CHEMISTRY 102 SPRING 2005

EXAM 1 Sample Test Dr. PECK

Directions: (1) Choose the best answer for the multiple choice questions. Transfer your multiple choice answers onto the scantron.
(2) Print your name below and fill-in your name and signature on page 5. Do not remove page 5

NAME_________________________________
(print)

1. A process **cannot** be spontaneous at any possible temperature if ______________.
   (a) it is exothermic, and there is an increase in disorder
   (b) it is endothermic, and there is an increase in disorder
   (c) it is exothermic, and there is a decrease in disorder
   (d) it is endothermic, and there is a decrease in disorder

2. Which of the following statements is **incorrect**?
   (a) A superscript "zero", such as in ΔH^0, indicates a specified temperature of 0°C.
   (b) For a pure substance in the liquid or solid phase, the standard state is the pure liquid or solid.
   (c) For a pure gas, the standard state is the gas at a pressure of one atmosphere.
   (d) For a substance in solution, the standard state refers to one-molar concentration.

3. Which statement is **incorrect**?
   (a) Energy is the capacity to do work or to transfer heat.
   (b) Kinetic energy is the energy of motion.
   (c) A process that absorbs energy from its surroundings is called exothermic.
   (d) The Law of Conservation of Energy is another statement of the First Law of Thermodynamics

4. Consider the following reaction at constant pressure. Which response is **true**?

   $N_2(g) + O_2(g) \rightarrow 2NO(g)$

   (a) Work is done on the system as it occurs.
   (b) Work is done by the system as it occurs.
   (c) No work is done as the reaction occurs.
   (d) Work may be done on or by the system as the reaction occurs, depending upon the temperature.

5. Which one of the following statements is **false**?
   (a) The change in internal energy, ΔE, for a process is equal to the amount of heat absorbed at constant volume, q_v.
   (b) The change in enthalpy, ΔH, for a process is equal to the amount of heat absorbed at constant pressure, q_p.
   (c) A bomb calorimeter measures ΔH directly.
   (d) The work done in a process occurring at constant pressure is zero if Δn_{gases} is zero.

6. Given the standard heats of formation for the following compounds, calculate ΔH^0_{298} for the following reaction.

$$CH_4(g) + H_2O(g) \rightarrow CH_3OH(g) + H_2(g)$$

Compound	ΔH^0_{f298}
$CH_{4(g)}$	–75 kJ/mol
$CH_3OH(g)$	–238 kJ/mol
$H_2O(g)$	–242 kJ/mol

(a) +79 kJ (b) –79 kJ (c) +594 kcal (d) –594 kcal

7. Given the following at 25°C and 1.00 atm:

	ΔH^0
$SO_3(g) + H_2O(l) \rightarrow H_2SO_4(l)$	–133 kJ
$Pb(s) + PbO_2(s) + 2H_2SO_4(l) \rightarrow 2PbSO_4(s) + 2H_2O(l)$	–509 kJ

Calculate the ΔH^0 for the reaction below at 25°C.

$$Pb(s) + PbO_2(s) + 2SO_3(g) \rightarrow 2PbSO_4(s)$$

(a) +376 kJ (b) – 642 kJ (c) –243 kJ (d) –775 kJ

8. Given that ΔH^0 for the oxidation of sucrose, $C_{12}H_{22}O_{11}(s)$, is –5648 kJ per mole of sucrose at 25°C, evaluate ΔH^0_f for sucrose.

	$C_{12}H_{22}O_{11}(s)$ +	$12O_2(g)$ →	$12CO_2(g)$ +	$11H_2O(l)$
ΔH^0_f (kJ/mol)	?	0	–393.5	–285.8

(a) –1676 kJ/mol (b) –2218 kJ/mol (c) –1431 kJ/mol (d) –1067 kJ/mol

9. Which one of the following reactions has a **positive** entropy change?

(a) $2NH_4NO_3(s) \rightarrow 2N_2(g) + 4H_2O(g) + O_2(g)$

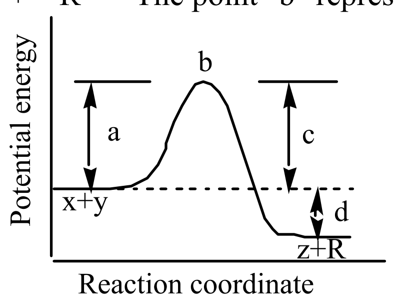
(b) $H_2O(g) \rightarrow H_2O(l)$

(c) $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

(d) $BF_3(g) + NH_3(g) \rightarrow F_3BNH_3(s)$

10. Given the following potential energy diagram for the one-step reaction

X + Y → Z + R The point "b" represents ____________.



