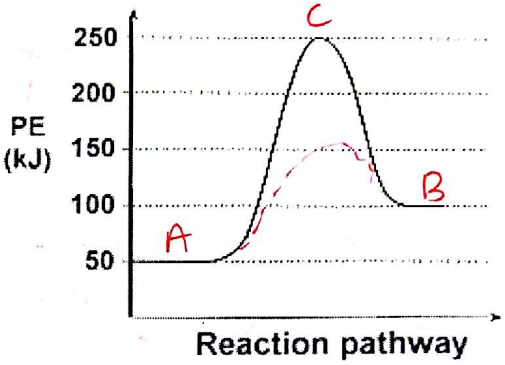
Name: Key Period: _____

Unit 13: Rates and Equilibrium- Funsheets

Part A: Reaction Diagrams

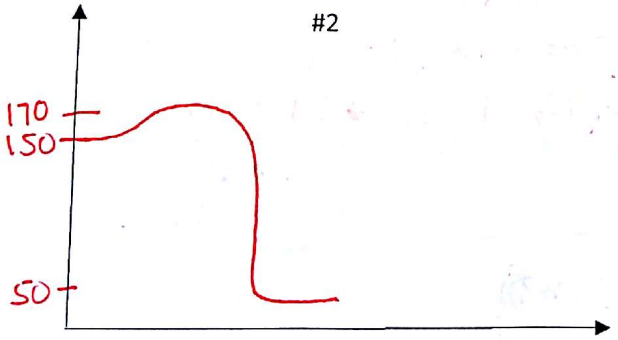
1) Answer the following questions based on the potential energy diagram shown here:
   a. Does the graph represent an endothermic or exothermic reaction? endo
   b. Label the position of the reactants, products, and activated complex. A B C
   c. Determine the heat of reaction, ΔH, (enthalpy change) for this reaction. + 50 KJ
   d. Determine the activation energy, E_a for this reaction. + 200. KJ
   e. How much energy is released or absorbed during the reaction? +50 KJ
   f. How much energy is required for this reaction to occur? 200 KJ
   g. Draw a dashed line on the diagram to indicate a potential energy curve for the reaction if a catalyst is added.



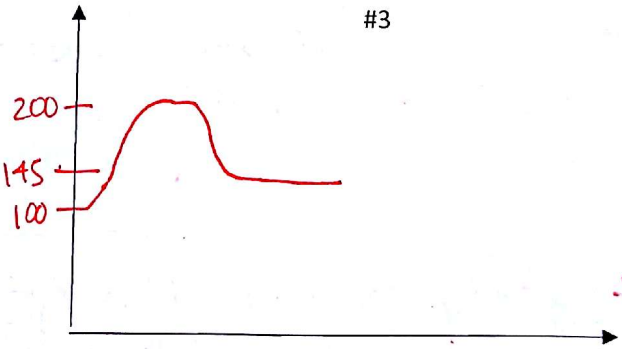
2) Sketch a potential energy curve below that is represented by the following values of ΔH and Ea (activation energy). You may make up appropriate values for the y-axis (potential energy). ΔH = -100 kJ and Ea = 20 kJ

3) Sketch a potential energy curve below that is represented by the following values of ΔH and Ea (activation energy). You may make up appropriate values for the y-axis (potential energy). ΔH = +45 kJ and Ea = 100 kJ

