Unit 9 Kinetics SA Review

1. Base your answer to the following question on the information below.

   The equilibrium equation below is related to the manufacture of a bleaching solution.
   In this equation, $Cl(aq)$ means that chloride ions are surrounded by water molecules.
   $Cl_2(g) + 2\ OH^-(aq) \rightleftharpoons OCl^-(aq) + Cl^-(aq)$

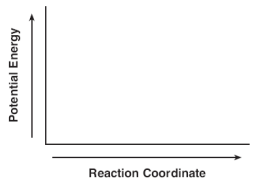
   Explain, in terms of collision theory, why increasing the concentration of $Cl_2(g)$ increases the concentration of $OCL^-(aq)$ in this equilibrium system.

Base your answers to questions **2** through **4** on the equation below.

$2H_2(g) + O_2(g) \rightarrow 2H_2O(\ell) + 571.6\ kJ$

2. Explain why the entropy of the system decreases as the reaction proceeds.

3. On the axes below, draw a potential energy diagram for the reaction represented by this equation.



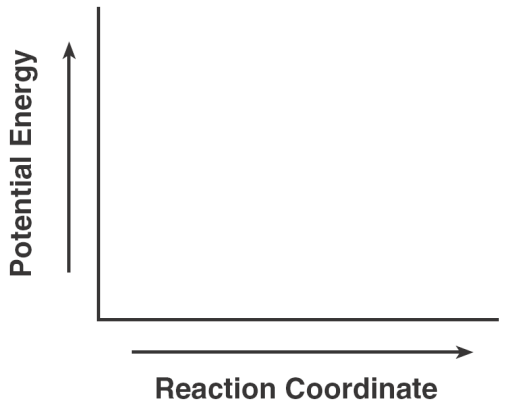
4. Identify the information in this equation that indicates the reaction is exothermic.

Base your answers to questions **5** through **8** on

Propane is a fuel that is sold in rigid, pressurized cylinders. Most of the propane in a cylinder is liquid, with gas in the space above the liquid level. When propane is released from the cylinder, the propane leaves the cylinder as a gas. Propane gas is

$C_3H8(g) + 5O_2(g) \rightarrow 2CO_2(g) + 4H_2O(\ell) + 2219.2kJ$

A small amount of methanethiol, which has a distinct odor, is added to the propane to help consumers detect a propane leak. In methanethiol, the odor is caused by the thiol functional group (–SH). Methanethiol, CH3SH, has a structure that is very similar to the structure of methanol.



5. In the space *below*, draw a structural formula for a molecule of methanethiol.

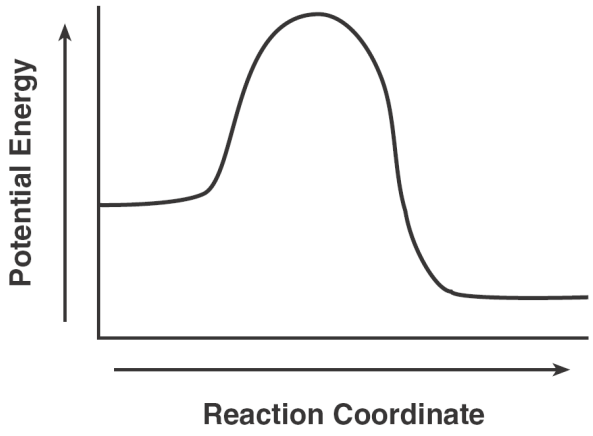
6. Determine the total amount of energy released when 2.50 moles of propane is completely reacted with oxygen.

7. On the diagram *above*, draw a potential energy diagram for this reaction.

8. Draw a particle diagram to represent propane in a pressurized cylinder. Your response must include *at least six* molecules of propane in the gas phase and *at least six* molecules of propane in the liquid phase.

9. Explain, in terms of collision theory, why an increase in temperature increases the rate of a chemical reaction.

10. A potential energy diagram for a chemical reaction is shown below. On this diagram, draw a curve to show how the potential energy diagram will change when a catalyst is added to the reaction.



