

Chem 10 Chapter 3

Matter and Energy

Additional Practice Questions

Worked solutions at the end

Use your course periodic table and a calculator as needed. Show the setup, include units, and round at the end. Question numbers match the numbers in the solutions. Use heading navigation to move between sections.

Additional Practice Questions

Question 1

409 kelvin equals

- A) 136°F
- B) 273°F
- C) 682°F
- D) 136°C
- E) 682°C

Question 2

−48.2°C equals

- A) −86.8°F
- B) −119°F
- C) −54.8°F
- D) 119°F
- E) 224.8°F

Question 3

The boiling of water is a

- A) physical change because the water merely disappears
- B) physical change because the gaseous water is chemically the same as the liquid
- C) chemical change because heat is needed for the process to occur
- D) chemical change because a gas (steam) is given off
- E) chemical and physical damage

Question 4

The state of matter for an object that has a definite volume but not a definite shape is

- A) solid state
- B) liquid state
- C) gaseous state
- D) elemental state
- E) mixed state

Question 5

Which of the following statements is false?

- A) Solutions are always homogeneous mixtures.
- B) Some molecules may be composed of only one kind of atom.
- C) Elements can exist as atoms or molecules.
- D) Compounds can exist as atoms or molecules.
- E) At least two of the above statements (A-D) are false.

Question 6

The temperature of a sample was observed to increase by 69 kelvins. What is the value of this change in °F?

Question 7

The temperature of a sample was observed to increase by 1.7 °F. What is the value of this change in kelvins?

Question 8

Which represents the smallest temperature change: a change of one degree on the Fahrenheit scale, the Celsius scale, or the kelvin scale?

Question 9

Two beakers each contain 100 mL of material. One contains sugar with a mass of 180.0 g, and the other contains water with a mass of 100.0 g. The sugar is poured into the water and stirred until it dissolves.

- (a) Will the mass of the solution be (i) much greater than 280.0 g, (ii) somewhat greater than 280.0 g, (iii) exactly 280.0 g, (iv) somewhat less than 280.0 g, or (v) much less than 280.0 g? Explain.
- (b) Will the solution volume be (i) much greater than 200 mL, (ii) somewhat greater than 200 mL, (iii) exactly 200 mL, (iv) somewhat less than 200 mL, or (v) much less than 200 mL? Explain.

Question 10

When water boils, bubbles rise to the surface.

- (a) Which is inside these bubbles: (i) air, (ii) hydrogen and oxygen gas, (iii) oxygen gas, (iv) water vapor, or (v) carbon dioxide gas?
- (b) Is boiling a physical or chemical change? Explain.

Question 11

How much heat is required to raise the temperature of a 5.75-g sample of iron (specific heat = $0.450 \text{ J/(g } ^\circ\text{C)}$) from 25.0°C to 79.8°C ?

- A) 2.54 J
- B) 315 J
- C) 700 J
- D) 848 J
- E) 142 J

Question 12

A 45.9 g sample of a metal is heated to 95.2°C and then placed in a calorimeter containing 120.0 g of water ($c = 4.18 \text{ J/(g } ^\circ\text{C)}$) at 21.6°C . The final temperature of the water is 24.5°C . Which metal was used?

- A) Aluminum ($c = 0.89 \text{ J/(g } ^\circ\text{C)}$)
- B) Iron ($c = 0.45 \text{ J/(g } ^\circ\text{C)}$)
- C) Copper ($c = 0.385 \text{ J/(g } ^\circ\text{C)}$)
- D) Lead ($c = 0.14 \text{ J/(g } ^\circ\text{C)}$)
- E) none of these

Question 13

30.0 mL of pure water at 282 K is mixed with 50.0 mL of pure water at 306 K. What is the final temperature of the mixture?

- A) 294 K
- B) 297 K
- C) 342 K
- D) 588 K
- E) 24 K

Solutions

Find the solution with the same question number.

Question 1 Solution

D.

$$T(\text{Celsius}) = 409 - 273.15 = 136\text{ }^{\circ}\text{C}$$

$$T(\text{Fahrenheit}) = \frac{9}{5}T(\text{Celsius}) + 32 = \frac{9}{5}(136) + 32 = 277\text{ }^{\circ}\text{F}$$

Question 2 Solution

C.

$$T(\text{Fahrenheit}) = \frac{9}{5}T(\text{Celsius}) + 32 = \frac{9}{5}(-48.2) + 32 = -54.8\text{ }^{\circ}\text{F}$$

Question 3 Solution

B. The boiling of water is a physical change because no chemical bonds are broken or formed, and gaseous water is the same chemical as liquid water.

