ANS. KEY

Practice: Reaction Rates

1. In addition, this metal has a strong tendency to rust and transform into iron (III) oxide ($Fe_2O_{3(s)}$). The oxidation of iron occurs as shown in the balanced chemical equation below:

$$4\ Fe_{(s)} + 3\ O_{2(g)} \rightarrow 2\ Fe_2O_{3(s)} + \text{energy}$$

Why does the iron rust so easily?

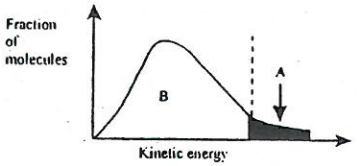
(A) The formation of rust is exothermic and requires a low activation energy.

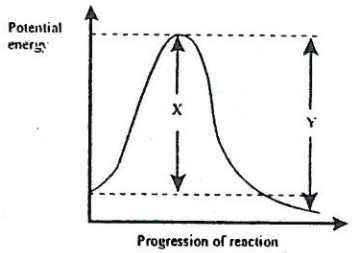
B) The formation of rust is endothermic and requires a low activation energy.

C) The formation of rust is exothermic and requires a high activation energy.

D) The formation of rust is endothermic and requires a high activation energy.

2. Consider the two graphs below.





Which of the following statements are FALSE according to the given graphs?

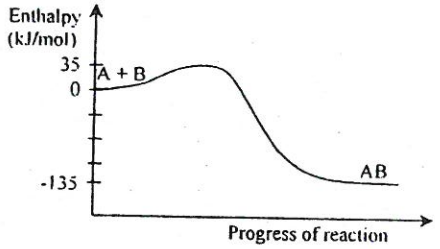
A) Area B represents the molecules that can neither react nor form an activated complex.

B) Area A represents the molecules that could form an activated complex.

C) X represents an activation energy.

(D) Y represents the ΔH for the forward reaction.

3. You are given the diagram for the following hypothetical, reaction: A + B → AB.



According to this diagram, what is the activation energy of the reverse reaction?

A) 35 kJ

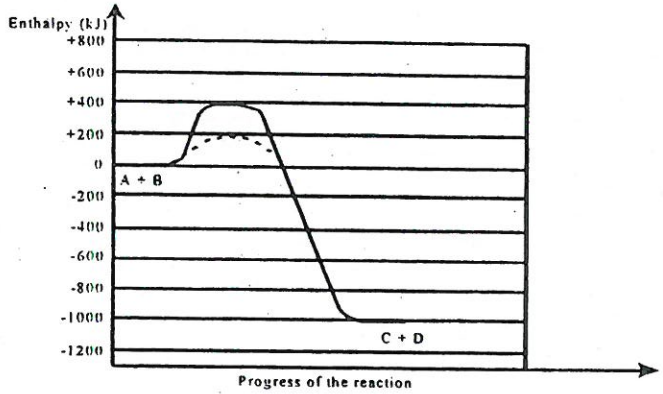
B) 100 kJ

C) 135 kJ

(D) 170 kJ

4. The graph below shows the potential energy changes for both the catalyzed and uncatalyzed chemical reactions represented by the following equation:

$$A + B \rightarrow C + D$$



What is the activation energy of the reverse uncatalyzed reaction?

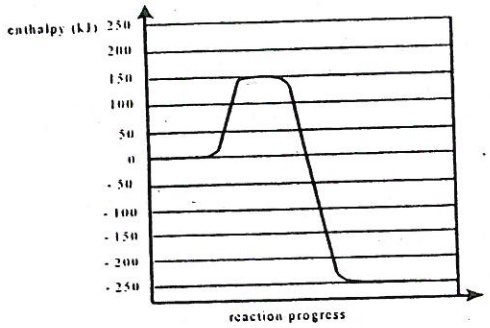
A) 200 kJ

B) 400 kJ

C) 1 200 kJ

(D) 1 400 kJ

5. Which of the statements about the following enthalpy diagram is FALSE?



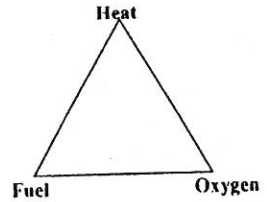
A) The ΔH of this reaction is -250 kJ. True

B) The product of this reaction is stable. True

C) The ΔH of this reaction is +250 kJ False

D) The enthalpy of the products is -250 kJ True

6.



