

February 1, 2008

Name: _____
Last Name First Name

Perm # _____

INSTRUCTIONS: No sharing of calculators. Cell Phones, iPods, headsets, etc. must be turned off and put away.

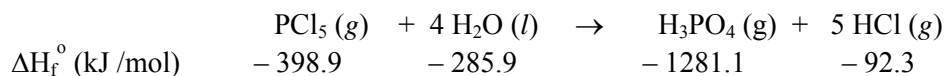
SCANTRON FORM: Use a **PENCIL**

- 1) Write your name
- 2) Bubble in **FORM A**
- 3) Bubble in your **PERM** number (7 digits only, no extra numbers)

INFORMATION PAGE: An information page is provided separately. No other notes or books are allowed.

There are 5 pages, 16 questions. Each question is worth 5 points. Work out the problems and write your answers on this exam. **Turn in the Exam and Scantron form.**

1. Use the values of ΔH_f° given below each substance to calculate ΔH° for the reaction.



- a) -200.1 kJ
- b) +200.1 kJ
- c) -688.6 kJ
- d) +688.6 kJ
- e) -900.3 kJ

Answers are given at the end of the exam.

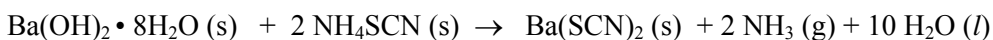
2. Which of the following substances has the largest absolute entropy per mole at 298 K?

- a) $\text{CH}_3\text{OH} (l)$
- b) $\text{NaCl} (s)$
- c) $\text{C}_4\text{H}_{10} (g)$
- d) $\text{H}_2 (g)$
- e) $\text{H}_2\text{O} (g)$

3. Which of the following statements can be made about the absolute entropy of one mole of $\text{O}_2 (g)$ at 298 K and 1.00 atm pressure?

- a) $S^\circ = 0$
- b) S° is positive
- c) S° is negative
- d) S° is given by $\Delta H^\circ/T$
- e) None of the above

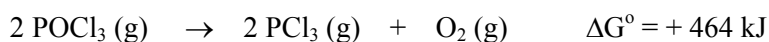
4. The following endothermic reaction is spontaneous at 25 °C and 1 atm.



Determine the signs of work (w), heat (q), ΔH , ΔS and ΔG .

- a) $w > 0$ $q < 0$ $\Delta H < 0$ $\Delta S > 0$ $\Delta G > 0$
b) $w > 0$ $q > 0$ $\Delta H > 0$ $\Delta S > 0$ $\Delta G < 0$
c) $w < 0$ $q < 0$ $\Delta H < 0$ $\Delta S < 0$ $\Delta G > 0$
d) $w < 0$ $q > 0$ $\Delta H > 0$ $\Delta S > 0$ $\Delta G < 0$
e) $w > 0$ $q > 0$ $\Delta H > 0$ $\Delta S > 0$ $\Delta G > 0$

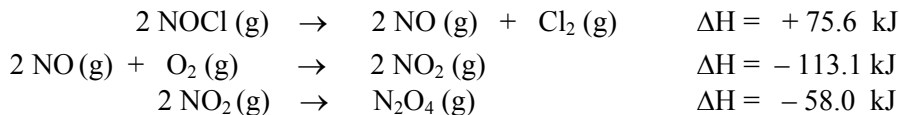
5. Consider the following reaction at 25°C and 1 atm.



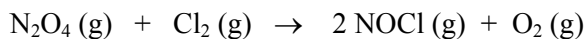
For this reaction $\Delta S^\circ = 179 \text{ J/K}$. At what temperatures is this reaction spontaneous under standard conditions?

- a) $T > 2617 \text{ K}$
b) $T < 2617 \text{ K}$
c) $T > 2890 \text{ K}$
d) $T < 2890 \text{ K}$
e) This reaction is not spontaneous at any temperature

6. Given the following data at 25 °C:



Calculate the ΔH for the following reaction.



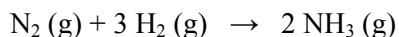
- a) + 95.5 kJ
b) - 130.7 kJ
c) + 130.7 kJ
d) - 95.5 kJ
e) + 20.5 kJ

7. What is the change in internal energy, ΔE , when one mole of a monatomic ideal gas is heated from 25 °C to 50 °C at constant pressure? For a monatomic ideal gas: $C_v = (3/2)R$ and $C_p = (5/2)R$.
- a) + 312 J
 - b) - 312 J
 - c) - 520 J
 - d) + 520 J
 - e) none of the above

8. Choose the correct equation for which the heat of reaction corresponds to the standard enthalpy of formation of CO (g).

