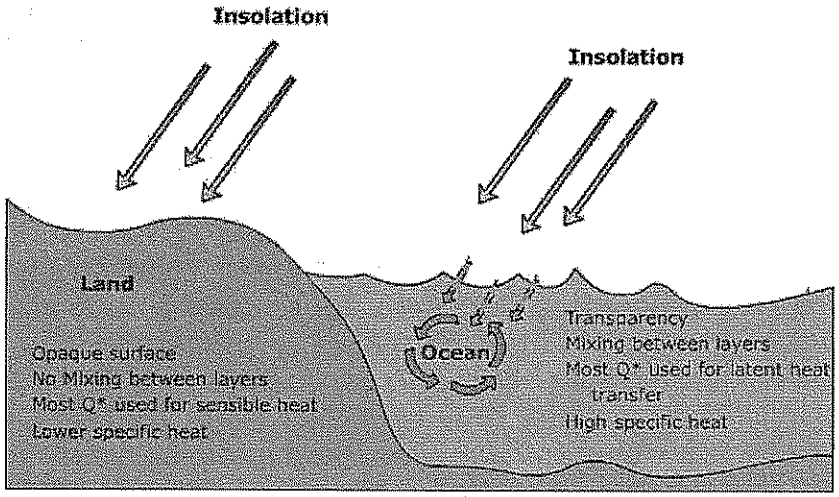
Name _____

WHAT EFFECT DOES SPECIFIC HEAT HAVE ON CLIMATE?
How does specific heat affect the temperature range of inland (continental) locations and coastal (marine) locations?



INTRODUCTION: Approximately 70 % of Earth's surface is covered by water. The unequal rates of the heating of land and water cause temperature conditions which significantly affect local and world-wide weather patterns. There are large variations in average monthly temperatures among cities located at the same latitude. This suggests that factors besides the angle and duration of insolation affect the rate of heating and cooling of any given location. Air temperature is greatly affected by the location of a place relative to a large body of water.

OBJECTIVE: To be able to describe the comparative rates at which water and land surfaces heat and cool due to their specific heats and to graph the average monthly temperatures of coastal and inland continental regions and interpret the range in temperatures.

VOCABULARY:

1. **Specific Heat** _____
_____
2. **Temperature Range** _____
3. **Moderate** _____

PROCEDURE PART A:

Your teachers have carefully measured the mass of the water and the mass of the sand to make sure they are equal.

