Investigating Temperature Changes in Materials

The instructions from Courseware are stated. Then they are followed by the instructions for the Alternate Activity.

Task 1

Planning

In this task, you will plan two controlled experiments. The experiments will investigate the change in temperature when the same amount of energy is added to different kinds of materials and to different amounts of the same material.

Part A

On a hot day, a concrete sidewalk feels hotter than the water in a small swimming pool. And a sandy beach feels hotter than the lake or ocean. What do these observations tell you about temperature changes when different materials are heated?

Part A
Answer to the best of your ability with full sentences and in your own words.

Part B

Plan a controlled experiment to investigate how much the temperatures of cold sand and cold water change when hot water is added to them.

Assume you have access to water, sand, containers, ice, a heat source, a scale, and thermometers. Summarize your experiment in a few sentences.

Part B
Answer to the best of your ability with full sentences and in your own words.
Make sure you include the steps you will take.
How much of each substance will you use?
What temperatures will you start at?
How hot will you make the water you add to the sand, or the cold water?

Part C

For your experiment in part B, which factors would you keep constant?

Part C
Remember that constant means the same
Which experimental factors will you keep the same throughout your ENTIRE experiment?

Things that are usually kept constant are the amounts of something being the same for more than one sample, adding a specific volume at a specific temperature for each trial, choosing to start with the same mass for more than one sample, or having something you measure to be the same for more than one sample.

Different Masses

Part D

On a hot day, water in a bucket gets warmer than water in a small swimming pool. What does this observation tell you about temperature changes when different amounts of the same material are heated?

Part D
Answer to the best of your ability with full sentences and in your own words.

The question is asking about how the temperature changes when different volumes of water are heated.

Part E

Plan a controlled experiment to investigate how much the temperature of a large mass and a small mass of cold water changes when hot water is added. Assume you have access to water, containers, ice, a heat source, a scale, and thermometers. Summarize your experiment in a few sentences.

Part E
Answer to the best of your ability with full sentences and in your own words.
Make sure you include the steps you will take to conduct an experiment. This is a thinking part, but it is important to put it down in words.

This is not asking for a hypothesis. It wants you to design an experiment to test how heat affects the temperature changing in different amounts of water.

A controlled experiment means you know the values of all the variables you start with. You are doing tests to see how one variable changes. In this case, you are creating situations that should lead to temperature changes. What will you do to see how much the temperature of a large mass of water will change compared to how much the temperature of a small mass of water will change? You choose the mass of the large amount of water. You choose the mass of the small amount of water. You decide on the starting temperature for both sets of water. You choose how much hot water to add to each sample. You can also choose the temperature of the hot water you are adding. The temperature of each sample should change. That is the data you want to collect.

Part F

For your experiment in part E, which factors would you keep constant?

Part F
Remember that constant means the same.

Which factors will you keep the same throughout your ENTIRE experiment?

Factors would be items used for the experiment. The container does not matter here. It is not being tested; water is.

Task 2

Conducting the Experiment

In this task, you will conduct a controlled experiment to investigate how different materials—sand and water—cool over time. You'll also consider the effect of mass on heat transfer. Then you will analyze and explain your results.

Question 1: Hypothesis and Data Collection

Begin this task by forming a hypothesis about the outcome of the experiment. Then conduct the experiment and document the results.

Part A (5 points)

In the experiment, you will heat up 50 grams of cold sand and 50 grams of cold water by adding hot water. Will the kind of material—sand or water—affect the temperature change? State your hypothesis.

Part A
This is a yes or no question AND a hypothesis
Use an if/then statement to create your hypothesis
Example: If I run fast, then I will be out of breath.
You are comparing two types of matter, not the amount you start with.

Part B (5 points)

In the experiment, you will heat up two samples of cold water—50 grams and 100 grams—by adding the same amount of hot water to each sample. Will the mass of the sample affect the temperature change? State your hypothesis.

This is a yes or no question AND a hypothesis
Use an if/then statement to create your hypothesis
Example: If I run fast, then I will be out of breath.
You are comparing the amount of matter you start with, not the type of matter.
You are adding the same amount of hot water to 50g of cold water and also to 100 g of cold water. For the sake of this question, you can assume you are adding 75 mL of hot water to 50 g of cold water, and you are adding 75 mL of hot water to 100g of cold water that is in a different container.

