Periodic Table of the Elements

1A 1																	8A 18
1 H 1.0079	**2A** 2											**3A** 13	**4A** 14	**5A** 15	**6A** 16	**7A** 17	**2 He** 4.0026
3 Li 6.941	**4 Be** 9.0122											**5 B** 10.811	**6 C** 12.011	**7 N** 14.0067	**8 O** 15.9994	**9 F** 18.9984	**10 Ne** 20.1797
11 Na 22.9898	**12 Mg** 24.3050	**3B** 3	**4B** 4	**5B** 5	**6B** 6	**7B** 7	**8**	**— 8B —** 9	**8** 10	**1B** 11	**2B** 12	**13 Al** 26.9815	**14 Si** 28.0855	**15 P** 30.9738	**16 S** 32.066	**17 Cl** 35.4527	**18 Ar** 39.948
19 K 39.0983	**20 Ca** 40.078	**21 Sc** 44.9559	**22 Ti** 47.88	**23 V** 50.9415	**24 Cr** 51.9961	**25 Mn** 54.9380	**26 Fe** 55.847	**27 Co** 58.9332	**28 Ni** 58.69	**29 Cu** 63.546	**30 Zn** 65.39	**31 Ga** 69.723	**32 Ge** 72.61	**33 As** 74.9216	**34 Se** 78.96	**35 Br** 79.904	**36 Kr** 83.80
37 Rb 85.4678	**38 Sr** 87.62	**39 Y** 88.9059	**40 Zr** 91.224	**41 Nb** 92.9064	**42 Mo** 95.94	**43 Tc** (98)	**44 Ru** 101.07	**45 Rh** 102.9055	**46 Pd** 106.42	**47 Ag** 107.8682	**48 Cd** 112.411	**49 In** 114.82	**50 Sn** 118.710	**51 Sb** 121.75	**52 Te** 127.60	**53 I** 126.9045	**54 Xe** 131.39
55 Cs 132.9054	**56 Ba** 137.327	**57 La** 138.9055	**72 Hf** 178.49	**73 Ta** 180.9479	**74 W** 183.85	**75 Re** 186.207	**76 Os** 190.2	**77 Ir** 192.22	**78 Pt** 195.08	**79 Au** 196.9665	**80 Hg** 200.59	**81 Tl** 204.3833	**82 Pb** 207.2	**83 Bi** 208.9804	**84 Po** (209)	**85 At** (210)	**86 Rn** (222)
87 Fr (223)	**88 Ra** (226)	**89 Ac** (227)	**104 Rf** (261)	**105 Db** (262)	**106 Sg** (263)	**107 Bh** (262)	**108 Hs** (265)	**109 Mt** (266)									

58 Ce 140.115	**59 Pr** 140.9076	**60 Nd** 144.24	**61 Pm** (145)	**62 Sm** 150.36	**63 Eu** 151.965	**64 Gd** 157.25	**65 Tb** 158.9253	**66 Dy** 162.50	**67 Ho** 164.9303	**68 Er** 167.26	**69 Tm** 168.9342	**70 Yb** 173.04	**71 Lu** 174.967
90 Th 232.0381	**91 Pa** 231.0359	**92 U** 238.0289	**93 Np** (237)	**94 Pu** (244)	**95 Am** (243)	**96 Cm** (247)	**97 Bk** (247)	**98 Cf** (251)	**99 Es** (252)	**100 Fm** (257)	**101 Md** (258)	**102 No** (259)	**103 Lr** (260)

This print-out should have 30 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering. The due time is Central time.

First Law Thermo 01
19:04, general, multiple choice, < 1 min, .
001
What is true about the first law of thermodynamics?

1. $\Delta E_{\text{univ}} = 0$ **correct**

2. $\Delta E_{\text{sys}} = 0$

3. $\Delta E_{\text{sys}} > 0$

4. $\Delta E_{\text{univ}} > 0$

5. $\Delta E_{\text{sys}} < 0$

6. $\Delta E_{\text{univ}} < 0$

Explanation:

Msci 15 0506
19:03, general, multiple choice, > 1 min, .
002
For an endothermic reaction in which more moles of gas are produced than are consumed, (at constant pressure) ΔH is

1. equal to ΔE.

2. less than ΔE.