BEFORE THE LAMP IS TURNED ON

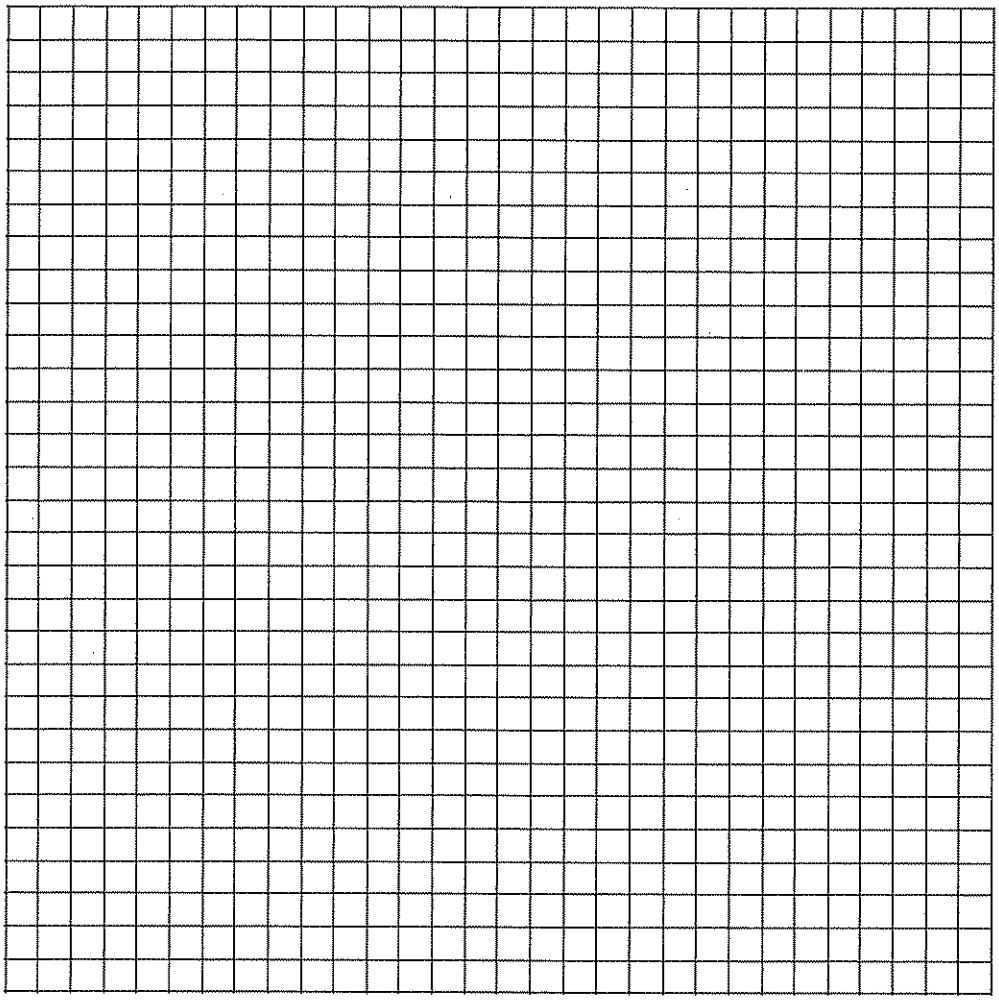
1. Both thermometers should read the room temperature. Enter the room temperature under Time 0 on your report sheet.
2. Don't touch cups.
3. Turn on the lamp and take readings at 1 minute intervals for 10 minutes – **WITHOUT TURNING OFF THE LAMP**.
4. Record these temperatures on your report sheet.
5. **At the end of 10 minutes, turn off the lamp and move it away from the cups.**
6. Continue reading and recording the temperature of both cups each minute for the next 5-10 minutes (the exact time determined by your teacher.)
7. Plot a graph showing both sets of data on one set of axes. CONSTRUCT THE GRAPH WITH TIME ON THE X - AXIS AND TEMPERATURE ON THE Y - AXIS. Use a different color line for the water and sand data and include a key.

REPORT SHEET

Time in minutes	0	1	2	3	4	5	6	7	8	9	10
Soil T in ° C											
Water T in °C											

Time in minutes	11	12	13	14	15	16	17	18	19	20
Soil T in ° C										
Water T in °C										

ABSORPTION AND RADIATION BY SAND AND WATER GRAPH



DISCUSSION QUESTIONS Part A: (ANSWER IN COMPLETE SENTENCES)

Time	Sand Temperature in ° C	Water Temperature in ° C
0 minutes		
10 minutes of heating		
Cooling end time _____		

	Sand (correct units)	Water (correct units)
RATE OF CHANGE = Change in field value / Time Heating (0 – 10 minutes)		
RATE OF CHANGE Cooling (10 minutes – your cooling end time)		

1. Is there a difference between the amount of energy received by the sand and the water? (Remember that the energy is coming from the lamp)

_____

_____

2. Which substance heated more slowly?

_____

3. Which cup cooled more slowly?

_____

- High specific heat = more energy needed to heat the substance.
- High specific heat = slow heating and slow cooling.
- Low specific heat = less energy needed to heat a substance
- Low specific heat = fast heating and fast cooling.

On the front cover of ESRT are the specific heat values for several substances.

Granite (sand) = 0.79 joules to raise the temperature of one gram of granite 1° C
Liquid water = 4.18 joules to raise the temperature of one gram of water 1° C.

4. Does the specific heat of granite (sand) and liquid water support the calculated rate of change of heating and cooling of sand and water?

_____

_____

_____

5. Fill in the blanks.
Substances with _____ (low, high) specific heat values will **RESIST** heating up and cooling because it takes _____(more, less) energy to change their temperatures. Consequently, the heating and cooling rate of change of liquid water is _____ (less, more) than the rate of change of land.