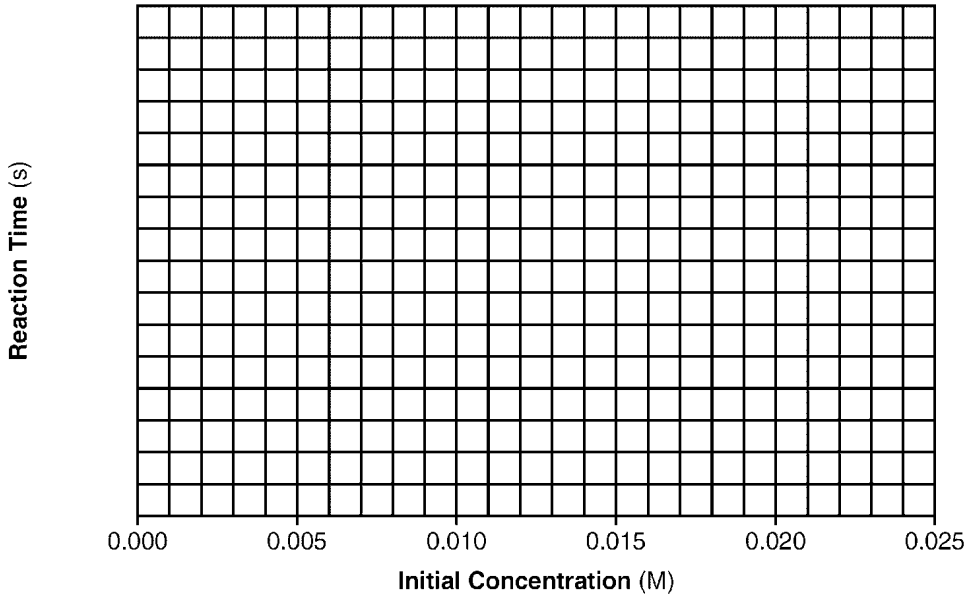
Base your answers to questions **11** through **13** on the information below.

An investigation was conducted to study the effect of the concentration of a reactant on the total time needed to complete a chemical reaction. Four trials of the same reaction were performed. In each trial the initial concentration of the reactant was different. The time needed for the chemical reaction to be completed was measured. The data for each of the four trials are shown in the table below.

Reactant Concentration and Reaction Time

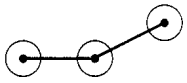
Trial	Initial Concentration (M)	Reaction Time (s)
1	0.020	11
2	0.015	14
3	0.010	23
4	0.005	58

Reaction Time Versus Initial Concentration



11. *a* On the grid, mark an appropriate scale on the axis labeled "Reaction Time (s)." An appropriate scale is one that allows a trend to be seen.

    b On the same grid, plot the data from the data table. Circle and connect the points.

    Example: 

12. In a different experiment involving the same reaction, it was found that an increase in temperature increased the rate of the reaction. Explain this result in terms of collision theory.

13. State the effect of the concentration of the reactant on the rate of the chemical reaction.

Base your answers to questions **14** and **15** on the information below.

Ethanol, C_2H_5OH, is a volatile and flammable liquid with a distinct odor at room temperature. Ethanol is soluble in water. The boiling point of ethanol is 78.2ºC at 1 atmosphere. Ethanol can be used as a fuel to produce heat energy, as shown by the balanced equation below.

$$C_2H_5OH(\ell) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(\ell) + 1367\ kJ$$

14. Identify *one* physical property of ethanol, stated in the passage, that can be explained in terms of chemical bonds and intermolecular forces.

15. Determine the total amount of heat produced by the complete combustion of 2.00 moles of ethanol.

Base your answers to questions **16** and **17** on the information below.
Given the reaction at equilibrium:

$$2NO_2(g) \leftrightarrow N_2O_4(g) + 55.3\ kJ$$

16. Explain, in terms of Le Chatelier's principle, why the equilibrium shifts to the right to relieve the stress when the pressure on the system is increased at constant temperature.

17. Explain, in terms of energy, why the forward reaction is exothermic.

18. Base your answer to the following question on the information and table below.

A student conducts an experiment to determine how the temperature of water affects the rate at which an antacid tablet dissolves in the water. The student has three antacid tablets of the same size and composition. The student drops one tablet into each of three beakers containing 200. milliliters of water at different temperatures and measures the time it takes for each tablet to completely dissolve. The results are shown in the table below.

Dissolving Data for Three Antacid Tablets

Beaker	**Original Temperature of Water (°C)**	**Time for Tablet to Dissolve** (s)
1	20.	40.
2	30.	25
3	40.	10.

What change, other than temperature, would affect the rate of dissolving?

Base your answers to questions **19** and **20** on the information and balanced equation below.

