Gen Chem II Lecture Spring 20 Dr. Hahn A section Quiz 2 1/24 Friday Exam # _____

Name Key Print Name _____

Please show work on all questions for partial credit even on questions which do not specify. (20 total pts this quiz, actually worth 10 pts each quiz for a total of 80 total quiz points with 20 pts HW points – quiz + HW points worth 10% of grade)

1. The enthalpy of fusion or heat of fusion (ΔH_{fusion}), of water is positive and corresponds to which physical change ? (2 pts)

(A) H_2O (s) → H_2O (l) (B) H_2O (g) → H_2O (s)
(C) H_2O (s) → H_2O (g) (D) H_2O (l) → H_2O (s)

2. Determine the sign of ΔS^o for each of the following. (2 pts)

I. C_6H_6 (s) → C_6H_6 (l) (+)
II. 2 SO_2 (g) + O_2 (g) → 2 SO_3 (g) (−)

3 mol gas 2 mol gas

(A) ΔS^o should be positive for I and positive for II (B) ΔS^o should be negative for I and negative for II.
(C) ΔS^o should be positive for I and negative for II. (D) ΔS^o should be negative for I and positive for II.

3. Which of the following compounds has the highest boiling point ? (2 pts)

(A) $HOCH_2CH_2OH$ (B) $H_3C—O—CH_3$ (C) CH_3CH_2OH (D) $CH_3CH_2CH_2CH_3$

2 - H bond dipole H bond dispersion

4. (a) What is ΔG for the reaction given below ? (5 pts) (show work)

$CO(g) + 2\ H_2(g) \rightarrow CH_3OH$ (l) at 25°C $\Delta H^o = 128.1$ kJ and $\Delta S^o = -332$J/K

[useful information: $\Delta G = \Delta H - T\Delta S$ K = °C + 273.15]

$T = 25 + 273.15$

$T = 298.15$

(b) Is the reaction spontaneous ? [(yes) or (no)] (circle one) (1 pt)

$\Delta H^o = 128.1\ kJ \times \frac{1000\ J}{1\ kJ} = 128100\ J$

math $-\frac{1}{2}$

$\Delta G = 128100\ J - (298.15\ K)(-332\ J/K)$

unit −1 conversion error

$\Delta G = 128100\ J + 98985.8\ J = 227085.8\ J \rightarrow 227\ kJ$

5. The enthalpy of fusion of naphthalene, $C_{10}H_8$ is 19.1 kJ/mol at 78.2 °C, its melting point.

[useful information: $\Delta G = \Delta H - T\Delta S$ K = °C + 273.15] $K = 78.2°C + 273.15 =$

(a) Under the condition above (fusion) what is ΔG ? [(no idea) or (zero)] (circle one) (1 pt)

(b) Calculate the entropy of fusion at the melting point. (5 pt)

$K = 351.35\ K$

$\Delta H = T\Delta S$ −2

$\Delta S = \frac{\Delta H}{T} = \frac{19.1\ \frac{kJ}{mol} \times \frac{1000\ J}{1\ kJ}}{351.35\ K} = \frac{54.4\ J}{mol\ K}$ or 0.0544 kJ/mol K

Gen Chem II Lecture Spring 20 Dr. Hahn C section A form Quiz 2 1/24 Friday Exam # _____

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1. Which of the following can be interpreted as a measure of randomness ? (2 pts)
(A) free energy (B) enthalpy (C) temperature (D) entropy

2. Which combination always results in a reaction being spontaneous ? (2 pts) $\Delta G = \Delta H - T\Delta S$ (−) (+)
(A) ΔH is negative and ΔS is positive (B) ΔH is positive and ΔS is negative
(C) ΔH is positive and ΔS is negative. (D) ΔH is negative and ΔS is negative.

3. The normal boiling point for HBr is higher than the normal boiling point for H Cl. This can be explained by: (2 pts) higher EN
(A) Larger dispersion forces for H Br
(B) Larger dipole-dipole forces for HBr
(C) Larger dipole-dipole forces, larger dispersion forces, and larger hydrogen – bond forces for HBr
(D) Larger hydrogen-bond forces for HBr.

