Welcome to our CHEM 4 lecture

Clicker question: Review from last class
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1) Acetylsalicylic acid (aspirin) is 59.9% C, 4.50% H, and 35.6% O. If the molar mass of aspirin is roughly 180 g/mol, what is its molecular formula?

A) $C_8H_8O_4$ C) $C_6H_{12}O_6$ E) C_2H_2O G) $C_9H_8O_4$

B) $C_{27}H_{24}O_{12}$ D) $C_{18}H_{16}O_8$ F) $C_{12}H_4O_2$ H) $C_3H_{16}O_8$

Answer: Assuming 100 g:

Here we divide by the smallest number of moles

- $(59.9\text{ g C})\left(\frac{1\text{ mol C}}{12.01\text{ g C}}\right) = 4.988\text{ mol C}/2.225\text{ mol} = \underline{2.2}42 \times 4 = \underline{8.9}67 \approx 9$
- $(4.50\text{ g H})\left(\frac{1\text{ mol H}}{1.008\text{ g H}}\right) = 4.464\text{ mol H}/2.225\text{ mol} = \underline{2.0}06 \times 4 = \underline{8.0}24 \approx 8$
- $(35.6\text{ g O})\left(\frac{1\text{ mol O}}{16.00\text{ g O}}\right) = 2.225\text{ mol O}/2.225\text{ mol} = \underline{1.0} \times 4 = 4$

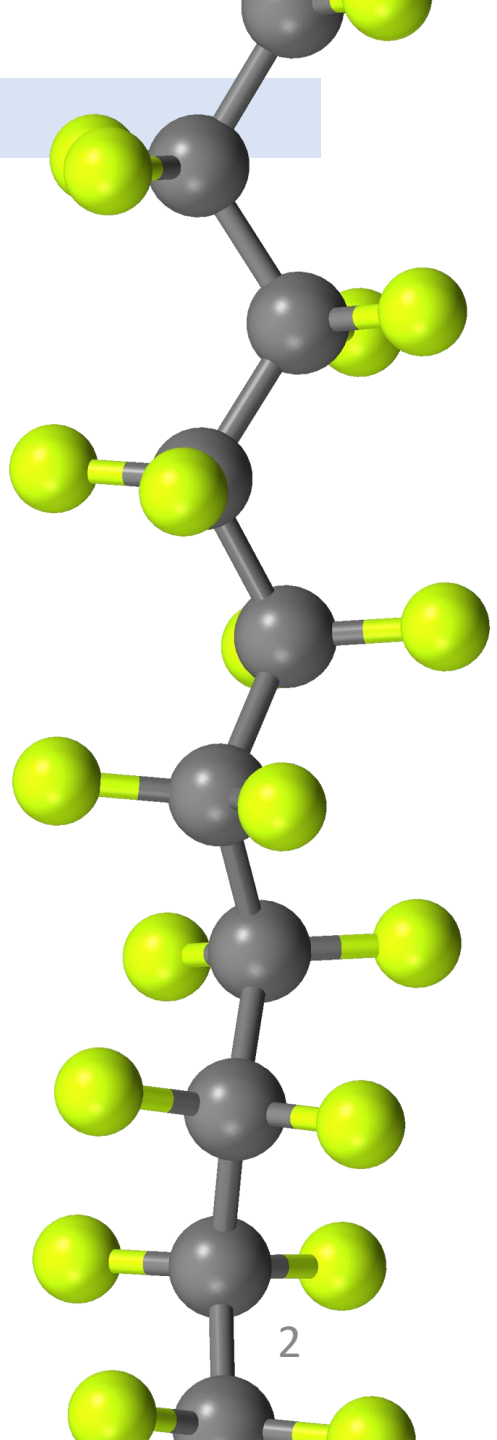
Because we don't have all whole numbers when we round to the 10ths place, we multiply everything by 4.

- Empirical formula = $C_9H_8O_4$, which has a molar mass = 180.15 g/mol.
- This matches the reported molar mass, so it is also the **molecular formula = $C_9H_8O_4$**

Need to make changes in how you study for CHEM 4?