Given the equation for a reaction at equilibrium:
$2\ SO_2(g) + O_2(g) \rightleftharpoons 2\ SO_3(g) + \text{energy}$

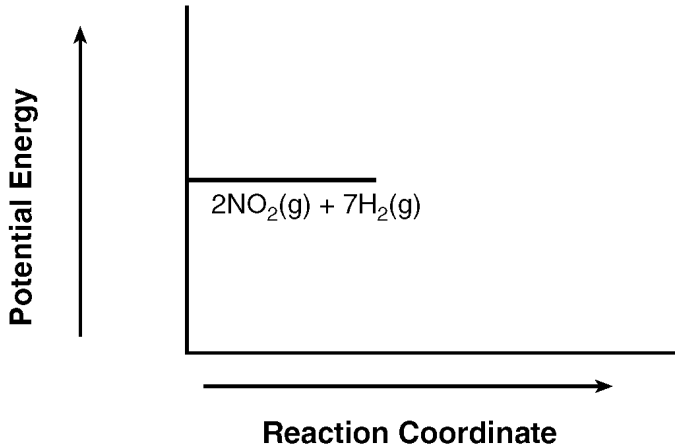
19. Explain, in terms of collisions between molecules, why increasing the concentration of O_2(g) produces a *decrease* in the concentration of SO_2(g).

20. Explain, in terms of LeChatelier's principle, why the concentration of $SO_2(g)$ increases when the temperature is increased.

21. Base your answer to the following question on the information below.

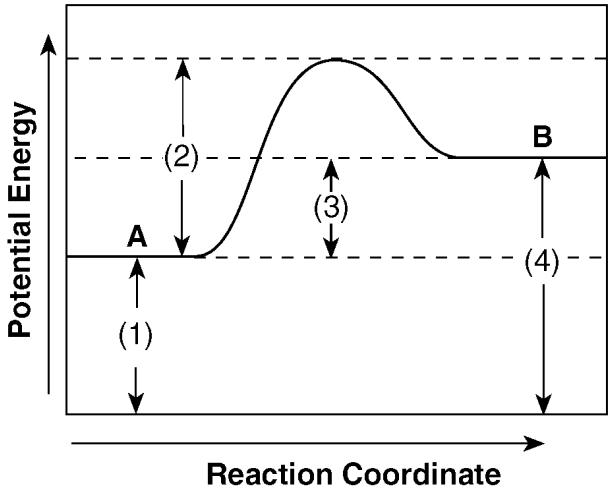
Given the reaction at equilibrium:

$$2\ NO_2(g) + 7\ H_2(g) \leftrightarrow 2\ NH_3(g) + 4\ H_2O(g) + 1127\ kJ$$



Explain, in terms of Le Chatelier's principle, why the concentration of $NH_3(g)$ *decreases* when the temperature of the equilibrium system increases.

Base your answers to questions **22** through **24** on the potential energy diagram and the equation below.



$$2\ C(s) + H_2(g) + 227.4\ kJ \rightarrow C_2H_2(g)$$

22. Describe how the potential energy diagram will change if a catalyst is added.

23. If 682.2 kilojoules are absorbed, how many moles of $C_2H_2(g)$ are produced?

24. The letter B represents which chemical formula or formulas in the equation?

Base your answers to questions **25** and **26** on the information below.

Given the equilibrium equation at 298 K:

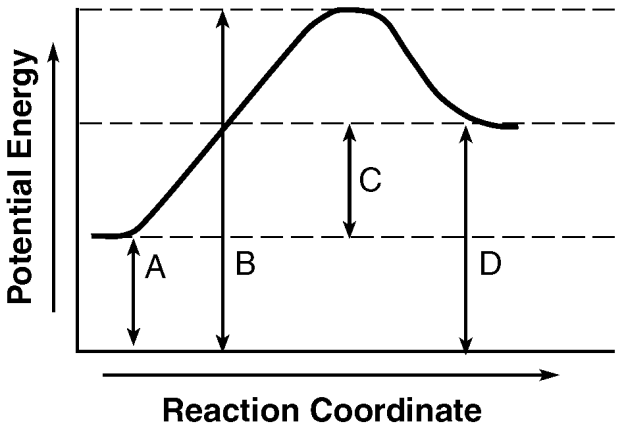
$$KNO_3(s) + 34.89\ kJ \leftrightarrow K^+(aq) + NO_3^-(aq)$$

25. The equation indicates that KNO_3 has formed a saturated solution. Explain, in terms of equilibrium, why the solution is saturated.

