HOT OVEN

Interactive Physics Simulation

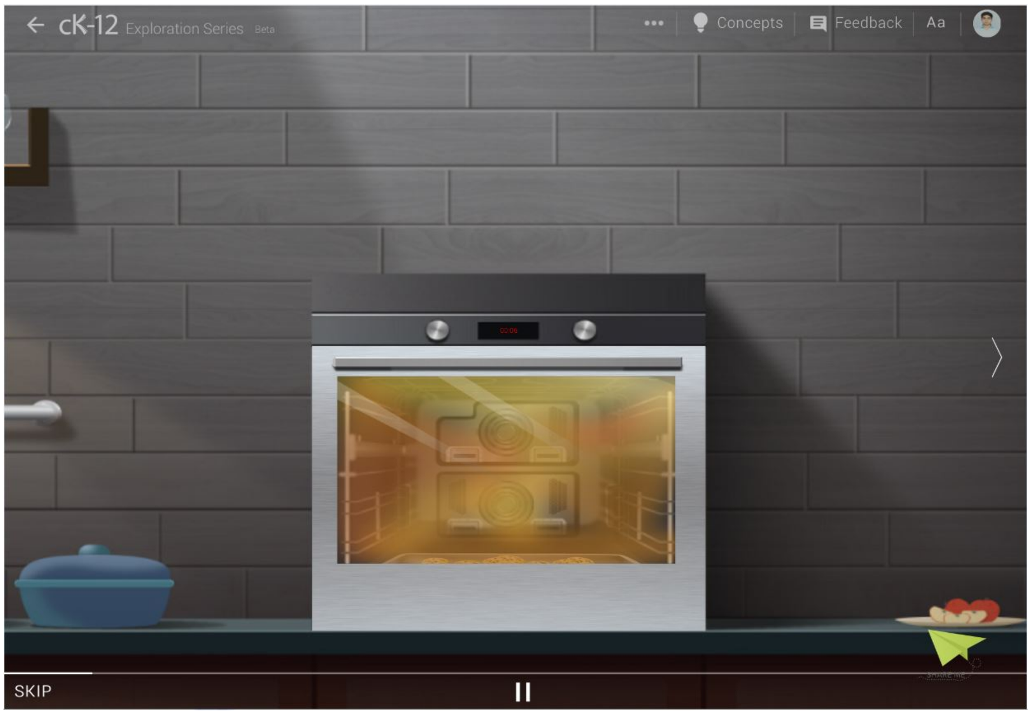
To visit this simulation :

http://interactives.ck12.org/simulations/physics/hot-oven/app/

Intriguing Question

Why does the metal in the oven burn you, but the air doesn't?

