Name: _____ AP Chemistry
March 12th, 2020 Pride of 2020

Spring Break Assignment – Final Countdown to AP EXAM!!!

Work Habits **100%** **95%** **85%** **75%** **65%**	□ Work is organized and neat for every problem. □ Thinking is shown for every problem. □ Key words are underlined / circled for **EVERY** problem □ Meticulous handwriting is used for MC and open ended questions

Directions: The time has come to start preparing for the AP exam! This packet includes questions since Day one of class. Take your time answering the questions, use your notes and online resources so that you can really understand the material. It's really easy to look up the answers online, but that is not the point of this. As you are working out these questions, **place a * next a question you don't understand**. We will go over these when we come back from break. **You should still work out EVERY question and show your work.** Email or text me if you have any questions ☺ (P.S. Ignore the numbers, I had to copy and paste)

1. In which of the following liquids do the intermolecular forces include dipole-dipole forces?

   (A) $F_2(l)$
   (B) $CH_4(l)$
   (C) $CF_4(l)$
   (D) $CH_2F_2(l)$

2. Which of the following best helps explain why an increase in temperature increases the rate of a chemical reaction?

   (A) At higher temperatures, reactions have a lower activation energy.
   (B) At higher temperatures, reactions have a higher activation energy.
   (C) At higher temperatures, every collision results in the formation of product.
   (D) At higher temperatures, high-energy collisions happen more frequently.

3. A sample of a hard, solid binary compound at room temperature did not conduct electricity as a pure solid but became highly conductive when dissolved in water. Which of the following types of interactions is most likely found between the particles in the substance?

   (A) Ionic bonds
   (B) Metallic bonds
   (C) Covalent bonds
   (D) Hydrogen bonds

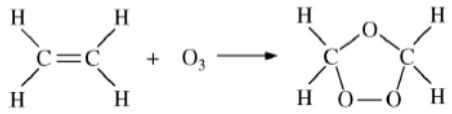
$$N_2(g) + 3\,H_2(g) \rightleftarrows 2\,NH_3(g) \quad \Delta H < 0$$

4. $NH_3(g)$ was synthesized at 200°C in the presence of a powdered $Os(s)$ catalyst, leading to the equilibrium system represented above. Which of the following changes would result in more $NH_3(g)$ in the mixture after equilibrium is reestablished?

   (A) Replacing the powdered $Os(s)$ with a solid cube of $Os(s)$ of the same total mass
   (B) Increasing the temperature of the system to 250°C at constant pressure
   (C) Removing some $H_2(g)$
   (D) Adding some $N_2(g)$

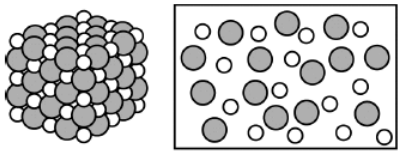
5. Which of the following arranges the molecules N_2, O_2, and F_2 in order of their bond enthalpies, from least to greatest?

   (A) $F_2 < O_2 < N_2$
   (B) $O_2 < N_2 < F_2$
   (C) $N_2 < O_2 < F_2$
   (D) $N_2 < F_2 < O_2$



7. In the reaction represented above, what is the hybridization of the C atoms before and after the reaction occurs?

	Before	After
(A)	sp	sp^2
(B)	sp	sp^3
(C)	sp^2	sp
(D)	sp^2	sp^3



Solid MgO Liquid MgO

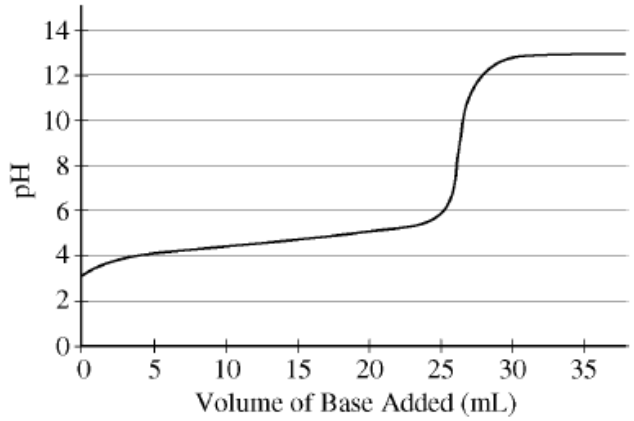
8. Based on the diagram above, which of the following best helps to explain why MgO(*s*) is not able to conduct electricity, but MgO(*l*) is a good conductor of electricity?