3. greater than ΔE. **correct**

4. unrelated to ΔE.

Explanation:

$$\Delta E = q + w$$
$$q = \Delta H$$
$$w = -P\,\Delta V = -(\Delta n)\,R\,T$$

For the described situation we have $+\Delta n$.

$$\Delta E = \Delta H - (\Delta n)\,R\,T$$

Since $\Delta H = \Delta E + (\Delta n)\,R\,T$, $\Delta H > \Delta E$.

Freeze Wood to Glass
20:50, general, multiple choice, > 1 min, .
003
A favorite thermodynamics demonstration involves the freezing of a block of wood to a beaker that contains a paste formed from solid barium hydroxide and ammonium nitrate. The smell of ammonia around the room is an unpleasant side effect of the reaction. Given this description of the reaction, what are the values for ΔG, ΔH, ΔS, and w, respectively, when this reaction occurs?

1. $-, +, +, -$ **correct**

2. $-, +, +, +$

3. $-, +, -, +$

4. $-, -, +, +$

5. $+, -, -, +$

6. $+, +, +, -$

7. $+, -, +, -$

8. $+, +, +, +$

Explanation:
Heat is absorbed, so $\Delta H > 0$. The reaction is spontaneous, so $\Delta G < 0$. Smelling ammonia means a gas is formed:
$$\text{solid} + \text{solid} \rightarrow \text{solid} + \text{gas}$$
$\Delta n > 0$ so $w = -\Delta n\,R\,T < 0$.

Msci 15 0202
19:04, general, multiple choice, > 1 min, .
004
Which of the following is true of a general thermodynamic state function?

1. The change in the value of a state function is always negative for a spontaneous reaction.

2. The value of a state function does NOT

change with a change in temperature of a process.

3. The change of the value of a state function is independent of the path of a process. **correct**

4. The change in the value of the state function is always positive for endothermic processes.

5. The value of the state function remains constant.
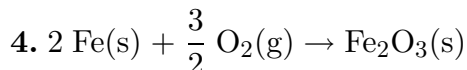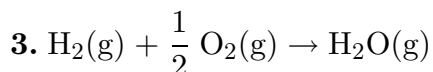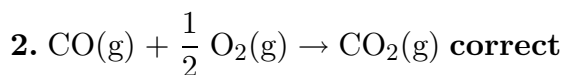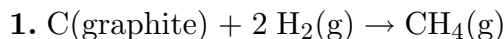
Explanation:
A change in a state function describes a difference between the two states. It is independent of the process or pathway by which the change occurs.

Mlib 05 0025
19:15, general, multiple choice, > 1 min, .
005
In which of the following reactions would ΔH_{rxn} NOT be equal to ΔH_f for the product?

1. $C(\text{graphite}) + 2\,H_2(g) \rightarrow CH_4(g)$

2. $CO(g) + \dfrac{1}{2}\,O_2(g) \rightarrow CO_2(g)$ **correct**

3. $H_2(g) + \dfrac{1}{2}\,O_2(g) \rightarrow H_2O(g)$

4. $2\,Fe(s) + \dfrac{3}{2}\,O_2(g) \rightarrow Fe_2O_3(s)$

Explanation:

$$\Delta H_{rxn}^0 = \sum n\,\Delta H_{f\,prod}^0 - \sum n\,\Delta H_{f\,rct}^0$$

$\sum n\,\Delta H_{f\,rct}^0 = 0$ for all except $CO + \dfrac{1}{2}\,O_2 \rightarrow CO_2$, so

$$\Delta H_{rxn}^0 = \sum n\,\Delta H_{f\,prod}^0 .$$

But for $CO + \dfrac{1}{2}\,O_2 \rightarrow CO_2$,

$$\Delta H_{rxn}^0 = \Delta H_{f\,CO_2}^0 - H_{f\,CO}^0$$

Heat Capacity Comparison

19:12, general, multiple choice, < 1 min, .
006
Water has a heat capacity per gram of substance that is about a factor of ten higher than copper metal. Assume 100 J of energy is deposited into equal masses of the two materials. What is true about the change in temperature that results?