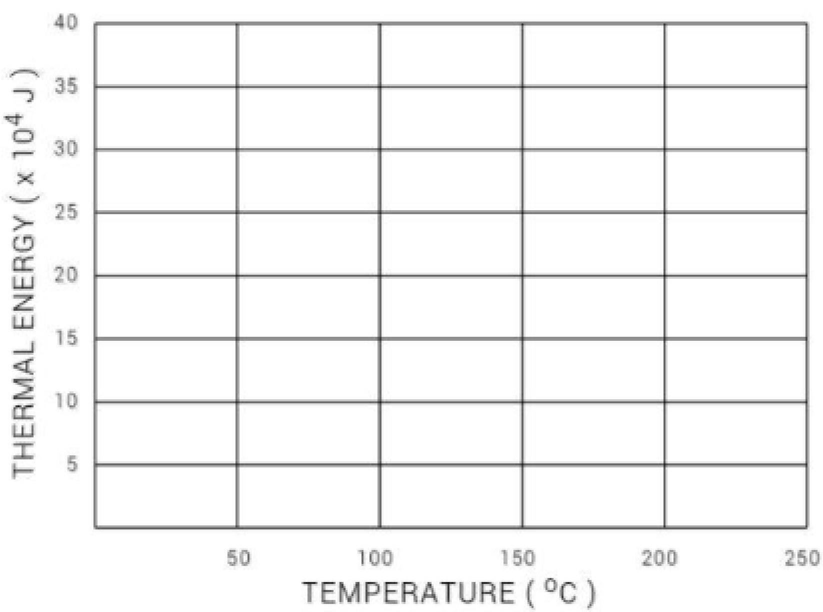
Illustrative Video



Your cookies are just about ready to come out of the oven. The cookies, the pan they're in, the metal shelf and air in the stove are all at the same temperature. But when you touch the metal, you're more likely to be burned than just touching the air. What is the difference between temperature and heat? The thermal energy available to transfer to your hand is much greater in the metal.Temperature tells us the average kinetic energy per particle, but does not tell us the total energy of the whole system. The air and the metal are at the same temperature, but the metal is denser, containing more atoms. The number of atoms or molecules involved makes a huge difference to the thermal energy.

Interactive Simulation

Temperature - This slider adjusts the temperature in the oven. Temperature is a measure of the average kinetic energy per particle, but is not a measure of the TOTAL energy of a system. To go from temperature to thermal energy, you need to know how many particles there are in the system - for this reason, higher density materials (like metal compared to air) can contain much more thermal energy at a given temperature than lower density materials.



Thermal energy vs Temperature - This is a plot of thermal energy vs. temperature. As you'd expect, a higher temperature would indicate greater total thermal energy. But the rate at which the thermal energy increases with temperature is different for the solid metal than it is for the gaseous air.

Interpreting Results

At what temperature will the air in the oven have a thermal energy of 5.0 x 10 J? (*Adjust the temperature slider until the graph indicates the air has a thermal energy of 5.0 x 10 J).*

At what temperature will the pan in the oven have a thermal energy of 3.3 x 10 J? (Adjust the temperature slider until the graph indicates the pan has a thermal energy of 3.3 x 10 J).

If the air has a thermal energy of 4.5 x 10 J, what is the air temperature? (Adjust the temperature slider until the graph indicates the air has a thermal energy of 4.5 x 10 J).

Challenge ME!

- Can you estimate the temperature (in Celsius) at which the thermal energy is zero for both the pan and the air?

- What are the units of the slope of the graph?

- By what factor is the slope of the graph higher for pan than for air?

Need Help?

Check out the Hot Oven Walkthrough video at: https://youtu.be/DjGGRXNdncw

Interesting Questions

How cold is outer space?

It is important when thinking about space to make clear whether you are talking about the energy content of space (which is very low, because there is almost nothing there) or the temperature of space (which can be high, because the few particles around might have very high kinetic energy on average). For instance, the corona of the Sun, which extends out into space very far from the visible surface, is very high in temperature - millions of degrees. But it wouldn't "feel" hot because the density of matter is very low.

Why is the Earth just the right temperature for liquid water?

The Sun shines light in every direction in the solar system - only a tiny fraction of that light actually falls on the Earth. This small amount of light is enough to heat the Earth. Without an atmosphere that, like a greenhouse, allows short-wavelength light from the Sun to enter but traps long-wavelength light, the Earth would be much colder than it is.

How fast are the molecules in this room moving?

The temperature of a room defines the average kinetic energy of the molecules. Some will be going faster, some slower. A "typical" air molecule in an ordinary room travels at around 450 m/s, or 1000 miles per hour! Some go faster, some slower - the distribution of speeds is well understood, and described by the Maxwell-Boltzmann distribution.

Why do metal objects sometimes feel cold?

Remember that you are yourself much warmer than room temperature - your body temperature is around 37 degrees Celsius (99 degrees Fahrenheit), whereas room temperature is more like 20 degrees Celsius (68 degrees Fahrenheit). When you touch a metal object, the electrons in that metal do a great job of conducting heat away from the part you are touching. This means the part you are touching doesn't warm up much by virtue of being in contact with you. When you touch something that isn't as good as a conductor, it warms up more quickly.

Physics Concepts | Click on the link below to learn more.

- Heat, Temperature, and Thermal Energy Transfer - http://www.ck12.org/physics/Heat-Temperature-and-Thermal-Energy-Transfer/
- Temperature - http://www.ck12.org/physics/Temperature/
- Specific Heat - http://www.ck12.org/physics/Specific-Heat/