Name_EXAM 1 KEY_____Section_____ chm152 sp09 Exam 1

1) F A reaction with a decrease in entropy ($\Delta S < 0$) is always spontaneous.

2) T Dry ice (solid CO_2) undergoes sublimation (solid → gas) at 25 °C. This phase transition **increases** the entropy of the system.
2) F Dry ice (solid CO_2) undergoes sublimation (solid → gas) at 25 °C. This phase transition **decreases** the entropy of the system.

3) F A reaction is second-order with respect to reactant A, therefore, doubling the concentration of A will **double** the reaction rate.
3) T A reaction is second-order with respect to reactant A, therefore, doubling the concentration of A will **quadruple** the reaction rate.

4) F The molar entropy of Carbon Dioxide (CO_2) is less than that of Carbon Monoxide (CO).

5) T A reaction which is Exothermic ($\Delta H < 0$) and increases Entropy ($\Delta S > 0$), is **always** spontaneous.
5) F A reaction which is Exothermic ($\Delta H < 0$) and increases Entropy ($\Delta S > 0$), is **never** spontaneous.

Multiple Choice (4 pts each)

6) All of the following increase entropy (S) EXCEPT

decreasing the temperature of a solid

7) Which of the following molecules has the highest molar entropy at 25 °C?

C_8H_{18} (l)

8) Which of the following is always **TRUE** for a spontaneous process?
i) $\Delta S_{sys} > 0$ ii) $\Delta S_{surr} > 0$ iii) $\Delta S_{univ} > 0$ iv) $\Delta G_{sys} < 0$ v) $\Delta G_{sys} > 0$

iii and iv

9) Predict the signs of ΔH, ΔS, and ΔG for the melting of ice (water) at 25 °C.

$\Delta H > 0$, $\Delta S > 0$, $\Delta G < 0$

10) For the following reaction, $\Delta H° = -74.9$ kJ and $\Delta S° = -80.7$ J/K, calculate $\Delta G°$ and select the right choice below. (Note: the standard temperature is 25 °C)

$$C \text{ (graphite)} + 2\ H_2\ (g) \rightarrow CH_4\ (g)$$

$\Delta G° = -50.85$ kJ, reaction is spontaneous at 25 °C

11) The following reaction is non-spontaneous at 25 °C, at what temperature would you expect the reaction to become spontaneous? ($\Delta H° = 131.3$ kJ and $\Delta S° = 133.6$ J/K)

$$C\ (s) + H_2O\ (g) \rightarrow CO\ (g) + H_2\ (g)$$

983 K

12) The rate expression for H_2 (g) in the following reaction is:

$$4\ PH_3\ (g) \rightarrow P_4\ (g) + 6\ H_2\ (g)$$

$\frac{1}{6}\frac{\Delta[H_2]}{\Delta t}$

13) What is the <u>reaction order</u> for a reaction whose rate law is: Rate = $k[A][B]^2$

third

14) The reaction A + B → C has the following rate law: Rate = k[A][B]. If the concentration of **A is doubled** and the concentration of **B is tripled**, <u>by what factor will the rate increase?</u>

6

15) For a reaction with the rate law: Rate = $k[A]^2$, the slope (m) of which plot will yield the value for the rate constant (k)?

(1/[A]) vs time

16) For the following reaction, $\frac{\Delta[H_2]}{\Delta t}$ was measured to be 0.352 M/s.

$$C_6H_{14}\ (g) \rightarrow C_6H_6\ (g) + 4\ H_2\ (g)$$

Determine the value of $\frac{\Delta[C_6H_{14}]}{\Delta t}$ over the same period of time.

8.80×10^{-2} M/s

17) The decomposition of hydrogen peroxide (H_2O_2) is a first-order reaction with a rate constant of 0.0410 min^{-1}. If the reaction is started with a hydrogen peroxide concentration of 0.500 M, what will be the concentration of the hydrogen peroxide after 10.0 minutes?

0.332 M

18) A certain first-order reaction starts with an initial concentration of 0.10 M. 30% of this reactant is <u>used up</u> in 115 minutes. What is the half-life ($t_{1/2}$) of the reaction?

