Chemistry 106 Exam 2 Fall 2007 Form A

1. Entropy is

   A. the energy of a system in terms of disorder.
   B. the energy wasted in a system.
   C. a measure of the disorder in a system.
   D. the tendency to disorder.
   E. a measure of energy in terms of disorder.

2. Calculate $\Delta S°$ for the reaction $SO_2(s) + NO_2(g) \longrightarrow SO_3(g) + NO(g)$.

	S°(J/K·mol)
$SO_2(g)$	248.5
$SO_3(g)$	256.2
$NO(g)$	210.6
$NO_2(g)$	240.5

   A. -53.6 J/K B. 53.6 J/K C. 474.8 J/K
   D. -474.8 J/K E. -22.2 J/K

3. At 0 K, the entropy of a perfect crystal

   A. is < 0.
   B. is = 0.
   C. must be measured.
   D. fluctuates.
   E. is > 0.

4. What is the entropy change if 4.500 g of $CaCO_3$ (s) is placed in a container and allowed to decompose to CaO (s) and CO_2 (g) according to the reaction

$$CaCO_3\,(s) \rightleftharpoons CaO\,(s) + CO_2(g)?$$

Substance	**S° (J/mol K)**
$CaCO_3$ (s)	92.88
CaO (s)	39.75
CO_2 (g)	213.6

   A. 160.5 J/K B. 35.7 J/K
   C. -160.5 J/K D. -35.7 J/K
   E. 7.2 J/K

5. Arrange the following compounds in order of increasing standard molar entropy at 25°C: $C_3H_8(g)$, $C_2H_4(g)$, ZnS(s), and $H_2O(l)$.

   A. $C_2H_4(g) < H_2O(l) < C_3H_8(g) < NaCl(s)$
   B. $ZnS(s) < H_2O(l) < C_3H_8(g) < C_2H_4(g)$
   C. $ZnS(s) < C_3H_8(g) < C_2H_4(g) < H_2O(l)$
   D. $ZnS(s) < H_2O(l) < C_2H_4(g) < C_3H_8(g)$
   E. $C_3H_8(g) < C_2H_4(g) < H_2O(l) < ZnS(s)$

6. Enthalpies of solution

   A. are difficult to measure.
   B. are always negative.
   C. can be positive or negative.
   D. are negative at low temperature.
   E. are always positive.

7. Some thermophilic (heat loving) bacteria that grow near hydrothermal ocean vents and in hot springs use elemental sulfur as their food source. They convert the sulfur to H_2SO_4. One possible reaction is:

$$2S(s) + 2H_2O(l) + O_2(g) \longrightarrow 2H_2SO_4(aq) \qquad \Delta G^o_{rxn} = -1015 \text{ kJ as written}$$

   What is the useful energy content of S in units of food Calories per gram if this is the reaction used by the organisms? In other words what is the fuel value of the sulfur? There are 4.184 J/cal.

   A. 66.20 Cal/g S
   B. 7.566 Cal/g S
   C. 3.781 Cal/g S
   D. 1.556×10^4 Cal/g S
   E. 3781 Cal/g S

8. Calculate ΔG^o for the combustion of ethanol vapor, $C_2H_5OH(g)$, <u>at 750°C</u> in oxygen to form carbon dioxide and water vapor. The following data is valid at 25°C (you may assume that ΔH^o_{rxn} and ΔS^o_{rxn} do not change with temperature):

	S^o(J/K/mol)	ΔH^o_f(kJ/mol)
$C_2H_5OH(g)$	161.04	-234.8
$O_2(g)$	205.0	0
$H_2O(g)$	188.7	-241.8
$CO_2(g)$	213.6	-393.5

   A. -1407 kJ/mol
   B. -4486 kJ/mol
   C. -1500 kJ/mol
   D. -1307 kJ/mol
   E. -2151 kJ/mol

9. Proteins are made by coupling amino acids together. Organisms form the simple dipeptide alanylglycine (exact structure unimportant) using the following two parallel reactions:

$$\text{alanine + glycine} \longrightarrow \text{alanylglycine + } H_2O \qquad \Delta G = +29.0 \text{ kJ}$$

simultaneously the organism uses up the water to produce the HPO_4^{2-} ion in the following reaction:

$$ATP + H2O \longrightarrow ADP + HPO_4^{2-} \qquad \Delta G = -30.5 \text{ kJ}$$

Which statement about the overall process is true?

