|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1. For which process is Δ*S* negative?   |  |  |  | | --- | --- | --- | |  | a. | evaporation of 1 mol of CCl4(*l*) | |  | b. | mixing 5 mL ethanol with 25 mL water | |  | c. | compressing 1 mol Ne at constant temperature from 1.5 L to 0.5 L | |  | d. | raising the temperature of 100 g Cu from 275 K to 295 K | |  | e. | grinding a large crystal of KCl to powder |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.1 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2. Ten identical coins are shaken vigorously in a cup and then poured out onto a table top. Which of the following distributions has the highest probability of occurrence? (T = Tails, H = Heads)   |  |  |  | | --- | --- | --- | |  | a. | T10H0 | |  | b. | T8H2 | |  | c. | T7H3 | |  | d. | T5H5 | |  | e. | T4H6 |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.1 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 3. If two pyramid-shaped dice (with numbers 1 through 4 on the sides) were tossed, which outcome has the highest entropy?   |  |  |  | | --- | --- | --- | |  | a. | The sum of the dice is 3. | |  | b. | The sum of the dice is 4. | |  | c. | The sum of the dice is 5. | |  | d. | The sum of the dice is 6. | |  | e. | The sum of the dice is 7. |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.1 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 4. A two-bulbed flask contains 7 particles. What is the probability of finding all 7 particles on the left side?   |  |  |  | | --- | --- | --- | |  | a. | 3.50% | |  | b. | 2.65% | |  | c. | 0.78% | |  | d. | 0.14% | |  | e. | 1.56% |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.1 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 5. Which of the following shows a decrease in entropy?   |  |  |  | | --- | --- | --- | |  | a. | precipitation | |  | b. | gaseous reactants forming a liquid | |  | c. | a burning piece of wood | |  | d. | melting ice | |  | e. | two of these |  |  |  | | --- | --- | | *ANSWER:* | e | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.1 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 6. Which of the following result(s) in an increase in the entropy of the system?   |  |  | | --- | --- | | I. |  | | II. | Br2(*g*) → Br2(*l*) | | III. | NaBr(*s*) → Na+(*aq*) + Br–(*aq*) | | IV. | O2(298 K) → O2(373 K) | | V. | NH3(1 atm, 298 K) → NH3(3 atm, 298 K) |  |  |  |  | | --- | --- | --- | |  | a. | I | |  | b. | II, V | |  | c. | I, III, IV | |  | d. | I, II, III, IV | |  | e. | I, II, III, V |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.1 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 2/27/2017 2:12 AM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 7. Consider the following processes:   |  |  | | --- | --- | | I. | condensation of a liquid | | II | increasing the volume of 1.0 mol of an ideal gas at constant temperature | | III. | dissolving sugar in water | | IV. | heating 1.0 mol of an ideal gas at constant volume |   For how many of these is Δ*S* positive?   |  |  |  | | --- | --- | --- | |  | a. | 0 | |  | b. | 1 | |  | c. | 2 | |  | d. | 3 | |  | e. | 4 |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.1 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy change for a reaction | general chemistry | thermochemistry | thermodynamics | third law of thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 8. The second law of thermodynamics states that:   |  |  |  | | --- | --- | --- | |  | a. | The entropy of a perfect crystal is zero at 0 K. | |  | b. | The entropy of the universe is constant. | |  | c. | The energy of the universe is increasing. | |  | d. | The entropy of the universe is increasing. | |  | e. | The energy of the universe is constant. |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.2 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 9. Which of the following statements is true?   |  |  |  | | --- | --- | --- | |  | a. | The total energy and entropy of the universe are both increasing. | |  | b. | The total energy of the universe is increasing, but the entropy is constant. | |  | c. | The total energy of the universe increases, while the entropy decreases. | |  | d. | The total energy of the universe is constant, but the entropy is increasing. | |  | e. | None of these. |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.2 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 10. A 100-mL sample of water is placed in a coffee cup calorimeter. When 1.0 g of an ionic solid is added, the temperature decreases from 21.5°C to 20.8°C as the solid dissolves. For the dissolving of the solid   |  |  |  | | --- | --- | --- | |  | a. | Δ*H* < 0 | |  | b. | Δ*S*univ > 0 | |  | c. | Δ*S*sys< 0 | |  | d. | Δ*S*surr > 0 | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.3 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 11. A chemical reaction is most likely to be spontaneous if it is accompanied by   |  |  |  | | --- | --- | --- | |  | a. | increasing energy and increasing entropy | |  | b. | lowering energy and increasing entropy | |  | c. | increasing energy and decreasing entropy | |  | d. | lowering energy and decreasing entropy | |  | e. | none of these (A-D) |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.3 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | free energy | general chemistry | spontaneity | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 12. Assume that the enthalpy of fusion of ice is 6020 J/mol and does not vary appreciably over the temperature range 270-290 K. If one mole of ice at 0°C is melted by heat supplied from surroundings at 279 K, what is the entropy change in the surroundings, in J/K?   |  |  |  | | --- | --- | --- | |  | a. | 22.1 | |  | b. | 21.6 | |  | c. | 0.0 | |  | d. | –21.6 | |  | e. | –22.1 |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.3 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | entropy change for a phase transition | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 13. If the change in entropy of the surroundings for a process at 439 K and constant pressure is –326 J/K, what is the heat flow absorbed by for the system?   |  |  |  | | --- | --- | --- | |  | a. | 326 kJ | |  | b. | 1.35 kJ | |  | c. | –143 kJ | |  | d. | 113 kJ | |  | e. | 143 kJ |  |  |  | | --- | --- | | *ANSWER:* | e | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.3 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | entropy change for a phase transition | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 14. The heat of vaporization for 1.0 mole of water at 100.°C and 1.0 atm is 40.55 kJ/mol. Calculate Δ*S* for the process H2O(*l*) → H2O(*g*) at 100.°C.   |  |  |  | | --- | --- | --- | |  | a. | 109 J/K mol | |  | b. | –109 J/K mol | |  | c. | 406 J/K mol | |  | d. | –406 J/K mol | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.3 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | entropy change for a phase transition | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 15. A change of state that occurs in a system is accompanied by 61.2 kJ of heat, which is transferred to the surroundings at a constant pressure and a constant temperature of 300. K. For this process Δ*S*surr is:   |  |  |  | | --- | --- | --- | |  | a. | 61.2 kJ/K | |  | b. | –61.2 kJ/K | |  | c. | –204 J/K | |  | d. | 204 J/K | |  | e. | 239 kJ/K |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.3 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | entropy change for a phase transition | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 16. Τhe enthalpy of vaporization of ethanol is 38.56 kJ/mol at its boiling point (78°C). Calculate the value of Δ*S*surr when 1.00 mole of ethanol is vaporized at 78°C and 1.00 atm.   |  |  |  | | --- | --- | --- | |  | a. | 0 | |  | b. | 4.92 × 102 J/K mol | |  | c. | 1.1 × 102 J/K mol | |  | d. | –1.1 × 102 J/K mol | |  | e. | –4.92 × 102 J/K mol |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.3 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | entropy change for a phase transition | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 17. Δ*S*surr is \_\_\_\_\_\_\_ for exothermic reactions and \_\_\_\_\_\_ for endothermic reactions.   |  |  |  | | --- | --- | --- | |  | a. | favorable, unfavorable | |  | b. | unfavorable, favorable | |  | c. | favorable, favorable | |  | d. | unfavorable, unfavorable | |  | e. | cannot tell |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.3 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 18. Which of the following is true for exothermic processes?   |  |  |  | | --- | --- | --- | |  | a. | Δ*S*surr < 0 | |  | b. | Δ*S*surr = –Δ*H*/*T* | |  | c. | Δ*S*surr = 0 | |  | d. | Δ*S*surr > 0 | |  | e. | two of these |  |  |  | | --- | --- | | *ANSWER:* | e | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.3 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |
