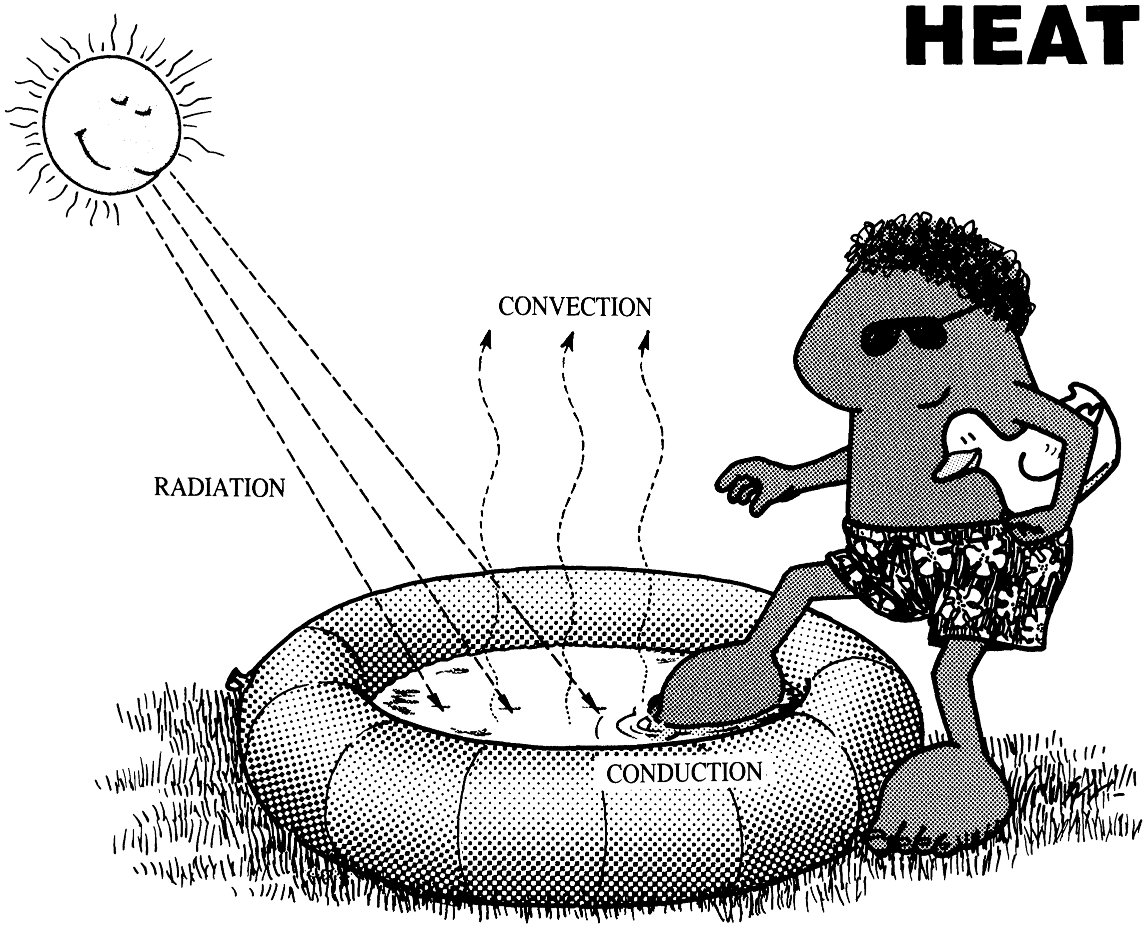
HEAT



TASK CARD SERIES

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TOPS LEARNING SYSTEMS

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ISBN 978-0-941008-85-3

CONTENTS

Gathering Materials

Listed below is everything you'll need to teach this module. Buy what you don't already have from your local supermarket, drugstore or hardware store. Ask students to bring recycled materials from home.

Keep this classification key in mind as you review what's needed.

general on-the-shelf materials:
Normal type suggests that these materials are common. Keep these basics on shelves or in drawers that are accessible to your students. The next TOPS module you teach will likely utilize many of these same materials.

special in-a-box materials:
Italic type suggests that these materials are unusual. Keep these specialty items in a separate box. After you finish teaching this module, label the box for storage and put it away, ready to use again.

