SI Physics - Full Discipline Demo

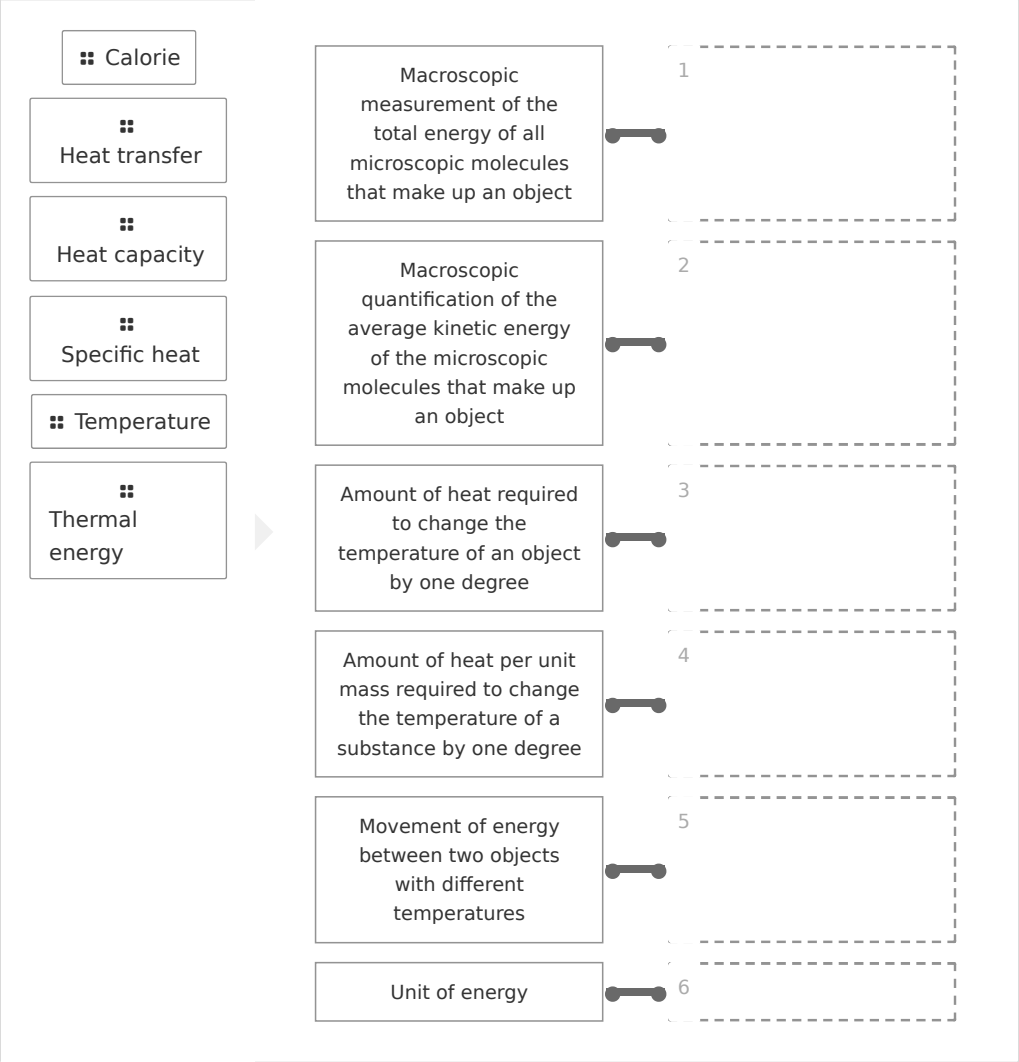
Specific Heat of Solids

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Physics - Full Discipline Demo
Course	SI Physics - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Match each term with the best description.

