

Concept Review

Section: Energy Transfer

Complete each statement below by choosing a term from the following list. Use each term only once.

intensive enthalpy heat higher
extensive temperature physical lower

1. Temperature and heat are different but related _____ properties.
2. If a sample has a(n) _____ temperature than its surroundings, energy is transferred from the sample. If the temperature of the sample is _____ than its surroundings, energy is transferred to the sample. The energy transferred between objects that are at different temperatures is _____. The _____ of a sample is a measure of the average kinetic energy of the particles in a sample.
3. The temperature of a sample does not depend on the amount of the sample, therefore temperature is a(n) _____ property. In contrast, heat is a(n) _____ property, which means that the amount of energy transferred as heat depends on the amount of the sample.
4. The total energy content of a sample is its _____, and is represented by the symbol H .

Complete each statement below by writing the correct term in the space provided.

5. The SI temperature unit is _____.
6. A kelvin is the same temperature interval as a degree _____.
7. Because 0.00°C is equal to _____, individual temperatures have different numerical values on the two scales.
8. A temperature difference taken between two objects has _____ numerical value in Kelvins and in degrees Celsius.
9. Heat, like other forms of energy, is measured in _____.

Concept Review *continued*

10. If the temperature of an object is found to be 73.15 K, its value in degrees Celsius is _____.

11. Kelvin temperature = Celsius temperature + _____

Solve the following problems and write your answers in the space provided.

12. Calculate the energy needed to raise the temperature of 180.0 g of water from 10.0°C to 40.0°C. The molar heat capacity for water is 75.3 J/K·mol.

13. How many joules would be required to change the temperature of 250.0 g of aluminum from 15.0°C to 75.0°C? The molar heat capacity of aluminum is 24.2 J/K·mol.

14. How much energy is required to raise the temperature of 68.0 g of tin from 25.0°C to 80.0°C? The molar heat capacity of tin is 11.1 J/K·mol.

15. The molar heat capacity of nitrogen, N₂, is 29.1 J/K·mol. How much energy is required to raise the temperature of 40.5 g of nitrogen 45 K?

Concept Review

Section: Using Enthalpy

Complete each statement below by writing the correct term in the space provided.

1. The total energy of a system is its _____, or H . The only way to measure energy is through a _____. The _____ enthalpy change is the enthalpy change of one mole of an element or compound.
2. When a pure substance is heated or cooled, but does not change state, the energy as heat is the _____ as the enthalpy change. Therefore the molar enthalpy change is equal to the _____ multiplied by the _____, or $\Delta H =$ _____.
3. A _____ enthalpy change means that the change requires energy and that the process is _____. A _____ enthalpy change means that the change releases energy or is a _____ process.
4. The science that examines the energy changes that accompany chemical and physical processes is called _____.

Solve the following problems and write your answers in the space provided.

5. How much does the molar enthalpy change when 147 g of water cools from 90.0°C to 17.0°C ? The molar heat capacity for water is $75.3 \text{ J/K}\cdot\text{mol}$.
6. How much does the molar enthalpy change when 432 g of water is heated from 18.0°C to 71.0°C ? The molar heat capacity for water is $75.3 \text{ J/K}\cdot\text{mol}$.

Concept Review

Section: Changes in Enthalpy During Chemical Reactions

Complete each statement below by writing the correct term in the space provided.

1. In most chemical reactions, the enthalpy change can be measured in terms of energy in the form of _____ released or gained during the reaction. A change in enthalpy in a reaction depends on many variables, but _____ is one of the most important. To standardize the enthalpies of reactions, data for _____ and _____ are presented at the standard thermodynamic temperature of _____ °C, or _____ K. When a chemical equation is used in calculating thermodynamic values, coefficients represent _____ of a substance. The enthalpy change in forming 1 mol of a substance from its elements at 298.15K is called the _____ of formation.

Write the answers to the following questions in the space provided.