26. Describe, in terms of *LeChatelier's principle*, why an increase in temperature increases the solubility of KNO_3.

Base your answers to questions **27** through **29** on the information and potential energy diagram below.

Chemical cold packs are often used to reduce swelling after an athletic injury. The diagram represents the potential energy changes when a cold pack is activated.



27. Identify a reactant listed in Reference Table *I* that could be mixed with water for use in a chemical cold pack.

28. Which lettered interval on the diagram represents the heat of reaction?

29. Which lettered interval on the diagram represents the potential energy of the products?

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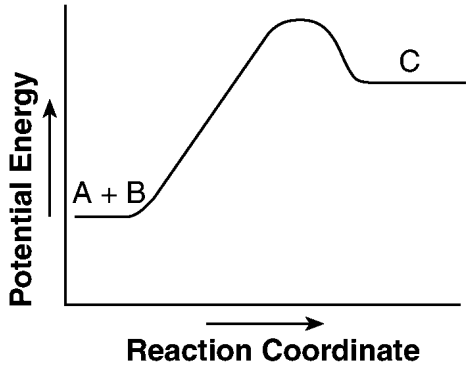
30. Explain how a catalyst may increase the rate of a chemical reaction.

31. Base your answer to the following question on the information and diagram below, which represent the changes in potential energy that occur during the given reaction.

Given the reaction: $A + B \rightarrow C$

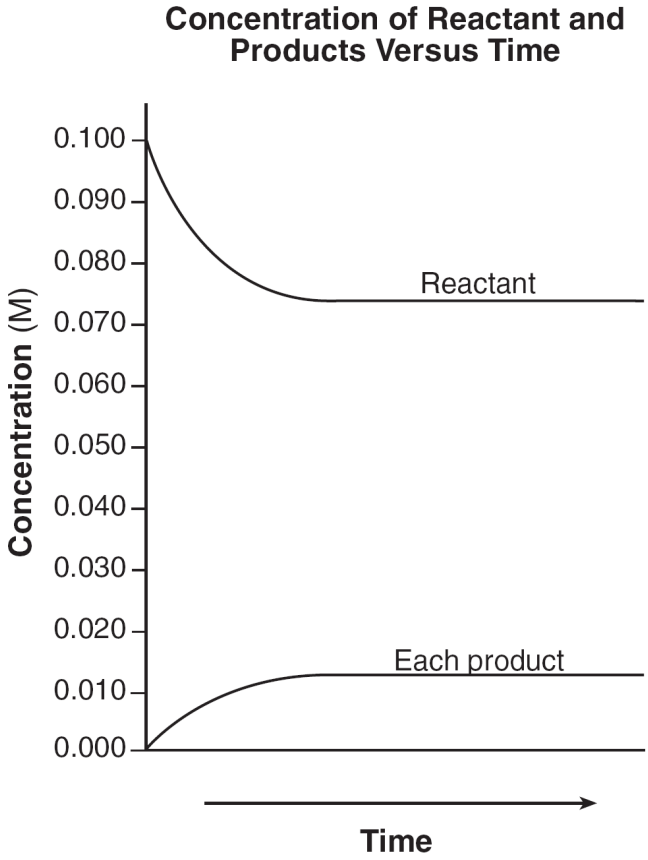


a. Does the diagram illustrate an exothermic or an endothermic reaction?

b. State one reason, in terms of energy, to support your answer.

Base your answers to questions **32** and **33** on the information below.

In a laboratory, 0.100 mole of colorless hydrogen iodide gas at room temperature is placed in a 1.00-liter flask. The flask is sealed and warmed, causing the HI(g) to start decomposing to H_2(g) and I_2(g). Then the temperature of the contents of the flask is kept constant.
During this reaction, the contents of the flask change to a pale purple-colored mixture of HI(g), H_2(g), and I_2(g). When the color of the mixture in the flask stops changing, the concentration of I_2(g) is determined to be 0.013 mole per liter. The relationship between concentration and time for the reactant and products is shown in the graph below.



32. Calculate the mass of I_2(g) in the flask at equilibrium. Your response must include *both* a correct numerical setup and the calculated result.

33. State, in terms of concentration, evidence that indicates the system in the flask has reached equilibrium.