Name: Key　　　　Date:

PRACTICE 7.2

Temperature Scales

READ

The Fahrenheit and Celsius temperature scales are the most commonly used scales for reporting temperature values. Scientists use the Celsius scale almost exclusively, as do many countries of the world. The United States relies on the Fahrenheit scale for reporting temperature information. You can convert information reported in degrees Celsius to degrees Fahrenheit or vice versa using conversion formulas.

Fahrenheit (°F) to Celsius (°C) conversion formula: $°C = \frac{5}{9}(°F - 32)$

Celsius (°C) to Fahrenheit (°F) conversion formula: $°F = \left(\frac{9}{5} \times °C\right) + 32$

EXAMPLE

- What is the Celsius value for 65° Fahrenheit?

$$°C = \frac{5}{9}(65°F - 32)$$

$$°C = 18.3$$

- 200°C is the same temperature as what value on the Fahrenheit scale?

$$°F = \frac{9}{5}(200°C) + 32$$

$$°F = 392$$

PRACTICE 1

1. The weatherman reports that today will reach a high of 45°F. Your friend from Sweden asks what the temperature will be in degrees Celsius. What value would you report to your friend? $C = \frac{5}{9}(45 - 32)$ 7.2C
2. Your parents order an oven from England. The temperature dial on the new oven is calibrated in degrees Celsius. If you need to bake a cake at 350°F in the new oven, at what temperature should you set the dial? 180 °C
$C = \frac{5}{9}(350 - 32)$
3. A German automobile's engine temperature gauge reads in Celsius, not Fahrenheit. The engine temperature should not rise above about 225°F. What is the corresponding Celsius temperature on this car's gauge? 107.2 °C
$C = \frac{5}{9}(225 - 32)$
4. Your grandmother in Ireland sends you her favorite cookie recipe. Her instructions say to bake the cookies at 190.5°C. To what Fahrenheit temperature would you set the oven to bake the cookies? 375 °F
$F = \left(\frac{9}{5} \times 190.5\right) + 32$
5. A scientist wishes to generate a chemical reaction in his laboratory. The temperature values in his laboratory manual are given in degrees Celsius. However, his lab thermometers are calibrated in degrees Fahrenheit. If he needs to heat his reactants to 232°C, what temperature will he need to monitor on his lab thermometers? 450 °F
$F = \left(\frac{9}{5} \times 232\right) + 32$
6. You call a friend in Denmark during the Christmas holidays and say that the temperature in Boston is 15 degrees. He replies that you must enjoy the warm weather. Explain his comment using your knowledge of the Fahrenheit and Celsius scales. To help you get started, fill in this table. What is 15°F on the Celsius scale? What is 15°C on the Fahrenheit scale? $C = \frac{5}{9}(15 - 32)$

15°F	=	-9.4° C
59° F	=	15°C

$F = \left(\frac{9}{5} \times 15\right) + 32$

PRACTICE 112m / 4 sec 7.2

Extension: the Kelvin temperature scale

For some scientific applications, a third temperature scale is used: the Kelvin scale. On the Kelvin scale, 0 K (degree symbols are not used for Kelvin values) represents **absolute zero**. Absolute zero is equal to -273°C, or -459°F. When scientists are conducting research, they often obtain or report their temperature values in Celsius, and other scientists must convert these values into Kelvin for their own use, or vice versa. To convert Celsius values to their Kelvin equivalents, you would use the formula:

$$K = °C + 273$$

EXAMPLE

- Water boils at a temperature of 100°C. What would be the corresponding temperature for the Kelvin scale?

$$K = °C + 273$$

$$K = 100°C + 273 = 373$$

To convert Kelvin values to Celsius, you would perform the opposite operation; subtract 273 from the Kelvin value to find the Celsius equivalent.

- A substance has a melting point of 625 K. At what Celsius temperature would this substance melt?

$$°C = K - 273$$

$$°C = 625\ K - 273 = 352$$

Although we rarely need to convert between Kelvin and Fahrenheit, use the following formulas to do so:

$$K = \frac{5}{9}(°F + 460)$$

$$°F = \left(\frac{9}{5} \times K\right) - 460$$

PRACTICE 2

1. A gas has a boiling point of -175°C. At what Kelvin temperature would this gas boil? 98° K
   K = -175°C + 273
2. A chemist notices some silvery liquid on the floor in her lab. She wonders if someone accidentally broke a mercury thermometer, but did not thoroughly clean up the mess. She decides to find out of the silver stuff is really mercury. From her tests with the substance, she finds out that the melting point for the liquid is 275 K. A reference book says that the melting point for mercury is -38.87°C. Is this substance mercury? Explain your answer and show all relevant calculations. C = 275 - 273
   2 °C = mp for unknown is much higher than mercury. So NO
3. It is August 1st and you are at a Science Camp in Florida. During an outdoor science quiz, you are asked to identify the temperature scale for a thermometer that reports the current temperature as 90. Is this thermometer calibrated for the Kelvin, Fahrenheit, or Celsius temperature scale? Fill in the table below to answer this question.

90°F	=	32°C	=	305
194°F	=	90°C	=	363
-298 °F	=	-183°C	=	90

$(\frac{9}{5} \times C) + 32$ $\frac{5}{9}(F - 32)$

Name: ______________________ Date: ______________

Specific Heat

READ

Specific heat is defined as the amount of heat energy needed to raise 1 gram of a substance 1°C in temperature.