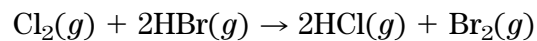
2. Explain how the two types of calorimeters are used to measure the energy released or absorbed in a chemical reaction.

3. State Hess's law.

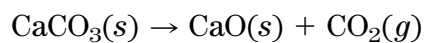
Concept Review *continued*

Solve the following problems and write your answers in the space provided.

4. What is the enthalpy change for the following reaction? Is the reaction exothermic or endothermic?



5. What is the enthalpy change for the following reaction? Is the reaction exothermic or endothermic?



Concept Review

Section: Order and Spontaneity

Complete each statement below by writing the correct term in the space provided.

1. The property of a system that makes a process occur consists of two driving forces, a tendency toward the greatest _____ state and a tendency toward the lowest _____ state.
2. The quantity of entropy possessed by 1 mol of a substance is called _____.
3. The symbol for standard entropy is _____ and the units used are _____, the same as for molar heat capacity.
4. The thermodynamic quantity used to predict whether a reaction will occur spontaneously is _____ and is defined by the equation $G =$ _____.

Complete each statement below by writing the correct term in the space provided.

5. A reaction is more likely to occur if the change in entropy is _____.
6. The entropy of a substance _____ with temperature.
7. _____ have greater standard entropies than liquids.
8. _____ have the most freedom to move, so their standard entropies are the greatest.
9. At _____, no disorder means no entropy.
10. The entropy change of a reaction is standard entropy of the _____ minus the standard entropy of the _____.
11. Because the atoms in a diamond are in a more ordered state than in graphite, the change in entropy in changing graphite into a diamond is _____.

Concept Review *continued*

12. A system with more energy has more _____.
13. A process is spontaneous if ΔG is _____.
14. All spontaneous processes occur with a _____ in Gibbs energy.

Complete each statement below by underlining the correct word or phrase in brackets. Refer to the following two expressions when answering the items below.

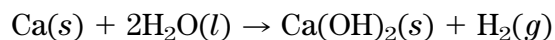
ΔH = enthalpy of products – enthalpy of reactants

$\Delta G = \Delta H - T\Delta S$

15. The products of an [endothermic, exothermic] reaction have an energy higher than that of the reactants.
16. In endothermic reactions, ΔH has a [positive, negative] value.
17. The drive to achieve a state of [minimum, maximum] Gibbs energy may be interpreted as the driving force of a chemical reaction.
18. A chemical reaction occurs if it is accompanied by a(n) [increase, decrease] in Gibbs energy.
19. If ΔG is negative, $-\Delta G$, the reaction is [spontaneous, nonspontaneous].
20. The expression for ΔG shows that when ΔH is negative and ΔS is positive, ΔG is [positive, negative]. Thus, [endothermic, exothermic] reactions, which are accompanied by a(n) [increase, decrease] in entropy of the system, are probable.
21. The expression for ΔG shows that when ΔH is positive and ΔS is negative, ΔG is [positive, negative]. This means that [endothermic, exothermic] reactions accompanied by a(n) [increase, decrease] in entropy are improbable.
22. At very high temperatures, the sign and magnitude of ΔG and the spontaneity of a reaction are determined primarily by the change in [enthalpy, entropy].
23. According to the expression for ΔG , the [higher, lower] the temperature for a positive entropy change, the greater the chances are that the reaction will be spontaneous.
24. When the temperature of a system is low, the product $T\Delta S$ is very [small, large] compared to the ΔH term and has little influence on the value of ΔG . In such cases, the reaction may occur as the [enthalpy, entropy] change predicts.

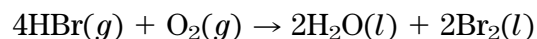
Solve the following problems and write your answers in the space provided.

25. What is the entropy change for the following reaction?



Concept Review *continued*

26. What is the entropy change for the following reaction?



27. Calculate the change in Gibbs energy for the following reaction at 25°C. Is the reaction spontaneous?



28. Calculate the change in Gibbs energy for the given reaction at 25°C. Is the reaction spontaneous?

