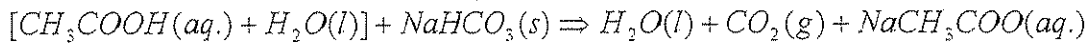
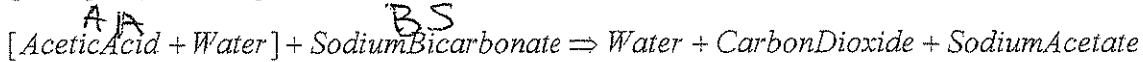
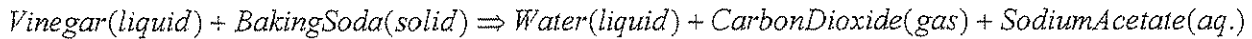


Skip key.

Baking Soda and Vinegar Lab WORKSHEET (50 lab Pts)

Kitchen Chemistry: The Baking Soda and Vinegar Reaction

1) Determine the molecular weight of each component and the stoichiometric coefficients to balance the reaction.



Coefficients	<u>1</u>	<u>1</u>	<u>1</u>	<u>2</u>	<u>1</u>	<u>1</u>
MW	<u>60 g/mole</u>	<u>18 g/mole</u>	<u>84 g/mole</u>	<u>18</u>	<u>44 g/mole</u>	<u>82 g/mole</u>
C	2 x 12 = 24		NA 1 x 23 = 23		C 2 x 12 = 24	NA 1 x 23 = 23
H	4 x 1 = 4		H 1 x 1 = 1		O 2 x 16 = 32	C 2 x 12 = 24
O	2 x 16 = 32		C 1 x 12 = 12		O 2 x 16 = 32	H 3 x 1 = 3
	<u>60 g/mole</u>		O 3 x 16 = 48			

2) Calculations to determine the amount of CO₂(g) produced in the BS-V reaction

Starting Material: 50 ml Vinegar (5vol% AA) S.G. (CH₃COOH) = 1.05

a) Calculate the stoichiometric amount (moles and grams) of sodium bicarbonate needed.

(50 ml vinegar) $\left(\frac{0.05 \text{ ml AA}}{\text{ml vinegar}} \right) \left(\frac{1.05 \text{ g AA}}{\text{ml AA}} \right) \left(\frac{1 \text{ mole}}{60 \text{ g}} \right) = 0.044 \text{ mole AA}$

Stoichiometry
1 AA + 1 BS \rightarrow 1 CO₂ 3.67g BS

0.044 mole BS \downarrow x 84 g/mole

b) Write the Ideal Gas Law. Identify the variables and their units.

$PV = nRT$
 P = pressure (atm)
 V = volume (L, m³, ft³)
 n = gmoles
 T = Temp. (K or °R)
 R = Ideal Gas Constant (units vary)

c) Calculate the Ideal Gas Constant (R) in units of liter-atm/mol-K

NOTE: Remember R is calculated at Standard Temperature and Pressure (STP = 273 K, 1 atm)

STP	Ts	Ps	Vs	ns
SI	273K	1atm	0.0224m ³	1g mole
Cgs	273K	1atm	22.4L	1g mole
ENG.	492R	1atm	359ft ³	1lb mole

$R = \frac{P_s V_s}{T_s n_s} = \frac{(1 \text{ atm})(22.4 \text{ L/mole})}{273 \text{ K}}$

$R = 0.08205 \frac{\text{L-Atm}}{\text{mol-K}}$

d) Use the Ideal Gas Law to calculate the volume of CO_2 produced at $T = 20^\circ\text{C}$.