Any measure used to extinguish a fire usually tries to reduce or eliminate one or more of the three components of the fire triangle.

Two of the most common substances used to extinguish fires are water and carbon dioxide.

A) Which component of the fire triangle does water reduce or eliminate?

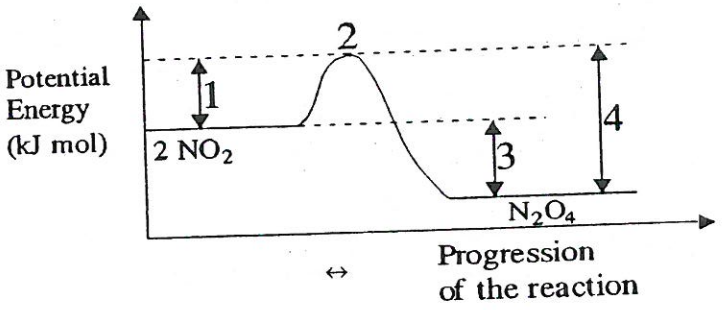
B) Which component of the fire triangle does carbon dioxide reduce or eliminate?

A) Heat

B) Oxygen

7. The following diagram represents the potential energy change [illegible]ne reversible reaction :

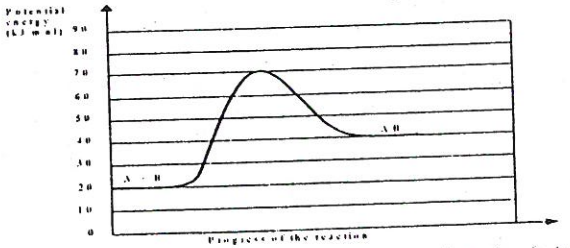
$2\ NO_{2(g)} \leftrightarrow N_2O_{4(g)} + \text{heat}$



Identify the activation energy of the **endothermic** reaction by using one of the numbers on the graph. The activation energy of the endothermic reaction is represented on the diagram by the number : 4.

8. Consider the following potential energy diagram for a hypothetical reversible reaction.

$A + B \leftrightarrow AB$

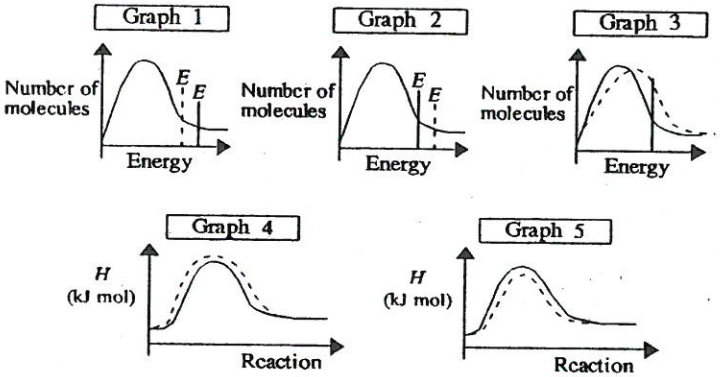


Which of the following sets of observations describes the forward reaction depicted in the graph?

	Reaction type	Activation energy	Change in enthalpy (ΔH)
~~A)~~	exothermic	70 kJ/mol	+ 20 kJ/mol
~~B)~~	exothermic	50 kJ/mol	- 20 kJ/mol
~~C)~~	endothermic	70 kJ/mol	- 20 kJ/mol
D)	endothermic	50 kJ/mol	+ 20 kJ/mol

$E_a = 50 \frac{kJ}{mol}$ $\Delta H = +20 \frac{kJ}{mol}$

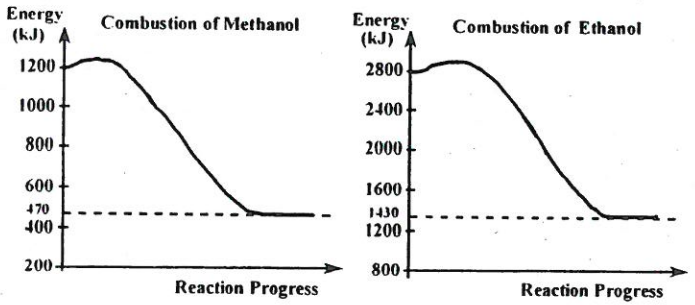
9. Graphs 1, 2 and 3 illustrate the distribution of molecules as a function of their energy. Graphs 4 and 5 illustrate the potential energy of the substances as a function of the progress of the reaction.
Each curve represents a situation without a catalyst (continuous line) and with a catalyst (dotted line).



