This print-out should have 20 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

001 10.0 points

Which one of the processes listed below (if any) have a positive value for ΔS ?

1. None of the choices here have a positive ΔS.

2. The condensation of water droplets on an ice cold drink.

3. The formation of ice crystals from water in a freezer compartment.

4. Rubbing alcohol (isopropanol) evaporating from your skin.

002 10.0 points

When sodium chloride is melted, the sign of q_{sys} and ΔS_{sys} are ____ and ____, respectively.

1. +, −

2. −, −

3. +, +

4. −, +

003 10.0 points

For which of the following is ΔS_{sys} likely to be greater than zero?

I. $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$

II. $Br_2(l) \rightarrow Br_2(g)$

III. Al(25 °C) → Al(80 °C)

1. III only

2. II, III

3. II only

4. I only

5. I, III

6. I, II, III

004 10.0 points

A glass of cold water sits on a table top. As the day progresses, the water warms up to room temperature. For this process, ΔS_{surr} is

1. Positive

2. Negative

3. Zero

005 10.0 points

Calculate the ΔS_{surr} for the following reaction at 25°C and 1 atm.

$Br_2(\ell) \rightarrow Br_2(g)$ $\Delta H^\circ_{rxn} = +31$ kJ

1. +93 J/K

2. +124 J/K

3. −104 J/K

4. +104 J/K

5. −124 J/K

6. −93 J/K

006 10.0 points

The sublimation of solid carbon dioxide is a spontaneous process. Predict the sign (+, −, or 0) of ΔG°_r, ΔH°_r, and ΔS°_r, respectively.

1. −, +, +

2. −, −, −

3. −, +, −

4. −, 0, +

5. 0, +, +

007 10.0 points

At constant pressure and temperature, which of the following is true about ΔS_{surr}

1. $\Delta S_{surr} = -\Delta H_{sys}/T$

2. $\Delta S_{surr} = -\Delta G_{sys}/T$

3. $\Delta S_{surr} = -T\Delta H_{sys}$

4. $\Delta S_{surr} = -\Delta S_{sys}$

5. $\Delta S_{surr} = -T\Delta S_{sys}$

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008 10.0 points

Consider a chemical reaction where ΔS is 36.1 J/mol K, and ΔH is -2.88 kJ/mol. What is the change in entropy for the universe (ΔS_{univ}) for this reaction at 50°C?

1. +40.5 J/mol K

2. +27.2 J/mol K

3. -47.9 J/mol K

4. +45.0 J/mol K

5. -36.1 J/mol K

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009 10.0 points

Calculate ΔG° for the following reaction at 298 K.

$$NH_4NO_3(s) \rightarrow N_2O(g) + 2H_2O(g)$$

1. +130 kJ

2. -1.33×10^5 kJ

3. +169 kJ

4. −113 kJ

5. +97.2 kJ

6. −169 kJ

7. −130 kJ

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010 10.0 points

For a given reaction, if ΔH°_{rxn} is (negative/positive/either) and ΔS°_{rxn} is (negative/positive/either), then the value of ΔG°_{rxn} will always be negative, regardless of the temperature.

1. positive, negative

2. negative, positive

3. positive, either

4. negative, either

5. either, positive

6. either, negative

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011 10.0 points

What is the change in entropy (ΔS) for the heating of 20.0 grams of methanol (CH_3OH, liquid) from 34°C to 62°C?

1. 0 J/K

2. 0.22 J/K

3. -30.42 J/K

4. 1418 J/K

5. 30.42 J/K

6. 168.81 J/K

7. 4.42 J/K

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012 10.0 points

A 15 g sample of steam at 110 °C was placed into a warehouse freezer at −40 °C. In order to properly calculate the total change in entropy of this system, what equations would you use?

I. $\Delta S = nC \ln\left(\frac{T_f}{T_i}\right)$

II. $\Delta S = \frac{\Delta H}{T}$

III. $\Delta S_{univ} = \Delta S_{sys} + \Delta S_{surr}$

IV. $\Delta S = mC\Delta T$

1. I, II, III, IV

2. I, III

3. II, IV

4. I, II

5. IV

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013 10.0 points

Iron metal will react with oxygen gas to form a variety of iron oxides. This oxidation reaction is typically referred to as the iron "rusting". The fact that this reaction is spontaneous at room temperature tells you that

1. the 2nd law of thermodynamics has been violated

2. iron oxides have a higher standard entropy compared to oxygen and iron

3. iron oxides have a positive enthalpy of formation

4. iron oxides have a negative Gibbs energy of formation

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014 10.0 points

The absolute entropy of a system (S measured in J/K) is related to the number of microstates in that system. Consider the three processes listed below. Which one(s) will result in an increase in the number of microstates in the system?

I) The temperature of a gas is raised by 3°C.

II) A fixed amount of gas is allowed to expand to a slightly larger volume.

III) The total number of gas molecules in a system is reduced to a smaller number.

1. II and III only

2. I and III only

3. I and II only

4. III only

5. I only

6. II only

7. I, II, and III

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015 10.0 points

The oxidation of sugar to carbon dioxide and water is a spontaneous chemical reaction. Since we know that reactions that occur spontaneously in one direction cannot occur spontaneously in the reverse direction, how can we understand photosynthesis?

1. It is not a spontaneous chemical reaction; it is driven by an external source of energy – light.

2. This reaction is characterized by an energy change so close to zero that it is essentially reversible.

3. Thermodynamics deals only with closed systems; photosynthesis is an open system.

4. Thermodynamics does not apply to photochemical reactions.

5. Thermodynamics does not apply to living systems.

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016 10.0 points

The conditions for a specific exothermic reaction are such that it is currently nonspontaneous. Which of the following changes to the conditions will likely make the reaction spontaneous?

1. increase the temperature

2. the reaction spontaneity, in this case, cannot be changed with temperature

3. decrease the temperature

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017 10.0 points

A particular protein folds spontaneously at 25 °C and 1 atm. During this folding, the protein changes conformation from a higher entropy unfolded state to a lower entropy folded state. For this process, ΔH is

1. No way to know

2. $\Delta H < 0$

3. $\Delta H = 0$

4. $\Delta H > 0$

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018 10.0 points

Calculate the entropy of vaporization for compound X at its boiling point of 138°C. The enthalpy of vaporization of compound X is 42.2 kJ/mol.

1. 114.168
2. 109.365
3. 61.3854
4. 96.5584
5. 92.3661
6. 76.0959
7. 79.1469
8. 76.8945
9. 102.639
10. 81.7896

Answer in units of J/molK.

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019 10.0 points

Which of the following have standard Gibbs free energy of formation values equal to zero?

$N_2(g)$ $O_2(\ell)$ $Ar(\ell)$ $CO_2(g)$ He(g)

1. $N_2(g)$ and He(g)

2. $Ar(\ell)$ and He(g)

3. $N_2(g)$, $CO_2(g)$, and He(g)

4. $N_2(g)$, $O_2(\ell)$, $Ar(\ell)$, and He(g)

5. $O_2(\ell)$ and $Ar(\ell)$

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020 10.0 points

When water condenses, what are the signs for q, w, and ΔS_{sys}, respectively?

1. +, +, −

2. −, +, −

3. +, −, +

4. +, −, −

5. +, +, +

6. −, +, +