(A) MgO(*s*) does not contain free electrons, but MgO(*l*) contains free electrons that can flow.

(B) MgO(*s*) contains no water, but MgO(*l*) contains water that can conduct electricity.

(C) MgO(*s*) consists of separate Mg^{2+} ions and O^{2-} ions, but MgO(*l*) contains MgO molecules that can conduct electricity.

(D) MgO(*s*) consists of separate Mg^{2+} ions and O^{2-} ions held in a fixed lattice, but in MgO(*l*) the ions are free to move and conduct electricity.



9. A student performs an acid-base titration and plots the experimental results in the graph above. Which of the following statements best explains the experimental findings?

(A) A strong acid was titrated with a strong base, as evidenced by the equivalence point at pH = 7.

(B) A strong acid was titrated with a strong base, as evidenced by the equivalence point at pH > 7.

(C) A weak acid was titrated with a strong base, as evidenced by the equivalence point at pH > 7.

(D) A weak acid was titrated with a weak base, as evidenced by the equivalence point at pH approximately 7.

$$NO_2(g) + CO(g) \rightarrow NO(g) + CO_2(g)$$

28. The reaction between $NO_2(g)$ and $CO(g)$ is represented above. The elementary steps of a proposed reaction mechanism are represented below.

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

Step 2: $NO_3(g) + CO(g) \rightarrow NO_2(g) + CO_2(g)$ (*fast*)

Which of the following is the rate law for the overall reaction that is consistent with the proposed mechanism?

(A) Rate = $k\,[NO_2][CO]$

(B) Rate = $k\,[NO_2]^2$

(C) Rate = $k\,[NO_3][CO]$

(D) Rate = $k\,[NO_2][NO_3][CO]$

Questions 22-25 refer to the following information.

$$N_2O_4(g) \rightleftarrows 2\,NO_2(g) \qquad K_p = 3.0 \text{ at } 70^\circ C$$

colorless brown

A mixture of $NO_2(g)$ and $N_2O_4(g)$ is placed in a glass tube and allowed to reach equilibrium at 70°C, as represented above.

22. If $P_{N_2O_4}$ is 1.33 atm when the system is at equilibrium at 70°C, what is P_{NO_2}?

(A) 0.44 atm
(B) 2.0 atm
(C) 2.3 atm
(D) 4.0 atm

23. Which of the following statements best helps to explain why the contents of the tube containing the equilibrium mixture turned a lighter color when the tube was placed into an ice bath?

(A) The forward reaction is exothermic.
(B) The forward reaction is endothermic.
(C) The ice bath lowered the activation energy.
(D) The ice bath raised the activation energy.

24. Which of the following best predicts how the partial pressures of the reacting species will be affected if a small amount of Ar(g) is added to the equilibrium mixture at constant volume?

(A) P_{NO_2} will decrease and $P_{N_2O_4}$ will increase.
(B) P_{NO_2} will increase and $P_{N_2O_4}$ will decrease.
(C) Both P_{NO_2} and $P_{N_2O_4}$ will decrease.
(D) No change will take place.

25. Which of the following statements about ΔH° for the reaction is correct?

(A) $\Delta H^\circ < 0$ because energy is released when the N–N bond breaks.
(B) $\Delta H^\circ < 0$ because energy is required to break the N–N bond.
(C) $\Delta H^\circ > 0$ because energy is released when the N–N bond breaks.
(D) $\Delta H^\circ > 0$ because energy is required to break the N–N bond.

40. When 5.0 g of $NH_4ClO_4(s)$ is added to 100. mL of water in a calorimeter, the temperature of the solution formed decreases by 3.0°C. If 5.0 g of $NH_4ClO_4(s)$ is added to 1000. mL of water in a calorimeter initially at 25.0°C, the final temperature of the solution will be approximately

(A) 22.0°C
(B) 24.7°C
(C) 25.3°C
(D) 28.0°C

$$3\,O_2(g) \rightleftarrows 2\,O_3(g) \qquad K_c = 1.8 \times 10^{-56} \text{ at } 570 \text{ K}$$

41. For the system represented above, $[O_2]$ and $[O_3]$ initially are 0.150 mol/L and 2.5 mol/L respectively. Which of the following best predicts what will occur as the system approaches equilibrium at 570 K?