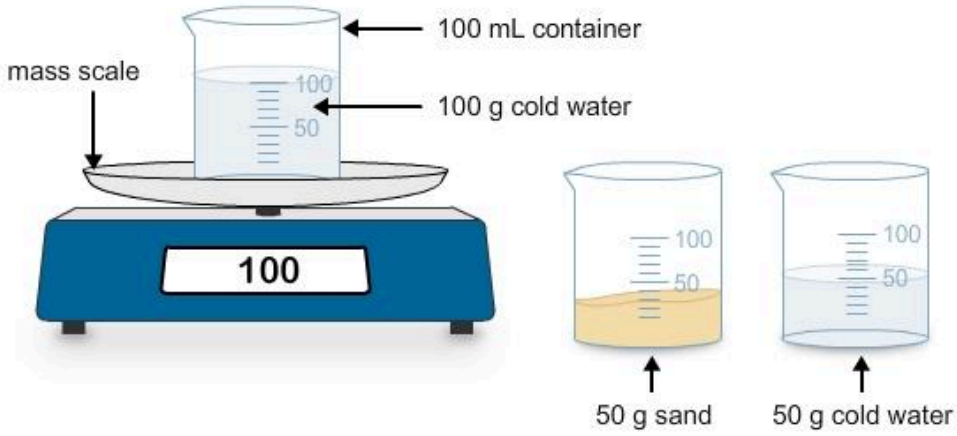
Change of temperature in: Type of Materials

You are now dealing with cold sand and cold water.

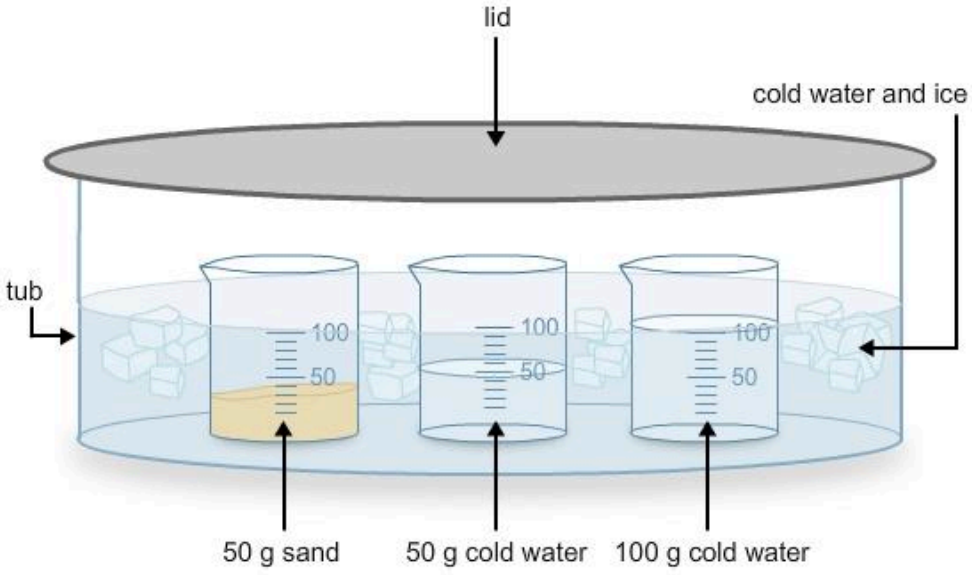
Part C (5 points)

Now, prepare the cold sand and cold water samples from part A:

1. Fill a 100-milliliter container with 50 grams of sand. Fill a 100-milliliter container with 50 grams of cold tap water. Fill the last 100-milliliter container with 100 grams of cold tap water. Use the scale to measure the masses.



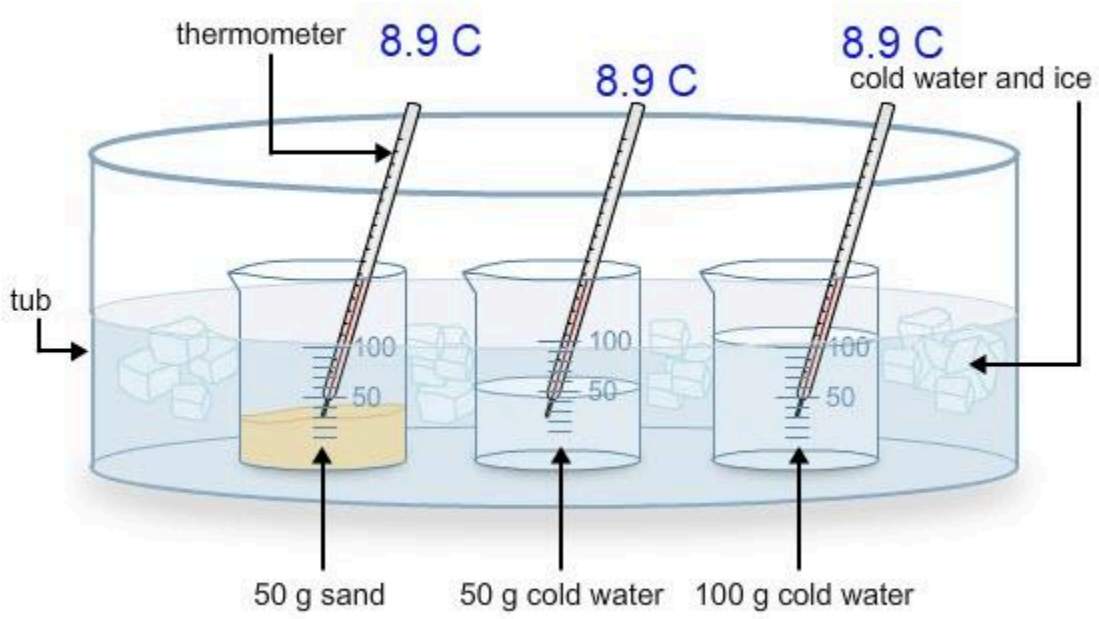
2. Pour all the ice cubes into a tub, and fill it with cool tap water to a depth of 2 inches. Place the sand and water samples in the ice water. Cover the entire tub.