PART B:

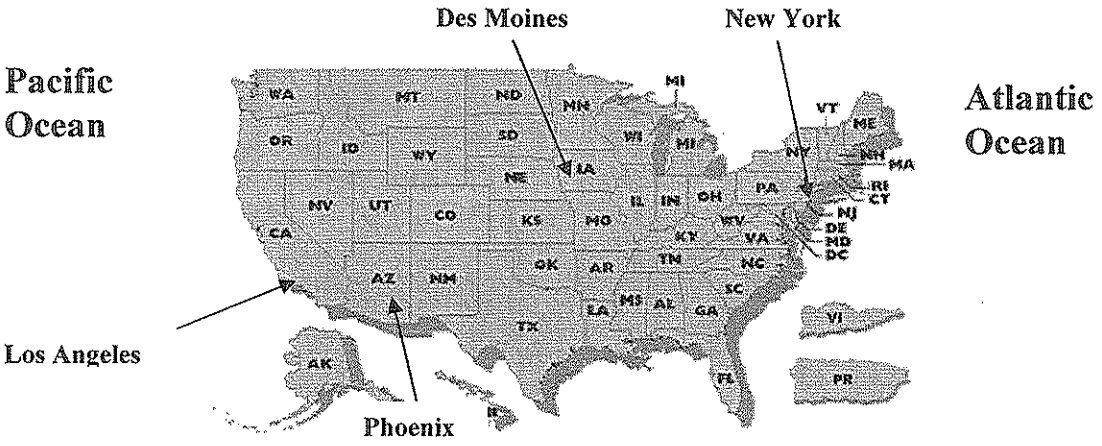
- **Latitude is the most important factor in determining climate because of its influence on temperature.**

- **SAME LATITUDE = SAME ANGLE OF INSOLATION**
  = SAME INTENSITY OF INSOLATION
  = SAME DURATION OF INSOLATION

What implication does the high specific heat of water have on the temperature for cities situated near large bodies of water?

PROCEDURE PART B:

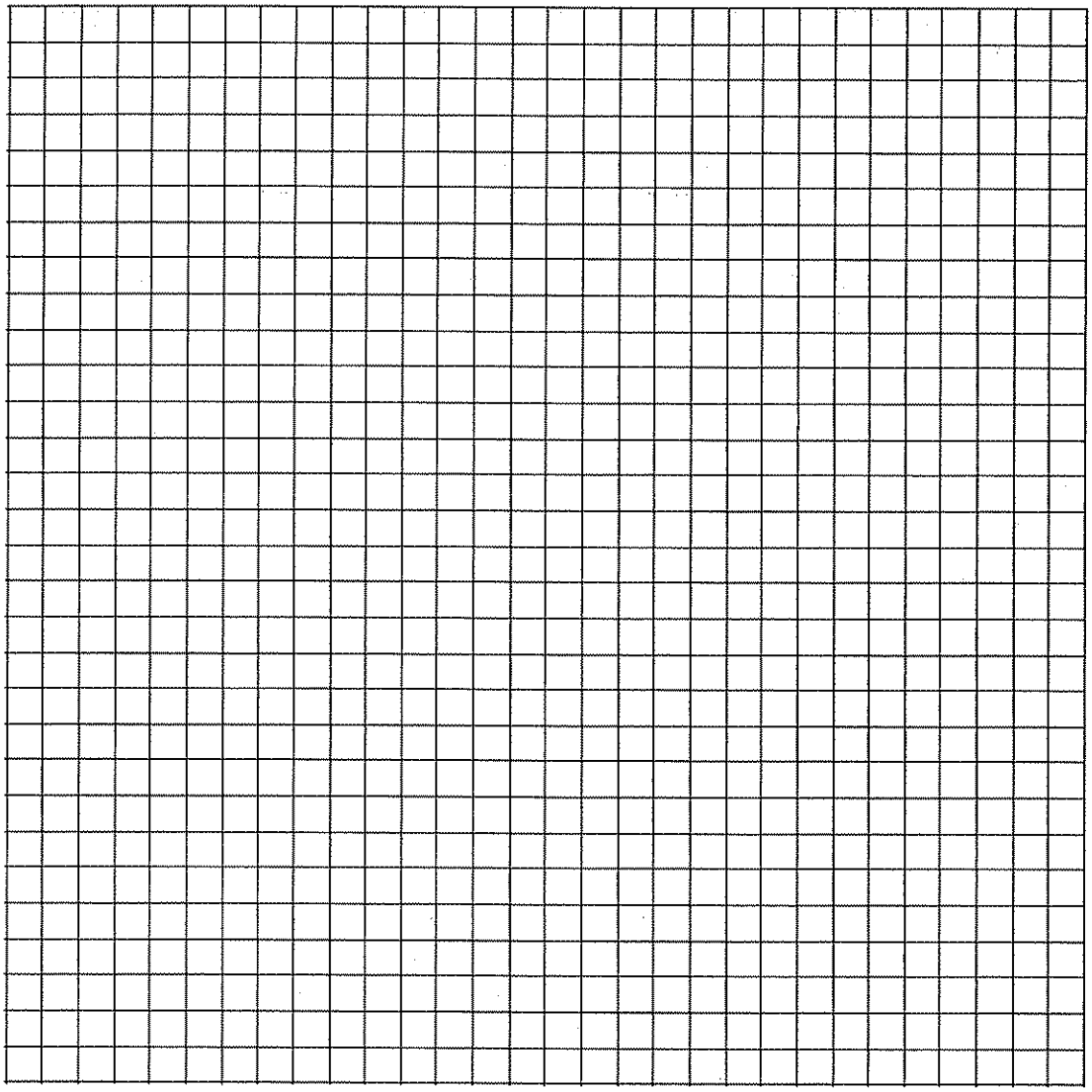
1. Graph the average monthly temperatures for the 4 cities given on the data chart. Plot ALL curves on the same set of axes. Months on X- axis, Temperature on Y-axis. Use a different color for each city and include a key.



