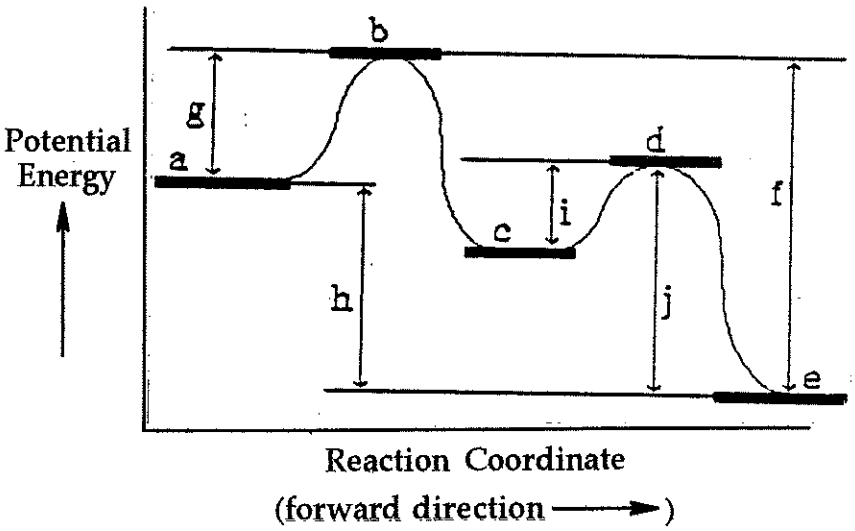
General Chemistry II
Dr. M. J. Wieder
Examination #2

Name _____

Questions (1)-(5) pertain to the potential energy diagram shown below:



(4) 1. Which one of the following statements is valid for the reaction in the **forward** direction?

a) Reactant is more stable than intermediate.
b) Reactant is more stable than product.
c) Intermediate is more stable than reactant.
d) Intermediate is more stable than product.

(4) 2. The E_{act} associated with the conversion of intermediate to final product (in the **forward** direction) is represented by the letter _____.

(4) 3. The E_{act} of the rate determining step of the reaction mechanism (in the **reverse** direction) is represented by the letter _____.

(4) 4. The transition state (activated complex) of the fast step in the reaction mechanism (in the **forward** direction) is represented by the letter _____.

(4) 5. Which one of the following statements is valid?

a) The overall reaction in the forward direction is endothermic.
b) If the concentration of intermediate is tripled, the reaction rate in the forward direction triples.
c) In the forward direction, reactant quickly forms intermediate that slowly forms final product.
d) In the forward direction, reactant slowly forms intermediate that quickly forms final product.

(4) 6. If the E_{act} in the forward direction of a one step reaction is +52 kj, and the E_{act} in the reverse direction is +24 kj, what is ΔH for the reaction in the forward direction?

a) +76 kj b) +28 kj c) -28 kj d) -52 kj e) -76 kj

(4) 7. Which one of the following statements is valid?

a) A catalyst can increase the average kinetic energy of reacting species at a fixed temperature.
b) A catalyst can alter ΔH for a chemical reaction.
c) A catalyst can speed up the forward reaction without altering the rate of the reverse reaction.
d) A catalyst never undergoes an alteration of its chemical structure during the course of reaction.
e) None of the above statements is true.

(4) 8. For the overall reaction, 2A $\longrightarrow$ 1B, a kinetic study indicates that doubling the concentration of reactant A quadruples the reaction rate. To obtain a straight line graph, _____ must be plotted vs. time.

