CHEM 12 REACTION KINETICS Unit 1 Review
CHECK YOUR UNDERSTANDING

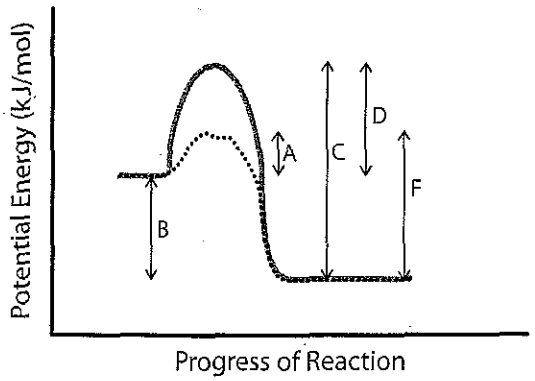
1. For a hypothetical reaction, $XY(g) \rightleftharpoons X(g) + Y(g)$ $\Delta H = 35$ kJ/mol. For the reverse reaction, $E_a = 25$ kJ/mol.

(a) Sketch a potential energy diagram for this reaction (label general values as given).

(b) What is the activation energy for the forward reaction?

(c) What is ΔH for the reverse reaction?

2. Study the potential energy diagram shown below.



(a) Indicate what each of the letters (A through E) represents.

A.

B.

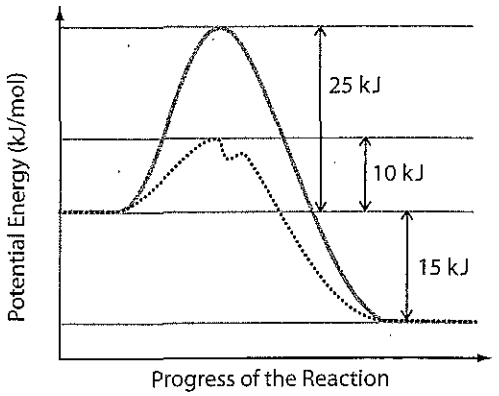
C.

D.

E.

(b) Is this reaction endothermic or exothermic?

3. Study the following potential energy diagram.



(a) Is this reaction endothermic or exothermic?

(b) What is E_a for the catalyzed pathway?

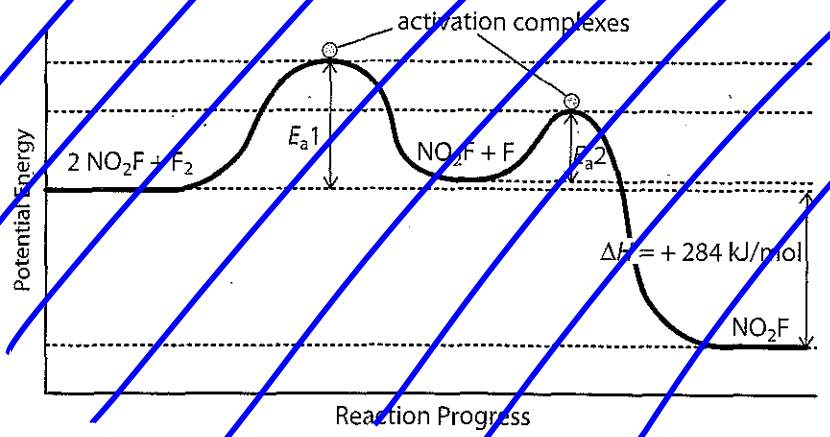
(c) What is E_a for the uncatalyzed pathway?

(d) What is ΔH for this reaction? How does this value change with a catalyst?

(e) How much lower is the potential energy of the activated complex with a catalyst?

