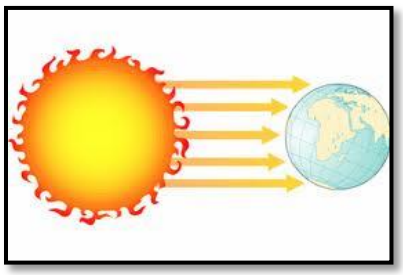
Student Sheet 1

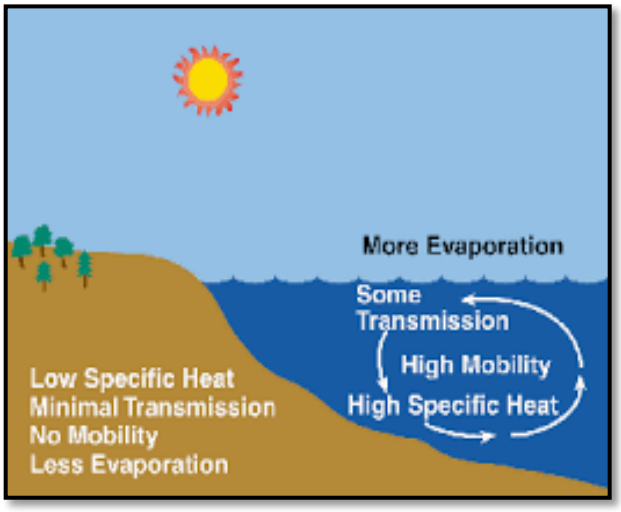
LAB ACTIVITY:
RADIATIVE HEATING OF LAND AND WATER



Radiation from the sun heats up Earth's landmasses and oceans. The weather and climate on Earth are directly dependent on this heat energy transfer, and so are all the phenomena that accompany weather, such as winds, tornadoes, hurricanes, rain, snow, and ocean waves.

The heating and cooling differences of land and water affect the temperature and movement of air masses above the land and water. Because water has a much higher heat capacity, or ***specific heat***, than do sands, soils or other materials, for a given amount of solar irradiation (insolation), water temperature will increase less than land temperature.

Regardless of temperature scale, during daytime, land temperatures might change by tens of degrees, while water temperature change by less than half a degree. At the same time, water's high heat capacity prevents rapid changes in water temperature at night; while land temperatures may drop tens of degrees, the water temperature remains relatively stable. Moreover, the lower heat capacity of crustal materials often allows them to cool below the nearby water temperature. It takes less energy to change the temperature of land compared to water. This means that land heats and cools more quickly than water and this difference affects the climate of different areas on Earth.

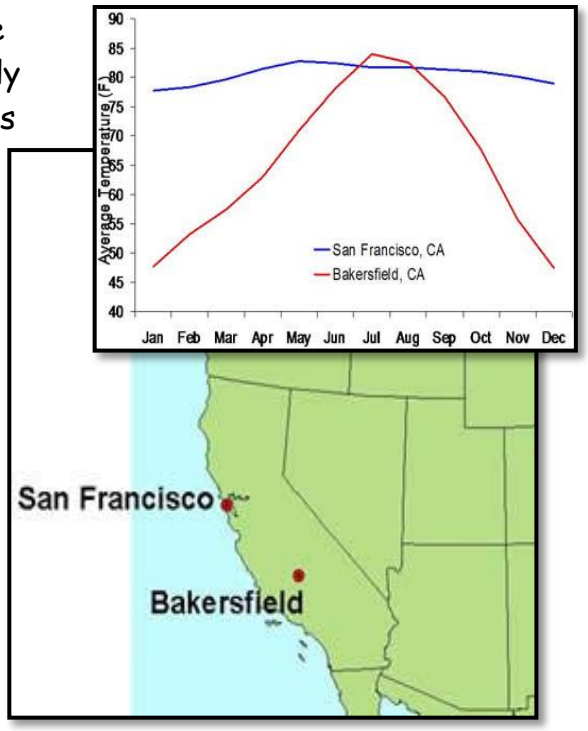


Different energy transfer processes also contribute to different rates of heating between land and water. One reason water heats more slowly than land is that it is a ***mobile medium***. The ability to mix in a circulatory motion allows heat to be distributed through more volume than conduction. The

opaqueness of water is less than that of land. Therefore, radiation is able to penetrate deeper into water and distributes the energy more evenly. Solar radiation only reaches a few centimeters into land while, depending on the clarity, solar radiation can reach several meters into water. The result is that a greater volume of water is heated at a slower rate. The smaller volume of land however attains higher temperatures.

Earth's oceans are far more important than the land as a source of the heat energy which drives weather and climate. Not only do the oceans cover more than 2/3 of the Earth's surface, they also absorb more sunlight and store more heat. Additionally the oceans retain heat longer. The Sun's rays also penetrate the oceans to a depth of many meters, but only heat up the top layer of the sand or soil. Water has to lose more energy than the sand (dry land) in order for the temperature to decrease.

Climates in coastal areas are moderated by the ocean. Because water does not heat up as easily as land does, oceans can help keep coastal areas cooler during the summer when inland temperatures soar. This phenomenon can be experienced by comparing coastal and inland cities in California. The average temperatures of San Francisco fluctuate very little over the course of a year due to the moderating effect that the ocean has on temperatures. In contrast, the inland city of Bakersfield is much cooler in the winter months and warmer in the summer months than San Francisco, in response to the differential heating and cooling of the surrounding land mass.



