Name:		l	Date	:	
<b>Chemistry</b> ~ Ms. Hart	Class:	Anions	or	Cations	SCHOOL FOR CRIMINAL
7.4 Pot	ential Energy	<u>y Diagrams</u>			J001102
	in hard the				1
Cnemical reactions can react	in both the directior	 1S			and
• All chemical reactions need _					
• Reactions can either release e	energy (				energy is a
PRODUCT) or absorb energy	· (			en	ergy is a REACTANT)
• Heat of formation also known	n as		is	difference in	n potential energy or
between th	e reactants and	l products.			
$\circ$ We use the following eq	uation to calcu	late the heat	of fo	rmation =	
<ul> <li>ΔH = Potential Ener</li> </ul>	rgy Products (_	) – Po	otent	ial Energy of	f the Reactant ()
<ul> <li>For HEAT of FORM</li> </ul>	ATION THI	NK			
<ul> <li>Activated Complex –</li> <li>Heat of FORWARD React</li> <li>Activation Energy (also kit)</li> </ul>	tion (ΔH)/Heat nown as E₄)– _	t of BACKWA	RD I	Reaction (∆H	I)
Potential Energy (He					
	Reaction Co	oordinate			
If $\Delta H$ is positive, the reaction is _					
If $\Delta H$ is negative, the reaction is					
Example: 1. A reaction has a $\Delta$ H of +100kJ	. Will this react	ion be endot	herm	ic or exothe	rmic?
2. A reaction has a $\Delta$ H of -11J. W	ill this reaction	be endother	mic o	or exothermi	c?

Lets do some group Practice! The diagram to the below represents the potential energy for the reaction:  $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ 



1) What does (a) represent?

2) What does (b) represent?

3) What does (c) represent?

4) What are the "reactants" in this equation? Place a 1 where you would find them on the potential energy diagram.

5) What are the "products" in this equation? Place a 2 where you would find them on the potential energy diagram.

Bring it in! Base your answers to questions 6-10 on the potential energy diagram below.



- 6) What is the potential energy of the reactants?
- 7) What is the potential energy of the products?
- 8) What is the heat of the forward (left to right) reaction? a. Heat of reaction ( $\Delta$ H)= Potential Energy of Products – Potential Energy of Reactants
- 9) Is this reaction exothermic or endothermic?



10) What is the effect of the catalyst on this reaction?

## **Quick Practice**

11) What is the heat of the FORWARD reaction? (Hint: heat of products-heat of reactants...)

12) What is the heat of the BACKWARD reaction? (Hint: where are the products of the BACKWARD reaction found?)

## **Classwork**

- 1. An increase in temperature increases the rate of a chemical reaction because the
  - a. Activation energy increases
  - b. Activation energy decreases
  - c. Number of molecular collisions increases
  - d. Number of molecular collisions decreases
- 2. Label the following diagram: PE reactants, PE products, and  $E_A$ .
- 3. If the potential energy of the reactants is 412 kJ, and the potential energy of the products is 212 kJ, what is the heat of reaction?
- 4. Is this reaction exothermic or endothermic? Explain.



5. Draw a reaction coordinate diagram for an endothermic reaction. LABEL IT!



6. Base your answers on the information and diagram below, which represent the changes in potential energy that occur during the given reaction,  $A + B \rightarrow C$ .



- a) Does the diagram illustrate an exothermic or endothermic reaction? State one reason, in terms of energy, to support your answer.
- b) On the diagram provided in your answer booklet, draw a dashed line to indicate a potential energy curve for the reaction if a catalyst is added.
- 7. Given the reaction,  $A + B \leftrightarrow AB + 210 kJ$

Is this reaction exothermic or endothermic?

Draw a potential energy diagram for the reaction above, assuming there is an activation energy of 21 kJ.

What would the activation energy of the reverse reaction be?

8. Given the reaction:  $S(s) + O_2(g) \rightarrow SO_2 + energy$ . Which diagram best represents the potential energy changes for this reaction?



- 9. Which statement correctly describes an endothermic chemical reaction?
  - (1) The products have higher potential energy than the reactants and the  $\Delta H$  is negative.
  - (2) The products have higher potential energy than the reactants and the  $\Delta H$  is positive.
  - (3) The products have lower potential energy than the reactants and the  $\Delta H$  is negative.
  - (4) The products have lower potential energy than the reactants and the  $\Delta H$  is positive.
- 10. The potential energy diagram below represents a reaction.



Reaction Coordinate

Which arrow represents the activation energy of the forward reaction?

- (1) A
- (2) B
- (3) C
- (4) D

## 11. Which information about a chemical reaction is provided by a potential energy diagram?

- a. The oxidation states of the reactants and products
- b. The average kinetic energy of the reactants and products
- c. The change in solubility of the reacting substances
- d. The energy released or absorbed during the reaction.
- 12. Which expression represents the  $\Delta H$  for the chemical reaction in terms of the potential energy, PE, of its products and reactants?
  - a. PE of products + PE of reactants
  - b. PE of products PE of reactants
  - c. PE of products x PE of reactants
  - d. PE of products ÷PE of reactants

- 13) Match the following to the letters on the graph left:
  - (1) Potential Energy of the products
  - (2) Potential Energy of the reactants
  - (3) Heat of Reaction
  - (4) Potential Energy of the activated complex
  - (5) Draw in and label what the activation energy would be.



**Reaction Coordinate** 

Given the reaction at equilibrium:

$$2NO_{0}(g) + 7H_{0}(g) \rightleftharpoons 2NH_{0}(g) + 4H_{0}O(g) + 1127 \text{ kJ}$$

- 57 On the diagram *in your answer booklet*, complete the potential energy diagram for the forward reaction. Be sure your drawing shows the activation energy and the potential energy of the products. [2]
- 58 Explain, in terms of Le Chatelier's principle, why the concentration of  $NH_3(g)$  decreases when the temperature of the equilibrium system increases. [1]

Answer for 57:

58:



In the smelting of iron ore,  $Fe_2O_3$  is reduced in a blast furnace at high temperature by a reaction with carbon monoxide. Crushed limestone,  $CaCO_3$ , is also added to the mixture to remove impurities in the ore. The carbon monoxide is formed by the oxidation of carbon (coke), as shown in the reaction below:

$$2 \text{ C} + \text{O}_2 \rightarrow 2 \text{ CO} + \text{energy}$$

Liquid iron flows from the bottom of the blast furnace and is processed into different alloys of iron.

Using the set of axes provided *in your answer booklet*, sketch a potential energy diagram for the reaction of carbon and oxygen that produces carbon monoxide. [1]



Reaction Coordinate

Which interval on this diagram represents the difference between the potential energy of the products and the potential energy of the reactants?

(1) 1	(3) 3
(2) 2	(4) 4

43 The potential energy diagram below represents a reaction.



Which arrow represents the activation energy of the forward reaction?

(1) A	(3) C
(2) <b>B</b>	(4) D

43 Given the potential energy diagram for a chemical reaction:



Reaction Coordinate

Which statement correctly describes the energy changes that occur in the forward reaction?

- (1) The activation energy is 10. kJ and the reaction is endothermic.
- $\left(2\right)$  The activation energy is 10. kJ and the reaction is exothermic.
- (3) The activation energy is 50. kJ and the reaction is endothermic.
- (4) The activation energy is 50. kJ and the reaction is exothermic.

Which information about a chemical reaction is provided by a potential energy diagram?

- (1) the oxidation states of the reactants and products
- (2) the average kinetic energy of the reactants and products
- (3) the change in solubility of the reacting substances
- (4) the energy released or absorbed during the reaction