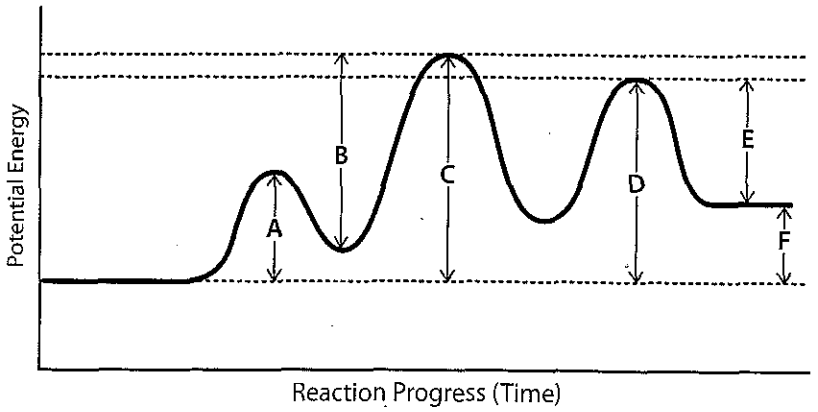
(f) How does this affect the reaction rate?

4. Examine the following potential energy diagram and use it to construct a reaction mechanism. Show each step and the overall reaction. Label the rate-determining step.



THIS QUESTION IS FLAWED

5. Look at the PE diagram shown here and answers the questions below. Write your answers at the end of each question.



(a) How many steps are in the reaction represented by this potential energy profile?

(b) Which step is rate determining?

(c) What arrow represents E_a for the forward reaction?

(d) What arrow represents E_a for the rate-determining step?

(e) What arrow represents ΔH for the reaction?

(f) Is this an endo- or exothermic reaction?

6. The reaction, $CO(g) + NO_2(g) \rightarrow CO_2(g) + NO(g)$ may occur by either of the following two mechanisms:

Mechanism 1: Step 1: $2\,NO_2(g) \rightarrow NO_3(g) + NO(g)$ slow

Step 2: _____ fast

Reaction:

Mechanism 2: Step 1: $2\,NO_2(g) \rightarrow N_2O_4(g)$ fast

Step 2: _____ slow

Reaction:

(a) Fill the reaction in and use it to discern the missing step 2 for each mechanism.

(b) Experimental data shows that increasing the [CO] has *no effect* on the overall reaction rate. Based on this data, which mechanism must be correct?

7. Consider the reaction: $4\,HBr(g) + O_2(g) \rightarrow 2\,H_2O(g) + 2\,Br_2(g)$ + heat

(a) Does this reaction represent an elementary process? Explain

(b) Propose a reaction mechanism for the overall reaction, given the following clues: There are two intermediates in the reaction. The first to form is $HOOBr(g)$ and the second is $HOBr(g)$.

(c) Experimental data shows that a change in [HBr] has the same effect on the rate of the reaction as an identical change in $[O_2]$. What is the rate-determining step?

8. A reaction between ammonium ions and nitrite ions to produce a salt has the following rate law:

$$\text{rate} = k[NH_4^+][NO_2^-]$$

Assume the rate of formation of the salt is 3.10×10^{-3} mol/L/s. Note that the units may also be expressed as *mol/L s. The reaction is performed in aqueous solution at room temperature.*

(a) What rate of reaction would result if the $[NH_4^+]$ was tripled and the $[NO_2^-]$ was halved?

(b) Determine the reaction rate if the $[NH_4^+]$ was unchanged and the $[NO_2^-]$ was increased by a factor of four?

(c) If the $[NH_4^+]$ and the $[NO_2^-]$ were unchanged, but the rate increased to 6.40×10^{-3} mol/L s, what must have happened to the reacting system?

(d) What would the new reaction rate be if enough water were added to double the overall volume?

9. A student reacts ground marble chips, $CaCO_3(s)$, with hydrochloric acid, HCl(*aq*), in an open beaker at constant temperature.

(a) In terms of collision theory, explain what will happen to the rate of the reaction as it proceeds from the beginning to completion.

(b) Sketch a graph of volume of $CO_2(g)$ vs. time to show the formation of product with time as the reaction proceeds.

(c) Explain, using a diagram, how increasing the temperature (for example, heating the HCl (aq)) would affect the rate, in terms of collision theory.