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# The Sizzling Science of Solar: Building and Testing a Pizza Box Oven

## Materials Needed

- **Primary Structure:** 1 large, clean pizza box (the kind that folds up, not with a separate lid).
- **Reflector Panel:** Aluminium foil.
- **Glazing (Window):** Heavy-duty plastic cling wrap (or an oven bag, cut to size).
- **Heat Absorption:** Black construction paper or black, non-toxic paint.
- **Insulation:** Newspaper (to be crumpled), or alternatively, wool or cotton batting.
- **Structural Support:** A wooden skewer, dowel rod, or a sturdy stick.
- **Tools:** Craft knife or box cutter (adult supervision recommended), ruler, permanent marker, clear packing tape, glue stick.
- **Testing Equipment:** An oven thermometer or any thermometer that can read up to 100°C.
- **Cooking Supplies:** Ingredients for s'mores (crackers, marshmallows, chocolate) or nachos (corn chips and cheese).
- **Data Collection:** Notebook and pen, or a digital device for recording observations and temperatures.

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## Lesson Plan

**Subject:** Science (Physics), Design and Technologies

**Year Level:** High School (Years 9-10)

**Estimated Time:** 2-3 hours for construction and initial testing (plus cooking time, which depends on the sun!)

### 1. Learning Objectives

By the end of this lesson, you will be able to:

- **Design and Construct:** Follow instructions and use problem-solving skills to build a functional solar oven from simple materials.
- **Explain Scientific Principles:** Clearly explain how the principles of heat transfer (radiation, convection) and the greenhouse effect work together to cook food in your oven.
- **Analyse and Evaluate:** Record temperature data, analyse the performance of your oven, and propose evidence-based improvements to the design.
- **Apply Knowledge:** Successfully use your solar oven to cook a simple food item, demonstrating the practical application of solar energy.

### 2. Alignment with Australian Curriculum

- **Science (Year 9):** Energy transfer through different mediums can be explained using wave and particle models (ACSSU182). Energy conservation in a system can be explained by describing energy transfers and transformations (ACSSU190).
- **Design and Technologies (Years 9-10):** Critique needs or opportunities to develop design briefs and investigate and select an increasingly sophisticated range of materials, systems, components, tools and equipment to develop design solutions (ACTDEP048, ACTDEP049).

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Lesson Procedure (The 5E Model)

Part 1: Engage - The Spark (15 minutes)

Let's start with a big question: **How could you cook a meal if the power went out on a hot, sunny day?**

Think about how hot the inside of a car gets on a sunny day, even when it's cool outside. Why does that happen? The car's windows let sunlight in, but they don't let all the heat back out. We're going to use this same principle, the **greenhouse effect**, to build an oven that can cook food using only the power of the sun.

Your challenge is to become a solar engineer for the day. Your mission: build, test, and improve a device that harnesses the sun's energy.

Part 2: Explore - The Build (60-90 minutes)

Follow these steps to construct your prototype pizza box oven. Remember, good engineers are precise!

1. **Create the Oven Door:** Using your ruler and marker, draw a square on the top of the pizza box lid, leaving about a 3cm border from the edges. With adult supervision, carefully use the craft knife to cut along **three** sides of the square, leaving the side along the back hinge of the box uncut. This creates a flap that will be your reflector panel.
2. **Install the Reflector:** Carefully fold the flap open. Cover the *underside* of this flap smoothly with aluminium foil, shiny side out. Use tape or glue to secure it. This foil will act like a mirror to direct extra sunlight into your oven.
3. **Create the Window:** Open the pizza box. On the inside of the lid, tape a double layer of plastic cling wrap over the opening you just created. Make it as airtight as you can to trap heat inside. This is your oven's "glass" window.
4. **Absorb the Heat:** Line the bottom inside of the pizza box with black construction paper. This black surface is crucial because it will absorb the sunlight that comes through the window, converting it into heat.
5. **Insulate the Oven:** Roll or crumple newspaper and stuff it into the sides of the box, between the black paper and the box walls. This insulation will stop the heat from escaping through the cardboard.
6. **Seal it Up:** Close the lid. You should now be able to look through the plastic window and see the black bottom. Use tape to seal any other gaps or holes around the box edges to prevent heat loss, but don't tape the lid shut!
7. **Prop it Up:** Use the wooden skewer or dowel rod to prop the foil-covered reflector flap open at an angle (about 45 degrees is a good start) so it can catch the sun and bounce it into the box.

Part 3: Explain - The Science Behind the Sizzle (20 minutes)

As you look at your finished oven, let's break down the science. In your notebook, draw a diagram of your oven and label these four key scientific concepts at work:

- **Radiation:** The sun sends energy to Earth in the form of electromagnetic waves (sunlight). The foil reflector *reflects* this radiation into the box, and the black paper *absorbs* it, turning it into heat.
- **Greenhouse Effect:** The plastic wrap window lets the sun's shortwave radiation in, but it traps the longwave radiation (heat) that is re-radiated from the black paper. This is just like the car window!
- **Conduction:** Heat transfers from the hot air and black paper to the food through direct

contact.

- **Insulation:** The crumpled newspaper traps pockets of air, which is a poor conductor of heat. This slows down the loss of heat through the cardboard walls of the box.

Part 4: Elaborate - The Cooking & Engineering Challenge (Time Varies)

Now for the real test! Time to collect data and cook.

1. **Position Your Oven:** Take your oven outside into direct sunlight. Angle it so the foil reflector catches the most sun and bounces it directly through the window.
2. **Collect Data:** Place your thermometer inside the oven on the black paper and close the lid. Record the starting temperature. Every 10 minutes for the next hour, record the temperature. Plot your results on a simple line graph (Time vs. Temperature). What is the highest temperature your oven reaches?
3. **The S'mores Test:** Place a cracker with a piece of chocolate and a marshmallow on it inside the oven. Place it on a small piece of foil to keep the oven clean. Close the lid and aim it at the sun. Check it every 10-15 minutes until it's perfectly melted. Enjoy your solar-powered snack!
4. **The Engineering Challenge:** Now that you have a working prototype, how can you make it better?
    - How could you improve the insulation?
    - Could you design a more effective reflector? What if you curved it?
    - How could you create a better seal to prevent heat from escaping?
    - What would happen if you painted the inside walls of the box black too?

    Brainstorm and sketch at least two improvements to your design.

Part 5: Evaluate - The Engineer's Report (30 minutes)

To complete your project, answer the following questions in your notebook or as a short video presentation. This is your chance to show what you've learned.

1. **Design & Process:** Describe the steps you took to build the oven. What was the most challenging part and how did you solve it? Include your scientific diagram from the "Explain" section.
2. **Data Analysis:** Include your time-temperature graph. What does the data tell you about your oven's performance? Did the temperature rise steadily or did it level off? Why do you think that happened?
3. **Critique and Improvement:** Based on your results, describe the two improvements you designed in the "Elaborate" section. Explain *why*, using scientific principles (like insulation or radiation), you believe these changes would make your oven more effective.
4. **Real-World Connection:** How could this simple technology be used to help people in remote communities in Australia or in developing countries around the world? Think about fuel costs, deforestation, and safety.

Differentiation and Extension

- **Need More Support?** Work with a pre-drawn box for cutting. Use a provided worksheet with fill-in-the-blanks to define the key scientific terms.
- **Ready for a Greater Challenge?** Build your improved "Version 2.0" oven and run a side-by-side comparison test with your original prototype. Research different designs of solar cookers (like parabolic or panel cookers) and write a short comparison of their advantages and disadvantages.

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