A. The ΔG = -1.5 kJ and the process is spontaneous.
B. The ΔG = -30.5 kJ and the process is spontaneous.
C. The ΔG = -1.5 kJ and the process is nonspontaneous.
D. The ΔG = 30.5 kJ and the process is nonspontaneous.
E. The ΔG = 1.5 kJ and the process is spontaneous.

10. Benzene, C_6H_6, has a normal boiling point of 80°C and its ΔH_{vap} is 30.8 kJ/mol. Calculate the molar entropy of vaporization (ΔS_{vap}).

A. 132.6 $J \cdot K^{-1} \cdot mol^{-1}$
B. 87.3 $J \cdot K^{-1} \cdot mol^{-1}$
C. 0.087 $J \cdot K^{-1} \cdot mol^{-1}$
D. 64.1 $J \cdot K^{-1} \cdot mol^{-1}$
E. 385.0 $J \cdot K^{-1} \cdot mol^{-1}$

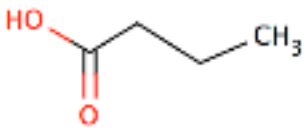
11. A negative sign for ΔG indicates that, at constant T and P,

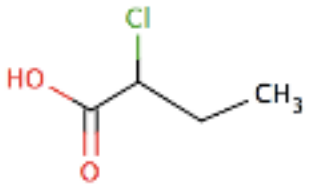
A. the reaction is spontaneous.
B. the reaction is exothermic.
C. ΔS must be > 0.
D. the reaction is endothermic.
E. the reaction is fast.

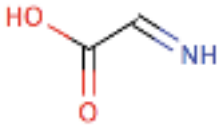
12. A peptide bond (also called an amide bond) joins two amino acids together. What atoms are linked by this bond?

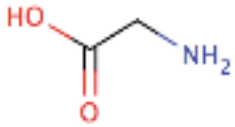
A. C — H B. S — C C. N — S D. C — N E. C — O

13. Which of the following species has an assymetric center (a chiral center)? In other words: which molecule has an enantiomer?

A. 

B. 

C. 

D. 

E. None of these have chiral centers

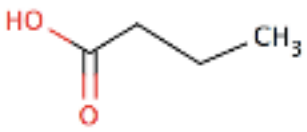
14. The helical structure of a double strand of DNA is lost when the DNA is unzipped for duplication or transcription. What interactions are being disrupted?

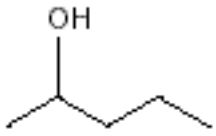
A. repulsive B. dipole C. dispersion D. ionic E. H-bond

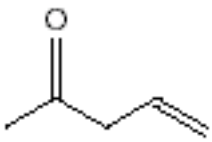
15. The biological significance of chirality (stereoisomerism) is that

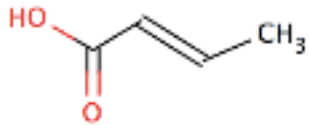
A. because proteins (enzymes) are made of chiral subunits they usually react with only one stereoisomer of a molecule.
B. because proteins (enzymes) are not made of chiral subunits they react with all stereoisomers of a molecule.
C. because proteins (enzymes) are made of chiral subunits they react with all stereoisomers of a molecule.
D. because proteins (enzymes) are not made of chiral subunits they usually react with only one stereoisomer of a molecule.
E. there is no biological significance of chirality.

16. Which of the following is a saturated fatty acid?

A. 

B. 

C. 

D. 