1. The temperature change for Cu will be 10-fold higher than that for water. **correct**

2. The temperature change for water will be 10-fold higher than that for Cu.

3. The temperature changes will be the same since each receives the same amount of heat.

4. The answer cannot be determined without knowing the initial temperatures of the two materials.

5. The answer cannot be determined without knowing the actual masses of the two materials.

Explanation:

Calorimeter Calibration
19:09, general, multiple choice, > 1 min, .
007
You just received a new bomb calorimeter. The factory calibration states that the heat capacity of the calorimeter itself is 50 J/K ($C_{cal} = 50$ J/K). You decide to check for yourself what C_{cal} is; you fill the calorimeter with 2 L of water, and detonate 1 g of sugar which you know releases 4000 calories of heat. You then measure a temperature change of 1.9881 K. What value of C_{cal} do you calculate for your new calorimeter and is this value within 5 J/K of the factory value? The specific heat capacity of water is 1 calorie $\cdot$ g^{-1} $\cdot$ K^{-1}, the density of water is 1 g $\cdot$ mL^{-1}, and 1 calorie = 4.184 J.

1. $C_{cal} = 11.97$ calories/K; yes **correct**

2. $C_{cal} = 23.8$ calories/K; no

3. $C_{\text{cal}} = -23.8$ calories/K; no

4. $C_{\text{cal}} = 11.97$ calories/K; no

5. $C_{\text{cal}} = 47.32$ calories/K; yes

6. $C_{\text{cal}} = -11.97$ calories/K; no

Explanation:

$$\Delta H = m\,C\,\Delta T + C_{\text{cal}}\,\Delta T$$
$$C_{\text{cal}} = \frac{\Delta H - m\,C\,\Delta T}{\Delta T} = \frac{\Delta H}{\Delta T} - m\,C$$
$$= \frac{4000 \text{ cal}}{1.9881 \text{ K}} - (2000 \text{ g})(1 \text{ cal} \cdot \text{g}^{-1} \cdot \text{K}^{-1})$$
$$= 11.9712 \text{ J/K}$$

ChemPrin3e T06 50
19:05, basic, multiple choice, < 1 min, .
008
If the standard enthalpy of combustion of octane $(C_8H_{18}(\ell))$ at 298 K is -5471 kJ $\cdot$ mol^{-1}, calculate the standard enthalpy of formation of octane. The standard enthalpies of formation of carbon dioxide and liquid water are -393.51 and -285.83 kJ $\cdot$ mol^{-1}, respectively.

1. -249 kJ $\cdot$ mol^{-1} **correct**

2. 249 kJ $\cdot$ mol^{-1}

3. -2490 kJ $\cdot$ mol^{-1}

4. 2490 kJ $\cdot$ mol^{-1}

5. 24.9 kJ $\cdot$ mol^{-1}

Explanation:

Enthalpy for Ethanol
19:14, general, multiple choice, < 1 min, .
009
Calculate the reaction enthalpy for the combustion of ethanol

$$CH_3CH_2OH + 3\,O_2 \rightarrow 2\,CO_2 + 3\,H_2O$$

given the data
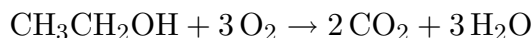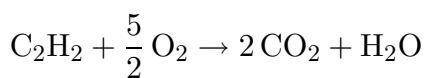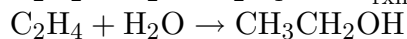
$$C_2H_2 + \frac{5}{2}\,O_2 \rightarrow 2\,CO_2 + H_2O$$
$$\Delta H^{\circ}_{\text{rxn}} = -1300 \text{ kJ/mol}$$
$$C_2H_2 + H_2 \rightarrow C_2H_4 \quad \Delta H^{\circ}_{\text{rxn}} = -175 \text{ kJ/mol}$$
$$C_2H_4 + H_2O \rightarrow CH_3CH_2OH$$
$$\Delta H^{\circ}_{\text{rxn}} = -44 \text{ kJ/mol}$$
$$H_2 + \frac{1}{2}\,O_2 \rightarrow H_2O \quad \Delta H^{\circ}_{\text{rxn}} = -286 \text{ kJ/mol}$$

1. -1367 kJ/mol **correct**

2. -1761 kJ/mol

3. -1717 kJ/mol

4. -1800 kJ/mol

5. None of these is correct.

Explanation:

Kinetic Energies
20:50, general, multiple choice, > 1 min, .
010
For a single $CHCl_3$ molecule, how much kinetic energy is found in translational, rotational, and vibrational degrees of freedom, respectively?