Here's our checklist of key behaviors that lead to success in CHEM 4:

- ✓ Study efficiently with a focus on the homework:
  - ✓ (1) do the assigned reading, then (2) attend lecture, then (3) review the lecture slides or video. You should then be ready to do the homework.
  - ✓ If you do (1) - (3) and start the required homework and have trouble, then put aside the homework and redo (1) and (3). Then try the optional homework.
  - ✓ If you still have trouble, put the homework aside and come to my office hours.
  - ✓ Remember is it okay if the homework is late, the most important thing is that you are really understanding the homework.
- ✓ Get help when needed:
  - ✓ Put together a weekly study group.
  - ✓ Jeff's office hours: MWF 9 – 9:30 am and 11 – 11:30 am; and by appointment.
  - ✓ PAL office hours: link is on our CHEM 4 website.
- ✓ Complete all of the practice exams.
- ✓ Visit our CHEM 4 website regularly: tinyurl.com/SacStateChem4



CHEM 4 lecture

Wednesday, November 18, 2020

Sec 3.7, 7.1 – 7.4

Chemical reactions

Reading clicker question: Chemical reactions (Sec 3.7, 7.1-7.4)
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2) Which of the following does not represent evidence suggesting a chemical reaction has occurred?

A) A solution changes color from clear to red

B) A solid turns into a liquid

C) Gas bubbles form when two reactants are mixed

D) A solid forms when two liquids are mixed

E) Heat is produced when two liquids are mixed

An example of this would be melting ice which is a physical change.

It is possible to have a chemical reaction with none of the above.

Reading clicker question: Chemical reactions (Sec 3.7, 7.1-7.4)
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3) Sugar ($C_6H_{12}O_6$) can be fermented to generate carbon dioxide and ethanol (C_2H_6O) as represented by the equation below. Which statement about this equation is true?

$$C_6H_{12}O_6(aq) \rightarrow 2\ CO_2(g) + 2\ C_2H_6O(l)$$

A) The ethanol is produced as a gas.

B) The "2 CO_2" could be substituted with "C_2O_4".

C) The mass of the products should be less than the mass of the reactants because one of the products is a gas.

D) The "(aq)" means that the sugar has been melted.

E) Every molecule of sugar can produce 4 molecules.

F) The total number of C atoms is greater on the left side of the "$\rightarrow$".

G) Compounds on the left side of the "$\rightarrow$" are the products.

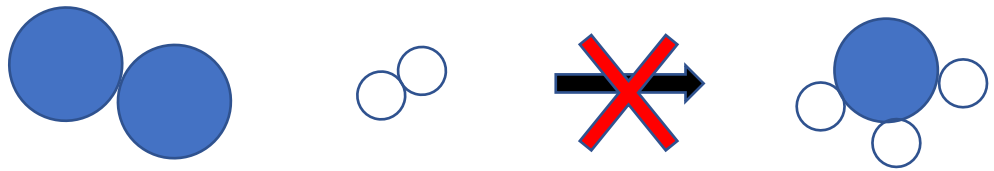
2 CO_2 molecules and
2 C_2H_6O molecules

Sample problem: Balancing a chemical reaction

Ex: Balance the following chemical reaction:

Nitrogen gas reacts with hydrogen gas to form gaseous ammonia.

