Chem 106: Class/ Lab
Week 10

Sign in: Roster @ front of lab
Pick up returned papers

For today's experiment
Work with the lab partner(s) who set up fermentation with you

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QUESTION

The electrolysis of water is the reverse of the synthesis of water. Which equation best represents the change that takes place when water is electrolyzed?

A) $H_2O(l) \rightarrow H_2O(g)$
B) $H_2O(g) \rightarrow H_2O(l)$
C) $2\ H_2O(l) \rightarrow 2\ H_2(g) + O_2(g)$
D) $2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(l)$

Answer

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QUESTION

Ammonium nitrate, when heated, decomposes into nitrogen gas, oxygen gas, and water vapor. It may be explosive. What is the sum of the coefficients in the balanced equation using smallest integer coefficients?

A) 3 **B) 5** **C) 7** **D) 9**

https://www.youtube.com/watch?v=c5orJHRHbX0 (2013)

$\_\_\ NH_4NO_3\ (s) \longrightarrow \_\_\ N_2\ (g) + \_\_\ O_2\ (g) + \_\_\ H_2O\ (g)$

ANSWER

Ammonium nitrate, when heated, decomposes into nitrogen gas, oxygen gas, and water vapor. What is the sum of the coefficients in the balanced equation using smallest integer coefficients?

A) 3 **B) 5** **C) 7** **D) 9**

$2\ NH_4NO_3\ (s) \longrightarrow 2\ N_2\ (g) + 1\ O_2\ (g) + 4\ H_2O\ (g)$

https://www.youtube.com/watch?v=kJEnfzlR1HY

QUESTION

Determine the coefficient for O_2 when the following equation is balanced in standard form (smallest whole number integers)

$C_4H_{10}(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$

A) 4
B) 8
C) 10
D) 13
E) 20

ANSWER

D) 13

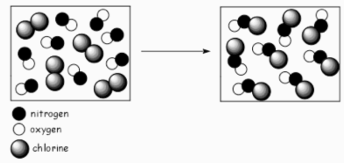
$2\ C_8H_{18\ (l)} + 25\ O_{2(g)} \rightarrow 16\ CO_{2(g)} + 18\ H_2O_{(l)}$

$2\ C_4H_{10\ (l)} + 13\ O_{2(g)} \rightarrow 8\ CO_{2(g)} + 10\ H_2O_{(l)}$

O_2 should be balanced last since it contains only one type of element and balancing it will not cause an imbalance in another element.

QUESTION

Consider the molecular view of reactants converted to a product in the boxes shown below:



Which balanced equation best represents this reaction?

A) $NO + Cl_2 \rightarrow Cl_2NO$
B) $2\ NO + Cl_2 \rightarrow 2\ ClNO$
C) $N_2 + O_2 + Cl_2 \rightarrow 2\ ClNO$
D) $NO + Cl \rightarrow ClNO$

ANSWER

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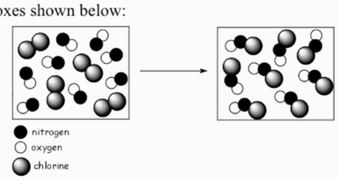

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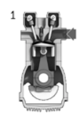
Chem 106: Class/ Lab

Week 10



Turn in Today

1. Chemical Reactions (Course/ Lab Manual pp. 49-51)

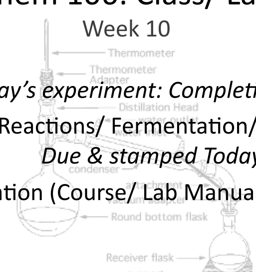
One report with everyone's name who contributed

2. Reactions, Balancing, Stoichiometry Worksheet (Course/ Lab Manual pp. 65-67)

One report with everyone's name who contributed

Chem 106: Class/ Lab

Week 10



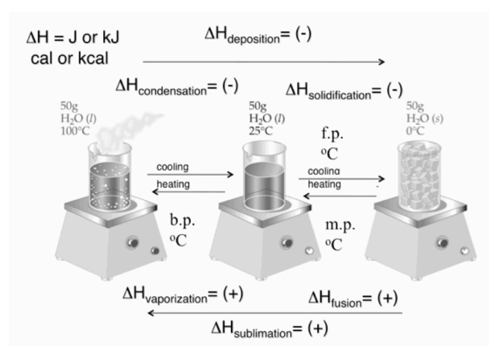
Today's experiment: Completion of

Chemical Reactions/ Fermentation/ Distillation

Due & stamped Today

Distillation (Course/ Lab Manual pg. 46)

Energy: Heat: Enthalpy (ΔH)



QUESTION

Answer either: A) endothermic, or: B) exothermic for each of the following 5 changes of physical state.