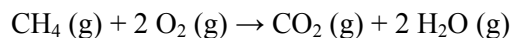
- a) $2 \text{C (s)} + \text{O}_2 \text{(g)} \rightarrow 2 \text{CO (g)}$
- b) $\text{C (s)} + \text{O (g)} \rightarrow \text{CO (g)}$
- c) $\text{C (s)} + (1/2) \text{O}_2 \text{(g)} \rightarrow \text{CO (g)}$
- d) $\text{C (s)} + \text{CO}_2 \text{(g)} \rightarrow 2 \text{CO (g)}$
- e) $\text{CO (s)} \rightarrow \text{C (s)} + \text{O (g)}$

9. The formation of ammonia from nitrogen and hydrogen at 298 K and 1.00 atm pressure is spontaneous.



What entropy change can one predict for this reaction?

- a) The entropy change must be positive since the reaction is spontaneous
 - b) The entropy change is negative
 - c) The entropy change is zero since ammonia is formed from the elements in their standard states
 - d) No prediction is possible since the spontaneous reaction is irreversible
 - e) None of the above
10. Consider the combustion of methane in air at constant temperature and pressure:



How is the value of ΔE for this reaction related to the value of ΔH ?

- a) ΔE is not related to ΔH
- b) ΔE is less negative than ΔH
- c) ΔE is more negative than ΔH
- d) ΔE is equal to ΔH
- e) None of the above

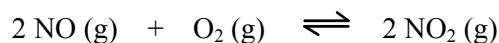
11. Consider the following reaction at 25°C and 1 atm.



For this reaction, $\Delta H^\circ = 110.0 \text{ kJ}$ and $\Delta S^\circ = 453.8 \text{ J/K}$. Which of the following statements are correct?

- a) The reaction is spontaneous at 25 °C
- b) The reaction is spontaneous as long as $T\Delta S < \Delta H$
- c) The reaction is spontaneous as long as $T\Delta S > \Delta H$
- d) Statements (a) and (b) are both correct
- e) Statements (a) and (c) are both correct

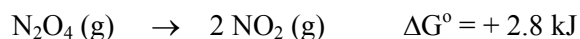
12. Consider the following exothermic reaction at 25°C and 1 atm.



For this system at equilibrium, how will raising the temperature affect the amount of NO present?

- a) The amount of NO will increase
- b) The amount of NO will decrease
- c) The amount of NO will stay the same
- d) More information is needed to answer this question

13. Consider the following reaction at 25°C and 1 atm.



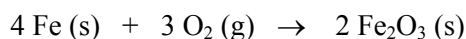
For this reaction, what are the signs of ΔH and ΔS and what is the value of equilibrium constant K?

- a) $\Delta H < 0$ $\Delta S < 0$ $K > 1$
- b) $\Delta H > 0$ $\Delta S > 0$ $K > 1$
- c) $\Delta H < 0$ $\Delta S < 0$ $K < 1$
- d) $\Delta H > 0$ $\Delta S > 0$ $K < 1$
- e) $\Delta H > 0$ $\Delta S > 0$ $K = 1$

14. Consider the freezing of liquid water at $-10\text{ }^{\circ}\text{C}$ and 1 atm. For this process, what are the signs of ΔH , ΔS and ΔG ?

- a) $\Delta H > 0$ $\Delta S < 0$ $\Delta G = 0$
- b) $\Delta H < 0$ $\Delta S > 0$ $\Delta G = 0$
- c) $\Delta H < 0$ $\Delta S > 0$ $\Delta G < 0$
- d) $\Delta H > 0$ $\Delta S < 0$ $\Delta G < 0$
- e) $\Delta H < 0$ $\Delta S < 0$ $\Delta G < 0$

15. Consider the reaction.



The heat of formation of $\text{Fe}_2\text{O}_3 \text{ (s)} = -826 \text{ kJ/mol}$. Calculate the heat of reaction when one mole of Fe (s) reacts completely with excess $\text{O}_2 \text{ (g)}$.

- a) -206 kJ
- b) -413 kJ
- c) -826 kJ
- d) -1652 kJ
- e) -3308 kJ

16. One mole of water, initially at $50.0\text{ }^{\circ}\text{C}$, is heated to $145.0\text{ }^{\circ}\text{C}$ at a constant pressure of 1.00 atm. **Calculate the work for this process.** Assume ideal gas behavior.

- a) -3.10 kJ
- b) -2.73 kJ
- c) -0.374 kJ
- d) -3.47 kJ
- e) None of these

Answers: 1. a 2. c 3. b 4. d 5. c 6. a 7. a 8. c
9. b 10. d 11. e 12. a 13. d 14. e 15. b 16. d