| --- |
| At 1 atm, liquid water is heated above 100°C. |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 19. Δ*S*surr for this process is   |  |  |  | | --- | --- | --- | |  | a. | greater than zero | |  | b. | less than zero | |  | c. | equal to zero | |  | d. | more information needed to answer this question | |  | e. | none of these (A-D) |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.3 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-1 | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 20. Δ*S*sys for this process is   |  |  |  | | --- | --- | --- | |  | a. | greater than zero | |  | b. | less than zero | |  | c. | equal to zero | |  | d. | more information needed to answer this question | |  | e. | none of these (A-D) |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.3 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-1 | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 21. Δ*S*univ for this process is   |  |  |  | | --- | --- | --- | |  | a. | greater than zero | |  | b. | less than zero | |  | c. | equal to zero | |  | d. | more information needed to answer this question | |  | e. | none of these (A-D) |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.3 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-1 | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 22. Given that Δ*H*vap is 52.6 kJ/mol, and the boiling point is 83.4°C, 1 atm, if one mole of this substance is vaporized at 1 atm, calculate Δ*S*surr.   |  |  |  | | --- | --- | --- | |  | a. | –148 J/K mol | |  | b. | 148 J/K mol | |  | c. | 631 J/K mol | |  | d. | –631 J/K mol | |  | e. | 0 |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.3 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | entropy change for a phase transition | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 23. As long as the disorder of the surroundings is increasing, a process will be spontaneous.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.3 | | *QUESTION TYPE:* | True / False | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 24. For any given process, Δ*S*surr and Δ*S*sys have opposite signs.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.3 | | *QUESTION TYPE:* | True / False | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 25. If Δ*S*surr = –Δ*S*sys, the process is at equilibrium.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | True | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.3 | | *QUESTION TYPE:* | True / False | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 26. Which of the following is true?   |  |  |  | | --- | --- | --- | |  | a. | By *spontaneous* we mean that the reaction or process will always proceed to the right (as written) even if very slowly. Increasing the temperature may speed up the reaction, but it does not affect the spontaneity of the reaction. | |  | b. | By *spontaneous* we mean that the reaction or process will always proceed to the left (as written) even if very slowly. Increasing the temperature may speed up the reaction, but it does not affect the spontaneity of the reaction. | |  | c. | By *spontaneous* we mean that the reaction or process will always proceed to the left (as written) even if very slowly. Increasing the temperature may speed up the reaction and it generally affects the spontaneity of the reaction. | |  | d. | By *spontaneous* we mean that the reaction or process will always proceed to the right (as written) even if very slowly. Increasing the temperature may speed up the reaction, and it generally affects the spontaneity of the reaction. | |  | e. | None of the above is true. |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.3 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | general chemistry | spontaneity and temperature change | temperature dependence of free energy | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 27. Substance X has a heat of vaporization of 41.4 kJ/mol at its normal boiling point (423°C). For the process X(*l*) → X(*g*) at 1 atm and 423°C calculate the value of Δ*S*univ.   |  |  |  | | --- | --- | --- | |  | a. | 0 | |  | b. | 59.5 J/K mol | |  | c. | 98 J/K mol | |  | d. | –59.5 J/K mol | |  | e. | –98 J/K mol |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.3 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | entropy change for a phase transition | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 28. Substance X has a heat of vaporization of 45.1 kJ/mol at its normal boiling point (423°C). For the process X(*l*) → X(*g*) at 1 atm and 423°C calculate the value of Δ*S*surr.   |  |  |  | | --- | --- | --- | |  | a. | 0 | |  | b. | 64.8 J/K mol | |  | c. | 107 J/K mol | |  | d. | –64.8 J/K mol | |  | e. | –107 J/K mol |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.3 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | entropy change for a phase transition | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 29. Substance X has a heat of vaporization of 46.7 kJ/mol at its normal boiling point (423°C). For the process X(*l*) → X(*g*) at 1 atm and 423°C calculate the value of Δ*S*.   |  |  |  | | --- | --- | --- | |  | a. | 0 | |  | b. | 67.1 J/K mol | |  | c. | 110 J/K mol | |  | d. | –67.1 J/K mol | |  | e. | –110 J/K mol |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | entropy change for a phase transition | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 30. Substance X has a heat of vaporization of 45.9 kJ/mol at its normal boiling point (423°C). For the process X(*l*) → X(*g*) at 1 atm and 423°C calculate the value of Δ*G*.   |  |  |  | | --- | --- | --- | |  | a. | 0 J | |  | b. | 65.9 J | |  | c. | 109 J | |  | d. | –65.9 J | |  | e. | –109 J |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | free energy | general chemistry | spontaneity | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 31. Τhe enthalpy of vaporization of methanol is 37.40 kJ/mol at its boiling point (64.7°C). Calculate the value of Δ*S* when 1.00 mole of methanol is vaporized at 64.7°C and 1.00 atm.   |  |  |  | | --- | --- | --- | |  | a. | 0 | |  | b. | 5.78 × 102 J/K mol | |  | c. | 1.11 × 102 J/K mol | |  | d. | –1.11 × 102 J/K mol | |  | e. | –5.78 × 102 J/K mol |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | entropy change for a phase transition | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 32. Δ*S* is \_\_\_\_\_\_\_ for exothermic reactions and \_\_\_\_\_\_ for endothermic reactions.   |  |  |  | | --- | --- | --- | |  | a. | favorable, unfavorable | |  | b. | unfavorable, favorable | |  | c. | favorable, favorable | |  | d. | unfavorable, unfavorable | |  | e. | cannot tell |  |  |  | | --- | --- | | *ANSWER:* | e | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 33. For the process CHCl3(*s*) → CHCl3(*l*), Δ*H*° = 9.17 kJ/mol and Δ*S*° = 43.9 J/mol/K. What is the melting point of chloroform?   |  |  |  | | --- | --- | --- | |  | a. | –64 °C | |  | b. | 209 °C | |  | c. | 130 °C | |  | d. | 64 °C | |  | e. | –130 °C |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | entropy change for a phase transition | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 34. Given that Δ*H*vap is 66.8 kJ/mol, and the boiling point is 83.4°C, 1 atm, if one mole of this substance is vaporized at 1 atm, calculate Δ*S*.   |  |  |  | | --- | --- | --- | |  | a. | –187 J/K mol | |  | b. | 187 J/K mol | |  | c. | 801 J/K mol | |  | d. | –801 J/K mol | |  | e. | 0 |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | entropy change for a phase transition | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 35. Δ*H*° is zero for a chemical reaction at constant temperature.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | True / False | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | enthalpy | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |
| --- |