AVERAGE MONTHLY TEMPERATURES (° F)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
New York, NY Lat: 40° 47'N	32	34	42	53	63	70	77	76	68	59	48	37
Des Moines, IA Lat: 41° 32'N	15	20	29	40	59	72	78	77	61	49	34	25
Los Angeles, CA Lat: 33° 56'N	58	60	61	63	66	70	74	75	74	70	63	58
Phoenix, AZ Lat: 33° 26'N	54	58	62	70	79	88	94	92	86	75	62	54

AVERAGE MONTHLY TEMPERATURES OF THE 4 CITIES



PART B

1. Even if you didn't know these were all cites of the United States, how could you tell from the temperature curves that they were all in the Northern Hemisphere?

_____

_____

2. Coastal locations (or marine locations) are places near a large body of water, like an ocean or a large lake. Continental locations (or inland locations) are surrounded by land and are far from a large body of water.

City	Calculate the temperature **RANGE** for each city	Using map, is city continental or coastal
New York, NY Lat: 40° 47'N		
Des Moines, IA Lat: 41° 32'N		
Los Angeles, CA Lat: 33° 56'N		
Phoenix, AZ Lat: 33° 26'N		

3. Since Los Angeles and Phoenix are at the same latitude, what can you infer about the intensity of insolation at both locations? **HINT - look at PART B bullets** (New York and Des Moines are also the same latitude)

4. In the Northern Hemisphere, the highest altitude of the sun at solar noon occurs on June 21st. The maximum daily temperature of the land occurs approximately 3-4 weeks later. The maximum temperature of the water occurs even later. How does the high specific heat of water contribute to this delay?

5. During the hottest days of the summer, the ocean is cooler than the land. If you lived near the **cooler** ocean, how would that affect your daily temperature? In other words, would your summer be warmer or cooler?

6. In the Northern Hemisphere, the minimum insolation occurs on December 21st, but the coldest temperatures occur January or early February. The minimum temperature of the water occurs even later. How does the high specific heat of water contribute to this delay?

7. During the coldest days of the winter, the ocean is warmer than the land. If you lived near the **warmer** ocean, how would that affect your daily temperature? In other words, would your winter be warmer or cooler?

8. Compare the temperature range of the 2 cities located at the same latitude: Los Angeles, CA and Phoenix, AZ and New York and Des Moines, IA. What do you notice about the temperature ranges of coastal locations when compared to continental locations at the same latitude?

9. Moderate climates have smaller temperature ranges. Cities located near large bodies of water have more moderate climates than continental locations: Use examples from your data table to support these statements.

10. Compared to an inland location at the same elevation and latitude, a coastal location is likely to have
a. warmer summers and cooler winters
b. cooler summers and warmer winters
c. warmer summers and warmer winters
d. cooler summers and cooler winters

CONCLUSION:

- **Using the data collected in Part A, compare the specific heat of liquid water and land (sand) and how this relates to the amount of energy required to change their temperatures.**
- **Latitude is the most important factor in determining climate because of its influence on temperature. This influence is due to the relationship between latitude and angle, intensity, duration of insolation, and temperature.**
- **But there are large variations in average monthly temperatures among cities located at the same latitude. This suggests that factors besides the angle and duration of insolation affect the rate of heating and cooling of any given location.**
- **Using the data collected you collected in Part A and the observations you made in Part B, explain why the high specific heat of water can moderate a coastal climate.**

MUST BE TYPED, DOUBLE SPACED, TIMES NEW ROMAN – FONT SIZE 12