(substituted materials):
Parentheses enclosing any item suggests a ready substitute. These alternatives may work just as well as the original. Don't be afraid to improvise, to make do with what you have.

***optional materials:**
An asterisk sets these items apart. They are nice to have, but you can easily live without them. They are probably not worth an extra trip to the store, unless you are gathering other materials as well.

Everything is listed in order of first use. Start gathering at the top of this list and work down. (The teaching notes may occasionally suggest additional *Extensions.* Supplies for these optional experiments are listed neither here nor under *Materials.* Read the extension itself to determine what new items, if any, are required.)

Quantities depend on how many students you have, how you organize them into activity groups, and how you teach. Decide which of these 3 estimates best applies to you, then adjust quantities up or down as necessary:

Q_1 / Q_2 / Q_3

- Q_1 — **Single Student:** Enough for 1 student to do all the experiments.
- Q_2 — **Individualized Approach:** Enough for 30 students informally working in pairs, all self-paced.
- Q_3 — **Traditional Approach:** Enough for 30 students, organized into pairs, all doing the same lesson.

KEY: general on-the-shelf materials (substituted materials) *special in-a-box materials* *optional materials

1/1/1	rolls of iron, copper and aluminum wire of roughly equal thickness, perhaps 20 gauge
1/5/10	*wire cutters
1/10/10	candles with drip catchers
1/10/10	books of matches
1/10/10	glass microscope slides
1/10/10	scissors
3/20/30	*thin, recyclable, aluminum pie tins*
1/2/2	trays of ice cubes
1/10/10	plastic sandwich bags
1/2/2	rolls masking tape
1/1/1	dropper bottle of blue food coloring
1/1/1	source of hot and cold water
1/10/10	Bunsen burners or alcohol lamps — other heating sources may be substituted in all experiments except activity 9
2/10/20	pint jars
3/20/30	baby food jars
2/20/20	index cards
1/1/1	spool of thread
3/30/30	test tubes
1/1/1	box steel wool
1/1/1	box paper clips
2/20/20	clothespins
1/10/10	toothpicks
2/10/20	tin can tops, about 15 ounce size
1/5/10	tin cans, about 15 ounce size
2/10/20	pennies
1/1/1	roll aluminum foil
1/2/2	rolls clear tape
1/10/10	laboratory thermometers
1/3/3	sheets black paper (or color white paper with black crayon or marking pen)
1/1/1	hot plate and teapot to heat water (or use Bunsen burners, Pyrex beakers and ring stands)
3/30/30	corks to fit test tubes (lumps of oil-based clay)
1/1/1	jar of sand
1/10/10	graduated cylinders, 100 mL capacity
2/20/20	small styrofoam cups — 150 mL minimum capacity
1/5/10	*large plastic milk jugs cut to half size, or equivalent*
1/5/10	*graduated cylinders, 1000 mL capacity (quart or liter jars)
1/10/10	hand calculators
.1/.3/.8	*kilograms washers, bolts or other small iron objects*
1/5/10	gram balances
1/1/1	small container flour
1/1/1	*bag roasted peanuts*
1/10/10	straight pins