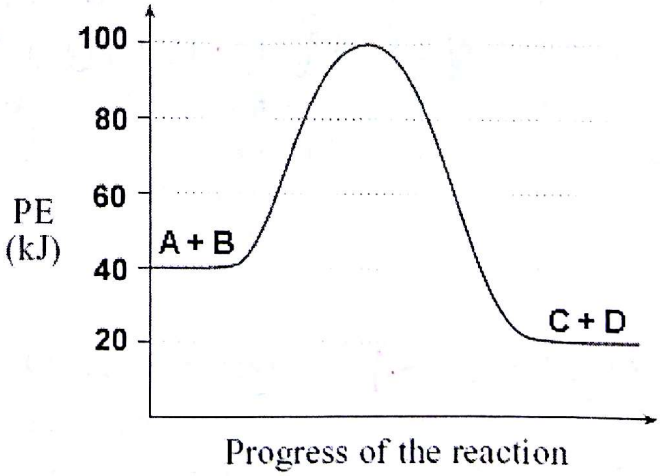
#2



#3



4) Answer the following questions based on the potential energy diagram shown here:
   a. Does the graph represent an endothermic or exothermic reaction? exo
   b. Determine the heat of reaction, ΔH, (enthalpy change) for this reaction. -20 KJ
   c. How much energy is released or absorbed during the reaction? - 20 KJ
   d. How much energy is required for this reaction to occur? 100 KJ



6) The standard heats of formation of HCl (g) and HBr (g) are -92.0 kJ/mol and -36.4 kJ/mol respectively. Diatomic gases have a heat of formation of 0 kJ Using this information, calculate ΔH for the following reaction:

$Cl_{2\,(g)} + 2\ HBr_{(g)} \rightarrow 2\ HCl_{(g)} + Br_{2\,(g)}$

$\Delta H = 2(-92) + 0 - 0 - 2(-36.4) = 111.2\ kJ = \Delta H$

7) Use the given standard enthalpies of formation to determine the heat of reaction of the following reaction:

$2\ LiOH(s) + CO_2(g) \rightarrow Li_2CO_3(s) + H_2O(l)$

$\Delta H°_f\ LiOH(s) = -487.23$ kJ/mole
$\Delta H°_f\ Li_2CO_3(s) = -1215.6$ kJ/mole
$\Delta H°_f\ H_2O(l) = -285.85$ kJ/mole
$\Delta H°_f\ CO_2(g) = -393.5$ kJ/mole

Products: $-1215.6 + -285.85 = -1501.45$ kJ

Reactants: $2(-487.23) + (-393.5) = -1367.96$ kJ

$\Delta H = -1501.45 - (-1367.96) = -133.49$ kJ

8) Use the given standard enthalpies of formation to determine the heat of reaction of the following reaction:

$2\ Cl_2(g) + 2\ H_2O(l) \rightarrow 4\ HCl(g) + O_2(g)$

$\Delta H°_f\ H_2O(l) = -285.8$ kJ/mole
$\Delta H°_f\ HCl(g) = -92.3$ kJ/mole

$\Delta H = 4(-92.3) - (2 \times -285.8)$

$\Delta H = 202.4$ kJ

9) Calculate $\Delta H°_f$ (kJ) for the following reaction from the listed standard enthalpies of formation:

$4\ NH_3(g) + 5\ O_2(g) \rightarrow 4\ NO(g) + 6\ H_2O(g)$

$\Delta H°_f\ NH_3(g) = -46.1$ kJ
$\Delta H°_f\ NO(g) = +90.2$ kJ
$\Delta H°_f\ H_2O(g) = -241.8$ kJ

Products: $4(90.2) + 6(-241.8) = -1090$ kJ

R: $4(-46.1) = -184.4$ kJ

$\Delta H = -1090 - (-184.4) = -905.6$ kJ

10) The standard enthalpy of formation of propane, C_3H_8, is -103.6 kJ/mole. Calculate the heat of combustion of C_3H_8. The heats of formation of $CO_2(g)$ and $H_2O(l)$ are -394 kJ/mole and -285.8 kJ/mole respectively. Diatomic molecules have a heat of formation of 0 kJ/mole. $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

P: $3(-394) + (4 \times -285.8) = -2325.2$ kJ

R: -103.6 kJ

$\Delta H = -2325.2 - (-103.6) = -2221.6$ kJ

11) The standard enthalpy of formation of propyne, C_3H_4, is +185.4 kJ/mole. Calculate the heat of combustion of C_3H_4. The heats of formation of $CO_2(g)$ and $H_2O(l)$ are -394 kJ/mole and -285.8 kJ/mole respectively.