3, Every 15 minutes, remove the cover and check the temperatures of the samples using the three thermometers. Wait 30 seconds before recording the thermometer reading. Once the temperatures of the three samples are no more than a degree apart, record the temperatures.

Use this picture to answer the question:

Take the average of the 3 temperatures, and that will be your answer.
Do not round to a whole number. Round to the tenth place.



Put this data table in Part C's answer space.

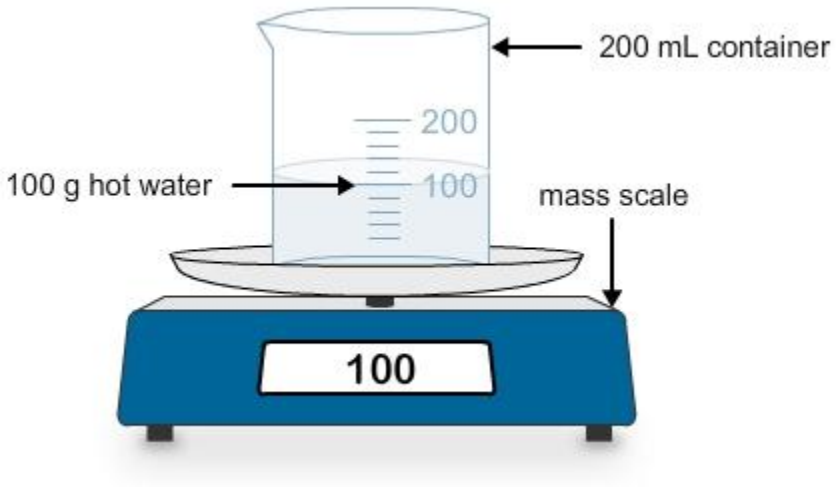
	Temperature after equilibrating to a close temperature. (look at the blue number near the thermometer) These are the starting temperatures for the table in part E.
50 g sand	
50 g water	
100 g of water	

Average the temperatures, showing the calculation, even though they are the same values.

Write down the data and write the numbers when you show the calculation.
You can copy the table and paste it in the answer space.
If you use your own data, provide a picture of your experiment so I know you really did it. If you can't take a picture, use my data. It's free.

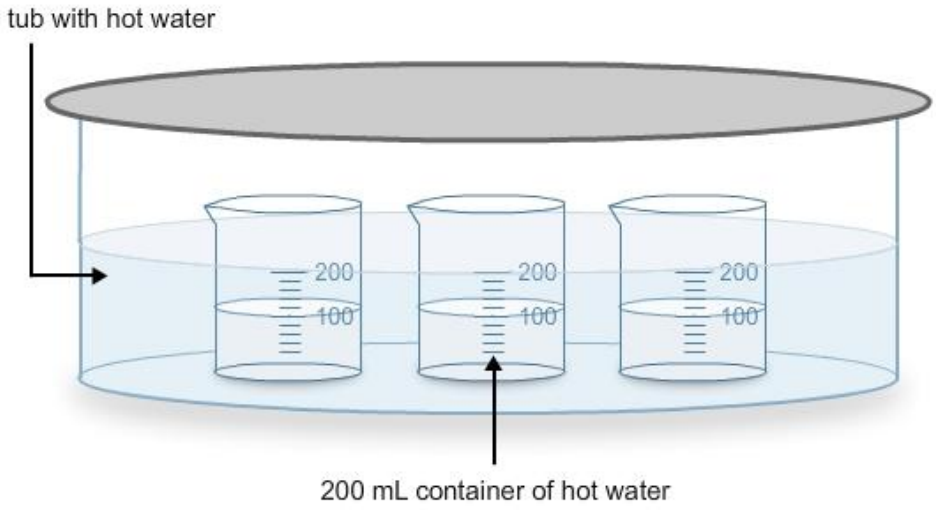
Next, prepare the hot water.