E. None of these are saturated fatty acids.

17. Given the following data, determine the rate constant of the reaction

$$2\ NO\ (g) + Cl_2\ (g) \rightarrow 2\ NOCl\ (g)$$

Experiment	**[NO] (M)**	**[Cl_2] (M)**	**Rate (M/s)**
1	0.0300	0.0100	3.4×10^{-4}
2	0.0150	0.0100	8.5×10^{-5}
3	0.0150	0.0400	3.4×10^{-4}

A. 9.44 $M^{-2}s^{-1}$ B. 0.750 $M^{-2}s^{-1}$ C. 0.0265 $M^{-2}s^{-1}$
D. 37.8 $M^{-2}s^{-1}$ E. 1.13 $M^{-2}s^{-1}$

18. Determine the overall order of the reaction 2 NO (g) + Cl_2 (g) → 2 NOCl (g) from the following data:

Experiment	**[NO] (M)**	**[Cl_2] (M)**	**Rate (M/s)**
1	0.0300	0.0100	3.4×10^{-4}
2	0.0150	0.0100	8.5×10^{-5}
3	0.0150	0.0400	3.4×10^{-4}

A. 1st B. 2nd C. 3rd D. 4th E. 0th

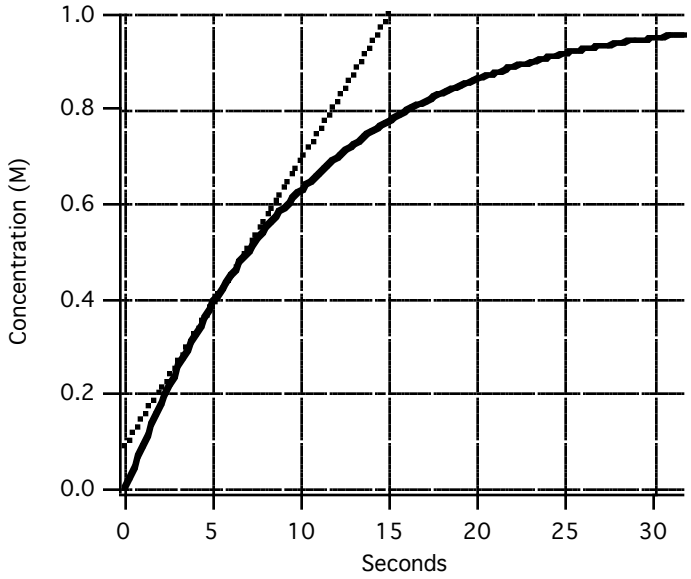
19. For the hypothetical reaction A + 3B —> 2C, the rate of appearance of C given by $(\Delta[C]/\Delta t)$ may also be expressed as

A. $(\Delta[C]/\Delta t) = -(1/2)\ \Delta[A]/\Delta t$
B. $(\Delta[C]/\Delta t) = -(3/2)\ \Delta[B]/\Delta t$
C. $(\Delta[C]/\Delta t) = -(2/3)\ \Delta[B]/\Delta t$
D. $(\Delta[C]/\Delta t) = -(1/2)(\Delta[A] + 3\Delta[B])/\Delta t$
E. $(\Delta[C]/\Delta t) = \Delta[A]/\Delta t$

20. The units of "reaction rate" are

A. mol L^{-1} s^{-1} B. $L^2 mol^{-2}$ s^{-1} C. s^{-1} D. s^{-2} E. L mol^{-1} s^{-1}

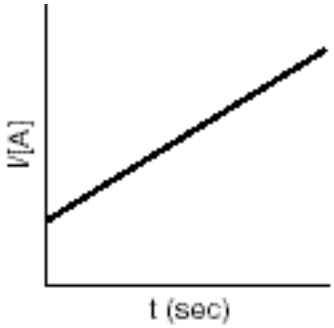
21. The graph below depicts the concentration versus time of species C in the reaction A + 3B —> 2C. What is the instantaneous rate of the reaction (not the rate of formation of C) at 5 seconds. A dashed tangent line has been drawn at 5 seconds to assist you.



