Temperature

1. A friend said the temperature inside a certain oven is 500 and the temperature inside a certain star is 50,000. You’re unsure about whether your friend meant Celsius degrees or kelvins. How much difference does it make in each case?
2. The temperature of the sun’s interior is about $10^7$ degrees. Does it matter whether this is degrees Celsius or kelvins? Explain.
3. If you vigorously shake a can of liquid back and forth for more than a minute, will the temperature of the liquid increase? (Try it and see.)
4. In a meeting room, there are chairs, a table and people. Which of these things has a temperature (a) lower than, (b) greater than, or (c) equal to the temperature of the air?
5. Which is greater, an increase in temperature of 1 Celsius degree or an increase of 1 Fahrenheit degree?
6. Why can't you establish whether you are running a high temperature by touching your won forehead?
7. In a glass of water at room temperature, do all the molecules have the same speed?
8. Why wouldn’t you expect all molecules in a gas to have the same speed?
9. Which has more kinetic energy, the molecules in a gram of ice or the molecules in a gram of steam? Defend your answer.
10. Which as the greater amount of internal energy, an iceberg or a cup of hot coffee? Defend your answer.
11. When a mercury thermometer is heated, the mercury expands and rises in the thin tube of glass. What does this indicate about the relative rates of expansion for mercury and glass? What would happen if their expansion rates were the same?
12. Would you expect the temperature of water at the bottom of Niagara Falls to be slightly higher than the temperature at the top of the falls? Why?
13. Adding the same amount of heat to two different objects does not necessarily produce the same increase in temperature. Why not?
14. A certain quantity of heat is supplied to both a kilogram of water and to a kilogram of iron. Which undergoes the greater change in temperature? Defend your answer.
15. Which has the greater specific heat, an object that cools quickly, or an object of the same mass that cools more slowly?
16. If the specific heat of water were less, would a nice hot bath be a longer or a shorter experience?
17. In addition to the random motion of molecules from place to place that are associated with temperature, some molecules can absorb large amounts of energy that go into vibrations and rotation of the molecule itself. Would you expect materials composed of such molecules to have a high or a low specific heat? Explain.
18. What role does specific heat capacity play in a watermelon staying cool after removal from cooler on a hot day?
19. Ethyl alcohol has about one-half the specific heat capacity of water. If equal masses of each at the same temperature are supplied with equal quantities of heat, which will undergo the greater change in temperature?
20. Why does the presence of large bodies of water tend to moderate the climate of nearby land - to make it warmer in cold weather and cooler in hot weather?
21. One of the reasons the first lightbulbs were expensive was that the electrical lead wires into the bulb were made of platinum which expands at about the same rate as glass when heated. Why is it important the metal leads and the glass have the same coefficient of expansion?
23. What was the precise temperature at the bottom of Lake Superior at 12:01 a.m. on October 31, 1894?
24. Suppose that water is used in a thermometer instead of mercury. If the temperature is at 4°C and then changes, why can’t the thermometer indicate whether the temperature is rising or falling?
25. Your friend states that the average speed of all hydrogen and nitrogen molecules in a gas is the same. Do you agree or disagree, and why?
26. Why would you not expect all the molecules of air in your room to have the same average speed?
27. In a mixture of hydrogen and oxygen gases at the same temperature, which molecules move faster? Why?
28. One container is filled with argon gas and the other with krypton gas. If both gases have the same
temperature, in which container are the atoms moving faster? Why?

29. Solid uranium can be converted chemically to uranium fluoride, UF₆, which can be cooked up into a dense vapor that diffuses through a porous barrier. Which is likely to diffuse at a greater rate, a gas with isotopes U₂³⁵ or U₂³⁸ (hint, U₂³⁸ is heavier)?

30. A great amount of water vapor changes phase to become water in the clouds that form a thunderstorm. Does this release thermal energy or absorb it?

31. When can you add heat to something without raising its temperature?

32. When can you withdraw heat from something without lowering its temperature?

33. Why does the temperature of boiling water remain the same as long as the heating and boiling continue?

**Heat transfer**

1. On a cold day, why does a metal doorknob feel colder than the wooden door?

2. What is the explanation for feather beds being warm?

3. Wrap a fur coat around a thermometer. Will the temperature rise?

4. If 70°F air feels warm and comfortable to us, why does 70°F water feel cool when we swim in it?

5. At what common temperature will a block of wood and a block of metal both feel neither hot nor cold to the touch?

6. If you hold one end of a metal nail against a piece of ice, the end in your hand soon becomes cold. Does cold flow from the ice to your hand? Explain.

7. What is the purpose of a layer of copper or aluminum on the bottom of stainless steel cookware?

8. In terms of physics, why do restaurants serve baked potatoes wrapped in aluminum foil?

9. Many tongues have been injured by licking a piece of metal on a very cold day. Why would no harm result if a clean piece of wood were licked on the same day?

10. What physics is involved in explaining why you can safely hold your bare hand in a hot pizza oven for few seconds, but if you momentarily touch the metal inside, you’ll burn yourself?

11. Does wood have a low conductivity if it is very hot— that is, in the stage of smoldering, red-hot coals? Could you safely walk across a bed of red-hot wooden coals with bare feet? Although the coals are hot, does much heat conduct from them to your feet if you step quickly? Could you do the same on red-hot iron coals? Explain. (Caution: Coals can stick to your feet, so—OUCH!—don’t try it!)