(4) 9. All of the following can influence the rate of reaction **except**:

a) activation energy b) ΔH_{rxn}
c) reactant concentration d) reaction temperature
e) All of the above can influence the rate of reaction

(4) 10. The E_{act} of an elementary step in a reaction pathway can be:

a) increased by decreasing the reaction temperature
b) decreased by increasing the reaction temperature
c) decreased by increasing the concentration of reactants
d) increased by using a catalyst
e) None of the above statements is true

(4) 11. Consider the **one step** overall reaction, $1A + 1B \longrightarrow 2C$. Initially, 4.0 moles of A and 3.0 moles of B are placed in an empty 1.0 liter flask. When the concentration of product C reaches 2.0M, the rate of reaction will be:

a) one twelfth the initial rate
b) one sixth the initial rate
c) one third the initial rate
d) one half the initial rate
e) the same as the initial rate

(15) 12. Consider the **jumbled sequence** of steps shown for the chain reaction nitration of ethane in the gas phase:

Overall rxn: $CH_3CH_3 + HONO_2 \longrightarrow CH_3CH_2NO_2 + H_2O$

Equation 1: $CH_3CH_2\cdot + HONO_2 \longrightarrow CH_3CH_2NO_2 + HO\cdot$
Equation 2: $CH_3CH_2\cdot + H_2O \longrightarrow CH_3CH_3 + HO\cdot$
Equation 3: $HONO_2 \longrightarrow HO\cdot + NO_2\cdot$
Equation 4: $CH_3CH_2\cdot + HO\cdot \longrightarrow CH_3CH_2OH$
Equation 5: $CH_3CH_3 + HO\cdot \longrightarrow CH_3CH_2\cdot + H_2O$

Designate **each** of the above steps in the chain reaction as **initiating**, **propagating**, **inhibiting**, or **terminating**.

(4) 13. Consider the following mechanism for a Friedel-Crafts reaction:

Step 1: $CH_3Cl + AlCl_3 \longrightarrow CH_3^+ + AlCl_4^-$

Step 2: $C_6H_6 + CH_3^+ \longrightarrow C_7H_9^+$

Step 3: $C_7H_9^+ + AlCl_4^- \longrightarrow C_7H_8 + AlCl_3 + HCl$

In the above mechanism, $AlCl_3$ is:

a) a product of the overall reaction
b) a reactant in the overall reaction
c) an inhibitor
d) a catalyst
e) None of the above choices is correct

(4) 14. For the reaction between NO and Cl_2 at a given temperature, tripling the concentration of Cl_2 while keeping the concentration of NO fixed triples the rate of reaction. Tripling the concentration of both reactants increases the rate of reaction by a factor of 27. The rate law for the reaction is ____ order in NO and ____ order in Cl_2.

(8) 15. For the overall reaction, $1O_3 + 2NO_2 \longrightarrow 1N_2O_5 + 1O_2$, the rate law has been determined to be **first order in O_3 and first order in NO_2.**
Propose a plausible mechanism invoking the intermediacy of NO_3 to account for the overall reaction consistent with the kinetic data. **Be sure to identify the rate determining and fast steps in your mechanism.** For the sake of aesthetics (and grading), **each elementary step in your mechanism should be unimolecular or bimolecular in nature.**

(8) 16. If, at 37°C, the rate of reaction is double that at 27°C (all other factors being equal), calculate E_{act} in units of kj for the reaction given the following equation:

$$\text{Log}\,(k_1/k_2) = \frac{E_{act}}{2.303\,R}(1/T_2 - 1/T_1) \qquad R = 8.314 \text{ joules/mol°K}$$

17. Consider the following table of kinetic data for the overall reaction shown below:

$$1A + 2B + 1C \longrightarrow 1X + 3Y$$

Expt. #	Initial Molar Concentrations A	B	C	Initial Rate of Formation of Y
1	0.10M	0.10M	0.10M	2×10^{-2}M/sec
2	0.05M	0.20M	0.10M	4×10^{-2}M/sec
3	0.10M	0.20M	0.10M	4×10^{-2}M/sec
4	0.05M	0.10M	0.025M	5×10^{-3}M/sec
5	0.02M	0.01M	0.01M	2×10^{-4}M/sec

(9) a) Determine the rate law for the reaction of interest based on the data provided. Show all work in the space below.

(4) b) Determine the numerical value of the specific rate constant. Show all work in the space below.

(4) c) If one were to double the concentration of each reactant, the rate of reaction would increase by a factor of _____.