1. Fusion
2. Vaporization
3. Condensation
4. Sublimation
5. Liquid → Solid

Answer

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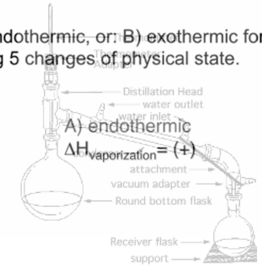
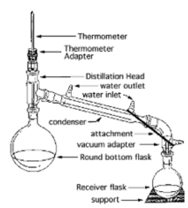
5. Liquid → Solid

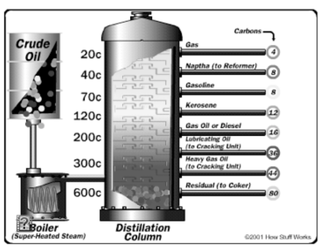
A) endothermic
$\Delta H_{vaporization} = (+)$



Distillation

http://chemconnections.org/general/movies/html-swf/oil-refining.swf



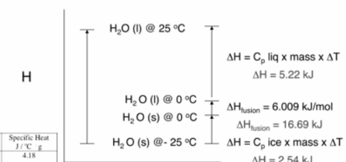


Oil Refining:
http://science.howstuffworks.com/oil-refining4.htm

Energy Diagrams

Heat @ constant Pressure (Enthalpy) ΔH

$s \leftrightarrows l \leftrightarrows g$



Substance	Specific Heat J / °C · g
$H_2O_{(l)}$	4.18
$H_2O_{(s)}$	2.03
$Al_{(s)}$	0.89
$Fe_{(s)}$	0.45

Process Path $\Delta H = \Delta H_{ice} + \Delta H_{fusion} + \Delta H_{liq}$

If 50.0 g of ice @ -25 °C warms to 25 °C what is ΔH of the process?

$\Delta H = ?$

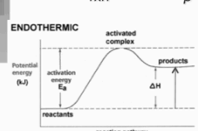
$\Delta H = 24.45$ kJ

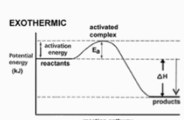
Energy Diagrams

Heat of Reaction

The heat of any reaction can be calculated from the heat(s) of formation of products minus reactants.

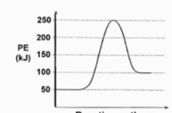
ð $\Delta H_{rxn}° = \Sigma n_p \Delta H_f°(products) - \Sigma n_r \Delta H_f°(reactants)$





Endothermic $\Delta H_{rxn}°=(+)$ and Exothermic $\Delta H_{rxn}°=(-)$

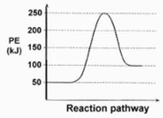
QUESTION



(True/False) The above energy diagram represents an exothermic reaction.

A. TRUE
B. FALSE

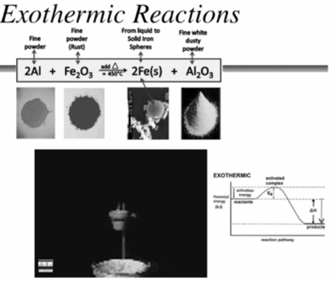
Answer



(True/False) The above energy diagram represents an exothermic reaction.

A. TRUE
B. FALSE

Exothermic Reactions



$\Delta H_{rxn}°$ = - 14,455 kJ/mol

http://www.youtube.com/watch?v=rdCsbZf1_Ng

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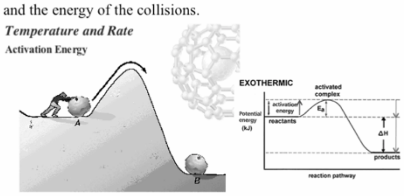
Kinetics: *Rate & TIME*
(What is a second?)

Molecules must collide in order to react.

***Activation Energy, (Ea) & Temperature*: molecules must collide with enough energy to react.** Raising the temperature increases the K.E. of the molecules, the number of collisions and the energy of the collisions.

Temperature and Rate

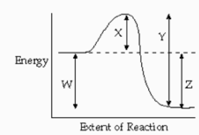
Activation Energy



Generally, raising the temperature 10°C doubles the rate.

QUESTION

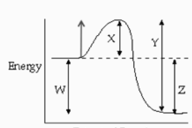
Which line in the Energy Diagram corresponds to the activation energy for the forward reaction?



A. X
B. Y
C. Z
D. W

Answer

Which line in the Energy Diagram corresponds to the activation energy for the forward reaction?

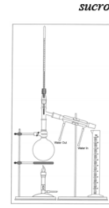


A. X
B. Y
C. Z
D. W

Theoretical & Percent Yield
Calculations
Distillation (Course/ Lab Manual pg. 46)

$$C_{12}H_{22}O_{11} + H_2O \rightarrow 4\ C_2H_5OH + 4\ CO_2$$

sucrose ***ethanol***



Determination of Percent Yield

From the total volume and percent alcohol of the distillate, calculate the actual yield in grams of ethanol. From the balanced equation for the reaction and the weighed mass of sucrose which fermented, calculate the theoretical yield. Finally, calculate the percent that the actual yield is of the theoretical.