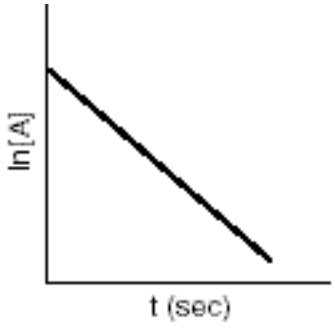
A. $-0.030\ Ms^{-1}$ B. $0.030\ Ms^{-1}$ C. $17.\ Ms^{-1}$
D. $0.060\ Ms^{-1}$ E. $-0.060\ Ms^{-1}$

22. Which of the following plots would indicate that a reaction was first order?

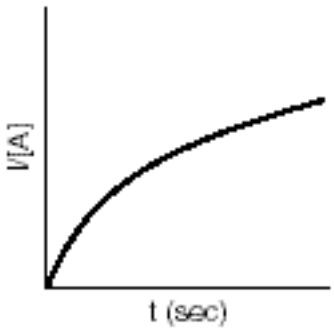
A.



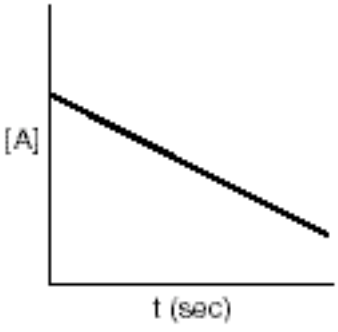
B.



C.



D.



E. Any of these could indicate first order.

23. For the overall chemical reaction shown below, which one of the following statements can be rightly assumed?
$2H_2S(g) + O_2(g) \longrightarrow 2S(s) + 2H_2O(l)$

A. The rate law cannot be determined from the information given.
B. The reaction is third-order overall.
C. The rate law is, rate = $k[H_2S]^2\,[O_2]$.
D. The reaction is second-order overall.
E. The rate law is, rate = $k[H_2S]\,[O_2]$.

24. Indicate which of the following compounds is a component of photochemical smog:

A. N_2O B. CO_2
C. H_2O D. O_3
E. none of these

25. At 25°C the rate constant for the first-order decomposition of a pesticide solution is 6.40×10^{-3} min^{-1}. If the starting concentration of pesticide is 0.0314 M, what concentration will remain after 62.0 min at 25°C?

A. 2.68×10^{-2} M B. 1.14×10^{-1} M C. 47.4 M
D. 2.11×10^{-2} M E. -8.72 M

26. The mechanism for the reaction $2H_2O_2\,(aq) \rightarrow$

$2H_2O(l) + O_2(g)$ in the presence of $I^-(aq)$ is proposed to be:

Step 1: $H_2O_2(aq) + I^-(aq) \rightarrow H_2O(l) + OI^-(aq)$ (slow)

Step 2: $H_2O_2(aq) + OI^-(aq) \rightarrow H_2O(l) + O_2(g) + I^-(aq)$ (fast)

What is the molecularity of the rate-determining step?

A. unimolecular
B. bimolecular
C. Not enough information is presented to answer this question.
D. termolecular

27. The reaction A + 2B —> products was found to have the rate law, rate = $k[A]\,[B]^2$. Predict by what factor the rate of reaction will increase when the concentration of A is doubled and the concentration of B is also doubled.

A. 4 B. 9 C. 8 D. 6 E. 2

28. The mechanism for the reaction $2H_2O_2\,(aq) \rightarrow$

$2H_2O(l) + O_2(g)$ in the presence of $I^-(aq)$ is proposed to be:

Step 1: $H_2O_2(aq) + I^-(aq) \rightarrow H_2O(l) + OI^-(aq)$

Step 2: $H_2O_2(aq) + OI^-(aq) \rightarrow H_2O(l) + O_2(g) + I^-(aq)$

Which of the following species is an intermediate?

A. H_2O_2 B. O_2 C. OI^- D. H_2O E. I^-

29. The following mechanism is proposed for the reaction A —> products. Assuming that the concentration of the intermediate C is in steady-state (the steady-state approximation) determine the rate law for this reaction.

