

conduction & convection

...adapted from **HEAT #15**
by TOPS Learning Systems

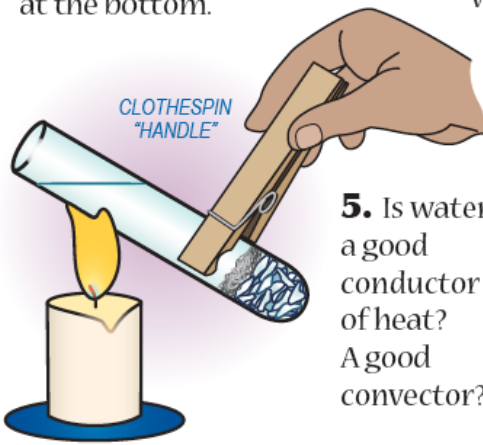
1. Fill a test tube $\frac{1}{5}$ full of crushed ice. Use your pencil to push in a little steel wool to hold the ice firmly in place.

2. Now fill the test tube with water. The ice should stay at the bottom.

3. Try to boil water at the *top* of the tube without melting the ice at the bottom.



4. Repeat this experiment without steel wool. Let the ice float as you heat from the *bottom*.



5. Is water a good conductor of heat? A good convector?



© 2009 by TOPS Learning Systems. Photocopies permitted if this notice appears. All rights reserved.

OBJECTIVE

To appreciate that water is a good *convector* of heat, but a poor *conductor*.

LAB NOTES

Copy the lab for each student or lab team.

INTRODUCTION:

Heat travels by *conduction*, *convection* and *radiation*:

Conduction: Heat causes atoms and molecules to vibrate more energetically. These in turn agitate nearby particles, transferring thermal motion through the material. Conduction happens more rapidly with metals than with non-metals, because free outer electrons in metals collide and transfer their thermal motion more quickly.

Convection: Atoms and molecules in a fluid (liquid or gas) move more energetically as they absorb heat, thereby expanding and rising above cooler, denser layers of the fluid, that then sink as they are displaced.

Radiation: Radiant heat energy travels through space as a wave, partly electric and partly magnetic. It fits between light and microwaves on the electromagnetic spectrum. (*This lab does not deal with radiant heat.*)

Step 3. Heating water at the top leaves solid ice below.

Step 4. Heating water at the bottom melts ice at the top.

ANSWERS

5. Water is a poor heat conductor. Heat absorbed at the top of the tube was only slowly conducted downward. Even as the water boiled above, ice remained unmelted below.

But water is a good heat convector. Heat absorbed at the bottom causes water to expand and rise, melting the ice above. Cool water sinks to the bottom where it can be heated, resulting in even heating throughout.

EVALUATION

Q: Should you apply heat at the bottom or the top to boil a pan of water? Explain.

A: Heat the bottom of the pan to efficiently circulate the heat upward by convection. (If applied top down, heat travels slowly by conduction.)

MATERIALS

- Small test tube (to boil water quickly).
- A candle with drip tray, or Bunsen burner.
- Steel wool.
- Safety goggles.
- Crushed ice (wrap cubes in a towel and pound with mallet, rock, or heavy mug).
- A clothespin or test tube holder.