Thermodynamic Review 2016

1) Consider a reaction that has a positive ΔH and a positive ΔS. Which of the following statements is TRUE?
A) This reaction will be spontaneous only at high temperatures.
B) This reaction will be spontaneous at all temperatures.
C) This reaction will be nonspontaneous at all temperatures.
D) This reaction will be nonspontaneous only at high temperatures.
E) It is not possible to determine without more information.

2) For a given compound, list the decreasing order of entropy for a liquid, solid, and gas
A) solid > gas > liquid
B) liquid > solid > gas
C) gas > liquid > solid
D) gas > solid > liquid
E) solid > liquid > gas

gas > liquid > solid

3) Identify the statement that is FALSE.
A) The entropy of a gas is greater than the entropy of a liquid. T
B) Entropy generally increases with increasing molecular complexity. T
C) Free atoms have greater entropy than molecules. F
D) Entropy increases with dissolution. T
E) For noble gasses, entropy increases with size. T

4) Calculate $\Delta S°_{rxn}$ for the following reaction. The S° for each species is shown below the reaction.

	$C_2H_2(g)$	+ $H_2(g)$	→ $C_2H_4(g)$
S°(J/mol·K)	200.9	130.7	219.3

A) +112.3 J/K
B) +550.9 J/K
C) -112.3 J/K
D) +337.1 J/K
E) -550.9 J/K

(219.3) − (200.9 + 130.7) = −112.3 J/kmol

5) Calculate ΔH for the reaction: C_2H_4 (g) + H_2 (g) → C_2H_6 (g), from the following data.

C_2H_4 (g) + ~~3 O_2 (g) → 2 CO_2 (g) + 2 H_2O (l)~~ ΔH = -1411. kJ
~~2 CO_2 + 3 H_2O → C_2H_6 + 3½ O_2~~
~~C_2H_6 (g) + 3½ O_2 (g) → 2 CO_2 (g) + 3 H_2O (l)~~ ΔH = +1560. kJ

H_2 (g) + ½ O_2 (g) → H_2O (l) ΔH = -285.8 kJ
C_2H_4 + H_2 → C_2H_6 ΔH$_{rxn}$ = −136.6 kJ/mol

6) A reaction that is not spontaneous at low temperature can become spontaneous at high temperature if ΔH is ___ and ΔS is ___.
A) +, + B) -, - C) +, - D) -, + E) +, 0

7) For a reaction to be spontaneous under standard conditions at all temperatures, the signs of ΔH and ΔSmust be − and + , respectively.

A) +, + B) +, - C) -, + D) -, - E) +, 0

8) Given the following table of thermodynamic data,

Substance	ΔHf (kJ/mol)	ΔS (J/mol K)
TiCl4 (g)	-763.2	354.9
TiCl4 (l)	-804.2	221.9

$TiCl_4(\ell) \rightarrow TiCl_4(g)$

$\Delta H = -763.2 - (-804.2) =$

$\Delta S = 354.9 - 221.9 =$

$\Delta H = +41\ KJ/mol$

$\Delta S = 133\ J/mol \cdot K$

complete the following sentence. The vaporization of TiCl4 is____.

A) spontaneous at all temperatures
B) spontaneous at low temperature and nonspontaneous at high temperature
C) nonspontaneous at all temperatures
D) nonspontaneous at low temperature and spontaneous at high temperature
E) not enough information given to draw a conclusion

9) For which one of the following is the heat of formation equal to zero?

a) $O_2(s)$ F
b) ice F
c) $N_2(g)$ T
d) $F_2(s)$ F
e) $I_2(g)$ F

at standard phase of matter (phase of matter from PT)

10) A cube of ice is added to some hot water in a rigid, insulated container, which is then sealed. There is no heat exchange with the surroundings. What has happened to the total energy and the total entropy when the system reaches equilibrium?

	Energy	Entropy
(A)	Remains constant	Remains constant
(B)	Remains constant	Decreases
(C)	Remains constant	Increases
(D)	Decreases	Increases
(E)	Increases	Decreases

$H_2O(s) \rightarrow H_2O(\ell)$

ΔH - E is conserved $q_{\text{lost by not } H_2O} = q_{\text{gained by ice}}$

ΔS increases

11) Which of the following statements are true for the reaction $I_2(g) \rightarrow 2\ I(g)$

I. ΔH is positive
II. ΔH is negative
III. ΔS is positive
IV. ΔS is negative
V. The reaction is spontaneous at any temperature

A. V only
B. I only
C. II and IV
D. I and III
E. IV only

$K < 1$

so $Q > 1$ nonspontaneous

ΔS is positive because there are more positions for the 2 moles of products than the 1 mole of reactants

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

$+ \quad + \quad - \quad +$

$\Delta H = ?$

$\Delta S = +$

$\Delta G = +$

12) Which of the following statements is true?

A. In a spontaneous process, DG has a positive value F

B. Exothermic reactions are always spontaneous F

C. For a process to be spontaneous, the number of moles of product must exceed the number of moles of reactant F

D. A system at constant temperature cannot experience entropy changes F

E. The entropy of the universe is increasing

13) For which of the following processes would $\Delta S°$ be expected to be most positive?

A. $C_6H_{12}O_6(s) + 6\ O_2(g) \rightarrow 6\ CO_2(g) + 6\ H_20(g)$ + lots of moles of gas

B. $Na^+(aq) + Cl^-(aq) \rightarrow NaCl(s)$ −

C. $CO_2(g) \rightarrow CO_2(s)$ −

D. $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$ −

E. $Cl_2(g) + H_2(g) \rightarrow 2\ HCl(g)$ +

14) Which of the following liquids is likely to have the highest value for $S°$?

A. Hg l

B. H_2O l

C. N_2H_4 aq

D. C_2H_5OH l

E. CH_3OH l

phase complexity

15) It is determined that for a particular process, $\Delta H = +185$ kJ and $\Delta S = +1.80$ J/K. At what temperature does the reaction become spontaneous?

A. 333 K

B. 0.00973 K

C. 376

D. 1.03×10^5 K

E 187 K

$0 = 185 + .00180t$

$-185 = .00180t$

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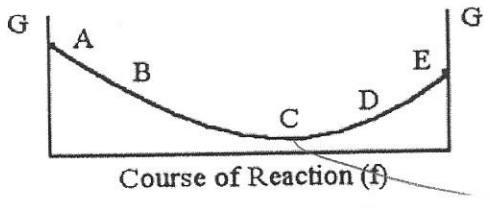
16) The equilibrium position corresponds to which letter on the graph of G vs f (course of reaction) below?



lowest value of G

A. B. C. D. E.