Sequencing Task Cards

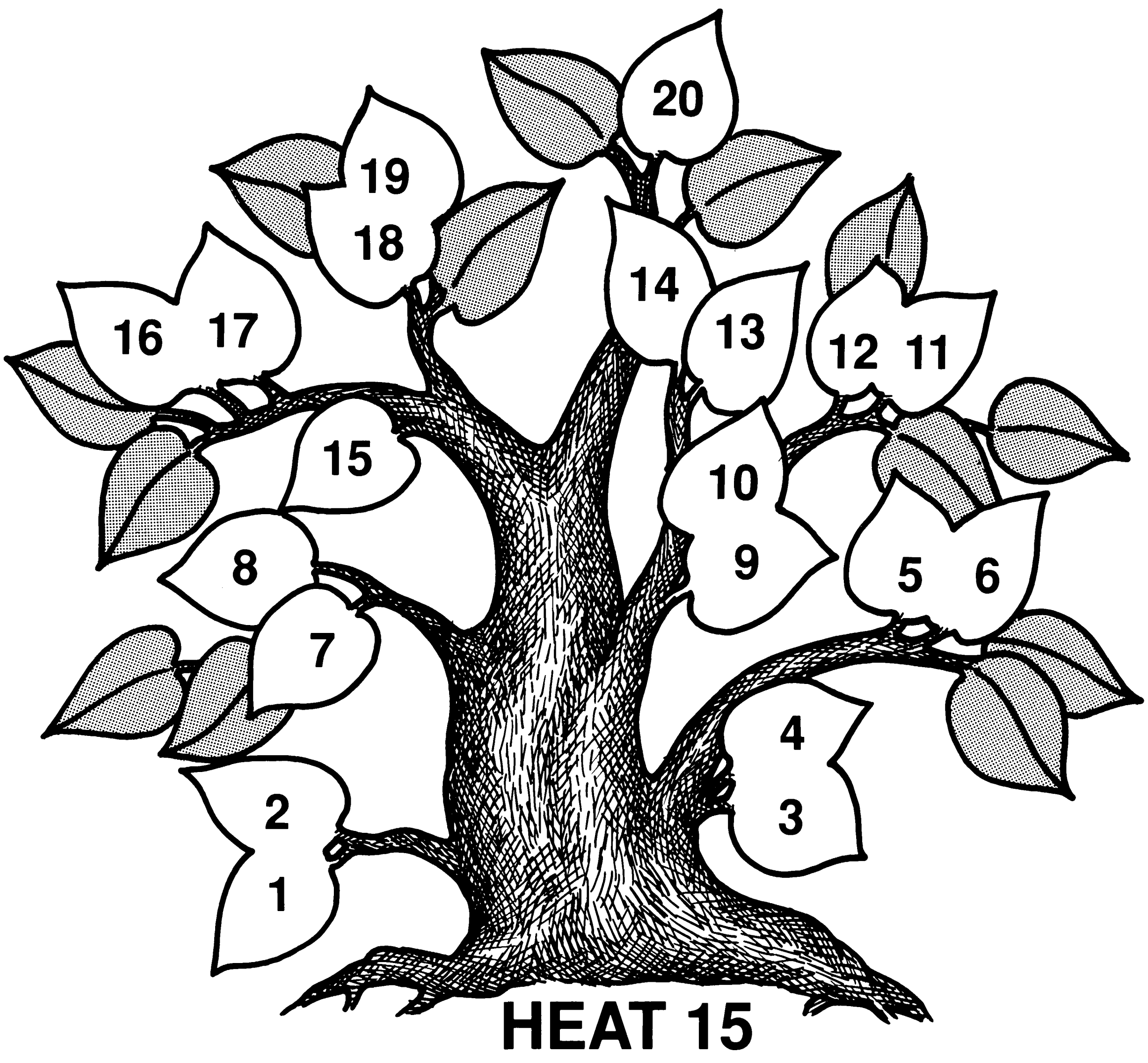
This logic tree shows how all the task cards in this module tie together. In general, students begin at the trunk of the tree and work up through the related branches. As the diagram suggests, the way to upper level activities leads up from lower level activities.

At the teacher's discretion, certain activities can be omitted or sequences changed to meet specific class needs. The only activities that must be completed in sequence are indicated by leaves that open *vertically* into the ones above them. In these cases the lower activity is a prerequisite to the upper.

When possible, students should complete the task cards in the same sequence as numbered. If time is short, however, or certain students need to catch up, you can use the logic tree to identify concept-related *horizontal* activities. Some of these might be omitted since they serve only to reinforce learned concepts rather than introduce new ones.

On the other hand, if students complete all the activities at a certain horizontal concept level, then experience difficulty at the next higher level, you might go back down the logic tree to have students repeat specific key activities for greater reinforcement.

For whatever reason, when you wish to make sequence changes, you'll find this logic tree a valuable reference. Parentheses in the upper right corner of each task card allow you total flexibility They are left blank so you can pencil in sequence numbers of your own choosing.



Review / Test Questions

Photocopy the questions below. On a separate sheet of blank paper, cut and paste those boxes you want to use as test questions. Include questions of your own design, as well. Crowd all these questions onto a single page for students to answer on another paper, or leave space for student responses after each question, as you wish. Duplicate a class set and your custom-made test is ready to use. Use leftover questions as a review in preparation for the final exam.

task 1-2
Heat from a candle flame is conducted through a metal wire.
a. How do atoms in this wire interact to transfer heat energy?
b. What about the electrons?

task 1-2
"Conductron" is advertised as a new metal alloy that conducts heat better than copper. How could you test the validity of this advertising claim?