Fill each of the three 200-milliliter containers with 100 grams of hot tap water. Measure the mass using the mass scale.



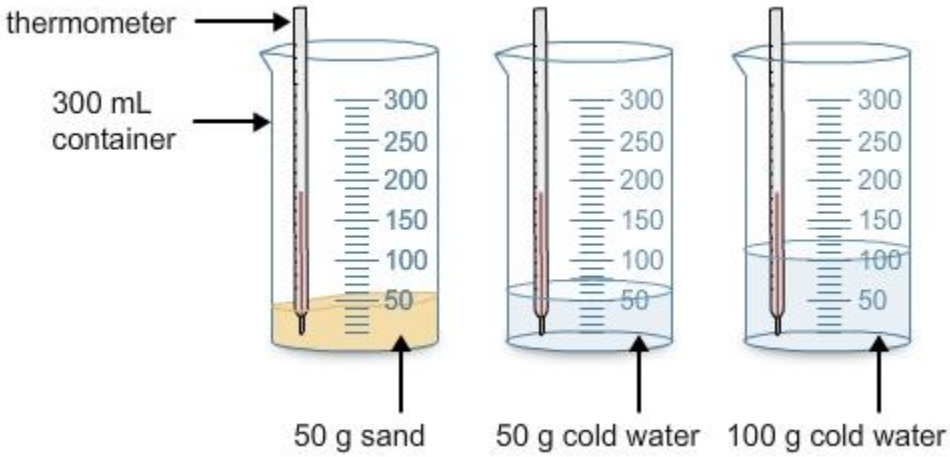
2. ⚠ Adult supervision is required for this step. Prepare a hot-water bath by boiling water in a pot. Use the heat mitts to pour the hot water from the pot into the second tub. Fill the tub to a depth of about 2 inches. Carefully place

the three containers of hot water into the bath without submerging them. Cover and wait for five minutes until the temperatures stabilize.

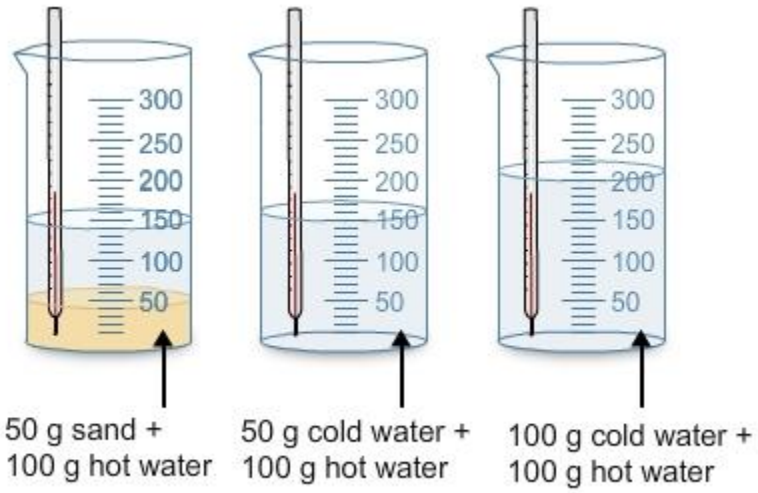


Prepare to mix the cold samples with hot water:

3. Have three empty 300-milliliter mixing containers and three thermometers ready. Timing is important. Uncover the cold-water bath, and pour each cold sample into a different mixing container.