1. $\frac{3}{2}\,kT$, $\frac{3}{2}\,kT$, $\frac{9}{2}\,kT$ **correct**

2. $3\,kT$, $3\,kT$, $9\,kT$

3. $\frac{3}{2}\,kT$, kT, $5\,kT$

4. $\frac{1}{2}\,kT$, $\frac{1}{2}\,kT$, $\frac{1}{2}\,kT$

5. $\frac{3}{2}\,kT$, $\frac{3}{2}\,kT$, $\frac{3}{2}\,kT$

Explanation:

Mlib 75 0009
19:16, general, multiple choice, > 1 min, .
011

Estimate ΔH for the gas-phase reaction

$$NCl_3 + 3\,H_2O \rightarrow NH_3 + 3\,HOCl,$$
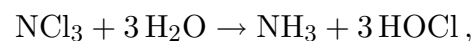
based on the bond energies N — Cl : 190 kJ/mol; O — H : 464 kJ/mol; N — H : 391 kJ/mol; O — Cl : 206 kJ/mol.

1. +171 kJ/mol rxn **correct**

2. −171 kJ/mol rxn

3. −407 kJ/mol rxn

4. +407 kJ/mol rxn
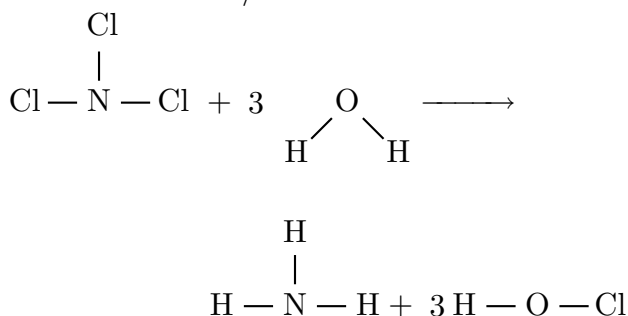
5. None of these is correct within 10 percent.

Explanation:
N — Cl = 190 kJ/mol
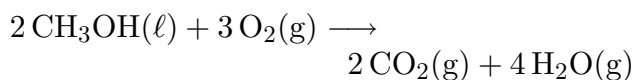O — H = 464 kJ/mol
N — H = 391 kJ/mol
O — Cl = 206 kJ/mol

$$\Delta H^0_{rxn} = \sum BE_{rct} - \sum BE_{prod}$$
$$= \Big[3\,(N \!-\! Cl) + 6\,(O \!-\! H)\Big]$$
$$\quad - \Big[3\,(N \!-\! H) + 3\,(O \!-\! H)$$
$$\quad + 3\,(O \!-\! Cl)\Big]$$
$$= \Big[3\,(N \!-\! Cl) + 3\,(O \!-\! H)\Big]$$
$$\quad - \Big[3\,(N \!-\! H) + 3\,(O \!-\! Cl)\Big]$$
$$= \Big[3\,(190 \text{ kJ/mol}) + 3\,(464 \text{ kJ/mol})\Big]$$
$$\quad - \Big[3\,(391 \text{ kJ/mol})$$
$$\quad + 3\,(206 \text{ kJ/mol})\Big]$$
$$= +171 \text{ kJ/mol rxn}$$

DAL 0301 01a
19:02, general, multiple choice, < 1 min, .
012
For the methanol combustion reaction

$$2\,CH_3OH(\ell) + 3\,O_2(g) \longrightarrow$$
$$2\,CO_2(g) + 4\,H_2O(g)$$

estimate the amount of work done and tell whether the work was done on or by the system. Assume a temperature of 27°C.

1. 2.5 kJ, work done on the system

2. 2.5 kJ, work done by the system

3. 7.5 kJ, work done on the system

4. 7.5 kJ, work done by the system **correct**

5. No work is done in this reaction.

Explanation:
$T = 27° \text{ C} + 273 = 300 \text{ K}$
Considering only moles of gas,

$$\Delta n = n_f - n_i = (2 + 4) - 3 = 3\,.$$

$$w = -\,\Delta n\,R\,T$$
$$= -\,(3\,\text{mol})\,(8.314\,\text{J/mol} \cdot \text{K})\,(300\,\text{K})$$
$$= -\,7500\,\text{J} = -\,7.5\,\text{kJ}$$

The system expands because Δn is positive, so the system does the work on the surroundings. Also, when w is negative, work is done by the system.

