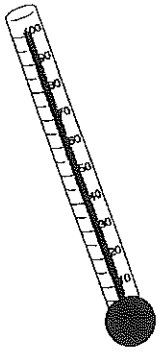
Name _____ # ____ Per ____

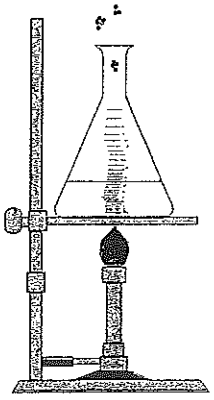
Specific Heats of Common Materials



MATERIAL	SPECIFIC HEAT (Joules/gram • °C)
Liquid water	4.18
Solid water (ice)	2.11
Water vapor	2.00
Dry air	1.01
Basalt	0.84
Granite	0.79
Iron	0.45
Copper	0.38
Lead	0.13

Heats up Faster ↓

↓ Heats up Faster



Overview:

Substances do not all heat up or cool down at the same rate. When heat (measured in joules) is absorbed by substances that do not go through a phase change, the temperature increases. Measuring how fast substances increase in temperature compared to water gives us this chart, called Specific Heats of Common Materials.

The Chart:

The Specific Heat chart shows how fast a substance heats up compared to liquid water, with water having a value of 4.18 joules/gram • °C. Any substance that heats up faster than water will have a specific heat value less than 4.18, and any substance that heats up slower than water has a specific heat higher than 4.18. As shown by the Specific Heats of Common Materials chart, lead, with the lowest value 0.13, would heat up the fastest. Copper having a specific heat of 0.38 would heat up slower than lead, but would heat up faster than all substances having a higher specific heat value. Granite and basalt, both being rocks, are used to represent land materials. From their respective specific heat values, one can see that land heats up much faster than water (about 5×'s as fast).

Additional Information:

- If a substance heats up fast, it also cools down fast. As shown by the chart, land not only heats up faster than water, but it also cools down faster than water. This is why the sand on a beach becomes much hotter than the body of water during a summer day, but cools down much faster than the water at night. This is also why large bodies of water have a major affect on the climate of coastal areas. Water, having a large specific heat, heats up very slowly and cools down very slowly. This property of water causes coastal land areas to have a smaller annual range of temperatures compared to inland cities at the same latitude.

- Joules is the derived unit of energy in the international system of units (SI – metric system).

Set 1 — Specific Heats of Common Materials

1. Liquid water can store more heat energy than an equal amount of any other naturally occurring substance because liquid water

   (1) covers 71% of Earth's surface
   (2) has its greatest density at 4°C
   (3) has the higher specific heat
   (4) can be changed into a solid or a gas 1 _____

2. How do the rates of warming and cooling of land surfaces compare to the rates of warming and cooling of ocean surfaces?

   (1) Land surfaces warm faster and cool more slowly.
   (2) Land surfaces warm more slowly and cool faster.
   (3) Land surfaces warm faster and cool faster.
   (4) Land surfaces warm more slowly and cool more slowly. 2 _____

3. The same amount of heat energy is added to equal masses of lead, iron, basalt, and water at room temperature. Assuming no phase change takes place, which substance will have the *smallest* change in temperature?

   (1) lead (3) basalt
   (2) iron (4) water 3 _____

4. Five-gram samples of granite, basalt, iron, and copper at room temperature are placed in a beaker of boiling water. Which sample would reach a temperature of 60°C first?

   (1) copper (3) granite
   (2) iron (4) basalt 4 _____

Note: Question 5 has only three choices.

5. When the Sun sets, which material would cool down the fastest, assuming they all have the same mass and initial temperature?

   (1) a metal manhole cover
   (2) a puddle of water
   (3) a pile of sand 5 _____

6. Large oceans moderate the climatic temperatures of surrounding coastal land areas because the temperature of ocean water changes

   (1) rapidly, due to water's low specific heat
   (2) rapidly, due to water's high specific heat
   (3) slowly, due to water's low specific heat
   (4) slowly, due to water's high specific heat 6 _____

7. Compared to the climate conditions of dry inland locations, the climate conditions of locations influenced by a nearby ocean generally result in

   (1) hotter summers and colder winters, with a larger annual range of temperatures
   (2) hotter summers and colder winters, with a smaller annual range of temperatures
   (3) cooler summers and warmer winters, with a larger annual range of temperatures
   (4) cooler summers and warmer winters, with a smaller annual range of temperatures 7 _____

Set 2 — Specific Heats of Common Materials

8. Land surfaces of Earth heat more rapidly than water surfaces because

   (1) more energy from the Sun falls on land than on water
   (2) land has a lower specific heat than water
   (3) sunlight penetrates to greater depths in land than in water
   (4) less of Earth's surface is covered by land than by water 8 _____

9. Pieces of lead, copper, iron, and granite, each having a mass of 1 kilogram and a temperature of 100°C, were removed from a container of boiling water and allowed to cool under identical conditions. Which piece most likely cooled to room temperature first?

   (1) copper
   (2) lead
   (3) iron
   (4) granite 9 _____

10. Equal volumes of the four samples shown below were placed outside and heated by energy from the Sun's rays for 30 minutes.

    (1) Water
    (3) Copper pennies
    (2) Basaltic sand
    (4) Iron fragments

    The surface temperature of which sample increased at the slowest rate?

    (1) water
    (2) copper pennies
    (3) basaltic sand
    (4) iron fragments 10 _____

11. After sunset, what can be expected with the cooling rate of soil compared to the cooling rate of water?

    (1) The soil will cool faster because it is a good reflector.
    (2) The soil will cool faster because it has a lower specific heat.
    (3) The water will cool faster because it is a good absorber.
    (4) The water will cool faster because it has a higher specific heat. 11 _____

12. Equal masses of copper, lead and basalt were placed in direct sunlight for the same time interval. Assuming they were all at the same initial temperature, place the name of the substance in the correct position below, showing how they would be expected to increase in temperature.

    A 10°C increase – _____

    A 6°C increase – _____

    A 4°C increase – _____