



## Online Introductory Chemistry

### Specific heat, the calorie, Joule and heat transfer

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Energy transferred from a hot object to a cold object is called heat. This how hot and cold are defined. Heat moves from high temperature hot objects to lower temperature cold objects. When you touch something that feels hot to you heat (energy) is moving to you from the hot object. When you touch an object that feels cold like an ice cube heat moves from you into the ice cube. You are hotter at  $98.6^{\circ}\text{F}$  ( $37^{\circ}\text{C}$ ) and losing energy to the ice cube at  $32^{\circ}\text{F}$  ( $0^{\circ}\text{C}$ ).

Energy is labeled with many unit types that depend on the measurement system.

The SI energy unit is the joule.  $4.186 \text{ Joule} = 1 \text{ calories}$ . Another common energy unit is the calorie.

The calorie, cal, is defined as the amount of energy (heat) needed to increase the temperature of one gram of water by  $1^{\circ}\text{C}$ . The kilocalorie, kcal, equals 1000 small calories. To make life more complicated Nutritional energy values are reported in dietetic calories or the big Calorie. The nutrition Calorie is really equal to the kilocalorie or 1000 cal.  $1 \text{ C} = 1000 \text{ calories} = 1 \text{ kcal}$ .

The little calorie is so small that the calorie yield from a slice of buttermilk bread equals 80 C or 80,000 calories. This link provides Calorie values for thousands of food items.

<http://www.calorieking.com/foods/>

Specific heat is a physical property of materials. It is used to describe heat transfer. The specific heat of a material is an intensive property that is independent of the amount of a substance. It is defined as the amount of energy needed to

heat one gram of the substance by 1 degree Celsius. The mathematical expression is  $\text{Specific heat} = \frac{\text{calories}}{\text{grams } ^\circ\text{C}}$

Specific heat is essential when designing engine cooling systems, constructing electronic circuits so they do not overheat, designing refrigeration equipment and everything that involves heat transfer.

The amount of heat needed to increase the temperature of any object can be figured using this relationship.

$\text{Heat in calories} = \text{mass in gram} \times \text{temperature change } ^\circ\text{C} \times \text{specific heat [ cal / gram } ^\circ\text{C]}$

The formula has four terms in it. You can calculate any of them if you have the other three.

**Example:**

How many calories are needed to heat a cup of 200 grams of water from room temperature at  $20^\circ\text{C}$  to  $100^\circ\text{C}$ ? The specific heat for water is 1 calorie / g  $^\circ\text{C}$ .

**Answer:**

Determine what you are supposed to figure. The question asks for the "heat".

Identify the quantities given in the question.

Mass = 200 grams

Temperature change in degrees  $^\circ\text{C} = T_{\text{final}} - T_{\text{initial}} = 100^\circ\text{C} - 20^\circ\text{C} = 80^\circ\text{C}$

Specific heat = 1 cal / g  $^\circ\text{C}$

Heat = ( 200 g ) ( 80 $^\circ\text{C}$  ) ( 1 cal / g  $^\circ\text{C}$  ) = 16000 calories

The grams and degrees C cancel.