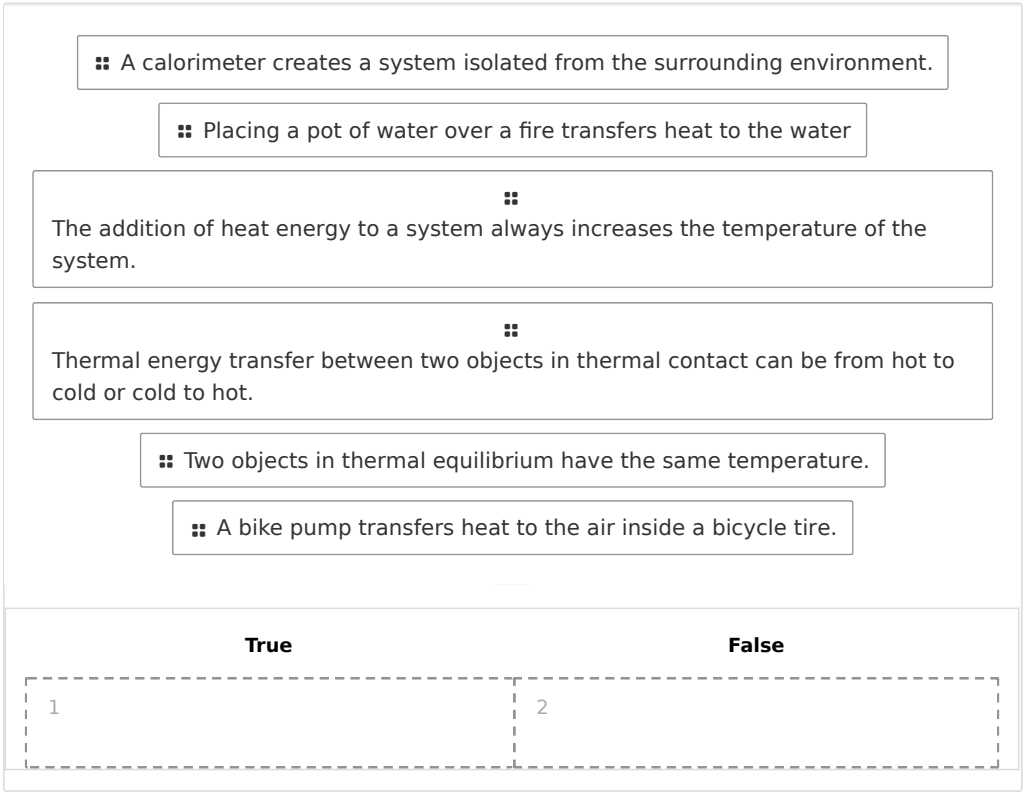


Correct answers:

1 Thermal energy 2 Temperature 3 Heat capacity 4 Specific heat

5 Heat transfer 6 Calorie

Categorize each statement as true or false.



Correct answers:

1 A calorimeter creates a system isolated from the surrounding environment.

Placing a pot of water over a fire transfers heat to the water

Two objects in thermal equilibrium have the same temperature.

2

The addition of heat energy to a system always increases the temperature of the system.

Thermal energy transfer between two objects in thermal contact can be from hot to cold or cold to hot.

A bike pump transfers heat to the air inside a bicycle tire.

Exploration

The SI units of heat are _____.

- calories
- joules ✔
- kelvin
- All of the above

The specific heat capacity of an object depends only on the substance from which the object is made.

- True ✔
- False

A substance with high specific heat warms up or cools down more quickly than a substance with low specific heat.

- True
- False ✔

Placing a pot of water over a fire transfers _____ to the water.

- heat ✔
- work
- temperature
- All of the above

The exchange of energy between two objects in thermal contact is always from _____.

- cold to hot
- hot to cold ✔
- larger to smaller
- None of the above

During a phase change, the temperature of a system _____.

- increases
- decreases
- remains constant ✔
- None of the above

Inside a calorimeter, the total change in energy before and after a reaction is _____.

- positive
- negative
- zero ✔
- All of the above

_____ is the measurement of the heat transfer between systems.

- Thermodynamics
- Calorimetry ✔
- Thermal equilibrium
- None of the above

Exercise 1

How close were your experimental results to the theoretical values? What experimental factors contributed to the error between experimental and theoretical measurements of specific heat?

The experimental results are relatively close to the theoretical values. Due to the hole at the top of the calorimeter, as well as any open gaps where the lid meets the base, the calorimeter is not an entirely-closed system. Further, the calorimeter isn't perfectly insulated. All of these can result in the system losing heat, affecting the measurement of temperature change. A slight misreading of the thermometer can change the specific heat capacity calculation significantly. There is also the possibility of losing a small amount of water mass after measuring the temperature of the water in

the calorimeter (because some water may have stuck to the thermometer). Another source of error could be the water not being at room temperature at the beginning of the experiment.