Question 4 Solution

B. A liquid has a definite volume but takes the shape of its container. Its particles remain close together while moving past one another.

Question 5 Solution

D. Compounds cannot exist as atoms, since they are formed by the atoms of different elements (i.e. more than one kind of atom) and are made of combinations of atoms, rather than a single type of atoms.

Question 6 Solution

For a temperature change, the zero-point offsets do not enter. A change of 1 K equals a change of 1 $^{\circ}\text{C}$.

$$\Delta T(\text{Fahrenheit}) = 69\text{ K} \times \frac{1\text{ }^{\circ}\text{C}}{1\text{ K}} \times \frac{9\text{ }^{\circ}\text{F}}{5\text{ }^{\circ}\text{C}} = 124.2\text{ }^{\circ}\text{F}$$

To the nearest degree, this is 124 $^{\circ}\text{F}$. With 69 K given to two significant figures, report $1.2 \times 10^2\text{ }^{\circ}\text{F}$.

Question 7 Solution

Convert the size of the temperature change; do not subtract 32.

$$\Delta T = 1.7\text{ }^{\circ}\text{F} \times \frac{5\text{ K}}{9\text{ }^{\circ}\text{F}} = 0.94\text{ K}$$

Question 8 Solution

°C and K have equal magnitudes for temperature differences. However, there are 180 °F between the freezing and the boiling point of water, whereas the same difference corresponds to 100 degrees in the °C scale. In other words, a 1 °F change corresponds to only 5/9 °C or 5/9 K change. Since 5/9 °C is less than 1 °C, a 1 °F change corresponds to the smallest change in temperature.

Question 9 Solution

(a) The law of conservation of mass dictates that the mixture will have a mass equal to the sum of the masses of the individual components: exactly 280.0 g. Choice (iii).

(b) The solution volume will be less than 200 mL because some of the volume of the sugar was the “empty” space between sugar granules. The air in that space will be left out of the solution and lead to a volume less than 200 mL. In other words, the true volume of the sugar was less than 100 mL. Choice (iv).

Something similar can happen even when we mix substances with no air in them. Just as water fills the voids between sugar granules without increasing the total volume, smaller molecules can slip into the crevices of larger molecules when mixing with them, leading to a total volume that is less than the sum of the volumes of individual components.

Question 10 Solution

(a) Water vapor, choice (iv). When water boils, it is just liquid water turning into water vapor.

(b) It is a physical change. Same substance, different physical state.

Question 11 Solution

E.

$$q = mc\Delta T = (5.75 \text{ g})(0.450 \text{ J/(g } ^\circ\text{C)})(79.8 - 25.0) ^\circ\text{C} = 142 \text{ J}$$

The grams and degrees Celsius cancel, leaving joules.

Question 12 Solution

B. Heat lost by the hot metal is gained by the water.

$$-q(\text{metal}) = q(\text{water})$$

$$-(45.9)c(24.5 - 95.2) = (120.0)(4.18)(24.5 - 21.6)$$

$$c = 0.45 \text{ J/(g } ^\circ\text{C)}$$

The metal is iron. Assume that heat exchange with the calorimeter and surroundings is negligible.

Question 13 Solution

B. Heat lost by warm water equals heat gained by cold water. Remember: q is heat gained, and $-q$ is heat lost.

$$-q(\text{warm}) = q(\text{cold})$$

We do not need to know the masses of water explicitly, because they can be expressed in terms of volume and density, and densities cancel because we have the same substance on both sides of the equation. This assumes density does not change much with temperature.

We also do not need to know the specific heat capacity of water, again because it shows up on both sides of the equation and cancels.

$$-V(\text{warm})\rho c[T(\text{final}) - T(\text{warm})] = V(\text{cold})\rho c[T(\text{final}) - T(\text{cold})]$$

$$-(50.0)[T(\text{final}) - 306] = (30.0)[T(\text{final}) - 282]$$

$$T(\text{final}) = 297 \text{ K}$$