$C_3H_4 + 4O_2 \rightarrow 3CO_2 + 2H_2O$

P: $3(-394) + 2(-285.8) = -1753.6$ kJ

R: 185.4 kJ

$\Delta H = -1753.6 - 185.4 = -1939$ kJ

12) The standard enthalpy of formation of ethanol, C_2H_5OH, is -277.7 kJ/mole. Calculate the heat of combustion of C_2H_5OH. The heats of formation of $CO_2(g)$ and $H_2O(l)$ are -394 kJ/mole and -285.8 kJ/mole respectively.

$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$

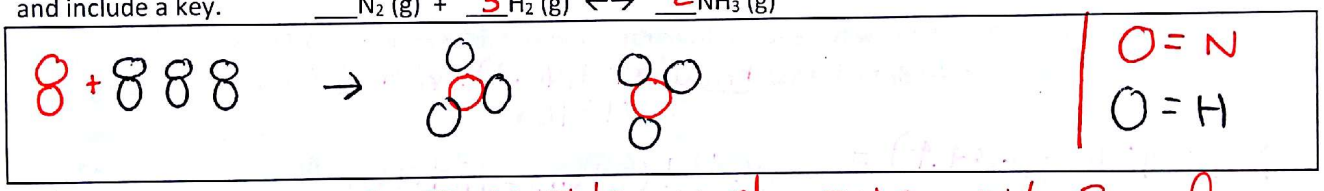
P: $2(-394) + 3(-285.8) = -1645.4$ kJ

R: -277.7 kJ

$\Delta H = -1645.4 - (-277.7) = -1367.7$ kJ

Part C: Vocabulary and Concepts

1) Fill in the blanks: When the products have more potential energy than the reactants, the ΔH values is positive. When the products have less potential energy than the reactants, the ΔH values is negative.
2) Indicate whether the following are endothermic (ENDO) or exothermic (EXO):
   a. EXO The burning of wood to produce a hot flame.
   b. EXO $4Fe(s) + 3O2(g) \rightarrow 2Fe2O3(s) + energy$
   c. ENDO A test tube that feels cold to the touch after two substances have been mixed.
   d. EXO $C(s) + 2\ F_2(g) \longrightarrow CF_4(g)$ $\Delta H° = -680$ kJ
3) According to the Collision Theory, in order for a reaction to occur molecules must collide with enough energy and in the proper orientation.
4) Explain why all reactions have an activation energy, using your knowledge of collision theory.
   In order for molecules to collide, they need energy. They also need energy to break and form bonds.
5) Describe how the activation energy of a reaction affects the overall rate of the chemical reaction.
   The higher the activation energy, the slower the reaction. The lower the activation energy, the faster the reaction
6) Model the following reaction and use your model to explain how the atoms are rearranged. Be sure to balance and include a key. ___N_2 (g) + 3 H_2 (g) ↔ 2 NH_3 (g)



   the nitrogens separate and pair w/ 3 of the hydrogens, creating a new product
7) What is a reversible reaction?
   a reaction in which the reactants can react to form products and the products react to form the reactants
8) What is an activated complex? the reactants after they have gained the activation energy
9) A catalyst speeds up a chemical reaction by lowing the activation energy.
10) What is enthalpy? the amount of energy transferred between the system and the surroundings
11) What is Hess's Law? the enthalpy of a whole reaction is equivalent to the sum of its steps
12) *Circle the correct answer:* If something is (endothermic/exothermic) more heat goes from surroundings into the system. The ΔH value is (positive/negative).
13) *Circle the correct answer*: If something is (endothermic/exothermic) more heat goes from the system into the surroundings. The ΔH value is (positive/negative).
14) What law explains that during a chemical reaction mass is not created or destroyed just rearranged to create new products? Law of Conservation of mass
15) What law explains that energy is not created or destroyed just transferred between system and surroundings?
    Law of Conservation of Energy