Calculations

Example

Reactant:

	g (grams)
Mass, sucrose + container	
- Mass container (Tare)	
Mass, sucrose	24.55 g

Simple Distillation:

Temperature Range	°C to °C
Volume of Distillate Collected (mL)	52.2 mL

Density, Mass & Percent Yield of Alcohol in the Distillate:

Volume of pipet (mL)	
Mass of beaker + distillate (grams)	
Mass of beaker (grams)	
Mass of distillate (grams)	
Density (g/mL)	0.990 g/mL
% Percent ethyl alcohol (from Table)	
Total mass of ethyl alcohol produced (calculated)	
% Percent Yield ethyl alcohol (calculated)	

Calculations

PERCENT ETHANOL FOR VARIOUS DENSITIES

% ethanol by mass	Density (g/mL)	% ethanol by mass	Density (g/mL)	% ethanol by mass	Density (g/m L)
0.0	0.998	35.0	0.945	69.0	0.870
1.0	0.996	36.0	0.943	70.0	0.868
2.0	0.995	37.0	0.941	71.0	0.865
3.0	0.993	38.0	0.939	72.0	0.863
4.0	0.991	39.0	0.937	73.0	0.860
5.0	0.989	40.0	0.935	74.0	0.858
6.0	0.988	41.0	0.933	75.0	0.856
7.0	0.986	42.0	0.931	76.0	0.853
8.0	0.985	43.0	0.929	77.0	0.851
9.0	0.983	44.0	0.927	78.0	0.848
10.0	0.982	45.0	0.925	79.0	0.846
11.0	0.980	46.0	0.923	80.0	0.843
12.0	0.979	47.0	0.920	81.0	0.841
13.0	0.978	48.0	0.918	82.0	0.838
14.0	0.976	49.0	0.916	83.0	0.836
15.0	0.975	50.0	0.914	84.0	0.833
16.0	0.974	51.0	0.912	85.0	0.831
17.0	0.973	52.0	0.909	86.0	0.828
18.0	0.971	53.0	0.907	87.0	0.826
19.0	0.970	54.0	0.905	88.0	0.823
20.0	0.969	55.0	0.903	89.0	0.821
21.0	0.967	56.0	0.900	90.0	0.818
22.0	0.966	57.0	0.898	91.0	0.815
23.0	0.965	58.0	0.896	92.0	0.813
24.0	0.963	59.0	0.893	93.0	0.810
25.0	0.962	60.0	0.891	94.0	0.807
26.0	0.960	61.0	0.889	95.0	0.804
27.0	0.959	62.0	0.887	96.0	0.801
28.0	0.957	63.0	0.884	97.0	0.798
29.0	0.955	64.0	0.882	98.0	0.795
30.0	0.954	65.0	0.879	99.0	0.792
31.0	0.952	66.0	0.877	100.0	0.789
32.0	0.950	67.0	0.875		
33.0	0.949	68.0	0.872		

4.5 %

Example

24.55 g

52.2 mL

0.990 g/mL

Theoretical Yield Calculation

24.55 g ? g (theoretical)

$$C_{12}H_{22}O_{11} + H_2O \rightarrow \mathbf{4}\ C_2H_5OH + 4\ CO_2$$

sucrose *ethanol*

Molar mass = 342.3 g/mol Molar mass = 46.07 g/mol

? mol *sucrose* = 24.55 g / 342.3 g/mol = 0.07172 mol

? mol C_2H_5OH = 4 x mol *sucrose* = 0.2869 mol

? g (theoretical) = mol C_2H_5OH x 46.07 g/mol = 13.22 g

? g (actual) = [4.5 % ,that is: 4.5/100] x 52.2 mL x 0.990 g/mL = 2.33g

% Yield = g (actual) / g (theoretical) x 100 = 17.6 %

Completed Report & Post Lab Questions

Due Next Week

http://chemconnections.org/general/chem106/ethanol-ques-106.pdf

Chem 106/ Dr. Rusay

Name:______________________________

Ethanol Post Lab Questions

http://chemconnections.org/general/chem120/ethanol-ques-106.html

1. Explain the genetic importance of the protein zymase in the production of ethanol in a sentence or two.

2. What year was ethanol first used in an internal combustion engine?

3. Clearly show your answers and calculations for the following problems.

A) How much energy (kJ) could be produced from the oxidation of one gallon of pure ethanol (d =0.789 g/mL)? The amount of energy produced per mole of ethanol is -1367.6 ± 0.3 kJ/mol.

B) How much energy (kJ) could be produced from the combustion of 1 gallon of isooctane (C_8H_{18} , gasoline), d= 0.69 g/mL? The amount of energy produced per mole of isooctane is −5460.0 kJ/mol.

Post Lab to turn in individually:
[Each Partner turns in a completed form]