(A) The amount of $O_3(g)$ will increase, because $Q < K_c$.
(B) The amount of $O_3(g)$ will decrease, because $Q < K_c$.
(C) The amount of $O_3(g)$ will increase, because $Q > K_c$.
(D) The amount of $O_3(g)$ will decrease, because $Q > K_c$.

Free-Response 1

Answer the following questions about nitrogen, hydrogen, and ammonia.

a. Draw the complete Lewis electron dot diagrams for N_2 and NH_3.
b. Calculate the standard free-energy change, $\Delta G°$, that occurs when 12.0 g of H_2 (g) reacts with excess N_2 (g) at 298 K according to the reaction represented below.

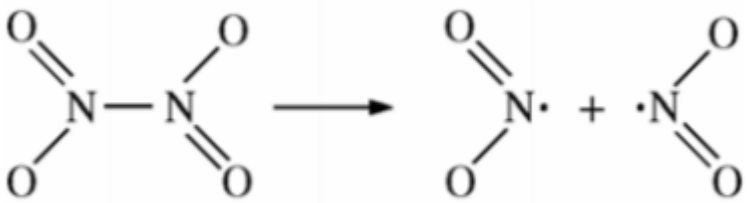
$$N_2(g) + 3\ H_2(g) \rightleftarrows 2\ NH_3(g) \qquad \Delta G^\circ_{298} = -34\ \text{kJ mol}^{-1}$$

c. Given that $\Delta H°_{298}$ for the reaction is -92.2 kJ mol^{-1}, which is larger, the total bond dissociation energy of the reactants, or the total bond dissociation energy of the products? Explain.
d. The value of the standard entropy change, $\Delta S°_{298}$, for the reaction is -199 J $mol^{-1}K^{-1}$. Explain why the value of $\Delta S°_{298}$ is negative.
e. Assume that $\Delta H°$ and $\Delta S°$ for the reaction are independent of temperature.
    i. Explain why there is a temperature above 298 K at which the algebraic sign of the value of $\Delta G°$ changes.
    ii. Theoretically, the best yields of ammonia should be achieved at low temperatures and high pressures. Explain.

Free-Response 2

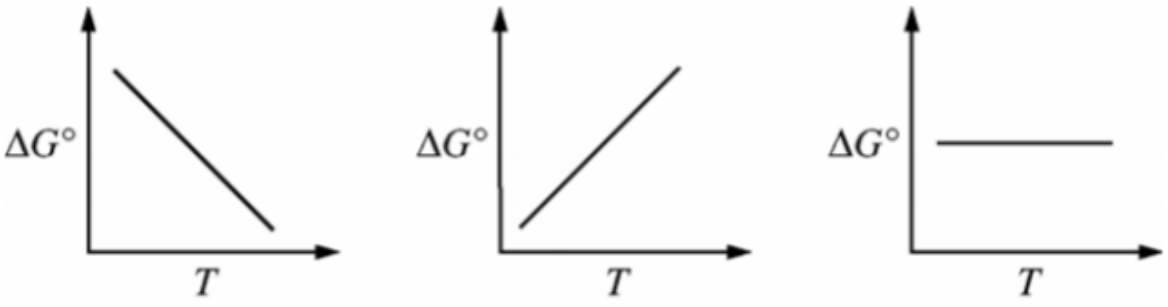
Use principles of thermodynamics to answer the following questions.

a. The gas N_2O_4 decomposes to form the gas NO_2 according to the equation below.



    a. Predict the sign of $\Delta H°$ for the reaction. Justify your answer.
    b. Predict the sign of $\Delta S°$ for the reaction. Justify your answer.

b. One of the diagrams below best represented the relationship between $\Delta G°$ and temperature for the reaction given in part (a). Assume that $\Delta H°$ and $\Delta S°$ are independent of temperature.



Draw a circle around the correct graph. Explain why you chose that graph in terms of the relationship $\Delta G° = \Delta H° - T\Delta S°$.

c. A reaction mixture of N_2O_4 and NO_2 is at equilibrium. Heat is added to the mixture while the reaction is maintained at constant pressure.
    i. Explain why the concentration of N_2O_4 decreases.
    ii. The value of K_{eq} at 25□ is 5.0×10^{-3}. Will the value of K_{eq} at 100□ be greater than, less than, or equal to this value? Justify your response.
    iii. Using the value of K_{eq} at 25□ given in part c (ii), predict whether the value of $\Delta H°$ is expected to be greater than, less than, or equal to the value of $T\Delta S°$. Explain.