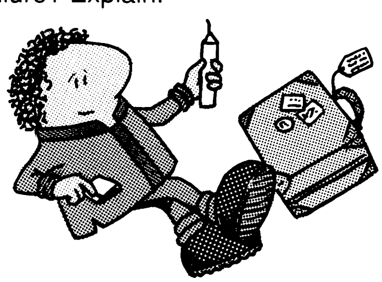
task 3
Why are metals better conductors of heat than nonmetals?

task 3
The metal spring on a clothespin feels cooler than the wood that surrounds it. Does this mean the spring has a lower temperature than the wood? Explain.

task 4
A goose down coat, a wool sweater and snow are all good heat insulators. What important property do they share?

task 5-6
Will a cup of hot chocolate stay hot longer if you put a lid on it? Why?

task 5-6
A space traveler brings along a candle and a book of matches, just in case the lights go out in her space ship. Will she have light in the event of a power failure? Explain.



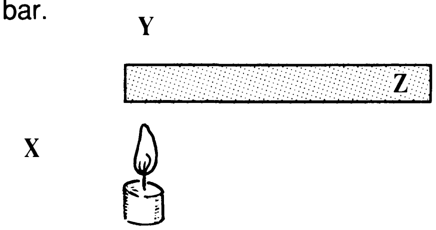
task 7
To heat a pot of boiling water, is it more effective to apply the heat at the bottom of the pot or the top? Explain.

task 1-7
Can heat travel...
a. Through solids by convection? Explain.
b. Through liquids by conduction? Explain.

task 8
A piece of paper is wrapped tightly around a thick metal bar and held over a candle flame. Do you think the paper will catch fire?

task 9
Energy from the sun warms your face. Does it travel to your face by conduction, convection, or radiation? Explain your reasoning.

task 1-9
Explain how heat travels from the flame to points x, y and z near or on the metal bar.



task 10-12
Suppose you live in a hot desert climate.
a. What color would you paint your house? Explain.
b. What color would you paint your solar hot-water collector?

task 13
If carbon dioxide levels in the Earth's atmosphere continue to climb, what overall climate change could result? Explain.

task 14
The table lists cooling data for 2 different brands of thermos bottles. Graph this data to show which thermos is the most effective heat insulator.

time (min)	Therm-X (°C)	Vac-U (°C)
0	79.6	81.0
10	77.5	78.6
20	75.6	76.3
30	73.9	74.1
40	72.4	72.0
50	71.1	70.0
60	70.0	68.1

task 15-17
If you want to heat up a pot of water as fast as possible, would you fill it half full or all the way full? Explain.

task 15-17
A rock, heated by the sun, is thrown into the ocean. The temperature of the rock drops. Does the temperature of the ocean rise? Explain.

task 15-17
Exactly 200 ml of water at an initial temperature of 21.3° C is heated to 26.9° C. How many calories of heat did this water absorb?

task 18-19
If you take a bite of hot pizza, the tomato sauce is more likely to burn your mouth than the crust. Explain why.

task 18-19
Winds blowing across the ocean have less temperature variation than winds blowing across a desert. Explain.

task 20
A burning potato chip raises the temperature of 500 ml of water by about 6° C.
a. How many calories did the water absorb? How many food Calories is this?
b. Assuming the water captured 33 % of the total heat produced, how many food Calories are in this single chip?
c. How many chips would a child need to eat to fill his entire daily requirement of 2,700 Calories?

TASK OBJECTIVE (TO) trace heat flow through a wire. To understand how atoms in the wire interact to conduct heat.