| Consider two perfectly insulated vessels. Vessel #1 initially contains an ice cube at 0°C and water at 0°C. Vessel #2 initially contains an ice cube at 0°C and a saltwater solution at 0°C. In each vessel, consider the "system" to be the ice, and the "surroundings" to be the liquid. |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 36. Determine the sign of Δ*S*sys, Δ*S*surr, and Δ*S*univ for the contents of         Vessel #1.   |  |  |  | | --- | --- | --- | | Δ*S*sys | Δ*S*surr | Δ*S*univ |  |  |  |  | | --- | --- | --- | |  | a. | 0          0          0 | |  | b. | +          –          0 | |  | c. | +          +          + | |  | d. | +          –          + | |  | e. | +          0          + |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-2 | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 37. Determine the sign of Δ*S*sys, Δ*S*surr, and Δ*S*univ for the system (ice/saltwater) in        Vessel #2.   |  |  |  | | --- | --- | --- | | Δ*S*sys | Δ*S*surr | Δ*S*univ |  |  |  |  | | --- | --- | --- | |  | a. | 0          0          0 | |  | b. | +          –          0 | |  | c. | +          +          + | |  | d. | +          –          + | |  | e. | +          0          + |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-2 | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 38. The melting point of water is 0°C at 1 atm pressure because under these conditions:   |  |  |  | | --- | --- | --- | |  | a. | Δ*S* for the process H2O(*s*) → H2O(*l*) is positive. | |  | b. | Δ*S* and Δ*S*surr for the process H2O(*s*) → H2O(*l*) are both positive. | |  | c. | Δ*S* and Δ*S*surr for the process H2O(*s*) → H2O(*l*) are equal in magnitude and opposite in sign. | |  | d. | Δ*G* is positive for the process H2O(*s*) → H2O(*l*). | |  | e. | None of these is correct. |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy change for a phase transition | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 39. For the vaporization of a liquid at a given pressure:   |  |  |  | | --- | --- | --- | |  | a. | Δ*G* is positive at all temperatures. | |  | b. | Δ*G* is negative at all temperatures. | |  | c. | Δ*G* is positive at low temperatures, but negative at high temperatures (and zero at some temperature). | |  | d. | Δ*G* is negative at low temperatures, but positive at high temperatures (and zero at some temperature). | |  | e. | None of these (A-D). |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy change for a phase transition | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 40. Which of the following statements is always true for a spontaneous process?   |  |  | | --- | --- | | I. | Δ*S*sys > 0 | | II. | Δ*S*surr > 0 | | III. | Δ*S*univ > 0 | | IV. | Δ*G*sys > 0 |   ​   |  |  |  | | --- | --- | --- | |  | a. | I | |  | b. | III | |  | c. | IV | |  | d. | I and III | |  | e. | III and IV |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | free energy | general chemistry | spontaneity | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/14/2017 6:45 AM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 41. For a spontaneous exothermic process, which of the following must be true?   |  |  |  | | --- | --- | --- | |  | a. | ΔG must be positive. | |  | b. | Δ*S* must be positive. | |  | c. | Δ*S* must be negative. | |  | d. | Two of the above must be true. | |  | e. | None of the above (A-C) must be true. |  |  |  | | --- | --- | | *ANSWER:* | e | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | free energy | general chemistry | spontaneity | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 42. A mixture of hydrogen and chlorine remains unreacted until it is exposed to ultraviolet light from a burning magnesium strip. Then the following reaction occurs very rapidly:   |  |  |  |  |  | | --- | --- | --- | --- | --- | |  |  |  | H2(*g*) + Cl2(*g*) → 2HCl(*g*) | Δ*G* = –45.54 kJ | |  |  |  |  | Δ*H* = –44.12 kJ | |  |  |  |  | Δ*S* = –4.76 J/K |   Which of the following is consistent with this information?   |  |  |  | | --- | --- | --- | |  | a. | The reactants are thermodynamically more stable than the products. | |  | b. | The reaction has a small equilibrium constant. | |  | c. | The ultraviolet light raises the temperature of the system and makes the reaction more favorable. | |  | d. | The negative value for Δ*S* slows down the reaction. | |  | e. | The reaction is spontaneous, but the reactants are kinetically stable. |  |  |  | | --- | --- | | *ANSWER:* | e | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | free energy | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 43. For a particular chemical reaction Δ*H* = 5.8 kJ and Δ*S* = –23 J/K. Under what temperature condition is the reaction spontaneous?   |  |  |  | | --- | --- | --- | |  | a. | When *T* < –252 K. | |  | b. | When *T* < 252 K. | |  | c. | The reaction is spontaneous at all temperatures. | |  | d. | The reaction is not spontaneous at any temperature. | |  | e. | When *T* > 252 K. |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | free energy | general chemistry | spontaneity | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 44. For a certain process at 355 K, Δ*G* = –12.1 kJ and Δ*H* = –9.2 kJ. Therefore, Δ*S* for the process is   |  |  |  | | --- | --- | --- | |  | a. | 0 J/K mol | |  | b. | 8.2 J/K mol | |  | c. | –8.2 J/K mol | |  | d. | –25.9 J/K mol | |  | e. | 25.9 J/K mol |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | free energy | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 45. Consider the freezing of liquid water at –10°C. For this process what are the signs for Δ*H*, Δ*S*, and Δ*G*?   |  |  |  | | --- | --- | --- | | Δ*H* | Δ*S* | ΔG |  |  |  |  | | --- | --- | --- | |  | a. | +        –        0 | |  | b. | +        –        – | |  | c. | –        +        0 | |  | d. | –        +        – | |  | e. | –        –        – |  |  |  | | --- | --- | | *ANSWER:* | e | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | free energy | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/16/2017 4:34 AM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 46. For the process of a certain liquid vaporizing at 1 atm, Δ*H*°vap = 68.5 kJ/mol and Δ*S*°vap= 74.1 J/mol K. Assuming these values are independent of *T*, what is the normal boiling point of this liquid?   |  |  |  | | --- | --- | --- | |  | a. | 924 °C | |  | b. | 1197 °C | |  | c. | 651 °C | |  | d. | 0.924 °C | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | free energy | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 47. For the reaction A + B → C + D, Δ*H*° = +40 kJ and Δ*S*° = +50 J/K. Therefore, the reaction under standard conditions is   |  |  |  | | --- | --- | --- | |  | a. | spontaneous at temperatures less than 10 K | |  | b. | spontaneous at temperatures greater than 800 K | |  | c. | spontaneous only at temperatures between 10 K and 800 K | |  | d. | spontaneous at all temperatures | |  | e. | nonspontaneous at all temperatures |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | free energy | general chemistry | spontaneity | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 48. In which case must a reaction be spontaneous at all temperatures?   |  |  |  | | --- | --- | --- | |  | a. | Δ*H* is positive, Δ*S* is positive. | |  | b. | Δ*H* = 0, Δ*S* is negative. | |  | c. | Δ*S* = 0, Δ*H* is positive. | |  | d. | Δ*H* is negative, Δ*S* is positive. | |  | e. | None of these. |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | free energy | general chemistry | spontaneity | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 49. For the process S8 (rhombic) → S8 (monoclinic) at 110°C, Δ*H* = 3.21 kJ/mol and Δ*S* = 8.70 J/K ⋅ mol (at 110°C). Which of the following is correct?   |  |  |  | | --- | --- | --- | |  | a. | This reaction is spontaneous at 110°C (S8 (monoclinic) is stable). | |  | b. | This reaction is spontaneous at 110°C (S8 (rhombic) is stable). | |  | c. | This reaction is nonspontaneous at 110°C (S8 (rhombic) is stable). | |  | d. | This reaction is nonspontaneous at 110°C (S8 (monoclinic) is stable). | |  | e. | Need more data. |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | free energy | general chemistry | spontaneity | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 50. As O2(*l*) is cooled at 1 atm, it freezes at 54.5 K to form Solid I. At a lower temperature, Solid I rearranges to Solid II, which has a different crystal structure. Thermal measurements show that Δ*H* for the I →II phase transition is –743.11 J/mol, and Δ*S* for the same transition is -17.0 J/K mol. At what temperature are Solids I and II in equilibrium?   |  |  |  | | --- | --- | --- | |  | a. | 13.6 K | |  | b. | 43.7 K | |  | c. | 19.8 K | |  | d. | 98.2 K | |  | e. | They can never be in equilibrium because they are both solids. |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | entropy change for a phase transition | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 51. At constant pressure, the following reaction 2NO2(*g*) → N2O4(*g*) is exothermic. The reaction (as written) is   |  |  |  | | --- | --- | --- | |  | a. | always spontaneous | |  | b. | spontaneous at low temperatures, but not high temperatures | |  | c. | spontaneous at high temperatures, but not low temperatures | |  | d. | never spontaneous | |  | e. | cannot tell |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | free energy | general chemistry | spontaneity | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 52. Given that Δ*H*vap is 63.2 kJ/mol, and the boiling point is 83.4°C, 1 atm, if one mole of this substance is vaporized at 1 atm, calculate Δ*G*.   |  |  |  | | --- | --- | --- | |  | a. | –177 J | |  | b. | 177 J | |  | c. | 758 J | |  | d. | –758 J | |  | e. | 0 J |  |  |  | | --- | --- | | *ANSWER:* | e | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | free energy | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| The following questions refer to the following reaction at constant 25°C and 1 atm.  2Fe(*s*) + (3/2)O2(*g*) + 3H2O(*l*) → 2Fe(OH)3(*s*)    Δ*H* = –789 kJ/mol   |  |  |  |  | | --- | --- | --- | --- | |  | Substance |  | *S*° (J/mol K) | |  | Fe(OH)3(*s*) |  | 107 | |  | Fe(*s*) |  | 27 | |  | O2(*g*) |  | 205 | |  | H2O(*l*) |  | 70 | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 53. Determine Δ*S*surr for the reaction (in kJ/mol K)   |  |  |  | | --- | --- | --- | |  | a. | 3.14 | |  | b. | 0.937 | |  | c. | 0.378 | |  | d. | 1.31 | |  | e. | 2.65 |  |  |  | | --- | --- | | *ANSWER:* | e | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-3 | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 54. Determine Δ*S*univ for the reaction (in kJ/mol K)   |  |  |  | | --- | --- | --- | |  | a. | 0.23 | |  | b. | 2.3 | |  | c. | 0.36 | |  | d. | 2.8 | |  | e. | 3.6 |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-3 | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 55. What must be true about Δ*G* for this reaction?   |  |  |  | | --- | --- | --- | |  | a. | Δ*G* = Δ*H* | |  | b. | Δ*G* = 0 | |  | c. | Δ*G* > 0 | |  | d. | Δ*G* < 0 | |  | e. | Δ*G* = Δ*S*univ |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.5 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-3 | | *KEYWORDS:* | Chemistry | free energy | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 56. Given the following data, calculate the normal boiling point for formic acid (HCOOH).   |  |  |  | | --- | --- | --- | |  | Δ*Hf°*(kJ/mol) | *S°*(J/mol K) | | HCOOH(*l*) | -410. | 130.0 | | HCOOH(*g*) | -363 | 250.8 |   ​   |  |  |  | | --- | --- | --- | |  | a. | 0.39 °C | |  | b. | 389 °C | |  | c. | 662 °C | |  | d. | 279 °C | |  | e. | 116 °C |  |  |  | | --- | --- | | *ANSWER:* | e | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | free energy | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 2/27/2017 5:17 AM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 57. The following reaction takes place at 120°C: H2O(*l*) → H2O(*g*)     Δ*H* = 44.0 kJ/mol   Δ*S* = 0.119 kJ/mol K Which of the following must be true?   |  |  |  | | --- | --- | --- | |  | a. | The reaction is not spontaneous. | |  | b. | The reaction is spontaneous. | |  | c. | Δ*G* = 0 | |  | d. | Δ*G* < 0 | |  | e. | Two of these. |  |  |  | | --- | --- | | *ANSWER:* | e | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | free energy | general chemistry | spontaneity | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| When ignited, solid ammonium dichromate decomposes in a fiery display. This is the reaction for a "volcano" demonstration. The decomposition produces nitrogen gas, water vapor, and chromium(III) oxide. The temperature is constant at 25°C.   |  |  |  | | --- | --- | --- | | Substance | Δ*Hf°* (kJ/mol) | *S*° (kJ/mol K) | | Cr2O3(*g*) | –1147 | 0.08120 | | H2O(*l*) | –242 | 0.1187 | | N2(*g*) | 0 | 0.1915 | | (NH4)2Cr2O7(*s*) | –22.5 | 0.1137 |   ​ |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 58. Determine Δ*S*univ*°* (in kJ/mol K).   |  |  |  | | --- | --- | --- | |  | a. | 7.66 | |  | b. | 6.39 | |  | c. | 84.3 | |  | d. | 5.22 | |  | e. | 6.03 |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Difficult | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-4 | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 59. Determine Δ*S°* reaction (in kJ/mol K).   |  |  |  | | --- | --- | --- | |  | a. | 0.2777 | |  | b. | 0.8612 | |  | c. | 0.7475 | |  | d. | 0.6338 | |  | e. | 0.1590 |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.5 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-4 | | *KEYWORDS:* | Chemistry | entropy change for a reaction | general chemistry | thermochemistry | thermodynamics | third law of thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 60. Determine Δ*G°* (in kJ/mol).   |  |  |  | | --- | --- | --- | |  | a. | –191.4 | |  | b. | –2281.4 | |  | c. | –38.9 | |  | d. | 1903.6 | |  | e. | –1555.4 |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.6 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-4 | | *KEYWORDS:* | Chemistry | free energy | general chemistry | standard free energy change | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 61. The third law of thermodynamics states:   |  |  |  | | --- | --- | --- | |  | a. | The entropy of the universe is increasing. | |  | b. | The entropy of the universe is constant. | |  | c. | The entropy is zero at 0 K for a perfect crystal. | |  | d. | The absolute entropy of a substance decreases with increasing temperature. | |  | e. | The entropy of the universe equals the sum of the entropy of system and surroundings. |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.5 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamics | third law of thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 62. For which of the following processes would Δ*S°* be expected to be most positive?   |  |  |  | | --- | --- | --- | |  | a. | O2(*g*) + 2H2(*g*) → 2H2O(*g*) | |  | b. | H2O(*l*) → H2O(*s*) | |  | c. | NH3(*g*) + HCl(*g*) → NH4Cl(*g*) | |  | d. | 2NH4NO3(*s*) → 2N2(*g*) + O2(*g*) + 4H2O(*g*) | |  | e. | N2O4(*g*) → 2NO2(*g*) |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.5 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy change for a reaction | general chemistry | thermochemistry | thermodynamics | third law of thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 63. Which of the following statements is (are) always true?   |  |  | | --- | --- | | I. | In order for a process to be spontaneous, the entropy of the universe must increase. | | II. | A system cannot have both energy disorder and positional disorder. | | III. | Δ*S*univ = | | IV. | *S*° is zero for elements in their standard states. |   ​   |  |  |  | | --- | --- | --- | |  | a. | I | |  | b. | I, IV | |  | c. | I, III, IV | |  | d. | II, IV | |  | e. | II |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.5 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 2/27/2017 7:39 AM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 64. In which process is Δ*S* expected to be positive?   |  |  |  | | --- | --- | --- | |  | a. | a reaction that forms a solid precipitant from aqueous solutions | |  | b. | an ideal gas being compressed at a constant temperature and against a constant pressure | |  | c. | water freezing below its normal freezing point | |  | d. | a spontaneous endothermic process at a constant temperature and pressure | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.5 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 65. In which reaction is Δ*S*° expected to be positive?   |  |  |  | | --- | --- | --- | |  | a. | I2(*g*) → I2(*s*) | |  | b. | H2O(*l*) → H2O(*s*) | |  | c. | CH3OH(*g*) + O2(*g*) → CO2(*g*) + 2H2O(*l*) | |  | d. | 2O2(*g*) + 2SO(*g*) → 2SO3(*g*) | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | e | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.5 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 66. For the dissociation reaction of the acid HF:         HF(*aq*) H+(*aq*) + F–(*aq*) Δ*S* is observed to be negative. The best explanation is:   |  |  |  | | --- | --- | --- | |  | a. | This is the expected result since each HF molecule produces two ions when it dissociates. | |  | b. | Hydration of the ions produces the negative value of Δ*S*. | |  | c. | The reaction is expected to be exothermic and thus Δ*S* should be negative. | |  | d. | The reaction is expected to be endothermic and thus Δ*S* should be negative. | |  | e. | None of these can explain the negative value of Δ*S*. |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.5 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 67. Consider the dissociation of hydrogen:                H2(*g*) 2H(*g*) One would expect that this reaction:   |  |  |  | | --- | --- | --- | |  | a. | will be spontaneous at any temperature | |  | b. | will be spontaneous at high temperatures | |  | c. | will be spontaneous at low temperatures | |  | d. | will not be spontaneous at any temperature | |  | e. | will never happen |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.5 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 68. When a stable diatomic molecule spontaneously forms from its atoms, what are the signs of Δ*H°*, Δ*S°*, and Δ*G°*?   |  |  |  | | --- | --- | --- | | Δ*H* | Δ*S* | ΔG |  |  |  |  | | --- | --- | --- | |  | a. | +        +        + | |  | b. | +        –        – | |  | c. | –        +        + | |  | d. | –        –        + | |  | e. | –        –        – |  |  |  | | --- | --- | | *ANSWER:* | e | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.5 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | free energy | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/16/2017 4:56 AM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Consider the reaction           2N2O5(*g*)  4NO2(*g*) + O2(*g*) at 25°C for which the following data are relevant:   |  |  |  | | --- | --- | --- | |  | Δ*Hf°* | *S°* | | N2O5 | 11.289 kJ/mol | 355.28 J/K mol | | NO2 | 33.150 kJ/mol | 239.90 J/K mol | | O2 | 0 kJ/mol | 204.80 J/K mol |   ​ |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 69. Calculate Δ*S°* for the reaction.   |  |  |  | | --- | --- | --- | |  | a. | 809.12 J/K | |  | b. | 89.42 J/K | |  | c. | 453.84 J/K | |  | d. | –265.86 J/K | |  | e. | 1164.40 J/K |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.5 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *PREFACE NAME:* | Ref 17-5 | | *KEYWORDS:* | Chemistry | entropy change for a reaction | general chemistry | thermochemistry | thermodynamics | third law of thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 70. Calculate Δ*H°* for the reaction.   |  |  |  | | --- | --- | --- | |  | a. | 110.022 kJ | |  | b. | 10.572 kJ | |  | c. | 121.311 kJ | |  | d. | 21.861 kJ | |  | e. | 155.178 kJ |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.6 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *PREFACE NAME:* | Ref 17-5 | | *KEYWORDS:* | Chemistry | general chemistry | heats of reaction | standard enthalpies of formation | thermochemistry | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 71. Calculate Δ*G°* for the reaction at 25°C.   |  |  |  | | --- | --- | --- | |  | a. | –1.35 × 105 kJ | |  | b. | 98.7 kJ | |  | c. | –25.2 kJ | |  | d. | 135 kJ | |  | e. | 0 |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.6 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *PREFACE NAME:* | Ref 17-5 | | *KEYWORDS:* | Chemistry | free energy | general chemistry | standard free energy change | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 72. The reaction is allowed to proceed until all substances involved have reached their equilibrium concentrations. Under those conditions, what is Δ*G* for the reaction?   |  |  |  | | --- | --- | --- | |  | a. | –1.35 × 105 kJ | |  | b. | 98.7 kJ | |  | c. | –25.2 kJ | |  | d. | 135 kJ | |  | e. | 0 |  |  |  | | --- | --- | | *ANSWER:* | e | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *PREFACE NAME:* | Ref 17-5 | | *KEYWORDS:* | Chemistry | free energy | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 73. Which of the following is true for this reaction?   |  |  |  | | --- | --- | --- | |  | a. | Both Δ*H*° and Δ*S*° favor the reaction's spontaneity. | |  | b. | Both Δ*H*° and Δ*S*° oppose the reaction's spontaneity. | |  | c. | Δ*H*° favors the reaction, but Δ*S*° opposes it. | |  | d. | Δ*H*° opposes the reaction, but Δ*S*° favors it. | |  | e. | The reaction cannot occur at room temperature. |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.6 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-5 | | *KEYWORDS:* | Chemistry | free energy | general chemistry | spontaneity | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 74. Which of the following is not a state function?   |  |  |  | | --- | --- | --- | |  | a. | *q* | |  | b. | *G* | |  | c. | *H* | |  | d. | *E* | |  | e. | *P* |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.6 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | free energy | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 75. The standard free energy of formation of NaCl(*s*) is –384.0 kJ/mol. Δ*G°* for the reaction 2NaCl(*s*) → 2Na(*s*) + Cl2(*g*) is:   |  |  |  | | --- | --- | --- | |  | a. | –384.0 kJ | |  | b. | 768.0 kJ | |  | c. | 384.0 kJ | |  | d. | –768.0 kJ | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.6 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | free energy | general chemistry | standard free energy change | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 76. Consider the following hypothetical reaction at 310 K. Standard free energies of formation are given in parentheses.   |  |  |  |  | | --- | --- | --- | --- | |  | B → | C | Δ*G°* = –33.6 kJ/mol | |  | (?) | (176.4 kJ/mol) |  |   Calculate the standard free energy of formation of compound B.   |  |  |  | | --- | --- | --- | |  | a. | 210.0 kJ/mol | |  | b. | –210.0 kJ/mol | |  | c. | 142.8 kJ/mol | |  | d. | –142.8 kJ/mol | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.6 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | free energy | general chemistry | standard free energies of formation | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 77. For the reaction Δ*H°* = 126.4 kJ/mol and Δ*S°* = –74.9 J/K mol. At 379°C, what is Δ*G* ?   |  |  |  | | --- | --- | --- | |  | a. | 154.8 kJ/mol | |  | b. | 49.0 kJ/mol | |  | c. | 175.2 kJ/mol | |  | d. | 77.6 kJ/mol | |  | e. | 157.3 kJ/mol |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.6 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | free energy | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 78. Determine Δ*G°* for the following reaction:           CH4(*g*) + 2O2(*g*) → CO2(*g*) + 2H2O(*l*)   |  |  | | --- | --- | | Substance | Δ*Gf°*(kJ/mol) | | CH4(*g*) | –50.74 | | O2(*g*) | 0 | | CO2(*g*) | –394.4 | | H2O(*l*) | –237.4 |  |  |  |  | | --- | --- | --- | |  | a. | –581.1 kJ | |  | b. | –919.9 kJ | |  | c. | –818.5 kJ | |  | d. | –682.5 kJ | |  | e. | 131.1 kJ |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.6 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | free energy | general chemistry | standard free energy change | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 79. Of Δ*S*, Δ*S*surr, Δ*S*univ, and Δ*G*, which are state functions?   |  |  |  | | --- | --- | --- | |  | a. | Δ*S*, Δ*S*surr, Δ*S*univ, and Δ*G* are all state functions. | |  | b. | Only Δ*S*, Δ*S*univ, and Δ*G* are state functions. | |  | c. | Only Δ*S* and Δ*G* are state functions. | |  | d. | Only Δ*S*, Δ*S*surr, and Δ*S*univ are state functions. | |  | e. | Only Δ*S*univ and Δ*G* are state functions. |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.6 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 80. At 699 K, Δ*G°* = –23.25 kJ for the reaction H2(*g*) + I2(*g*) 2HI(*g*). Calculate Δ*G* for this reaction if the reagents are both supplied at 10.0 atm pressure and the product is at 2.27 atm pressure.   |  |  |  | | --- | --- | --- | |  | a. | –17.2 kJ | |  | b. | 17.2 kJ | |  | c. | 6.0 kJ | |  | d. | –40.5 kJ | |  | e. | 40.5 kJ |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.7 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | free-energy dependence on pressure | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 81. The standard molar free energies of formation of NO2(*g*) and N2O4(*g*) at 25°C are 51.84 and 98.00 kJ/mol, respectively. What is the value of Δ*G* for the reaction written as follows at 25°C if the pressures of both gases are 1.88 atm?           2NO2 N2O4   |  |  |  | | --- | --- | --- | |  | a. | –4.12 | |  | b. | 4.12 | |  | c. | –7.24 | |  | d. | –5.68 | |  | e. | –5.81 |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.7 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | free-energy dependence on pressure | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 82. Elemental sulfur exists in two crystalline forms, rhombic and monoclinic. From the following data, calculate the equilibrium temperature at which monoclinic sulfur and rhombic sulfur are in equilibrium.   |  |  |  | | --- | --- | --- | |  | Δ*H*f° (kJ/mol) | *S*° (J/K mol) | | S (rhombic) | 0 | 31.880 | | S (monoclinic) | 0.30 | 32.546 |  |  |  |  | | --- | --- | --- | |  | a. | 450 K | |  | b. | 200 K | |  | c. | –200 K | |  | d. | –450 K | |  | e. | 0 K |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.7 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | free energy | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 83. Given the following data (Δ*H*f, *S*°, respectively) for N2O4(*l*) -20. kJ/mol, 209.0 J/K mol, and N2O4(*g*) 10. kJ/mol, 303.8 J/K mol. Above what temperature (in °C) is the vaporization of N2O4 liquid spontaneous?   |  |  |  | | --- | --- | --- | |  | a. | Above –178 °C. | |  | b. | Above –230 °C. | |  | c. | Above 3 °C. | |  | d. | Above 30. °C. | |  | e. | Above 43 °C. |  |  |  | | --- | --- | | *ANSWER:* | e | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.7 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | entropy change for a reaction | general chemistry | thermochemistry | thermodynamics | third law of thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 84. The reaction 2H2O(*g*) → 2H2(*g*) + O2(*g*) has a positive value of Δ*G*°. Which of the following statements must be true?   |  |  |  | | --- | --- | --- | |  | a. | The reaction is slow. | |  | b. | The reaction will not occur. (When H2O(*g*) is introduced into a flask, no O2 or H2 will form even over a long period of time.) | |  | c. | The reaction is exothermic. | |  | d. | The equilibrium lies far to the right. | |  | e. | None of these is true. |  |  |  | | --- | --- | | *ANSWER:* | e | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 85. Given the following free energies of formation:   |  |  | | --- | --- | |  | Δ*Gf°* | | C2H2(*g*) | 209.2 kJ/mol | | C2H6(*g*) | –32.85 kJ/mol |   calculate *K*p at 298 K for C2H2(*g*) + 2H2(*g*) C2H6(*g*)   |  |  |  | | --- | --- | --- | |  | a. | 97.7 | |  | b. | 1.10 | |  | c. | 8.17 × 1030 | |  | d. | 2.69 × 1042 | |  | e. | None of these is within a factor of 10 of the correct answer. |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 86. The acid dissociation constant for a weak acid HX at 25°C is 1.9  10–6. Calculate the free energy of formation for X–(*aq*) at 25°C. The standard free energies of HX(*aq*) and H+(*aq*) at 25°C are –245.4 kJ/mol and 0, respectively.   |  |  |  | | --- | --- | --- | |  | a. | –243 kJ/mol | |  | b. | 278 kJ/mol | |  | c. | 0 | |  | d. | –213 kJ/mol | |  | e. | –278 kJ/mol |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 87. The standard molar free energies of formation of NO2(*g*) and N2O4(*g*) at 25°C are 51.840 and 98.065 kJ/mol, respectively. What is the value of *K*p (in atm) for the reaction written as follows at 25°C?           2NO2 N2O4   |  |  |  | | --- | --- | --- | |  | a. | 5.40 × 1011 | |  | b. | 1.00 | |  | c. | 9.64 | |  | d. | 4.33 × 10–36 | |  | e. | 7.89 × 10–9 |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 88. Given that Δ*Gf°* for NH3 = –16.673 kJ/mol, calculate the equilibrium constant for the following reaction at 298 K:           N2(*g*) + 3H2(*g*) 2NH3(*g*)   |  |  |  | | --- | --- | --- | |  | a. | 7.00 × 105 | |  | b. | 8.37 × 102 | |  | c. | 1.01 | |  | d. | 4.73 × 1069 | |  | e. | 5.86 × 108 |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 89. Calculate *K*sp for the salt NaCl at 25°C.   |  |  | | --- | --- | | Substance | Δ*Gf°*(in kJ/mol) | | Na+(*aq*) | –262.0 | | Cl–(*aq*) | –131.0 | | NaCl(*s*) | 383.6 |  |  |  |  | | --- | --- | --- | |  | a. | 44 | |  | b. | 4.4 × 1019 | |  | c. | 9.4 | |  | d. | 4.4 | |  | e. | 0.44 |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 90. Determine Δ*G°* for the weak acid, HF, at 25°C. (*K*a = 7.17 × 10–4)   |  |  |  | | --- | --- | --- | |  | a. | 1.5 kJ | |  | b. | 177 kJ | |  | c. | 7.79 kJ | |  | d. | 1.78 kJ | |  | e. | 17.9 kJ |  |  |  | | --- | --- | | *ANSWER:* | e | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 91. Assume that the reaction:           CO(*g*) + H2O(*g*) CO2(*g*) + H2(*g*) occurs in an ideal mixture of ideal gases. At 700. K, *K*p = 3.58. At this temperature, Δ*G°* equals:   |  |  |  | | --- | --- | --- | |  | a. | 0 kJ | |  | b. | 7.42 kJ | |  | c. | –3.71 kJ | |  | d. | –7.42 kJ | |  | e. | –3.22 kJ |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 92. Consider the reaction:            2SO2(*g*) 2SO3(*g*)  for which Δ*H°* = –200. kJ and Δ*S°* = –186.8 J/K at 25°C. Assuming that Δ*H°* and Δ*S°* are independent of temperature, calculate the temperature where *K*p = 1.   |  |  |  | | --- | --- | --- | |  | a. | 971. K | |  | b. | 2071 K | |  | c. | 200. K | |  | d. | 1071 K | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/16/2017 5:47 AM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 93. For the following reaction, CO2(g) + 2H2O(g) CH4(g) + 2O2(g), Δ*H°* = 803 kJ which of the following will increase *K*?   |  |  |  | | --- | --- | --- | |  | a. | decrease number of moles of methane | |  | b. | increase volume of system | |  | c. | increase the temperature of system | |  | d. | all of the above | |  | e. | none of the above |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 94. For a particular reaction the equilibrium constant is 0.0124 at 370.°C and Δ*H°* is +16.0 kJ at 25°C. Assuming Δ*H°* and Δ*S°* are temperature independent, calculate Δ*S°* for the reaction.   |  |  |  | | --- | --- | --- | |  | a. | 6.74 J/K | |  | b. | –6.74 J/K | |  | c. | –11.6 J/K | |  | d. | 11.6 J/K | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 95. Calculate Δ*G°* for at 599.9 K, using the following data:           H2(*g*) + O2(*g*) H2O2(g)               *K*p = 2.3 × 106 at 599.9 K           2H2(*g*) + O2(*g*) 2H2O(*g*)            *K*p = 1.8 × 1037 at 599.9 K   |  |  |  | | --- | --- | --- | |  | a. | 141 kJ | |  | b. | –501 kJ | |  | c. | 501 kJ | |  | d. | –287 kJ | |  | e. | 287 kJ |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 96. Consider the following hypothetical reaction (at 310.2 K). Standard free energies in kJ/mol are given in parentheses.               A           B         +            C                    Δ*G°* = ?        (-32.2)             (207.8)            (-237.0) What is the value of the equilibrium constant for the reaction at 310.2 K?   |  |  |  | | --- | --- | --- | |  | a. | 0.31 | |  | b. | 1.0 | |  | c. | 8.3 × 104 | |  | d. | 273 | |  | e. | 0.42 |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 97. The equilibrium constant *K* for the dissociation reaction of a molecule X2           X2(*g*) 2X(*g*) was measured as a function of temperature (in K). A graph of ln *K* versus 1/*T* for this reaction gives a straight line with a slope of –1.352 × 104 and an intercept of 16.77 K. The value of Δ*S* for this dissociation reaction is:   |  |  |  | | --- | --- | --- | |  | a. | 2.017 J/K mol | |  | b. | 278.9 J/K mol | |  | c. | 139.4 J/K mol | |  | d. | 69.71 J/K mol | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Difficult | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 98. The following reaction has a ΔG° value of 42.05 kJ/mol at 25°C.          HB(*aq*) + H2O(*l*)  H3O+(*aq*) + B–(*aq*)  Calculate the *K*a for the acid HB.   |  |  |  | | --- | --- | --- | |  | a. | 0.983 | |  | b. | –17 | |  | c. | 4.26 × 10–8 | |  | d. | 4.21 × 107 | |  | e. | –202 |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/8/2017 8:18 AM | | *DATE MODIFIED:* | 3/23/2017 5:48 AM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 99. The standard free energy of formation of nitric oxide, NO, at 1000. K (roughly the temperature in an automobile engine during ignition) is 78.4 kJ/mol. Calculate the equilibrium constant for the reaction           N2(*g*) + O2(*g*) 2NO(*g*) at 1000. K.   |  |  |  | | --- | --- | --- | |  | a. | 1.57 × 105 | |  | b. | 8.03 × 10–5 | |  | c. | –14.8 | |  | d. | 6.45 × 10-9 | |  | e. | 0.948 |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 100. Consider the reaction 2NO2(*g*) N2O4(*g*); Δ*H°* = –56.8 kJ and Δ*S°* = –175 J/K. In a container (at 298 K) N2O4(*g*) and NO2(*g*) are mixed with initial partial pressures of 2.4 atm and 0.42 atm, respectively. Which of the following statements is correct?   |  |  |  | | --- | --- | --- | |  | a. | Some N2O4(*g*) will decompose into NO2(*g*). | |  | b. | Some NO2(*g*) will dimerize to form N2O4(*g*). | |  | c. | The system is at equilibrium at these initial pressures. | |  | d. | The final total pressure must be known to answer this question. | |  | e. | None of these. |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |
| --- |
| Consider the gas phase reaction NO + O2 NO2 for which Δ*H°* = –57.05 kJ and *K* = 1.54 × 106 at 25°C.  ​  ​ |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 101. Calculate Δ*H°* at 25°C for the following reaction:           2NO + O2 2NO2   |  |  |  | | --- | --- | --- | |  | a. | 57.05 kJ | |  | b. | –114.1 kJ | |  | c. | –28.5 kJ | |  | d. | 3255 kJ | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *PREFACE NAME:* | Ref 17-6 | | *KEYWORDS:* | Chemistry | general chemistry | heats of reaction | Hess's law | thermochemistry | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 102. Calculate *K* for the following reaction at 25°C:           2NO + O2 2NO2   |  |  |  | | --- | --- | --- | |  | a. | 3.08 × 106 | |  | b. | 2.37 × 1012 | |  | c. | 7.70 × 105 | |  | d. | 1.24 × 103 | |  | e. | 1.54 × 106 |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *PREFACE NAME:* | Ref 17-6 | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 103. Calculate Δ*G°* at 25°C for the following reaction:           2NO + O2 2NO2   |  |  |  | | --- | --- | --- | |  | a. | –70.6 kJ | |  | b. | –5.92 kJ | |  | c. | –35.3 kJ | |  | d. | 5.92 kJ | |  | e. | 70.6 kJ |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *PREFACE NAME:* | Ref 17-6 | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 104. Calculate Δ*S°* at 25*°*C for the following reaction:           2NO + O2 2NO2   |  |  |  | | --- | --- | --- | |  | a. | 237 J/K | |  | b. | –146 J/K | |  | c. | –237 J/K | |  | d. | –264 J/K | |  | e. | 264 J/K |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *PREFACE NAME:* | Ref 17-6 | | *KEYWORDS:* | Chemistry | general chemistry | heats of reaction | Hess's law | thermochemistry | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 105. For this system at equilibrium, how will raising the temperature affect the amount of NO present?   |  |  |  | | --- | --- | --- | |  | a. | The amount of NO will increase. | |  | b. | The amount of NO will decrease. | |  | c. | The amount of NO will remain the same. | |  | d. | Cannot be determined. | |  | e. | Answer depends on the value of *K*. |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-6 | | *KEYWORDS:* | Chemistry | general chemistry | temperature dependence of free energy | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 106. What would be the effect on the amount of NO present of compressing the equilibrium system to a smaller volume, while keeping the temperature constant?   |  |  |  | | --- | --- | --- | |  | a. | The amount of NO will increase. | |  | b. | The amount of NO will decrease. | |  | c. | The amount of NO will remain the same. | |  | d. | Cannot be determined. | |  | e. | Answer depends on the value of *K*. |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-6 | | *KEYWORDS:* | Chemistry | free-energy dependence on pressure | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 107. Given CH3CO2H(*aq*) H+(*aq*) + CH3CO2–(*aq*) at 25°C, *K*a = 1.80 × 10–5. What is Δ*G°* at 25°C?   |  |  |  | | --- | --- | --- | |  | a. | –27.1 kJ | |  | b. | 27.1 kJ | |  | c. | 2.27 kJ | |  | d. | –2.27 kJ | |  | e. | 27.1 J |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 108. Given CH3CO2H(*aq*) H+(*aq*) + CH3CO2–(*aq*) at 25°C, *K*a = 1.83 × 10–5. What is Δ*G* at 25°C for a solution in which the initial concentrations are:           [CH3CO2H]0 = 0.10 *M*           [H+]0 = 6.4 × 10–8 *M*           [CH3CO2–]0 = 0.010 *M*   |  |  |  | | --- | --- | --- | |  | a. | –73.8 kJ | |  | b. | 73.8 kJ | |  | c. | 19.7 kJ | |  | d. | –19.7 kJ | |  | e. | 27.0 kJ |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 109. The equilibrium constant of a certain reaction was measured at various temperatures to give the plot shown below. What is Δ*S°* for the reaction in J/mol ⋅ K?   |  |  |  | | --- | --- | --- | |  | a. | 0.20 | |  | b. | 3.0 | |  | c. | 25 | |  | d. | –50. | |  | e. | –8.3 × 103 |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | general chemistry | spontaneity and temperature change | temperature dependence of free energy | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 110. Consider a weak acid, HX. If a 0.10 *M* solution of HX has a pH of 4.04 at 25°C, what is Δ*G°* for the acid's dissociation reaction at 25°C?   |  |  |  | | --- | --- | --- | |  | a. | –40.4 kJ | |  | b. | 3.39 kJ | |  | c. | 0 | |  | d. | –3.39 kJ | |  | e. | 40.4 kJ |  |  |  | | --- | --- | | *ANSWER:* | e | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 111. For the reaction CO(*g*) + 2H2(*g*) CH3OH(*g*)  Δ*G°*700K = –13.456 kJ. The *K*p for this reaction at 700. K is:   |  |  |  | | --- | --- | --- | |  | a. | 10.1 | |  | b. | 1.00 | |  | c. | 1.54 | |  | d. | 2.31 | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 112. For the reaction 2HF(*g*) H2(*g*) + F2(*g*), Δ*G°* = 38.3 kJ, at 1000 K. If, at this temperature, 5.00 moles of HF(*g*), 0.500 moles of H2(*g*), and 0.75 moles of F2(*g*) are mixed in a 1.00-L container:   |  |  |  | | --- | --- | --- | |  | a. | Some HF will decompose (to yield H2 and F2). | |  | b. | The system is at equilibrium. | |  | c. | Some HF will be formed (from H2 and F2). | |  | d. | Not enough data are given to answer this question. | |  | e. | None of these (A-D). |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |
| --- |
| Consider the following system at equilibrium at 25°C: PCl3(*g*) + Cl2(*g*) PCl5(*g*) for which Δ*H°* = –92.5kJ at 25°C. |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 113. If the temperature of the system is raised, the ratio of the partial pressure of PCl5 to the partial pressure of PCl3 will   |  |  |  | | --- | --- | --- | |  | a. | increase | |  | b. | decrease | |  | c. | stay the same | |  | d. | impossible to tell without more information | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-7 | | *KEYWORDS:* | chemical equilibrium | Chemistry | general chemistry | Le Chatelier's principle | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 114. When some Cl2(*g*) is added at constant volume and temperature, the ratio of the partial pressure of PCl5 to the partial pressure of PCl3 will   |  |  |  | | --- | --- | --- | |  | a. | increase | |  | b. | decrease | |  | c. | stay the same | |  | d. | impossible to tell without more information | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-7 | | *KEYWORDS:* | chemical equilibrium | Chemistry | general chemistry | Le Chatelier's principle | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 115. When the volume is decreased at constant temperature, the ratio of the partial pressure of PCl5 to the partial pressure of PCl3 will   |  |  |  | | --- | --- | --- | |  | a. | increase | |  | b. | decrease | |  | c. | stay the same | |  | d. | impossible to tell without more information | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-7 | | *KEYWORDS:* | chemical equilibrium | Chemistry | general chemistry | Le Chatelier's principle | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 116. Water gas, a commercial fuel, is made by the reaction of hot coke carbon with steam.           C(*s*) + H2O(*g*) CO(*g*) + H2(*g*) When equilibrium is established at 816°C the concentrations of CO, H2, and H2O are 4.00 × 10–2, 4.00 × 10–2, and 1.00 × 10–2 mole/liter, respectively. Calculate the value of Δ*G°* for this reaction at 816°C.   |  |  |  | | --- | --- | --- | |  | a. | 12.4 kJ | |  | b. | –12.55 kJ | |  | c. | 54.25 kJ | |  | d. | 16.59 kJ | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |
| --- |
| The equilibrium constant *K*p (in atm) for the dissociation reaction of Cl2 2Cl was measured as a function of temperature (in K). A graph of ln *K*p versus 1/*T* for this reaction gives a straight line with a slope of –1.427 × 104 and an intercept of 14.51. |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 117. From these data, which of the following statements is true?   |  |  |  | | --- | --- | --- | |  | a. | The reaction is exothermic. | |  | b. | The reaction is endothermic. | |  | c. | The reaction rate is high | |  | d. | The reaction is not spontaneous. | |  | e. | None of these. |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-8 | | *KEYWORDS:* | Chemistry | general chemistry | spontaneity and temperature change | temperature dependence of free energy | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 118. The value of Δ*H* for this dissociation reaction is:   |  |  |  | | --- | --- | --- | |  | a. | –118.6 kJ | |  | b. | 118.6 kJ | |  | c. | 1.716 kJ | |  | d. | –1.716 kJ | |  | e. | none of these |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.8 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *PREFACE NAME:* | Ref 17-8 | | *KEYWORDS:* | Chemistry | general chemistry | thermochemistry | thermodynamic equilibrium constant (K) | thermodynamics | | *OTHER:* | Quantitative | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/29/2017 12:13 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 119. For a certain process, at 300. K, Δ*G* = –48.7 kJ and Δ*H* = –7.0 kJ. If the process is carried out reversibly, the amount of useful work that can be performed is   |  |  |  | | --- | --- | --- | |  | a. | –55.7 kJ | |  | b. | –7.0 kJ | |  | c. | –41.7 kJ | |  | d. | –48.7 kJ | |  | e. | 41.7 kJ |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.9 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | general chemistry | reversible and irreversible processes | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 120. For a certain process, at 300. K, Δ*G* = –14.5 kJ and Δ*H* = –7.0 kJ. If the process is carried out so that no useful work is performed, Δ*G* is   |  |  |  | | --- | --- | --- | |  | a. | 14.5 kJ | |  | b. | 7.0 kJ | |  | c. | 0 | |  | d. | –7.0 kJ | |  | e. | –14.5 kJ |  |  |  | | --- | --- | | *ANSWER:* | e | | *POINTS:* | 1 | | *DIFFICULTY:* | Moderate | | *REFERENCES:* | 17.9 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | True | | *KEYWORDS:* | Chemistry | free energy and work | general chemistry | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 121. Which statement is true?   |  |  |  | | --- | --- | --- | |  | a. | All real processes are irreversible. | |  | b. | A thermodynamically reversible process takes place infinitely fast. | |  | c. | In a reversible process, the state functions of the system are always much greater than those of the surroundings. | |  | d. | There is always more heat given off to the surroundings in a reversible process than in an unharnessed one. | |  | e. | All statements (A–D) are true. |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.9 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | general chemistry | reversible and irreversible processes | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |
| --- |