$A \xrightarrow{k_1} B + C$
$C + A \xrightarrow{k_2} D$

A. $R = (k_1/k_2)[A]$
B. $R = (k_1^2/k_2)[C]^2$
C. $R = (k_2^2/k_1)[A]$
D. $R = k_1[A]$
E. $R = (k_1^2/k_2)[A]$

30. The rate law for the reaction $2NO_2 + O_3 \rightarrow N_2O_5 + O_2$ is rate = $k[NO_2][O_3]$. Which one of the following mechanisms is consistent with this rate law?

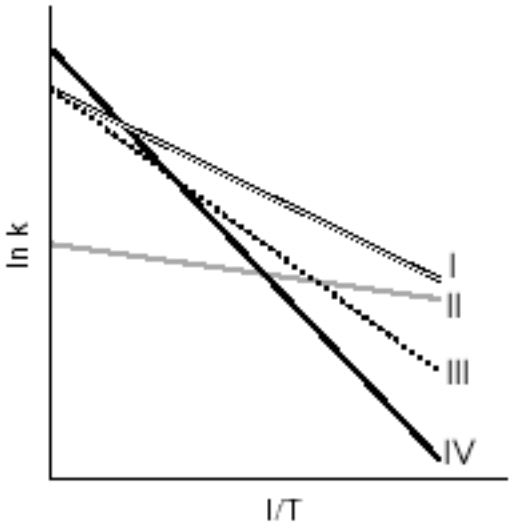
A. $NO_2 + O_3 \rightarrow NO_3 + O_2$ (slow)
$NO3 + NO_2 \rightarrow N_2O_5$ (fast)
B. $NO_2 + NO_2 \rightarrow N_2O_2 + O_2$ (slow)
$N_2O_2 + O_3 \rightarrow N_2O_5$ (fast)
C. $NO_2 + O_3 \rightarrow NO_5$ (fast)
$NO_5 + NO_5 \rightarrow N_2O_5 + (5/2)O_2$ (slow)
D. $NO_2 + NO_2 \rightarrow N_2O_2 + O_2$ (fast)
$N_2O_2 + O_3 \rightarrow N_2O_5$ (slow)
E. $NO_2 + NO_2 \rightarrow N_2O_4$ (fast)
$N_2O_4 + O_3 \rightarrow N_2O_5 + O_2$ (slow)

31. The mechanism of a reaction is

A. the same as the balanced chemical equation.
B. obvious if the activation energy is known.
C. the molecularity of the reaction.
D. the order of the reaction.
E. the elementary steps of the reaction.

Use the following information to answer questions 32-33.

Arrhenius plots for four different reactions.



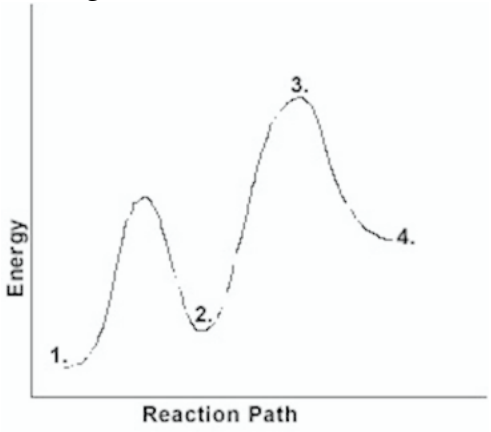
32. Which reaction has the greatest activation energy?

A. III B. IV C. I D. II E. All same

33. Which reaction has the largest frequency factor?

A. II B. IV C. III D. I E. All same

34. With respect to the figure below, which choice correctly identifies all the numbered positions?



A. 1. reactants 2. intermediate 3. activated complex 4. catalyst
B. 1. reactants 2. activated complex 3. intermediate 4. product
C. 1. reactants2. intermediate 3. activated complex 4. product
D. 1. catalyst 2. intermediate 3. activated complex 4. product
E. 1. reactants 2. activated complex 3. catalyst 4. product

35. The activation energy of a certain uncatalyzed reaction is 64 kJ/mol. In the presence of a catalyst, the E_a is 55 kJ/mol. How many times faster is the catalyzed than the uncatalyzed reaction at 400°C? Assume that the frequency factor remains the same.