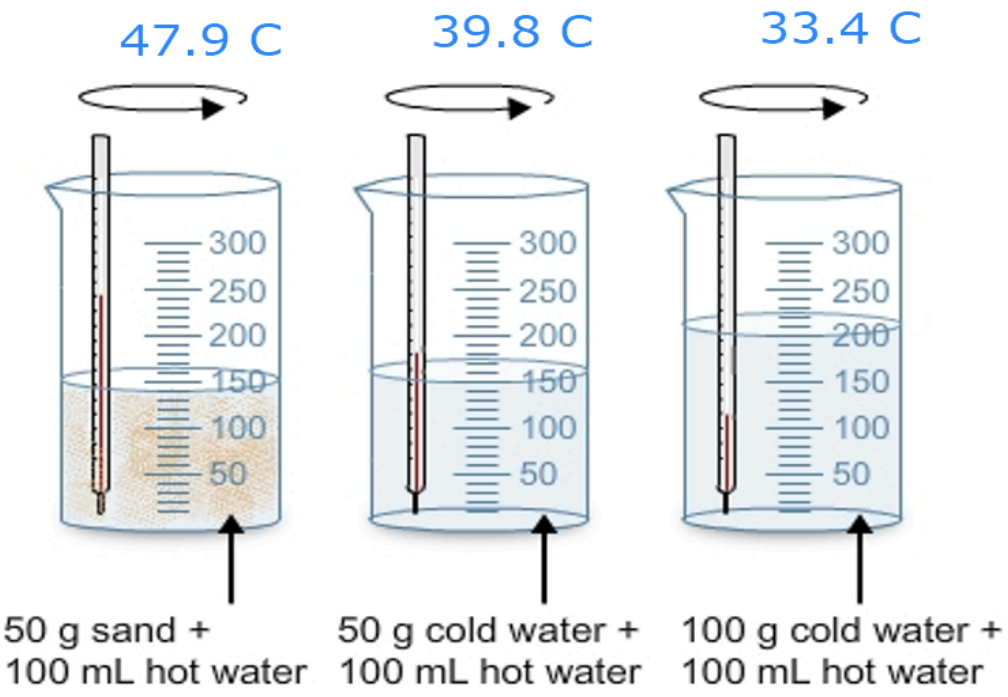
4. Uncover the hot-water bath, and use a heat mitt to remove the three containers of hot water from the hot-water bath. Pour 100 grams of hot water into each mixing container.



Change of temperature in Different Masses

Part D (5 points)

Use this picture to answer the question; remember you are mixing sand and water to see the change of temperatures regarding different masses:



Swirl each container for about 20 seconds, and then place a thermometer in it. Wait for 30 seconds before recording a reading for each container. Record the final temperatures of the three mixtures in the table.

Fill in the chart accordingly. Place this table in Part D.

Mixture	**Ending Temperature** (look at the number on top of the beakers)
50 g cold sand and 100 g hot water	
50 g cold water and 100 g hot water	
100 g cold water and 100 g hot water	

Part E (10 points, show your calculations)

Find the change in temperature of each sample after the hot water was added. Fill in the table with the data you collected in parts C and D. To find the change in a sample's temperature, subtract the starting temperature from the ending temperature.

Read the directions CAREFULLY, then using the information from Parts C and D, fill in the chart provided.

Sample	**Starting Temperature Comes from Part C**	**Ending Temperature Comes from Part D**	**Change in Temperature Show your calculation**
50 g sand			
50 g water			
100 g water			

If you use your own data, provide a picture of your experiment so I know you really did it. If you can't take a picture, use my data. It's free.

Question 2: Analyze and Extend

Use the data you collected in question 1 to analyze and explain the results of your experiment.

Part A (5 points)

Compare the temperature change for cold sand and cold water when the same amount of hot water was added. What do you discover?

Part A

Answer to the best of your ability with full sentences and in your own words.

Part B (10 points)

If equal masses of sand and water are heated to the same temperature, which sample will absorb more energy? Base your argument on the definition of heat and what you learned from the experiment.

Let's say you have 100 g of sand and 100 g of water at 22°C. Which sample needs to absorb more energy to reach the same temperature, say 40°C?

Part B

Answer to the best of your ability with full sentences and in your own words.

Part C (5 points)

Compare the temperature change for the two masses of cold water (50 grams and 100 grams) when the same amount of hot water was added. What do you discover?

Part C

Answer to the best of your ability with full sentences and in your own words.

Part D (10 points)

If different masses of water are heated to the same temperature, which sample will absorb more energy? Base your argument on the definition of heat and what you learned from the experiment.

Part D

Answer to the best of your ability with full sentences and in your own words.

Which sample, the 50 g of water or the 100 g of water, will need more heat for its temperature to rise?

Part E (10 points)

When a material is heated, the change in temperature depends on the kind of material and its mass. Different objects can absorb and release different amounts of energy when heated and cooled. This property is called heat capacity. How might scientists apply this property to design something useful in the real world? Give one or two examples.

Part E

Answer to the best of your ability with full sentences and in your own words.

These links may help provide ideas you did not realize are connected to understanding the specific heat or heat capacity of a substance. They may help with ideas on how to answer the question. Please include URLs when you answer the question.

https://www.linseis.com/en/applications/cosmetics-pharmaceuticals-food/

https://www.linseis.com/en/applications/automotive-aviation-aerospace/

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