$$V_{\text{CO}_2} = \frac{(n_{\text{CO}_2})(R)(T)}{P} = \frac{(0.044 \text{ mol CO}_2)(0.08205 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(293\text{K})}{1 \text{ atm}}$$

$$V_{\text{CO}_2} = 1.058 \text{ L} = 1058 \text{ ml CO}_2 @ 20^\circ\text{C}$$

e) What is the pressure in a 700ml Gatorade Plastic Bottle? with 50ml. Vinegar @ 20°C

$$P_{\text{Bottle}} = \frac{(n_{\text{CO}_2})(R)(T)}{V_{\text{Bottle}} - V_{\text{liquid}}}$$

$$= \frac{(0.044 \text{ mol CO}_2)(0.08205 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(293\text{K})}{0.70 \text{ L} - 0.050 \text{ L (Vinegar)}}$$

$$P_{\text{Bottle}} = 1.63 \text{ atm}$$

Note: MAX pressure allowed in bottle = 5 atm!

f.) Limiting reactant concept.

Limiting reactant = reactant in least amount present.
 excess reactant = in excess relative to other reactants.

e.g. if we had (1.8g BS) ($\frac{1 \text{ mol}}{60\text{g}}$) = 0.030 moles BS.
 and some vinegar.
 BS is limiting reactant.

$$0.030 \text{ moles CO}_2$$

Felder: ROUSSEAU (Front Cover Table)

FACTORS FOR UNIT CONVERSIONS

Quantity	Equivalent Values
Mass	1 kg = 1000 g = 0.001 metric ton = 2.20462 lb _m = 35.27392 oz 1 lb _m = 16 oz = 5 × 10 ⁻⁴ ton = 453.593 g = 0.453593 kg
Length	1 m = 100 cm = 1000 mm = 10 ⁶ microns (μm) = 10 ¹⁰ angstroms (Å) = 39.37 in. = 3.2808 ft = 1.0936 yd = 0.0006214 mile 1 ft = 12 in. = 1/3 yd = 0.3048 m = 30.48 cm
Volume	1 m ³ = 1000 L = 10 ⁶ cm ³ = 10 ⁶ mL = 35.3145 ft ³ = 220.83 imperial gallons = 264.17 gal = 1056.68 qt 1 ft ³ = 1728 in. ³ = 7.4805 gal = 0.028317 m ³ = 28.317 L = 28,317 cm ³
Force	1 N = 1 kg·m/s ² = 10 ⁵ dynes = 10 ⁵ g·cm/s ² = 0.22481 lb _f 1 lb _f = 32.174 lb _m ·ft/s ² = 4.4482 N = 4.4482 × 10 ⁵ dynes
Pressure	1 atm = 1.01325 × 10 ⁵ N/m ² (Pa) = 101.325 kPa = 1.01325 bar = 1.01325 × 10 ⁶ dynes/cm ² = 760 mm Hg at 0°C (torr) = 10.333 m H ₂ O at 4°C = 14.696 lb _f /in. ² (psi) = 33.9 ft H ₂ O at 4°C = 29.921 in. Hg at 0°C
Energy	1 J = 1 N·m = 10 ⁷ ergs = 10 ⁷ dyne·cm = 2.778 × 10 ⁻⁷ kW·h = 0.23901 cal = 0.7376 ft·lb _f = 9.486 × 10 ⁻⁴ Btu
Power	1 W = 1 J/s = 0.23901 cal/s = 0.7376 ft·lb _f /s = 9.486 × 10 ⁻⁴ Btu/s = 1.341 × 10 ⁻³ hp

Example: The factor to convert grams to lb_m is $\left(\frac{2.20462 \text{ lb}_m}{1000 \text{ g}}\right)$.

Standard Conditions for Gases (STP)

System	T _s	P _s	V _s	n _s
SI	273K	1atm	0.02241 m ³	1mole (gmole)
CGS	273K	1atm	22.415 L	1mole (gmole)
Engineering	492°R	1atm	359.05 ft ³	1bmole

Notes: 1 lbmole = 454 gmole
1 kg mole = 1000 gmole

Ideal Gas Law: $PV = nRT$ (\hat{V} = molar volume = V/n)

@ STP $P_s \frac{V_s}{n_s} = RT_s$

$$R = \frac{P_s V_s / n_s}{T_s}$$

* Notes: R always evaluated @ STP * Ideal gas constant