What would be the overall outcome of starting the procedures with cold water instead of room temperature water?

If we didn’t start at room temperature, the water would continue to warm to room temperature during the experiment. The time between temperature reading and introduction of the hot metal would have an effect, impacting the measurement of temperature change of the water and thus the calculated specific heat capacity.

What is the amount of heat, in calories, given off from a 5 g piece of aluminum when it cools from 80°C to 20°C? The specific heat capacity of aluminum is 0.215 cal/g·°C. Show your work.

Heat is defined as: $Q=mc\Delta T$.
$\Delta T=20°- 80°C = -60°C$
$Q=5\ g*0.215\ cal/g•°C*(-60°C) = -64.5\ cal$
The amount of heat given off is 64.5 cal. (The negative sign indicates the heat leaves the material.)

Which material would cause a more severe burn if equal masses of two distinct metals are heated to a temperature of 100 °C: the one with the higher specific heat capacity or the one with the lower specific heat capacity? Explain your answer using the definition of specific heat.

The higher specific heat material would cause a more severe burn. Heat is given by: $Q=mc\Delta T$. Since mass and temperature change are the same, the material with the higher specific heat capacity will transfer more heat to the region it touches, causing a more severe burn.

Data Table 1: Mass and Temperature Measurements
(SAMPLE ANSWER BELOW)

Trial	Material	Mass (g)	Initial Temperature (°C)	Final Temperature (°C)	ΔT (°C)

1	Water	74.91	19.0	22.0	3.0
	Steel washers	29.66	90.0		-68.0
2	Water	75.25	19.0	24.0	5.0
	Brass ball	71.24	88.0		-64.0

Data Table 2: Specific Heat Capacities
(SAMPLE ANSWER BELOW)

Material	Specific Heat Capacity c (cal/g•°C)	Material's Specific Heat Capacity (cal/g•°C)	Percent Uncertainty (%)
Steel	0.111	0.122	8.67
Brass	0.083	0.091	9.32

Competency Review

_____ is a measurement of the average kinetic energy of the microscopic particles that make up an object.

- Heat
- Temperature ✔
- Thermal energy
- All of the above

_____ is a measurement of the total energy of microscopic particles that make up an object.

- Heat
- Temperature
- Thermal energy ✔
- All of the above

The specific heat capacity is the amount of heat required to raise the temperature of _____ of a substance by one degree.

- one gram ✔
- the total mass
- ten kilograms
- None of the above

_____ equilibrium is the final state of two objects in thermal contact with each other.

- solid
- thermal ✔
- heat
- None of the above

During a phase change, the temperature of a substance remains constant.

- True ✔
- False

The mass of the water in a calorimeter is not necessary for calorimetry calculations.

- True
- False ✔

_____ cal of heat are required to increase the temperature of a 100 g block of lead by 5.00 °C. The specific heat of lead is 0.0305 cal/g•°C.

- 15.3 ✔
- 3.05
- 0.153
- None of the above

Styrofoam is a recommended material to use when constructing a calorimeter because it is a good _____.

- conductor
- diffuser
- insulator ✔
- None of the above

42 cal of heat are required to increase the temperature of a 30 g piece of an unknown substance from 20 to 27 °C and the specific heat capacity of the substance is _____ cal/g deg•°C.

- 0.5
- 0.2 ✔
- 0.8
- None of the above

The experimental value of the specific heat capacity of a metal may be different than the theoretical value because of _____ the environment.

- heat loss to ✔
- work done by
- the humidity of
- All of the above

Extension Questions

Explain why water, with its high specific heat capacity, is utilized for heating systems such as hot-water radiators. (SAMPLE ANSWER BELOW)

Water's high specific heat capacity means that a small mass of water is needed to transfer the same amount of heat. Water is also relatively dense, so only a small volume of water is required to contain that mass.

A heated fruit pie often seems to have filling that is warmer than the crust. Why is this? What can you conclude about the specific heat of the filling and the crust? (SAMPLE ANSWER BELOW)

The warmer filling has a higher specific heat than the cooler crust. The filling releases more heat energy as it cools down than crust, so it is more likely to feel warmer than the crust when both are actually the same temperature.