

- Which of the following is not one of the laws of thermodynamics?
  - The entropy of a perfect crystal approaches zero as its temperature approaches zero.
  - The internal energy of the universe is a constant
  - The entropy of the universe is increased by all spontaneous processes.
  - The universe is a closed system.
- If a compound's formation reaction is \_\_\_\_\_,  $\Delta G^\circ_f$  is \_\_\_\_\_ and the compound is \_\_\_\_\_.
  - exothermic, zero, unstable
  - non-spontaneous, positive, stable
  - spontaneous, negative, stable
  - endothermic, negative, stable
  - at equilibrium, positive, unstable
  - spontaneous, zero, stable
  - endothermic, positive, unstable
- Which of the following will result in the greatest increase in entropy of the surroundings ( $\Delta S_{\text{surr}}$ )?
  - $\Delta H_{\text{sys}} = -2.68 \text{ kJ}$ ,  $T_{\text{surr}} = 70 \text{ K}$
  - $\Delta H_{\text{sys}} = -2,680 \text{ J}$ ,  $T_{\text{surr}} = 556 \text{ K}$
  - $\Delta H_{\text{sys}} = 4.13 \text{ kJ}$ ,  $T_{\text{surr}} = 415 \text{ K}$
  - $\Delta H_{\text{sys}} = 4,130 \text{ J}$ ,  $T_{\text{surr}} = 23 \text{ K}$
- The enthalpy of fusion ( $\Delta H_{\text{fus}}$ ) of tungsten is  $35.23 \text{ kJ/mol}$ , and its melting point is  $3422^\circ\text{C}$ . What is the entropy of fusion ( $\Delta S_{\text{fus}}$ ) of tungsten?
  - $130.17 \text{ J}/(\text{mol}\cdot\text{K})$
  - $10.30 \text{ J}/(\text{mol}\cdot\text{K})$
  - $10.30 \text{ kJ}/(\text{mol}\cdot\text{K})$
  - $9.53 \text{ J}/(\text{mol}\cdot\text{K})$
  - $4.76 \text{ J}/(\text{mol}\cdot\text{K})$

5. Given the enthalpies of formation and molar entropies ( $\Delta H^\circ_f$  and  $S^\circ_m$ ) in the following table, what is the Gibbs free energy change ( $\Delta G$ ) for the manufacture of metallic aluminum from alumina at  $1300\text{K}$ ?

	$\Delta H^\circ_f$ (298 K)	$S^\circ_m$ (298 K)
Al(l)	$10.71 \text{ kJ}\cdot\text{mol}^{-1}$	$39.77 \text{ J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$
Al <sub>2</sub> O <sub>3</sub> (l)	$-1675.7 \text{ kJ}\cdot\text{mol}^{-1}$	$50.92 \text{ J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$
C <sub>graphite</sub> (s)		$5.7 \text{ J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$
CO <sub>2</sub> (g)	$-393.51 \text{ kJ}\cdot\text{mol}^{-1}$	$213.74 \text{ J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$

- 2 Al<sub>2</sub>O<sub>3</sub>(l) + 3 C<sub>graphite</sub>(s) → 4 Al(l) + 3 CO<sub>2</sub>(g)     $\Delta G = ?$
- $-1,327.94 \text{ kJ}\cdot\text{mol}^{-1}$
  - $1,327.94 \text{ kJ}\cdot\text{mol}^{-1}$
  - $1036.94 \text{ kJ}\cdot\text{mol}^{-1}$
  - $-1036.94 \text{ kJ}\cdot\text{mol}^{-1}$

6. Your roommate left 1 kg of dry ice out on the counter last night and all of it sublimated. Given that  $\Delta H = 393.5 \text{ kJ}\cdot\text{mol}^{-1}$  and  $\Delta S = 2.023 \text{ kJ}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$  for dry ice sublimating and that the temperature in the room was  $25^\circ\text{C}$ , by how much in total has your roommate increased the entropy of the universe?
- $-1.320 \text{ kJ}\cdot\text{K}^{-1}$

2. 0  $\text{kJ}\cdot\text{K}^{-1}$
3. 0.703  $\text{kJ}\cdot\text{K}^{-1}$
4. 2.023  $\text{kJ}\cdot\text{K}^{-1}$
5. 15.97  $\text{kJ}\cdot\text{K}^{-1}$
6. 45.96  $\text{kJ}\cdot\text{K}^{-1}$
7. -39.99  $\text{kJ}\cdot\text{K}^{-1}$