 15 minutes; do not uncover the containers during this time.

- After the 15 minute reading, remove the cardboard covers letting any steam escape. Measure the final temperature of the water in each container as you did at the beginning of the experiment. Record the temperatures in the table and calculate the temperature change of the water from beginning to end.

Data Table II: Heat loss through various materials

Container Material →	Glass	Metal	Paper	Plastic	Styrofoam
Initial (I) Water Temp.					
Outside temp. at 5 min.					
Outside temp. at 10 min.					
Outside temp. at 15 min.					
Final (F) Water Temp.					
Temp. Change (F - I)					

Conclusion:

List the materials in order from BEST to WORST insulator according to the temperature change observed.

(Best) → → → → (Worst)

Part III:

Do some research on the internet about materials used to insulate walls, windows, etc. in a building. Use your new-found knowledge to make a recommendation to the school board as to how they can insulate the building better at the lowest cost to the district. On a separate sheet of paper, create a **labeled sketch** with your recommendations and **explain why** you chose those options.

Wrap up: Members of the class will present their ideas to one another and discuss the best options.