12. In which form of heat transfer is a medium not required?

13. When you step out of a swimming pool on a hot, dry day in the southwest, you feel quite chilly. Why?

14. Why is sweating an efficient mechanism for cooling off on a hot day?

15. Why does blowing over hot soup cool the soup?

16. Can you give two reasons why pouring a cup of hot coffee into a saucer results in faster cooling?

17. A covered glass of water sits for days with no drop in water level. Strictly speaking, can you say that nothing has happened, that no evaporation or condensation has taken place? Explain

18. Why does a good emitter of heat radiation appear black at room temperature?

19. An electric fan not only doesn’t decrease the temperature of air, but actually increases air temperature. How, then, are you cooled by a fan on a hot day?

20. A number of bodies at different temperatures placed in a closed room share radiant energy and ultimately reach a common temperature. Would this thermal equilibrium be possible if good absorbers were poor emitters and poor absorbers were good emitters? Explain.

21. Since energy is radiated by all objects, why can’t we see them in the dark?

22. On a very cold sunny day, you wear a black coat and a transparent plastic coat. Which should be work on the outside for maximum warmth?

23. If the composition of the upper atmosphere were changed so that it permitted a greater amount of terrestrial radiation to escape, what effect would this have on Earth’s climate?

24. As more energy from fossil fuels and other nonrenewable fuels is consumed in Earth, the overall temperature of the Earth tends to rise. Regardless of the increase in energy, however, the temperature does not rise indefinitely. By what process is an indefinite rise prevented? Explain your answer.
Thermodynamics

1. When air is quickly compressed, why does its temperature increase?
2. When you pump a tire with a bicycle pump, the cylinder of the pump becomes hot. Give two reasons why this is so.
3. What happens to the gas pressure within a sealed gallon can when it is heated? Cooled? Why?
4. What is the ultimate source of energy in a hydroelectric power plant?
5. The combined molecular kinetic energies of molecules in a cool lake are greater than the combined molecular kinetic energies in a cup of hot tea. Pretend you partially immerse the teacup in the lake and that the tea absorbs 10 calories from the water and becomes hotter, while the water that gives up 10 calories becomes cooler. Would this energy transfer violate the first law of thermodynamics? The second law of thermodynamics? Defend your answers.
6. Why is thermal pollution a relative term?
7. Why is it advantageous to use steam as hot as possible in a steam-driven turbine?
8. How does the ideal efficiency of an automobile relate to the temperature of the engine and temperature of the environment in which it runs? Be specific.
9. Will the efficiency of a car engine increase, decrease, remain the same if the muffler is removed? If driven on a very cold day? Defend your answers.
10. What happens to the efficiency of a heat engine when the temperature of the reservoir into which thermal energy is transferred is lowered?
11. Why do diesel engines need no spark plugs?
12. Everybody knows that warm air rises. So it might seem that the air temperature should be higher at the top of mountains than down below. But the opposite is most often the case. Why?
13. What is the ultimate source of energy in coal, oil and wood? Why do we call energy from wood renewable but energy from coal and oil non-renewable?
14. Under what conditions would a heat engine be 100% efficient?
15. Could you cool a kitchen by leaving the refrigerator door open and closing the kitchen door and windows? Explain.
17. The efficiency of an OTEC power plant is very small compared with the efficiency of fossil fuel and nuclear power plants. Why isn’t this a serious shortcoming?
18. In buildings that are being electrically heated, is it at all wasteful to leave all the lights on?
19. A wet bathing suit spontaneously chills itself (and its occupant.) How can this happen without violating the second law of thermodynamics? (Hint: Is the bathing suit just transforming heat to its warmer surroundings, or is it doing more than that?)
20. Is the total energy of the universe becoming more unavailable with time? Explain.
21. Comment on this statement: The second law of thermodynamics is one of the most fundamental laws of nature yet is not an exact law at all.
22. Water evaporates from a salt solution and leaves behind salt crystals that have a higher degree of molecular order than the more randomly moving molecules in the salt water. Has the entropy principle been violated? Why or why not?
23. Water put into a freezer compartment in your refrigerator goes to a state of less molecular disorder when it freezes. Is this an exception to the entropy principle? Explain.
24. As a chicken grows from an egg, it becomes more ordered with time. Does this violate the principle of entropy? Explain.
25. The Patent Office rejects claims for perpetual motion machines (in which the energy out is as great or greater than the energy in) without even studying them. Why is this?
26. (a) If you spent ten minutes repeatedly shaking and throwing own a pair of coins, would you expect to see two heads come up at least once? (b) If you spent an hour shaking a handful of ten coins and throwing them down, would you expect to see all ten come up heads at least once? (c) If you stirred a box of 10,000 coins and dumped them repeatedly on the floor all day long, would you expect to see all 10,000 come up heads at least once?
27. In your bedroom are probably some $10^{27}$ air molecules. IF they all happened to congregate on one side
of room, you could suffocate. But this is unlikely. Is such a circumstance less likely, more likely, or the same if there are many times fewer molecules in the room?

28. How might water be desalinized by freezing?
29. Pretend that all the molecules in a liquid have the same speed, not random speeds. Would evaporation of this liquid cause the remaining liquid to be cooled? Explain.
30. What is the ultimate source of energy in coal, oil, and wood? Why do we call energy from wood renewable but energy from coal and oil nonrenewable?
31. The ocean possesses enormous numbers of molecules, all with kinetic energy. Can this energy be extracted and used as a power source? Defend your answer.