1. The rate constants for the first-order decomposition of a compound are $\overset{k_1}{5.22\times 10^{-4}}\ s^{-1}$ at 43°C and $\overset{k_2}{2.91 \times 10^{-3}}\ s^{-1}$ at 62°C. What is the value of the activation energy for this reaction?

$T_1 = 316$

$T_2 = 335$

A. 0.87104 kJ/mol
B. 34.5 kJ/mol
C. 0.751 kJ/mol
D. 79.5 kJ/mol
E. 2 kJ/mol

$$\ln\left(\frac{k_1}{k_2}\right) = \frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

2. Given the following mechanism:

$Cl + O_3 \rightarrow ClO + O_2$

$ClO + O \rightarrow Cl + O_2$

Identify any catalysts and intermediates in the reaction.

A. Cl is a catalyst, there are no intermediates
B. O is an intermediate, ClO is a catalyst
C. O_2 is a catalyst, O is an intermediate
D. ClO is a catalyst, there are no intermediates
E. Cl is a catalyst, ClO is an intermediate

3. Which of the following statements is **NOT** a requirement for a valid reaction mechanism?

A. Each elementary reaction must be bimolecular.
B. There must not be net production of any intermediates.
C. The elementary reactions of a mechanism must add up to the net chemical reaction.
D. A mechanism must have only one rate-determining step.
E. The rate law predicted by a mechanism must agree with the experimental rate law.

4. For the following reaction at equilibrium

$$CO_{(g)} + 3H_{2(g)} \rightleftarrows CH_{4(g)} + H_2O_{(g)}$$

If CO gas was added to the reaction mixture, then it will:

A. More water vapor will form
B. More hydrogen gas will form
C. Less methane gas will form
D. The reaction will go backward
E. Nothing will happen

$[E] = k[D][B]$

$[B][D][E] = k[A][B]^2$

$\frac{1}{2}[A] = [B] = [C]$

$[C] = [E][A]$

$D + B \rightarrow A$

$= [D][B][A]$

$[E] = [D][B]$

5. The reaction

$$2A + B \rightarrow C$$

has the following proposed mechanism:

Step 1: $A + B \rightleftharpoons D$ (fast equilibrium)

Step 2: $D + B \rightarrow E$

Step 3: $E + A \rightarrow C + B$

If step 2 is the rate-determining step, then the rate of formation of C should equal:

A. $k[A]$

B. $k[A]^2[B]$

C. $k[A]^2[B]^2$

D. $k[A][B]$

E. $k[A][B]^2$

$\frac{[CO]^2}{[CO_2]}$

6. For the following reaction

$$CO_{2(g)} + C_{(s)} \rightleftharpoons 2CO_{(g)}$$

The correct equilibrium constant expression is:

A. $K = \frac{[CO]^2}{[CO_2][C]}$

B. $K = \frac{[CO]^2}{[CO_2]}$

C. $K = \frac{[CO]}{[CO_2][C]}$

D. $K = \frac{[CO]^2}{[CO_2]^{1/2}}$

E. $K = \frac{[CO]}{[CO_2]^{1/2}}$

$16 = \frac{[HCl]^2}{[H_2][Cl_2]}$

$K_c = 16$

7. For the reaction

$$H_{2(g)} + Cl_{2(g)} \rightleftharpoons 2HCl_{(g)}$$

At a certain temperature, the equilibrium constant is 16, if the initial concentration of ~~Sulfur~~ H_2 and for ~~oxygen~~ Cl_2 is 0.20 M each, then the equilibrium concentration of HCl is:

A. 0.10

B. 0.40

C. 0.17

D. 0.35

E. 0.27

0.13 $\quad$ $0.2 - x$ $\quad$ $2x$

$K_c =$

$\sqrt{16} = \sqrt{\frac{4x^2}{(0.2-x)^2}}$

$4 = \frac{2x}{0.2-x}$

$0.4 - 2x = x$

$3x = 0.4$

8. For the reaction

$$A_{(g)} + B_{(g)} \rightleftarrows C_{(g)}$$

What will be its equilibrium constant K_P at 25 °C, if Kc at 25 °C is 2.8×10^{-2}

A. 1.0×10^{-3}
B. 1.5×10^{-4}
C. 5.2×10^{-2}
D. 2.1×10^{-3}
E. 1.9×10^{-4}

$K_P = K_c\,(RT)^{\Delta n}$

9. Which of the following reactions is not product-favored?

A. $NaOH(aq) \rightarrow Na^{+}(aq) + OH^{-}(aq)$
B. $NH_3(aq) + H_2O(l) \rightarrow NH_4^{+}(aq) + OH^{-}(aq)$
C. $HClO_4(aq) + H_2O(l) \rightarrow H_3O^{+}(aq) + ClO_4^{-}(aq)$
D. $HCl(aq) + H_2O(l) \rightarrow H_3O^{+}(aq) + Cl^{-}(aq)$
E. $H_2SO_4(aq) + H_2O(l) \rightarrow H_3O^{+}(aq) + HSO_4^{-}(aq)$

10. Rank the following in order of decreasing acid strength in aqueous solution: $HClO_2$, HOCl, HOBr, HOI.

A. $HClO_2$>HClO>HBrO> HIO
B. HIO >HBrO>HClO>$HClO_2$
C. $HClO_2$> HIO >HBrO>HClO
D. HClO>$HClO_2$>HBrO> HIO
E. HClO>HBrO>$HClO_2$> HIO

11. What is the hydronium-ion concentration of a 0.0017 *M* $Ba(OH)_2$ solution?

$[H_3O^{+}]$

A. 3.4×10^{-3} *M*
B. 1.7×10^{-3} *M*
C. 2.9×10^{-12} *M*
D. 5.9×10^{-12} *M*
E. 1.0×10^{-7} *M*

12. What is the pOH of a 0.011 *M* HI solution?

A. 4.51
B. 12.04
C. 9.49
D. 15.96
E. 1.96