| Would you predict an increase or decrease in entropy for each of the following? |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 122. The freezing of water   |  |  | | --- | --- | | *ANSWER:* | decrease in entropy  Positional entropy relates to the phase of the substance: *S*solid < *S*liquid < *S*gas. See Sec. 17.1, Zumdahl, *Chemistry*. | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.1 | | *QUESTION TYPE:* | Subjective Short Answer | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-9 | | *KEYWORDS:* | Chemistry | entropy and molecular disorder | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 123. He(*g*) at 3 atm → He(*g*) at 1 atm   |  |  | | --- | --- | | *ANSWER:* | increase in entropy  At constant temperature, a decrease in pressure corresponds to an increase in volume, which imparts greater positional entropy. See Sec. 17.1, Zumdahl, *Chemistry*. | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.1 | | *QUESTION TYPE:* | Subjective Short Answer | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-9 | | *KEYWORDS:* | Chemistry | entropy and molecular disorder | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 124. 2H2(*g*) + O2(*g*) → 2H2O(*g*)   |  |  | | --- | --- | | *ANSWER:* | decrease in entropy  The change in positional entropy is dominated by the relative numbers of molecules in the gas phase. See Sec. 17.5, Zumdahl, *Chemistry*. | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.5 | | *QUESTION TYPE:* | Subjective Short Answer | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-9 | | *KEYWORDS:* | Chemistry | entropy change for a reaction | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 125. 2KClO3(*s*) → 2KCl(*s*) + 3O2(*g*)   |  |  | | --- | --- | | *ANSWER:* | increase in entropy  The change in positional entropy is dominated by the relative numbers of molecules in the gas phase. See Sec. 17.5, Zumdahl, *Chemistry*. | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.5 | | *QUESTION TYPE:* | Subjective Short Answer | | *HAS VARIABLES:* | False | | *PREFACE NAME:* | Ref 17-9 | | *KEYWORDS:* | Chemistry | entropy change for a reaction | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 126. Which of the following statements is FALSE?   |  |  |  | | --- | --- | --- | |  | a. | Increasing the temperature of a system increases the entropy. | |  | b. | 2 moles of a gas at one atmosphere pressure has a greater entropy than 2 moles of the same gas at 1000 mmHg pressure. | |  | c. | The reaction of O3(g) to produce O2(g) has a negative entropy change. | |  | d. | The S° of methane (CH4) is less than that of ethane (C2H6). | |  | e. | A substance can only have zero entropy at absolute zero in a perfect crystal. |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.1 17.5 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 127. Which item (a, b or c) in each of the three groups below has the lowest entropy?  ​  I.        (a) 10 g ice   (b) 10 g water vapor   (c) 10 g liquid water  II.       (a) 1 mole NaCl solid   (b) 1 mol NaCl in 1 M aqueous solution   (c) 1 mol molten NaCl  III.      (a) 1 mole C2H6(g),   (b) 1 mole CH4(g),   (c) 1 mol C3H8(g) all at 25 °C and 1 atm   |  |  |  | | --- | --- | --- | |  | a. | a, a, b | |  | b. | c, b, c | |  | c. | b, b, c | |  | d. | a, b, c | |  | e. | a, a, c |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.5 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 2/28/2017 12:46 AM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 128. In which of the following pairs is the substance with the HIGHER entropy listed first?  ​  I.   NaCl(s), NaCl(aq)  II.  CO(g), CO2(g)  III. 1 mole of H2(g) at 25°C; 1 mole of H2(g) at 50°C   |  |  |  | | --- | --- | --- | |  | a. | I only | |  | b. | II only | |  | c. | III only | |  | d. | all of them | |  | e. | none of them |  |  |  | | --- | --- | | *ANSWER:* | e | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.5 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 2/28/2017 2:10 AM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 129. Predict the sign of ΔS° for each of the following processes:  ​  I.      2 K(s) + Cl2(g) → 2 KCl(s)  II.    CH4(g) → C(s) + 2 H2(g)  III.   CaCO3(s) → CaO(s) + CO2(g)   |  |  |  | | --- | --- | --- | |  | a. | negative, negative, positive | |  | b. | negative, negative, negative | |  | c. | positive, negative, negative | |  | d. | negative, positive, positive | |  | e. | positive, positive, positive |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.5 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy change for a reaction | general chemistry | thermochemistry | thermodynamics | third law of thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 2/28/2017 12:54 AM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 130. Which of the following reactions will have a positive value of ΔS°?  ​  I.   Pb(s)   +   Cl2(g)    →  PbCl2(s)  II.  2H2S(g)   +   3O2(g)  →    2H2O(g)   +   2SO2(g)  III. K2SO4(s)   →   2K+(aq)   +   SO42-(aq)   |  |  |  | | --- | --- | --- | |  | a. | I only | |  | b. | II only | |  | c. | III only | |  | d. | I and II | |  | e. | II and III |  |  |  | | --- | --- | | *ANSWER:* | c | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.5 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy change for a reaction | general chemistry | thermochemistry | thermodynamics | third law of thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 2/28/2017 2:12 AM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 131. Which of the following processes should show the greatest increase in entropy?   |  |  |  | | --- | --- | --- | |  | a. | C6H6(l) + 15/2 O2(g) →  6 CO2(g) + 3 H2O(g) | |  | b. | 2 NO2(g) →  N2O4(g) | |  | c. | C2H4(g) + H2(g) →  C2H6(g) | |  | d. | BaS(s) + 2 NaNO3(s) →  Ba(NO3)2(s) + Na2S(s) | |  | e. | This cannot be predicted without additional information. |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.5 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy change for a reaction | general chemistry | thermochemistry | thermodynamics | third law of thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 2/28/2017 2:13 AM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 132. In which of the following reactions do you expect to have the largest increase in entropy?   |  |  |  | | --- | --- | --- | |  | a. | I2(s) → I2(g) | |  | b. | 2IF(g) → I2(g) + F2(g) | |  | c. | Mn(s) + O2(g) → MnO2(s) | |  | d. | Hg(*l*) + S(s) → HgS(s) | |  | e. | CuSO4(s) + 5H2O(*l*) → CuSO4.H2O(s) |  |  |  | | --- | --- | | *ANSWER:* | a | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.5 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | entropy change for a reaction | general chemistry | thermochemistry | thermodynamics | third law of thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 2/28/2017 2:14 AM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 133. The exothermic reaction, 2 Cu(s) + O2(g) → 2 CuO(s), is spontaneous   |  |  |  | | --- | --- | --- | |  | a. | At high temperatures | |  | b. | At low temperatures | |  | c. | At all temperatures | |  | d. | The reaction is nonspontaneous at all temperatures | |  | e. | Cannot be determined with the available information |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.5 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | free energy | general chemistry | spontaneity | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 2/28/2017 1:08 AM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 134. For the reaction, X + Y → A + B, ΔGo is –1324 kJ. Which one of the following statements is NOT valid concerning the reaction?   |  |  |  | | --- | --- | --- | |  | a. | The reaction is thermodynamically favorable. | |  | b. | The reaction is spontaneous as written. | |  | c. | The products are more stable than the reactants. | |  | d. | The reaction will proceed rapidly from left to right. | |  | e. | Three of these statements are valid. |  |  |  | | --- | --- | | *ANSWER:* | d | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.4 | | *QUESTION TYPE:* | Multi-Mode (Multiple choice) | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | free energy | general chemistry | spontaneity | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 2/28/2017 1:40 AM | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 135. The Second Law of Thermodynamics states that   |  |  |  | | --- | --- | --- | |  | a. | energy is conserved in a spontaneous process. | |  | b. | the entropy of the universe increases during a spontaneous process. | |  | c. | the heat content of the universe increases during a spontaneous process. | |  | d. | all of these are valid components of the second law. | |  | e. | none of these is correct. |  |  |  | | --- | --- | | *ANSWER:* | b | | *POINTS:* | 1 | | *DIFFICULTY:* | Easy | | *REFERENCES:* | 17.3 | | *QUESTION TYPE:* | Multiple Choice | | *HAS VARIABLES:* | False | | *KEYWORDS:* | Chemistry | general chemistry | second law of thermodynamics | thermochemistry | thermodynamics | | *OTHER:* | Conceptual | | *DATE CREATED:* | 3/4/2016 4:30 PM | | *DATE MODIFIED:* | 3/4/2016 4:30 PM | |