Which of the graphs illustrates the effect of a positive catalyst?

A) Graphs 1 and 4
C) Graphs 2 and 4
B) Graphs 1 and 5
D) Graphs 3 and 5

10. Methanol, CH_3OH, and ethanol, C_2H_5OH, can be used as fuel for a burner. The following diagrams show the energy released during the combustion of one mole of each substance.



Which of the two combustion reactions illustrated above releases the most energy when 1 g of substance is burned?

Methanol ⇒ $1g \times \frac{1mol}{32.02g}$

$= 0.031 mol$

$\Delta H = \frac{730kJ}{0.031mol}$

$\Delta H = 23374.60kJ$

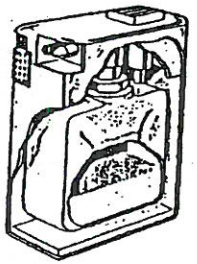
Ethanol ⇒ $1g \times \frac{1mol}{34.07g}$

$= 0.029 mol$

$\Delta H = \frac{1370kJ}{0.029}$

$\Delta H = 46675.9kJ$

11.



A lighter has a reservoir containing a flammable gas under pressure.

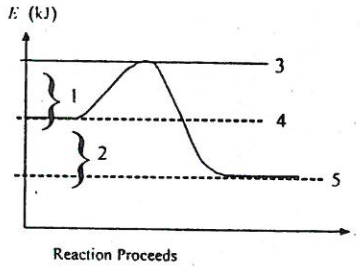
When the lighter is ignited, two things occur :

- gaseous butane escapes through an opening;
- hot sparks are produced friction from the flint.

The combustion of butane is exothermic.

Associate the expressions on the right with the numbers on the energy diagram on the left.

Energy Diagram



Expressions

a. The energy contained in butane when the lighter is opened

b. The energy associated with the butane heated by the sparks

c. The energy liberated by the combustion of butane

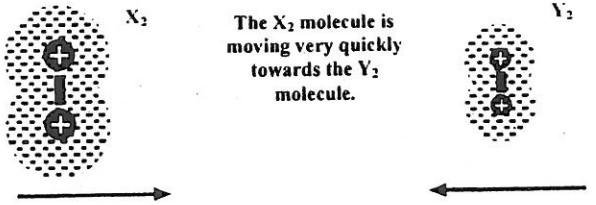
d. The energy contained in the products formed by the combustion of butane ($CO_{2(g)}$ and $H_2O_{(g)}$).

A) a-2, b-1, c-5 and d-4
B) a-4, b-3, c-1 and d-5
C) a-4, b-3, c-2 and d-5
D) a-5, b-3, c-2 and d-4

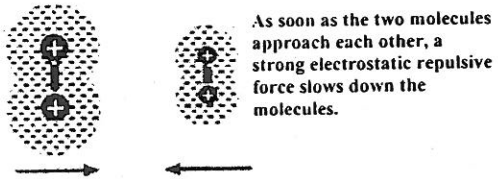
a-4
b-3
c-2
d-5

12. During the following exothermic reaction, at which stage of the molecular collision will the enthalpy be highest?

A)

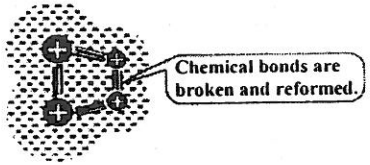


B)

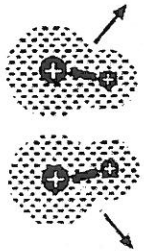


C)

The molecules stop as the activated complex is formed.



D)



Two XY molecules are formed and quickly move away from each other.