4. (a) Calculate ΔG^o for the reaction below at 25°C. (5 pts)

$2S(s) + 3O_2(g) + 2H_2O(l) \rightarrow 2H_2SO_4(l)$ $\Delta H^o = -1056$ kJ/mol $\Delta S^o = -505$ J/mol · K

[useful information: $\Delta G = \Delta H - T\Delta S$ $K = {}^oC + 273.15$] $K = 25 + 273.15 = 298.15$

(b) Is the reaction spontaneous ? [(yes) or (no)] (circle one) (1 pt) unit conversion error

$\Delta G = \Delta H - T\Delta S$ $\Delta H = -1056\ kJ/mol \times \frac{1000}{1} = -1.056 \times 10^6$ J/mol

$\Delta G = -1.056 \times 10^6\ J/mol - (298.15\ K)(-505\ J/mol\ K)$

$\Delta G = -905434.25\ J/mol = -905\ kJ/mol$

5. The boiling point of ethanol is 78.4 °C and $\Delta H_{vap} = 38.56$ kJ/mol.
[useful information: $\Delta G = \Delta H - T\Delta S$ $K = {}^oC + 273.15$] $T = 78.4^oC + 273.15$

(a) Under the condition above (vaporization) what is ΔG ? [(no idea) or (zero)] (circle one) (1 pt)

(b) Calculate the entropy of vaporization at the boiling point. (5 pts) $T = 351.55\ K$

$\Delta H = T\Delta S$

$\Delta S = \frac{\Delta H}{T} = \frac{38.56\ kJ/mol \times \frac{1000\ J}{1\ kJ}}{351.55\ K} = 109.7\ J/mol\ K$ or $0.1097\ kJ/mol$

$\Delta S_{vap} = 110\ J/mol\ K$ (s.f.)

Gen Chem II Lecture Spring 20 Dr. Hahn C section B form Quiz 2 1/24 Friday Exam # _____

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1. Which of the following best explains why ΔH_{vap} is usually higher than ΔH_{fusion} ? (2 pts)

   (A) Vaporization involves the breaking of bonds within molecules
   (B) Vaporization involves the breaking of all bonds between molecules
   (C) Vaporization increases the entropy of molecules.
   (D) Vaporization occurs at high temperature.

2. When a substance melts at its normal melting point, the sign of ΔH is + and the sign of ΔS of this phase change is +. (2 pts)

   (A) +, - (B) +, + (C) -, + (D) -, -

3. Which of the following is expected to have the greatest viscosity ? (2 pts)

   (A) $C_5H_{11}OH$ (B) C_5H_{12} (C) CH_4 (D) C_6H_{14}

4. (a) If $\Delta H = 83$ kJ and $\Delta S = -234$ J/K at 35 °C, (a) what is ΔG ? (5 pts)

[useful information: $\Delta G = \Delta H - T\,\Delta S$ $K = °C + 273.15$]

(b) Is the reaction spontaneous ? [(yes) or (no)] (circle one) (1 pt)

$83\ kJ \times \frac{1000\ J}{1\ kJ} = 83000$

$35 + 273.15 = 308.15$

$\Delta G = 83000\ J - (308.15\ K)(-234\ J/K)$ unit conversion error -1

$\Delta G = 83000\ J + 72107.1\ J = 155107\ J \div 1000 =$

$155\ kJ$ (# s.f. 1.6 $\times 10^2$ kJ)

5. (a) The heat of vaporization of water at 100°C is 40.66 kJ/mol. Calculate the quantity of heat that is absorbed/released when 20.00 g of steam condenses to liquid water at 100°C. (formula mass of water = 18.02 g/mol) (5 pts)

[useful information: $q = n\,\Delta H_{vap}$]

(b) Is the heat [(absorbed) or (released)] ? (1 pt)

$n = 20.00\ g \times \frac{mol\ H_2O}{18.02\ g}$

$n = 1.110\ mol\ H_2O$

$q = (1.110\ mol\ H_2O)\left(\frac{40.66\ kJ}{mol\ H_2O}\right) = 45.13\ kJ$

-1

BA -2 ±

2nd page same all forms

6. Given the following reaction being done in a calorimeter (constant pressure rxn)

H_2SO_4 (aq) + 2 NaOH (aq) → 2 H_2O (l) + Na_2SO_4 (aq)

When 25.0 mL of 1.0 M H_2SO_4 is added to 50.0 mL of a 1.0 M NaOH at 25°C in a calorimeter, The temperature of the solution rises to 33.9 °C. If the specific heat of the solution is 4.18 J/g°C and density is 1.00 g/mLand the calorimeter does not absorb much heat.

The calculation of q is given below for 75 grams of water

q = (4.18 J/g°C)(75.0 g) (8.9 °C) = 2790.15 J

surroundings

(a) What is the system ? [(reaction) or (water in the calorimeter)] (circle one) ? (1 pt)

(b) If I want the **Δ H for the reaction** as done in the procedure outlined above resulting in the heating of the calorimeter and water as shown above, how would you do that ? (give a number with a sign) (1 pt)

−2790.15 J, sign −½

(c) Is the answer to (b) the same as for 1 mole of H_2SO_4 and 2 moles of NaOH ? The reaction in the calorimeter above was done for (25.0 mL * 1.0 mole / 1000 mL = 0.025 moles of H_2SO_4)

[(yes) or (no)] (circle one) (1 pt)

(for 0.025 mol H_2SO_4 not for 1 mol H_2SO_4)