- Specific heat values are used in the heat equation is:

$$Q = mC_p(T_2 - T_1)$$

where Q is the heat energy (joules), m is the mass of the substance (kilograms), C_p is the specific heat of the substance (J/kg°C), and $(T_2 - T_1)$ is the change in temperature (°C)

- The higher the specific heat, the more energy is required to cause a change in temperature. Substances with higher specific heats require more loss of heat energy to experience a lowering of their temperature than do substances with a low specific heat. Some sample specific heat values are presented in the table below:

Material	Specific Heat (J/kg °C)
water (pure)	4,184
aluminum	900
steel	470
silver	235
oil	1,900
concrete	880
glass	800
gold	129
wood	2,500

- Water has the highest specific heat of the listed types of matter. This means that water is slower to heat but is also slower to lose heat.

EXAMPLE

- How much energy is required to heat 35 grams of gold from 10°C to 50°C?

Looking for

The heat energy in joules to heat 35 grams of gold by 40°C.

Given

Mass = 35 grams = 0.35 kilogram

Specific heat of gold = 129 J/g°C

T_2 = 50°C and T_1 =10°C

Relationship

$$Q = mC_p(T_2 - T_1)$$

Solution

$$Q = mC_p(T_2 - T_1)$$

$$Q = (0.35\text{ kg})\left(129\frac{\text{J}}{\text{kg}\cdot{}^\circ\text{C}}\right)(50^\circ\text{C} - 10^\circ\text{C})$$

$$Q = (0.35\text{ kg})\left(129\frac{\text{J}}{\text{kg}\cdot{}^\circ\text{C}}\right)(40^\circ\text{C})$$

$$Q = 1{,}806\text{ joules}$$

To produce the necessary change in temperature, 1,806 joules of heat energy need to be put into this sample of gold.

$Q = mC\Delta T$

PRACTICE 7.3

PRACTICE

Using the heat formula and the table of specific heat values, solve the following heat problems.

1. A 0.5-kilogram piece of aluminum increases its temperature 7°C when heat energy is added. How much heat energy produced this change in temperature? $Q = (.5\text{ kg})(900)(7°C) =$ 3150 J

2. A volume of water has a mass of 0.5 kilogram. If the temperature of this amount of water was raised by 7°C, how much heat energy is produced? $Q = (.5\text{ kg})(4{,}184)(7°C) =$ 14644 J

3. How much heat energy is required to raise the temperature of 1 kilogram of steel by 10°C?
   $Q = (1\text{ kg})(470)(10) =$ 4700 J

4. How much heat energy is needed to raise the temperature of 100-liters of water from 10°C to 25°C? Note: One liter of water has a mass of one kilogram. $(100\text{ kg})(4{,}184)(15) =$ 6276,000 J 6.3×10^6 J

5. When 1,500 joules of energy is lost from a 0.12-kilogram object, the temperature decreases from 45°C to 40°C. What is the specific heat of this object? Of what material is the object made?
   $1500\text{ J} = (.12\text{ kg})(C)(40-45)$ C = 2500 J/kgC° - WOOD

6. What is the specific heat of a material that gains 600 joules of energy when a 0.25-kilogram object increases in temperate by 3°C? What is this material? C = 800 J/kgC° - glass
   $600\text{ J} = (.25\text{ kg})(C)(3°)$

7. A liquid with a specific heat of 1,900 J/kg·°C has 4,750 joules of heat energy is added to it. If the temperature increases from 20°C to 30°C, what is the mass of the liquid?
   $4{,}750\text{ J} = (m)(1{,}900)(10°C)$ m = .25 kg

8. What is the mass of a block of concrete that gains 52,800 joules of energy when its temperature is increased by 5°C? $52{,}800\text{ J} = (m)(880)(5°C)$ m = 12 kg

9. A scientist wants to raise the temperature of a 0.10-kilogram sample of glass from –45°C to 15°C. How much heat energy is required to produce this change in temperature?
   $Q = (.10\text{ kg})(800)(60)$ Q = 4800 J

10. A person wishes to heat pot of fresh water from 20°C to 100°C in order to boil water for pasta. They calculate that their pot holds 2 kilograms of water and that they would need to apply 669,440 joules of heat energy to produce the desired temperature change. Are the person's calculations correct? Defend your answer and demonstrate all relevant calculations. $669{,}440\text{ J} = (2\text{ kg})(4{,}184)(80)$ YES!

11. A 0.25-kilogram sample of aluminum is provided with 5,000 joules of heat energy. What will be the change in temperature of this sample of aluminum? $5000 = (.25\text{ kg})(900)(\Delta T)$ $\Delta T = 22.2°C$

12. What is the change in temperature for a 2-kilogram mass of water that loses 8,500 joules of energy?
    $-8{,}500 = (2\text{ kg})(4{,}184)(\Delta T)$ $-1.0°C$

13. Which of the substances listed in the table on the first page would heat up more quickly if an equal amount of heat energy were applied to all of the substances at the same time? Explain your answer.
    gold & silver b/c ↓ C

14. Which of the substances listed in the table on the first page would you choose as the best insulator (substance that requires a lot of heat energy to experience a change in temperature)? Explain your answer.
    water, oil, wood ↑ C

15. Which substance—wood or steel—is the better conductor? A conductor is a material that requires very little heat energy to experience a change in temperature. Explain your answer.
    Steel → ↓ C