Name _____

Class _____ Date _____

Reaction Rates

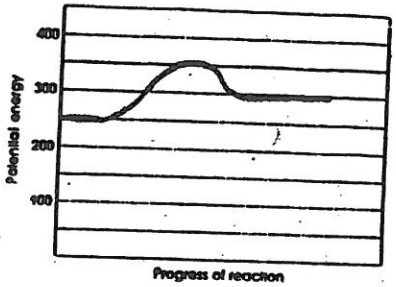
A. Potential Energy Diagrams

The potential energy of substances involved in a reaction can be plotted versus the progress of the reaction, as the process moves from initial reactants, through activated complex, to final products.

On the grids below, plot energy diagrams for 1-3 below, given the following information, and answer the questions. For number 4, study the energy diagram and answer the questions.

1. Potential energy of reactants: 250
Potential energy of activated complex: 350
Potential energy of products: 300
Is the reaction exothermic or endothermic? How can you tell?
What is the value of ΔH?

Endo → ΔH = +50kJ

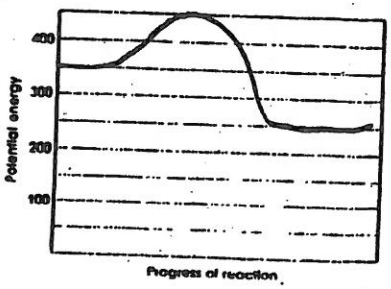


If a catalyst were added, what would happen to the diagram? What would happen to the energies of reactants, products, and activated complex, and to the rate? Explain the effect on the rate.

Ea = Same
Ep = Same
Activated Complex = lower energy
Rate = faster

2. Potential energy of reactants: 350
Activation energy (energy needed to form activated complex from reactants): 100
Potential energy of products: 250
Is this reaction exothermic or endothermic? Why? What is the value of ΔH?

Exo → ΔH = -100kJ



What is the potential energy of the activated complex? 450 kJ

CHAPTER 18 WORKSHEET

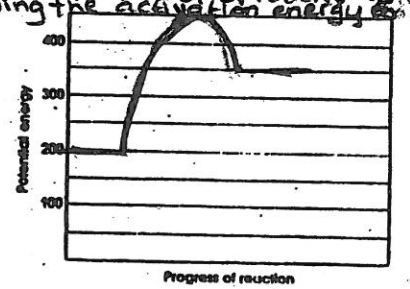
If the concentration of the reactants were increased, what would happen to the diagram? What would happen to the energies of reactants, products, and activated complex, and to the rate?

Explain the effect on the rate. there would be no effect on the diagram. the energy for reactants products & activated complex would stay the same. The rate would increase because with an ↑ # of particles there is an ↑ # of effective collisions allowing the activation energy to be reached sooner

3. Potential energy of reactants: 200
Potential energy of activated complex: 400
ΔH = +150
Is this reaction exothermic or endothermic? Why?

endo because the ΔH is positive

What is the potential energy of the products? 350kJ

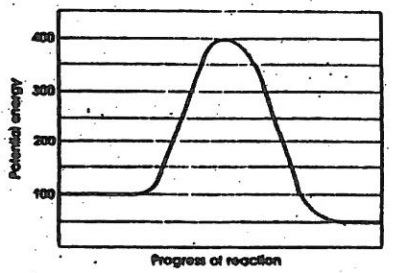


What is the activation energy? 200kJ

If temperature were increased, what would happen to the diagram? What would happen to the energies of reactants, products, and activated complex, and to the rate? Explain the effect on the rate.

nothing would happen to the diagram the energies would remain the same, but the rate would ↑ because with a temp ↑ the agitation of the particles causes more collisions allowing the activation energy to be attained more quickly

4. Potential energy of reactants: 100kJ
Potential energy of activated complex: 400kJ
Activation energy: 300kJ
Potential energy of products: 50kJ
ΔH: -50 KJ



