Heat Capacity (C)

- the quantity of energy , in Joules (J), needed to change the temperature of a substance by one degree Celsius (˚C).
- unit is J/˚C or kJ/˚C
- Formulas: C = mc q = CΔT

Examples:

1. A frying pan with a heat capacity of 1.20 kJ/˚C is heated from 22.0 ˚C to 198.0 ˚C.
   Calculate the heat change.

Solution:

C = 1.20 kJ/˚C T_1 *= 22.0 ˚C*
T_2 *= 198.0 ˚C*

q = CΔT

q = (1.20 kJ/˚C)(198.0 ˚C - 22.0 ˚C)

q = 211 kJ

2. A tub of water has a heat capacity of 418.4 kJ/˚C. If the water in the tub starts at 45.0 ˚C and loses 6276 kJ of heat, what will be the resulting temperature of the tub of water?

Solution: (In 2 steps)
C = 418.4 kJ/˚C *q = - 6276 kJ*
T_1 *= 45.0 ˚C*

Step 1 *q = CΔT*
-6276 kJ = (418.4 kJ/˚C)(ΔT)
ΔT = -15.0 ˚C

Step 2 $\Delta T = T_2 - T_1$
$-15\ ^\circ C = T_2 - 45.0\ ^\circ C$
$T_2 = 30.0\ ^\circ C$

Exercises:

1. The temperature of a copper statue rose from 25.0 ˚C to 50.0 ˚C when the statue absorbed 456 kJ of heat energy.
   a) Calculate the heat capacity of the statue. (18.2 kJ/°C)

   b) The specific heat capacity of copper is 0.385 J/g •˚C. What is the mass of copper contained in the statue. (47.4 kg)

2. An iron bar contains 2.50 kg of iron. The specific heat capacity for iron Is 0.444 J/g •˚C.
   a) Calculate the heat capacity of the iron bar. (1.11 kJ/°C)

   b) How much energy is needed to heat the iron bar from 20.0 ˚C to 150.0 ˚C. (144 kJ)

   c) If the 2.50 kg iron bar is at 80.0 ˚C and loses 38.85 kJ, what will be the final temperature of the bar? (45 °C)

3. Which best defines the specific heat capacity of a substance?
(A) the energy required to raise the temperature of 1.0 g of a substance by 1.0 °C
(B) the energy required to raise the temperature of a substance by 1.0 °C

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5. A bathtub and a teacup are both full of water at 80.0 °C. Use <, >, or = to show the relationship between the heat capacity and the specific heat capacity of the water in each.

c_{cup} O $c_{bathtub}$ C_{cup} O $C_{bathtub}$

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6. A freezer pack has a heat capacity of 9.67 kJ/˚C. Calculate the heat change of the freezer pack when it is warmed from -18.4˚C to 0.0˚C. (178 kJ)

7. a) A 23.9 g silver spoon is put in a cup of hot chocolate. It takes 0.343 kJ of energy to change the temperature of the spoon from 24.5˚C to 85.0˚C. What is the specific heat capacity of solid silver? (0.237)

(b) What is the heat capacity, *C*, of the silver spoon? (5.66)

8. When iron nails are hammered into wood, friction causes the nails to heat up.
(a) Calculate the heat that is gained by a 5.2 g iron nail as it changes from 22.0˚C to 38.5˚C. (See Table 16.1.) (38 J)

8. (b) Calculate the heat that is gained by a 10.4 g iron nail as it changes from 22.0˚C to 38.5˚C. (76.2 J)

8. (c) Calculate the heat that is gained by the 5.2 g nail if its temperature changes from 22.0˚C to 55.0˚C. (76 J)

9. The specific heat capacity of aluminum is 0.902 J/g˚C. The specific heat capacity of copper is 0.389 J/g˚C. The same amount of heat is transferred to equal masses of these two metals. Which metal increases more in temperature? Explain your answer.