223 min

19) All collisions do not lead to reaction. Which choices give correct reasons why all collisions between reactant molecules do not lead to reaction?

i) The two colliding molecules total energy is less than some minimum amount needed.
ii) Molecules cannot react with each other unless a catalyst is present.
iii) Molecules may be improperly oriented during collision.
iv) The reaction is endothermic.

i and iii

20) The following second-order reaction has the mechanism shown below.

$$ABY + C \rightarrow ABC + Y$$

Mechanism
Step 1: $ABY \rightarrow AB + Y$ (slow)
Step 2: $AB + C \rightarrow ABC$ (fast)

What is the rate law for the overall reaction?

rate = $k[ABY]^2$

Short Answer and Calculation Section

21) (6 pts) The following reaction was studied and the following data were obtained:

$$H_2SeO_3\ (aq)\ +\ 6\ I^-\ (aq)\ +\ 4\ H^+\ (aq)\ \rightarrow\ Se\ (s)\ +\ 2\ I_3^-\ (aq)\ +\ 3\ H_2O\ (l)$$

Experiment	$[H_2SeO_3]$	$[H^+]$	$[I^-]$	Initial Rate (M/s)
1	$1.0 \times 10^{-4}\ M$	$2.0 \times 10^{-2}\ M$	$2.0 \times 10^{-2}\ M$	1.66×10^{-7}
2	$3.0 \times 10^{-4}\ M$	$2.0 \times 10^{-2}\ M$	$2.0 \times 10^{-2}\ M$	4.98×10^{-7}
3	$1.0 \times 10^{-4}\ M$	$4.0 \times 10^{-2}\ M$	$2.0 \times 10^{-2}\ M$	6.64×10^{-7}
4	$1.0 \times 10^{-4}\ M$	$2.0 \times 10^{-2}\ M$	$1.0 \times 10^{-2}\ M$	8.30×10^{-8}

Write the RATE LAW for this reaction. **You MUST show your work to get full credit!!!**

rate = $k[H_2SeO_3][H^+]^2[I^-]$

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1	$1.0 \times 10^{-4}\ M$	$2.0 \times 10^{-2}\ M$	$2.0 \times 10^{-2}\ M$	1.66×10^{-7}
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3	$1.0 \times 10^{-4}\ M$	$2.0 \times 10^{-2}\ M$	$4.0 \times 10^{-2}\ M$	6.64×10^{-7}
4	$1.0 \times 10^{-4}\ M$	$2.0 \times 10^{-2}\ M$	$1.0 \times 10^{-2}\ M$	8.30×10^{-8}

rate = $k[H_2SeO_3][H^+][I^-]^2$

22a) (4 pts) At 25 °C, a certain reaction has a ΔH = 17 kJ/mol and ΔS = 65 J/K*mol.

What is the value of ΔG for the reaction?

-2.37 kJ/mol

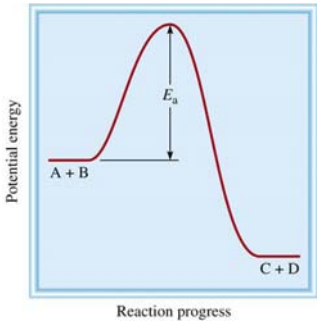
22a) (4 pts) At 25 °C, a certain reaction has a ΔH = 21.74 kJ/mol and ΔS = 65 J/K*mol.

What is the value of ΔG for the reaction?

+2.37 kJ/mol

22b) (2 pts) At 25 °C, does this reaction proceed spontaneously?

YES, for NEGATIVE
NO, for POSITIVE



The figure above shows the potential energy profile for the following reaction.

$$A + B \rightarrow C + D$$

It is well know that reaction rate increases with increasing temperature.

23a) (4 pts) Which of the following statements about a reaction are <u>TRUE</u> when the temperature is raised?

i) The reaction forms products faster.
ii) The kinetic energy of the reactants (A and B) is increased.
iii) The height of the reaction barrier (Ea) is decreased.
iv) The height of the reaction barrier (Ea) is increased.
v) The speed of the molecules is increased.

<u>Circle your answer choice below</u>, DO NOT SELECT ON SCANTRON!!!!

(A) i, iii, v **(B) i, ii, v** (C) ii, iii, v (D) v only (E) i, ii, iii, v

23b) (4 pts) <u>Explain</u> your answer choice from Question 23a.
Please be as detailed as possible.

An increase in temperature raises the kinetic energy of the molecules, this allows them to move faster. Moving faster means they will collide more frequently and with more energy. The increased kinetic energy, and collision frequency allows them to make it over the energy barrier (Ea) at a faster rate, therefore increasing the reaction rate and speed of product formation.

An increase in temperature does NOT affect the value of Ea (height of barrier), this is only a function of the identity of the reactant and products.