Is the reaction exothermic or endothermic? Why? exo, the ΔH is negative

Reaction Mechanisms

1. $OCl^- + H_2O \rightarrow HOCl + OH^-$
$HOCl + I^- \rightarrow HOI + Cl^-$
$HOI + OH^- \rightarrow H_2O + OI^-$

i) The net chemical equation is: $OCl^- + I^- \rightarrow Cl^- + OI^-$

ii) The reaction intermediates are: $HOCl$, HOI, OH^-

iii) The catalyst is: H_2O

2. Nitrogen monoxide reacts with hydrogen gas to produce nitrogen gas and water vapour. The mechanism is believed to be:

$2\,NO \rightarrow N_2O_2$

$N_2O_2 + H_2 \rightarrow N_2O + H_2O$

$N_2O + H_2 \rightarrow N_2 + H_2O$

i) The net balanced equation: $2N_2O + 2H_2 \rightarrow N_2 + 2H_2O$

ii) The reaction intermediates: N_2O_2, N_2O

3. $Br_2 \rightarrow 2Br$ fast
$Br + OCl_2 \rightarrow BrOCl + Cl$ slow
$Br + Cl \rightarrow BrCl$ fast

i) The net chemical equation is: $Br_2 + OCl_2 \rightarrow BrOCl + BrCl$

ii) The reaction intermediates are: $2Br$, Cl

iii) The rate-determining step is slow (2)

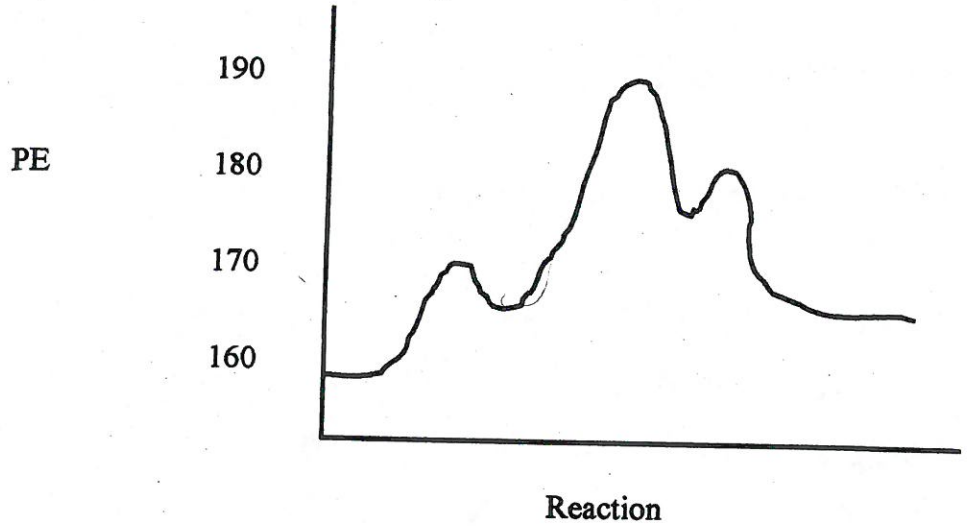
3. The mechanism for the catalytic decomposition of formic acid is shown below.

step 1 $HCOOH + H^+ \rightarrow [HCOOHH]^+$ (very fast)

step 2 $[HCOOHH]^+ \rightarrow [HCO]^+ + HOH$ (slow)

step 3 $[HCO]^+ \rightarrow CO + H^+$ (fast)

a) The potential energy diagram is:



i) The catalyst is H^+

ii) The rate determining step is 2 (slow)

iii) ΔH = +10 KJ (~8KJ)

iv) The enthalpy of the activated complex of the rate determining step 190 KJ

v) The enthalpy of $[HCOOHH]^+$ is +165

4. The catalyzed decomposition of acetaldehyde has an overall reaction of:

$$CH_3CHO \rightarrow CH_4 + CO$$

Determine step 2 of the reaction mechanism.

A proposed mechanism is:

step 1 $CH_3CHO + I_2 \rightarrow CH_3I + HI + CO$

step 2 $CH_3I + HI \rightarrow CH_4 + I_2$

5. Complete the following mechanism.

step 1 $NO + Pt \rightarrow NOPt$

step 2 $NOPt + NO \rightarrow O_2Pt + N_2$

step 3 $O_2Pt \rightarrow O_2 + Pt$

overall $2NO \rightarrow N_2 + O_2$

Identify the catalyst Pt

Identify the two intermediates NOPt O_2Pt