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1. The enthalpy of fusion or heat of fusion (ΔH_{fusion}), of water is positive and corresponds to which physical change ? (2 pts)

   (A) H_2O (s) → H_2O (l) (B) H_2O (g) → H_2O (s)
   (C) H_2O (s) → H_2O (g) (D) H_2O (l) → H_2O (s)

2. Determine the sign of ΔS^o for each of the following. (2 pts)

I. C_6H_6 (s) → C_6H_6 (l)
II. 2 SO_2 (g) + O_2 (g) → 2 SO_3 (g)

(A) ΔS^o should be positive for I and positive for II (B) ΔS^o should be negative for I and negative for II.
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3. Which of the following compounds has the highest boiling point ? (2 pts)
   (A) $HOCH_2CH_2OH$ (B) $H_3C—O—CH_3$ (C) CH_3CH_2OH (D) $CH_3CH_2CH_2CH_3$

4. (a) What is ΔG for the reaction given below ? (5 pts) (show work)

CO(g) + 2 H_2 (g) → CH_3OH (l) at 25°C ΔH^o = 128.1 kJ and ΔS^o = -332J/K

[useful information: $\Delta G = \Delta H - T\,\Delta S$ K = °C + 273.15]

(b) Is the reaction spontaneous ? [(yes) or (no)] (circle one) (1 pt)

5. The enthalpy of fusion of naphthalene, $C_{10}H_8$ is 19.1 kJ/mol at 78.2 °C, its melting point.
   [useful information: $\Delta G = \Delta H - T\,\Delta S$ K = °C + 273.15]

   (a) Under the condition above (fusion) what is ΔG ? [(no idea) or (zero)] (circle one) (1 pt)

   (b) Calculate the entropy of fusion at the melting point. (5 pt)

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6. Which of the following can be interpreted as a measure of randomness ? (2 pts)
   (A) free energy (B) enthalpy (C) temperature (D) entropy

7. Which combination always results in a reaction being spontaneous ? (2 pts)
   (A) ΔH is negative and ΔS is positive (B) ΔH is positive and ΔS is negative
   (C) ΔH is positive and ΔS is negative. (D) ΔH is negative and ΔS is negative.

8. The normal boiling point for HBr is higher than the normal boiling point for H Cl. This can be explained by: (2 pts)
   (A) Larger dispersion forces for H Br
   (B) Larger dipole-dipole forces for HBr
   (C) Larger dipole-dipole forces, larger dispersion forces, and larger hydrogen – bond forces for HBr
   (D) Larger hydrogen-bond forces for HBr.

9. (a) Calculate ΔG^o for the reaction below at 25°C. (5 pts)

$2S(s) + 3O_2(g) + 2\ H_2O\ (l) \rightarrow 2\ H_2SO_4\ (l)$ $\Delta H^o = -1056$ kJ/mol $\Delta S^o = -505$ J/mol

[useful information: $\Delta G = \Delta H - T\ \Delta S$ $K = {}^oC + 273.15$]

(b) Is the reaction spontaneous ? [(yes) or (no)] (circle one) (1 pt)

10. The boiling point of ethanol is $78.4\ ^oC$ and $\Delta H_{vap} = 38.56$ kJ/mol.

[useful information: $\Delta G = \Delta H - T\ \Delta S$ $K = {}^oC + 273.15$]

(a) Under the condition above (vaporization) what is ΔG ? [(no idea) or (zero)] (circle one) (1 pt)

(b) Calculate the entropy of vaporization at the boiling point. (5 pts)

Gen Chem II Lecture Spring 20 Dr. Hahn C section B form Quiz 2 1/24 Friday Exam # _____

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11. Which of the following best explains why ΔH_{vap} is usually higher than ΔH_{fusion} ? (2 pts)

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(B) Vaporization involves the breaking of all bonds between molecules
(C) Vaporization increases the entropy of molecules.
(D) Vaporization occurs at high temperature.

12. When a substance melts at its normal melting point, the sign of ΔH is _____ and the sign of ΔS of this phase change is _____. (2 pts)

(A) +, - (B) +, + (C) -, + (D) -, -

13. Which of the following is expected to have the greatest viscosity ? (2 pts)

(A) $C_5H_{11}OH$ (B) C_5H_{12} (C) CH_4 (D) C_6H_{14}

4. (a) If $\Delta H = 83$ kJ and $\Delta S = -234$ J/K at 35 ^oC, (a) what is ΔG ? (5 pts)

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(b) Is the reaction spontaneous ? [(yes) or (no)] (circle one) (1 pt)

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(c) Is the answer to (b) the same as for 1 mole of H_2SO_4 and 2 moles of NaOH ? The reaction in the calorimeter above was done for (25.0 mL * 1.0 mole / 1000 mL = 0.025 moles of H_2SO_4)

[(yes) or (no)] (circle one) (1 pt)