Internal Energy Facts
19:03, general, multiple choice, < 1 min, .
013
Which statement about internal energy is true?

1. The internal energy of a system is equal to q at constant volume. **correct**

2. The internal energy of a system is equal to w at constant pressure.

3. The internal energy of a system is equal to w at constant volume.

4. The internal energy of a system is constant at constant pressure.

5. The internal energy of a system is constant at constant volume.

6. The internal energy of a system is equal to q at constant pressure.

Explanation:

Bomb Calorimetry
19:09, general, multiple choice, > 1 min, .
014
Which of the following is NOT a feature of the bomb calorimetry apparatus used to measure the internal energy of a reaction?

1. The thermometer is inserted directly into the reaction vessel to measure ΔT of the reaction. **correct**

2. The large heat capacity of water is beneficial in measuring heat released by combustion reactions.

3. The volume of the reaction vessel is held constant to eliminate energy released as work.

4. The heat capacity of the calorimeter should be known to accurately correct for any heat lost to it.

5. Large quantities of water surrounding the reaction vessel absorb the majority of the heat loss.

Explanation:
The thermometer is placed in the water that surrounds the reaction vessel.

ChemPrin3e T06 18
19:03, general, multiple choice, < 1 min, .
015
A battery does 35 kJ of work driving an electric motor. The battery also releases 7 kJ of heat. What is the change in internal energy of the system?

1. -35 kJ

2. $+42$ kJ

3. -42 kJ **correct**

4. -28 kJ

5. $+28$ kJ

Explanation:

Rxn Entropy
20:03, general, multiple choice, < 1 min, .
016
Which chemical reaction is most likely to have the smallest change in thermal entropy?

1. $CH_4(g) + 2\,O_2(g) \rightarrow CO_2(g) + 2\,H_2O(g)$ **correct**

2. $CH_4(g) + 2\,O_2(g) \rightarrow CO_2(g) + 2\,H_2O(\ell)$

3. $2\,H_2(g) + O_2(g) \rightarrow 2\,H_2O(g)$

4. $2\,H_2(g) + O_2(g) \rightarrow 2\,H_2O(\ell)$

Explanation:
Consider Δn for the reactions:
$CH_4(g) + 2\,O_2(g) \rightarrow CO_2(g) + 2\,H_2O(g)$
$$\Delta n = 3 - 3 = 0$$
$2\,H_2(g) + O_2(g) \rightarrow 2\,H_2O(g)$
$$\Delta n = 2 - 3 = -1$$
$CH_4(g) + 2\,O_2(g) \rightarrow CO_2(g) + 2\,H_2O(\ell)$
$$\Delta n = 1 - 3 = -2$$
$2\,H_2(g) + O_2(g) \rightarrow 2\,H_2O(\ell)$
$$\Delta n = 0 - 3 = -3$$

Msci 15 1218
20:04, general, multiple choice, > 1 min, .
017
For the evaporation of water from an open pan at 25°C, the values of ΔS for the water, the surroundings, and the universe must be, respectively,

1. positive, positive, positive.

2. positive, negative, positive. **correct**

3. positive, negative, zero.

4. negative, negative, negative.
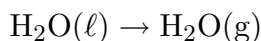
5. None of these is correct.

Explanation:
The process is spontaneous, which means $\Delta S_{\text{universe}} > 0$ according to the Second Law of Thermodynamics.

Entropy (S) is high for systems with high degrees of freedom, disorder or randomness and low for systems with low degrees of freedom, disorder or randomness.

$$S(g) > S(\ell) > S(s).$$

The system is

$$H_2O(\ell) \rightarrow H_2O(g)$$

so $\Delta S_{\text{system}} > 0$.

The entropy of the surroundings must be negative. Energy is removed from the surroundings to get the water to evaporate.

Second Law Thermo 01
20:05, general, multiple choice, > 1 min, .
018
How is ΔS_{univ} related to ΔG_{sys}?