A. 15 times B. 0.2 times C. 5.0 times D. 1.16 times E. 2.0 times

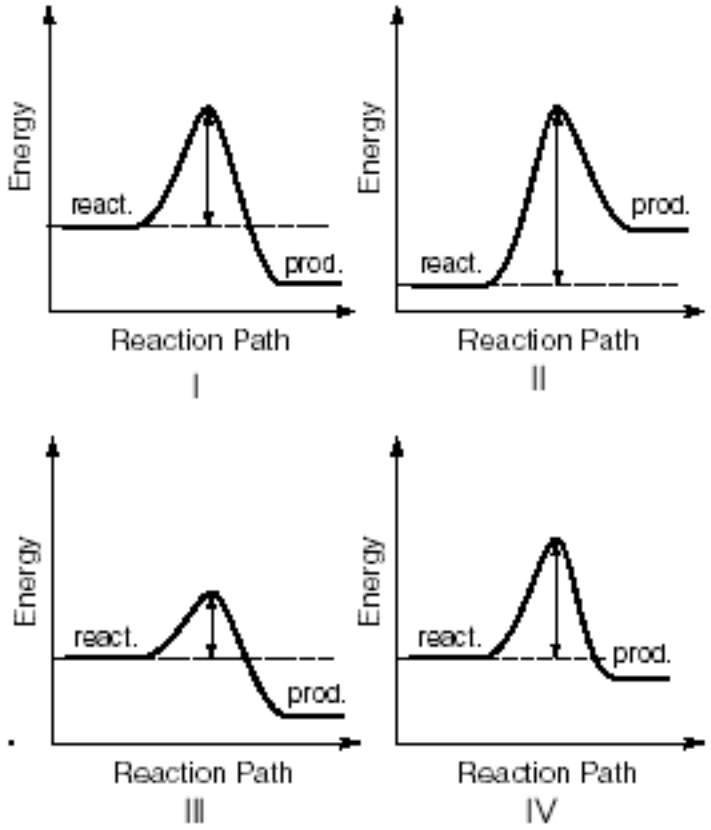
36. Peroxodisulfate ion can oxidize iodide ions to iodine according to the balanced equation $S_2O_8^{2-} + 2I^- \longrightarrow 2SO_4^{2-} + I_2$.
The reaction is catalyzed by certain chemical species. Identify the catalyst in the following mechanism:
step 1: $Fe^{3+} + 2I^- \longrightarrow Fe^{2+} + I_2$
step 2: $S_2O_8^{2-} + Fe^{2+} \longrightarrow 2SO_4^{2-} + Fe^{3+}$

A. SO_4^{2-}
B. I^-
C. $S_2O_8^{2-}$
D. Fe^{2+}
E. Fe^{3+}

37. A catalyst that is in the same phase as the reactants and products is a _____ catalyst.

A. inherent B. partial
C. homogeneous D. heterogeneous
E. directed

Energy profiles for four different reactions



38. Which of the reactions will have the smallest rate constant?

A. II B. III C. IV D. I E. All the same

Answer Key for Test “Exam 2 F07 Form A.mte”, 5/8/08

No. in Q-Bank	No. on Test	Correct Answer
13 15	1	C
13 94	2	E
13 19	3	B
13 40	4	E
13 89	5	D
13 3	6	C
13 99	7	C
13 97	8	C
13 65	9	A
13 98	10	B
13 96	11	A
13 101	12	D
13 86	13	B
13 102	14	E
13 100	15	A
13 68	16	A
14 39	17	D
14 29	18	C
14 103	19	C
14 101	20	A
14 104	21	B
14 41	22	B
14 102	23	A
14 2	24	D
14 106	25	D
14 58	26	B
14 105	27	C
14 56	28	C
14 108	29	D
14 107	30	A
14 52	31	E
14 77	32	B
14 79	33	B
14 110	34	C
14 109	35	C
14 111	36	E
14 92	37	C
14 66	38	A