$$N_2(g) + H_2(g) \rightarrow NH_3(g)$$

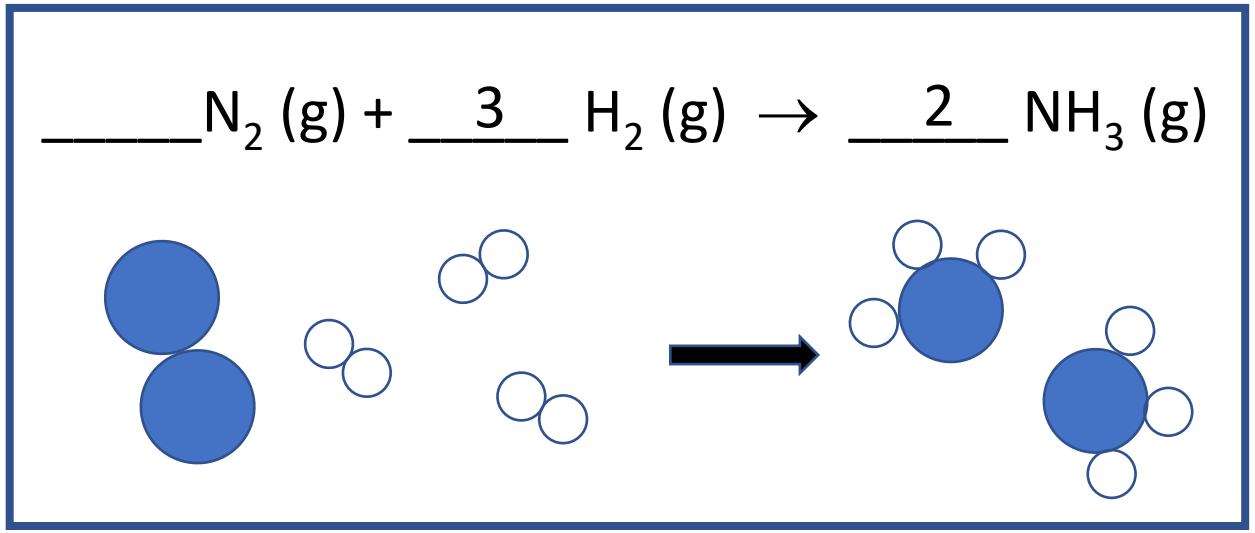


Reactant side	Product side
# N = 2	# N = 1
# H = 2	# H = 3

- It looks like a N atom turned into a H atom!
- That can't happen; so it is "unbalanced".

Sample problem: Balancing a chemical reaction

- When balancing, we can only change the coefficients (never the subscripts).
- No clear steps; some trial and error.
- Balance the reaction:



Reactant side	Product side
# N = 2	# N = 2
# H = 6	# H = 6

- The ratio is what is important (here 1:3:2). Can scale up to "dozen" or more usefully, to “moles” which we can actually weigh out after converting to grams.

Clicker question: Balancing a chemical reaction
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4) What is the coefficient in front of the HCl when the following reaction is balanced?

_____ $Al(s)$ + _____ $HCl(aq) \rightarrow$ _____ $AlCl_3(aq)$ + _____ $H_2(g)$

A) 1
B) 2
C) 3
D) 4
E) 5
F) 6

Answer: $2Al(s) + 6HCl(aq) \rightarrow 2AlCl_3(aq) + 3H_2(g)$

Clicker question: Balancing a chemical reaction
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5) What is the coefficient in front of the Na_2CO_3 when the following reaction is balanced?

___ Na_2CO_3 (aq) + ___ $Al(NO_3)_3$ (aq) → ___ $NaNO_3$ (aq) + ___ $Al_2(CO_3)_3$ (s)

A) 1
B) 2
C) 3
D) 4
E) 5
F) 6

Answer: 3 Na_2CO_3 (aq) + 2 $Al(NO_3)_3$ (aq) → 6 $NaNO_3$ (aq) + $Al_2(CO_3)_3$ (s)

Sample problem: Balancing a chemical reaction using a fraction

- Save elements that are in more than one place on the product and/or reactant side until the end.
- When the reaction with a diatomic element (typically O_2) results in an odd number of that element on one side and an even number on the other, use a fraction to balance, then multiply each side by 2 to get rid of the fraction.

Example: _____ NH_3 (g) + _____ O_2 (g) $\rightarrow$ _____ NO (g) + _____ H_2O(g)

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

Clicker question: Balancing a chemical reaction
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6) The combustion of butane produces water and carbon dioxide. What is the coefficient in front of the O_2 when the reaction is balanced?

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

A) 2.5
B) 4
C) 6.5
D) 9.5
E) 13
F) 18

Answer: 2 $C_4H_{10}(l)$ + 13 $O_2(g) \rightarrow$ 8 $CO_2(g)$ + 10 $H_2O(g)$

Be able to predict combustion reactions: **fuel + $O_2(g) \rightarrow CO_2(g) + H_2O(g)$**

Clicker question: Balancing a chemical reaction
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7) In rocket boosters for spacecrafts, solid ammonium perchlorate and solid aluminum react to form solid aluminum oxide, solid aluminum chloride, gaseous nitrogen monoxide and water vapor. What is the coefficient in front of the aluminum chloride when the reaction is balanced?

A) 1 C) 3 E) 5

B) 2 D) 4 F) 6

Answer:

___ NH_4ClO_4 (s) + ___ Al (s) → ___ Al_2O_3 (s) + ___ $AlCl_3$ (s) + ___ NO (g) + ___ H_2O (g)

3 NH_4ClO_4 (s) + 3 Al (s) → Al_2O_3 (s) + $AlCl_3$ (s) + 3 NO (g) + 6 H_2O (g)