1. $\Delta G_{\text{sys}} = -T\,\Delta S_{\text{univ}}$ **correct**

2. $\Delta G_{\text{sys}} = \Delta S_{\text{univ}}$

3. $\Delta G_{\text{sys}} = T\,\Delta S_{\text{univ}}$

4. $\Delta G_{\text{sys}} = -\Delta S_{\text{univ}}$

5. $\Delta G_{\text{sys}} = -\dfrac{\Delta S_{\text{univ}}}{T}$

6. $\Delta G_{\text{sys}} = \dfrac{\Delta S_{\text{univ}}}{T}$

Explanation:

Perfect Crystal
20:07, general, multiple choice, < 1 min, .
019
Which of the compounds
$\quad$ H_2 $\quad$ HCl $\quad$ CCl_4 $\quad$ CO $\quad$ O_3 $\quad$ CO_2
will form a perfect crystal at 0 K?

1. H_2, CCl_4, CO_2 **correct**

2. H_2, CCl_4, O_3, CO_2

3. HCl, CO, O_3

4. H_2, CCl_4, CO, O_3, CO_2

5. All compounds form perfect crystals at 0 K.

Explanation:

Positional Entropy Ammonia
20:04, general, multiple choice, > 1 min, .
020
Which statement about the positional entropy of ammonia at 0 K must be true? (Hint: Think about the kind of intermolecular forces present in NH_3.)

1. A mole of ammonia has a positional entropy less than $11.5 \text{ J/mol} \cdot \text{K}$. **correct**

2. A mole of ammonia has a positional entropy of $0 \text{ J/mol} \cdot \text{K}$.

3. A mole of ammonia has a positional entropy greater than $9.13 \text{ J/mol} \cdot \text{K}$.

4. A mole of ammonia has a positional entropy of $9.13 \text{ J/mol} \cdot \text{K}$.

5. A mole of ammonia has a positional entropy of $11.5 \text{ J/mol} \cdot \text{K}$.

Explanation:

ChemPrin3e 07 25 26
20:03, general, multiple choice, < 1 min, .
021

Which one shows the substances in the increasing order of their molar entropy?

1. C(s), H_2O(s), H_2O(ℓ), H_2O(g) **correct**

2. H_2O(g), H_2O(ℓ), H_2O(s), C(s)

3. C(s), H_2O(ℓ), H_2O(g), H_2O(s)

4. C(s), H_2O(g), H_2O(ℓ), H_2O(s)

5. H_2O(s), H_2O(ℓ), H_2O(g), C(s)

6. None of these

Explanation:
For H_2O entropy increases going from a solid to a liquid to a gas. We would automatically expect C(s,diamond) to have less entropy than any liquid. Water is a molecular substance held together in the solid phase by weak hydrogen bonds, and the carbons in C(s,diamond) are more rigidly held in place and will have less entropy.
The correct order is
C(s, diamond) $<$ H_2O(s) $<$ H_2O(ℓ)
$<$ H_2O(g)
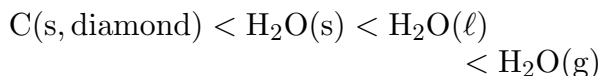
Entropy SiC59
20:07, general, multiple choice, $>$ 1 min, .
022
Imagine that one carbon in buckminsterfullerene (C_{60}) is replaced by a silicon atom, yielding SiC_{59}. This molecule can then orient in 60 different ways. What is the entropy of one mole of SiC_{59} at $T = 0$ K?

1. 34.0 J/K **correct**

2. 5.65×10^{-23} J/K

3. 27.3 kJ/K

4. 4.53×10^{-20} J/K

Explanation:
$n = 1$ mol $k = 1.38066 \times 10^{-23}$ J/k
$W = 60$ $N_A = 6.02214 \times 10^{23}$ mol^{-1}

$$S = n\, k\, N_A \ln W$$
$$= (1 \text{ mol})(1.38066 \times 10^{-23} \text{ J/k})$$
$$\times (6.02214 \times 10^{23} \text{ mol}^{-1}) \ln(60)$$
$$= 34.0425 \text{ J/K}$$

Zeros in Thermo
20:50, general, multiple choice, $<$ 1 min, .
023

Which of the following has a numerical value not equal to zero?