Student Sheet 3

PREDICTION:

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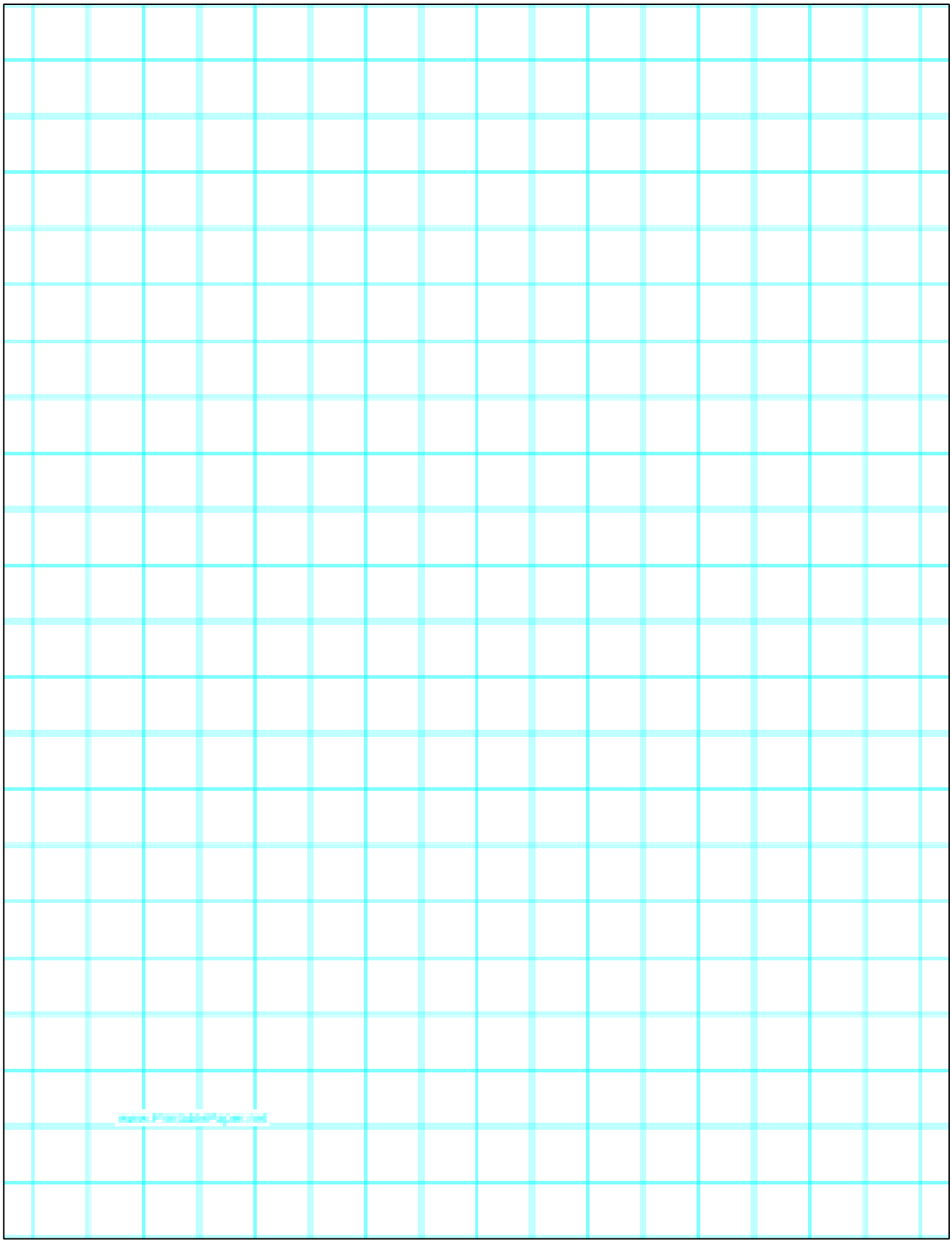
DATA TABLE 1: Temperature Measurements While Heating

Time (min)	0	3	6	9	12
Water Temp. (°C)					
Soil Temp. (°C)					

DATA TABLE 2: Temperature Measurements While Cooling

Time (min)	15	18	21	24
Water Temp. (°C)				
Soil Temp. (°C)				



Student Sheet 4

ANALYSIS

1. Which material heated up the fastest: water or land? Support your answer with evidence from the lab.
2. Which substance required the most energy to change its temperature?
3. Which material cooled the fastest once the light was turned off? Support your answer with evidence from the lab.
4. How do these results compare to your hypothesis?
5. Air in the troposphere is heated from the bottom up by heat given off by the surface. Locate Seattle, Washington and Bismarck, North Dakota on the map. If the sun shines equally on both Seattle and Bismarck, which location would get hotter during the day? Explain.
6. Based on the results of the lab, which city would probably have a bigger difference between its day and night temperatures?
7. Anchorage (southern coast of Alaska) is several hundred miles north of Helena, Montana, yet its January temperatures are similar to Helena's. Explain why.
8. Based on the data, what can you infer about the effects on the air temperature above land compared to water during the daytime? In other words, will the air heat up faster or slower over land compared to water. Explain your answer.
9. Draw and label a diagram of an area where land and ocean meet and one where the opposite type of location is shown. Show the temperature changes due to absorption of thermal energy during the day and radiation of thermal energy at night. Indicate the convection currents produced and the direction the wind will flow.