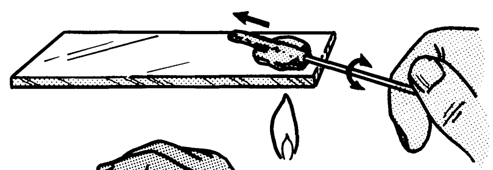
HOT WIRE

O

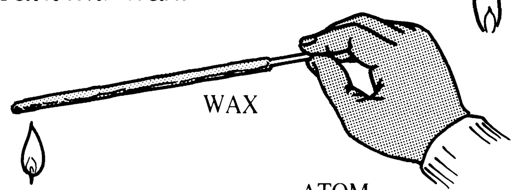
Heat (   )

1. Cut a piece of iron wire about 10 cm long (as tall as this task card).

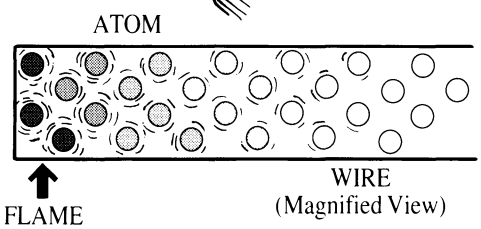
2. *Partly* melt a small lump of wax on a microscope slide. Roll the wire in this wax, just as it begins to resolidify, to thoroughly coat it with wax.



3. Hold the end of the wire just above the flame so it tilts slightly down. Describe how heat conducts (travels) from the flame through the wire.



4. Atoms in the wire vibrate more vigorously as they absorb heat energy. Propose a theory to explains how agitated atoms near the flame pass this energy along to atoms in the middle of the wire.



5. Gases in a candle flame ignite at about 600° C. Wax liquefies around 60° C. Temperatures above 40° C feel uncomfortably hot. Describe the temperatures present in your hot wire.

1

Answers / Notes

2. *Wax sticks to the wire only when it is cool enough to solidify. If students fully melt the wax, both the glass slide and wire will be too hot. No wax will stick until the temperature drops back down to the temperature of solidification.*

3. *The melted drops of wax should drip toward the flame. If the drips move up the wire, they carry heat up the wire as well.*

The wax directly over the flame melts instantly, followed by wax adjacent to the flame, followed by wax further away, and so on, in a continuous melting front that advances towards the fingers. This front moves rapidly at first, then gradually slows down. It stops before reaching the fingers.

4. Atoms at the end of the wire that are exposed to the flame vibrate more energetically as they are heated. These atoms bump into adjacent atoms further down the wire that, in turn, bump into other atoms. Soon all the atoms are heated (vibrating vigorously). In this way, heat energy transfers through the wire without the atoms changing their positions.

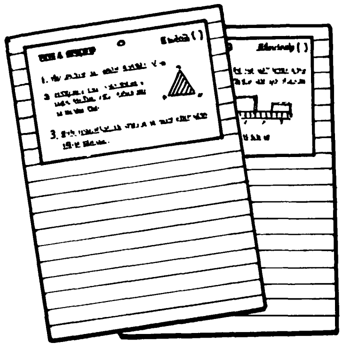
5. The temperature of the wire drops from 600° C in the candle flame down to 60° C where the wax just melts. Beyond this point the temperature drops well below 40° C since it is still comfortable to hold.

Materials

☐ A roll of iron wire. Choose a diameter (perhaps 20 gauge) that is roughly the same thickness as aluminum wire and copper wire, also used in this module. A paper clip bent straight, or wire extracted from twist ties may be substituted. Avoid extremely thin wire.
☐ Wire cutters (optional). Or rapidly bend the wire back and forth until it breaks.
☐ A candle with drip catcher plus matches.
☐ A microscope slide.

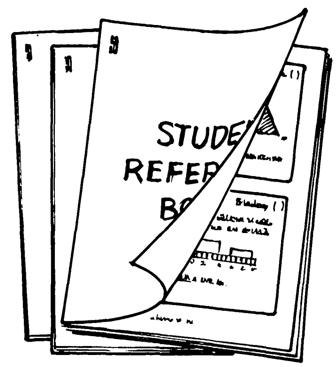
Task Cards Options

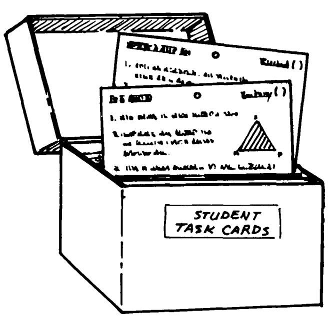
Here are 3 management options to consider before you photocopy:



1. Consumable Worksheets: Copy 1 complete set of task card pages. Cut out each card and fix it to a separate sheet of boldly lined paper. Duplicate a class set of each worksheet master you have made, 1 per student. Direct students to follow the task card instructions at the top of each page, then respond to questions in the lined space underneath.