(a) the energy of the mixture when half of the reactants have been converted to products

(b) the energy of the transition state

(c) the energy of the forward reaction

(d) the energy of the reverse reaction

11. What can be said about the stoichiometric coefficients of a balanced overall chemical equation for a reaction and the powers to which the concentrations are raised in the rate law expression?
    (a) There is an exact relationship between the two.
    (b) Not much can be said except that there is no necessary relationship.
    (c) The powers are equal to the number of molecules that must collide and react through the rate-determining step.
    (d) (b) and (c) are both correct.

12. The gas phase reaction A + B $\rightarrow$ C has a reaction rate which is experimentally observed to follow the relationship Rate = k$[A]^2[B]$. The overall order of the reaction (a) is first. (b) is second. (c) is third. (d) is zero.

13. The units of the rate constant for a second order reaction can be _________.
    (a) $M^{-1}\cdot s^{-1}$ (b) $M\cdot s^{-1}$ (c) s^{-1} (d) $M^2\cdot s^{-1}$

14. A reaction is first order in X and second order in Y. Tripling the initial concentration of X and cutting the initial concentration of Y to three-fourths of its previous concentration at constant temperature causes the initial rate to _______ by a factor of _______.
    (a) increase, 1.69 (b) decrease, 0.19 (c) increase, 1.33 (d) decrease, 1.25

15. Determine the rate-law expression for the reaction below.

$$2A + B_2 + C \rightarrow A_2B + BC$$

Trial	Initial [A]	Initial [B_2]	Initial [C]	Initial Rate of Formation of BC
1	0.20 *M*	0.20 *M*	0.20 *M*	$2.4 \times 10^{-6} \cdot M \cdot min^{-1}$
2	0.40 *M*	0.30 *M*	0.20 *M*	$9.6 \times 10^{-6} \cdot M \cdot min^{-1}$
3	0.20 *M*	0.30 *M*	0.20 *M*	$2.4 \times 10^{-6} \cdot M \cdot min^{-1}$
4	0.20 *M*	0.40 *M*	0.40 *M*	$4.8 \times 10^{-6} \cdot M \cdot min^{-1}$

(a) Rate = k$[A]^2[B_2][C]$ (b) Rate = k$[B_2]^2[C]^2$ (c) Rate = k$[A][C]^2$ (d) Rate = k$[A]^2[C]$

16. At 300 K the following reaction is found to obey the rate law Rate = k$[NOCl]^2$.

$$2NOCl \rightarrow 2NO + Cl_2$$

Consider the three postulated mechanisms given below. Then choose the response that lists all those that are **possibly** correct and no others.

I.
- $NOCl \rightarrow NO + Cl$ slow
- $Cl + NOCl \rightarrow NOCl_2$ fast
- $NOCl_2 + NO \rightarrow 2NO + Cl_2$ fast
- $2NOCl \rightarrow 2NO + Cl_2$

II.
- $2NOCl \rightarrow NOCl_2 + NO$ slow
- $NOCl_2 \rightarrow NO + Cl_2$ fast
- $2NOCl \rightarrow 2NO + Cl_2$

III.
- $NOCl \rightarrow NO + Cl$ fast
- $NOCl + 2Cl \rightarrow NO + Cl_2$ slow
- $2NOCl \rightarrow 2NO + Cl_2$

(a) I (b) II (c) III (d) I and II

NAME________________
(print)

Signature____________
(sign)

17. For a certain process at 127°C, $\Delta G = -16.20$ kJ and $\Delta H = -17.0$ kJ. What is the entropy change for this process at this temperature? Express your answer in the form, $\Delta S =$ ______ J/K.

18. If 4.168 kJ of heat is added to a calorimeter containing 75.40 g of water, the temperature of the water and the calorimeter increases from 24.58°C to 35.82°C. Calculate the heat capacity of the calorimeter (in J/°C). The specific heat of water is 4.184 J/g•°C.

19. Estimate the boiling point of hydrogen peroxide, H_2O_2. For H_2O_2(l), $\Delta H_f^0 =$ –187.8 kJ/mol and $S^0 = 109.6$ J/mol•K and for H_2O_2(g), $\Delta H_f^0 = -136.3$ kJ/mol and $S^0 = 233$ J/mol•K.

20. Cyclopropane rearranges to form propene in a reaction that is first order. If the rate constant is 2.74×10^{-3} s^{-1}, how long would it take for 70.6% of the cyclopropane to rearrange if the initial concentration was 0.460 *M*?

ANSWERS: 1. (D), 2. (A), 3. (C), 4. (C), 5. (C), 6. (A), 7. (D), 8. (B), 9. (A), 10. (B), 11. (D), 12. (C), 13. (A), 14. (A), 15. (D), 16. (B), 17. (-2.00 J/K), 18. (57.0 J/K), 19. (417 K or 144°C), 20. (447 sec)