Slide 1

Quantitative Concepts

CH 110

25 September 2008

Slide 2

Counting by particles

- Chemical formulas
  - Show the number of each kind of atom in the molecule – CO_2: one C atom and 2 O atoms
  - Show the number of moles of each kind of atom molecule – CO_2: one mole of C atoms and 2 moles of O atoms
- Equations are balanced
  - In terms of molecules $CH_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$
  - In terms of moles

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Counting by Mass

- In the chemistry lab quantities are usually measured as
  - Mass – in grams (g)
  - Volume – in milliliters (mL)
  - Temperature – in degrees (°C)
- The particles of interest – atoms and molecules – are too small to see and count
- So, we combine counting numbers and mass to count by mass.

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What is the mass of a mole of carbon dioxide?

- 1 mole of C has a mass of 12.011 g
- 1 mole of O has a mass of 15.994 g
- 1 mole of CO2 will have a mass of
  - 1 mol C x 12.001 g C/mol = 12.011 g
  - 2 mol O x 15.994 g O/mol = 31.988 g
    - 43.999 g CO_2/mol
    - or 44 g CO_2/mol
- What is the mass of 1 mole of ammonia?

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If 3.3 Gt of C as CO_2 is added to the atmosphere annually, what is the mass of CO_2 added?

- The relationship between C and CO_2 is represented by C + O_2 → CO_2
- Each mole of C added to the atmosphere then represents 1 mole of CO_2 added
- Mass comparisons
  - The ratio of mass of C to mass of CO_2 is 0.2727272 or the mass of C is 0.273 (about ¼) that of CO_2
    - The inverse is also true!
  - The ratio of the mass of CO_2 to mass of C is 44:12 or the mass of CO_2 is 3.666666667 time that of carbon.
- So the mass of CO_2 added to the atmosphere will be 3.67 x the mass reported as C or
- 3.67 x 3.3 Gt = 12.111 Gt CO_2

G → giga is 10^9
t is metric ton is 1000 kg

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$$CH_4 + 3O_2 \rightarrow CO_2 + 2H_2O$$

The above equation represents the reaction of one mole of methane with 3 moles of oxygen to produce 1 mole of carbon dioxide and 2 moles of water.

A. True
B. False

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$$CH_4 + 3O_2 \rightarrow CO_2 + 2H_2O$$

Based on the above equation, if 3 moles of methane are burned, how many moles of water would be produced?

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Another problem

$$CH_4 + 3O_2 \rightarrow CO_2 + 2H_2O$$

- How many moles of water will be produced if we burn 128 g of methane?
  - Calculate the molar mass of methane
  - Calculate the moles of methane that burned
  - Use the balanced equation to find moles of water produced.
- What will be the mass of that amount of water?
  - Calculate the molar mass of water
  - Calculate the mass of the moles of water

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What follows is a problem to be worked in three sequential steps

Give answers in whole numbers.

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$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

How many moles of propane are used if 132 g of propane are burned?

molar mass of propane
44 g C_3H_8/mol

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$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

When 132 g of propane are burned, how many moles of oxygen are required?

molar mass of propane
44 g/mol

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$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

When 132 g of propane are burned, what mass of oxygen gas is consumed?