1. The standard molar entropy of He at 298 K **correct**

2. All of these values are equal to zero.

3. The change in energy of an isolated system

4. The heat of formation of O_2(g) at 298 K

5. The positional entropy of CCl_4 at 0 K

6. The free energy of a reaction at equilibrium

Explanation:

Combustion Entropy
20:04, general, multiple choice, $>$ 1 min, .
024
What is the ΔS_{surr} when a balloon filled with 8 grams of hydrogen is combusted at 8°C? The heat of combustion for a mole of H_2 is 242 kJ/mol.

1. 3444 J/K **correct**

2. -3444 J/K

3. 121000 J/K

4. -121000 J/K

5. 861 J/K

6. -861 J/K

7. 30.25 J/K

8. -30.25 J/K

Explanation:

$$q_{\text{surr}} = \frac{8 \text{ g}}{2 \text{ g/mol}} \cdot (242 \text{ kJ/mol}) = 968 \text{ kJ}$$

$$\Delta S = \frac{q}{T} = \frac{968000 \text{ J}}{281 \text{ K}} = 3444.84 \text{ J/K}$$

ChemPrin3e T07 13
20:03, general, multiple choice, < 1 min, .
025
Calculate the standard entropy of vaporization of ethanol at its boiling point 352 K. The standard molar enthalpy of vaporization of ethanol at its boiling point is 40.5 kJ ·mol^{-1}.

1. +40.5 kJ·K^{-1}·mol^{-1}

2. +115 J·K^{-1}·mol^{-1} **correct**

3. − 40.5 kJ·K^{-1}·mol^{-1}

4. +513 J·K^{-1}·mol^{-1}

5. − 115 J·K^{-1}·mol^{-1}

Explanation:

Second Law Thermo
20:50, general, multiple choice, > 1 min, .
026
What is ΔS_{univ} for the condensation of a mole of water at $80°$C if $S°$ of liquid water at $100°$C is 87 J/mol · K and if $S°$ of water vapor at $100°$C is 197 J/mol · K? Assume that the calculated ΔH_{vap} and ΔS_{vap} values are independent of temperature.

1. 6.2 J/mol · K **correct**

2. 0 J/mol · K

3. 110 J/mol · K

4. 116.2 J/mol · K

5. −116.2 J/mol · K

6. −110 J/mol · K

7. 226.2 J/mol · K

8. Water does not condense at $80°$C, so the reaction does not occur.

Explanation:

Mlib 05 3017
20:06, general, multiple choice, > 1 min, .
027
A reaction for which ΔS is (negative, positive) and ΔH is (negative, positive) can only be spontaneous at sufficiently high temperatures.

1. positive; positive **correct**

2. positive; negative

3. negative; negative

4. negative; positive

Explanation:
For spontaneous process, ΔG must be negative. If $\Delta S = (+)$ and $\Delta H = (+)$, then

$$\Delta G = \Delta H - T\,\Delta S$$
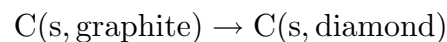$$= (+) - T(+)$$
$$= (+) - T, \quad \text{and}$$

ΔG will be negative only at high values of T.

ChemPrin3e 07 59c
20:06, basic, multiple choice, > 1 min, .
028

Assume that $\Delta H_{\text{r}}^{\circ}$ and $\Delta S_{\text{r}}^{\circ}$ are independent of temperature to calculate $\Delta G_{\text{r}}^{\circ}$ for the reaction

$$C(s, \text{graphite}) \rightarrow C(s, \text{diamond})$$

at $80°$C for the data

(298 K)	$S°$ $\left(\frac{\text{J}}{\text{K}\cdot\text{mol}}\right)$	$\Delta H_{\text{f}}^{\circ}$ $\left(\frac{\text{kJ}}{\text{mol}}\right)$
C(s), graphite	5.74	0
C(s), diamond	2.377	1.895

What is the cutoff temperature at which the reaction is spontaneous?