2. Nonconsumable Reference Booklets: Copy and collate the 2-up task card pages in sequence. Make perhaps half as many sets as the students who will use them. Staple each set in the upper left corner, both front and back to prevent the outside pages from working loose. Tell students that these task card booklets are for reference only. They should use them as they would any textbook, responding to questions on their own papers, returning them unmarked and in good shape at the end of the module.



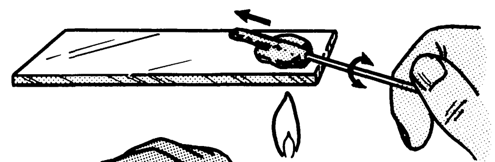


3. Nonconsumable Task Cards: Copy several sets of task card pages. Laminate them, if you wish, for extra durability, then cut out each card to display in your room. You might pin cards to bulletin boards; or punch out the holes and hang them from wall hooks (you can fashion hooks from paper clips and tape these to the wall); or fix cards to cereal boxes with paper fasteners, 4 to a box; or keep cards on designated reference tables. The important thing is to provide enough task card reference points about your classroom to avoid a jam of too many students at any one location. Two or 3 task card sets should accommodate everyone, since different students will use different cards at different times.

HOT WIRE ○ Heat ( )

1. Cut a piece of iron wire about 10 cm long (as tall as this task card).

2. *Partly* melt a small lump of wax on a microscope slide. Roll the wire in this wax, just as it begins to resolidify, to thoroughly coat it with wax.



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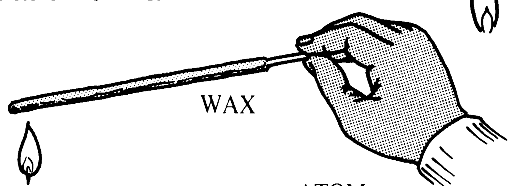
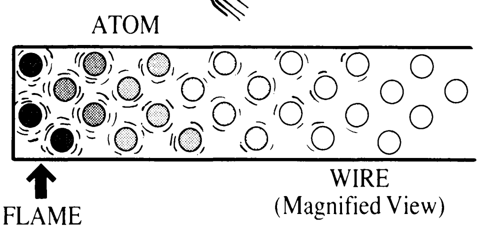


4. Atoms in the wire vibrate more vigorously as they absorb heat energy. Propose a theory to explains how agitated atoms near the flame pass this energy along to atoms in the middle of the wire.

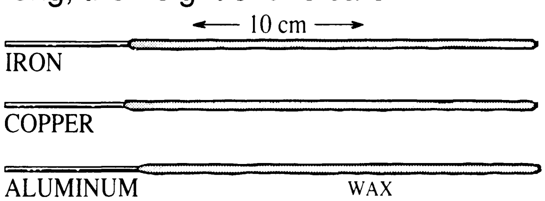


5. Gases in a candle flame ignite at about 600° C. Wax liquefies around 60° C. Temperatures above 40° C feel uncomfortably hot. Describe the temperatures present in your hot wire.

 1

HEAT RACE ○ Heat ( )

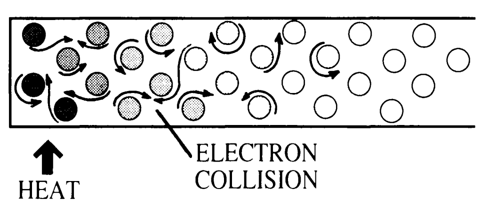
1. Coat 3 pieces of wire with wax as before. Each should be about 10 cm long, the height of this card.



2. Hold heat races: Place 2 wires side by side, tipped slightly down, over a candle flame. Summarize your results in a table.

Race	Result
iron vs. copper	
iron vs. aluminum	
copper vs. aluminum	

3. Heat is conducted through metals because atoms vibrate against each other. Even more importantly, their free outer electrons also collide with each other, and other atoms.



a. Which metal likely holds its outer electrons most tightly? What makes you think so?

b. Would you expect good conductors of heat to be good conductors of electricity (electrons) as well? Explain.

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