1. Nonspontaneous at all temperatures **correct**

2. Spontaneous at all temperatures

3. 475 K

4. 327 K

5. 603 K

6. 875 K

7. 515 K

Explanation:
$T = 80°C + 273 = 298$ K

In order to find ΔG_r° at a temperature other than 298 K, we must first calculate ΔH_r° and ΔS_r°, then calculate ΔG_r°.

$$\Delta S_r^\circ = S_{C(s,\text{diamond})}^\circ - S_{C(s,\text{graphite})}^\circ$$
$$= \left(2.377 \ \frac{J}{K \cdot mol}\right)$$
$$- \left(5.74 \ \frac{J}{K \cdot mol}\right)$$
$$= -3.363 \ \frac{J}{K \cdot mol}.$$

$$\Delta H_r^\circ = \Delta H_{f,\, C(s,\text{diamond})}^\circ$$
$$= 1.895 \text{ kJ/mol}.$$

$$\Delta G_r^\circ = \Delta H_r^\circ - T \,\Delta S_r^\circ$$
$$= 1.895 \text{ kJ/mol} - (298 \text{ K})$$
$$\times \left(-3.363 \ \frac{J}{K \cdot mol}\right)\left(\frac{kJ}{1000 \text{ J}}\right)$$
$$= 2.89717 \text{ kJ/mol}.$$

Because ΔH_r° is positive and ΔS_r° is negative, the reaction will be nonspontaneous at all temperatures. Note: This calculation is for atmospheric pressure. Diamond can be produced from graphite at elevated pressures and high temperatures.

Diamond Stability
20:06, general, multiple choice, < 1 min, .
029
They say that diamonds last forever. But given the facts that at 298 K, diamonds have a molar enthalpy of formation of +1.89

kJ/mol, a molar entropy of formation of +2.37 J/mol · K and a free energy of formation of +2.9 kJ/mol, which of the following is a better statement about diamonds?

1. Diamonds are unstable and over time decompose to graphite. **correct**

2. Diamonds are stable and non labile.

3. Diamonds are stable and labile.

4. Diamonds are stable at any temperature.

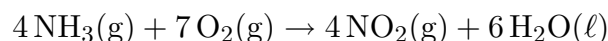**5.** Diamonds are unstable and labile.

6. Diamonds are stable at 298 K.

Explanation:

Msci 15 1422M
20:05, general, multiple choice, < 1 min, .
030
Calculate the standard Gibbs free energy at 298 K for the reaction

$$4\,NH_3(g) + 7\,O_2(g) \rightarrow 4\,NO_2(g) + 6\,H_2O(\ell)$$

Species	ΔH_f^0	S^0
	kJ/mol	J/mol · K
$NH_3(g)$	−46.11	192.3
$O_2(g)$	0.0	205.0
$NO_2(g)$	+33.2	240.0
$H_2O(\ell)$	−285.8	69.91

1. −1152 kJ/mol rxn **correct**

2. +1152 kJ/mol rxn

3. −1643 kJ/mol rxn

4. +1643 kJ/mol rxn

5. −1398 kJ/mol rxn

6. $+1398$ kJ/mol rxn

7. -825 kJ/mol rxn

8. $+825$ kJ/mol rxn

9. $-180,455$ kJ/mol rxn

10. $+244,363$ kJ/mol rxn

Explanation:

$$\Delta H^0_{\text{rxn}} = \sum n\,\Delta H^0_{\text{f prod}} - \sum n\,\Delta H^0_{\text{f rct}}$$
$$= \Big[6(-285.8 \text{ kJ/mol})$$
$$+ 4(33.2 \text{ kJ/mol})\Big]$$
$$- 4(-46.11 \text{ kJ/mol})$$
$$= -1397.56 \text{ kJ/mol}$$

$$\Delta S^0_{\text{rxn}} = \sum n\,\Delta S^0_{\text{f prod}} - \sum n\,\Delta S^0_{\text{f rct}}$$
$$= \Big[6(69.91 \text{ J/mol} \cdot \text{K})$$
$$+ 4(240.0 \text{ J/mol} \cdot \text{K})\Big]$$
$$- \Big[7(205.0 \text{ J/mol} \cdot \text{K})$$
$$+ 4(192.3 \text{ J/mol} \cdot \text{K})\Big]$$
$$= -824.74 \text{ J/mol} \cdot \text{K}$$
$$= -0.82474 \text{ kJ/mol} \cdot \text{K}$$

$$\Delta G^0 = \Delta H^0 - T\,\Delta S^0$$
$$= -1397.56 \text{ kJ/mol}$$
$$- (298 \text{ K})\,(-0.82474 \text{ kJ/mol} \cdot \text{K})$$
$$= -1151.79 \text{ kJ/mol}$$