

Lecture 11 CH101 A1 (MWF 9 am) Fall 2016 Copyright © 2016 Dan Dill dan@bu.edu

[TP] Substances A and B combine to form substance C in the balanced chemical equation  

$$3 A + 2 B \rightarrow 4 C$$
 If 12 mol A and 6 mol B react completely, how many moles of C are **formed**?

25% 1. 16 mol C  
 25% 2. 9 mol C  
 25% 3. 6 mol C  
 25% 4. None of the above

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Lecture 11 CH101 A1 (MWF 9 am)  
 Monday, October 3, 2016

- Review: Stoichiometry: Amounts in chemical transformations
- Limiting reagent
- Percent yield

Begin ch6

- Hydrogen bonding in ice and water

Next lecture: Heat versus temperature; heat capacity; vapor pressure and boiling; intermolecular forces

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### Stoichiometry: Chemical amounts

Intense exercise uses **lactic acid**,  $\text{CH}_3\text{CH}(\text{OH})\text{C}(\text{O})\text{OH}$ , as a combustion **fuel**. How many **moles of carbon dioxide** are formed for **each mole of lactic acid** "burned" completely in the oxygen of air, forming  $\text{CO}_2$  and water?

Strategy: Each C makes one  $\text{CO}_2$ .

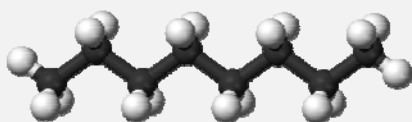
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[Quiz] A primary component of gasoline is octane,  $\text{C}_8\text{H}_{18}$ , shown in the figure. How many **moles of water** are formed for **each mole of octane** "burned" completely in the oxygen of air?

20% 1. 3 mol water  
 20% 2. 6 mol water  
 20% 3. 9 mol water  
 20% 4. 12 mol water  
 20% 5. None of the above



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## Limiting reagent

Our Learning Assistants are starting a sandwich making business.

To start, they will offer only a single option ...

A cheese **club sandwich** on whole wheat bread.



With 15 slices of bread and 6 slices of cheese, ...

How many sandwiches can they make?

How much of each ingredient will be left over?

Let's see...

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## Limiting reagent

$3 \text{ Bread} + 2 \text{ Cheese} \rightarrow 1 \text{ Sandwich}$

Balanced chemical **equation** is the "recipe"

**Amounts** of reactants is **how much** can be made

**Limiting** is which reactant **makes the least**

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[TP] Substances A and B combine to form substance C in the balanced chemical equation

$$3 \text{ A} + 2 \text{ B} \rightarrow 4 \text{ C}$$

If 12 mol A and 6 mol B react completely, how many moles of C are **formed**?

25% 1. 16 mol C

25% 2. 9 mol C

25% 3. 6 mol C

25% 4. None of the above

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[TP] Substances A and B combine to form substance C in the balanced chemical equation

$$3 \text{ A} + 2 \text{ B} \rightarrow 4 \text{ C}$$

If 12 mol A and 6 mol B react completely, how many moles of A remain **unreacted**?

25% 1. 0 mol A

25% 2. 3 mol A

25% 3. 6 mol A

25% 4. None of the above

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## Reaction yield

Reaction yield is the proportion of the actual yield to the theoretical yield.

1. Determine the limiting reagent.
2. Determine the theoretical (maximum possible) yield.
3. Use the actual yield to compute the reaction yield

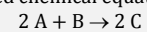


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[Quiz] Substances A and B combine to form substance C in the balanced chemical equation



8 mol A and 5 mol B react to form 6 mol C. The % yield is ...

- 20% 1. 100%  
20% 2. 75%  
20% 3. 60%  
20% 4. 40%  
20% 5. None of these

Response  
Counter

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H-bonding in ice and water

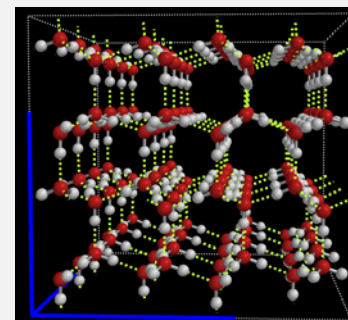


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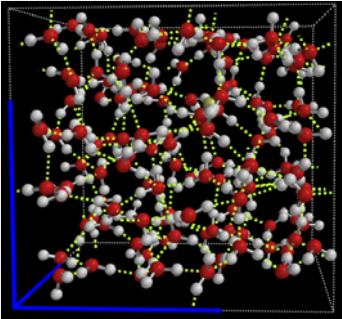
## Ice and water



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### Ice and water



A ball-and-stick model of water molecules. Each molecule consists of one red oxygen atom and two white hydrogen atoms. Dotted lines represent hydrogen bonds between the oxygen of one molecule and the hydrogen of another. The model is contained within a blue wireframe box.

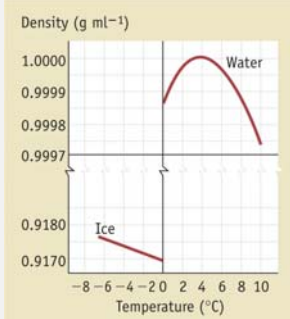
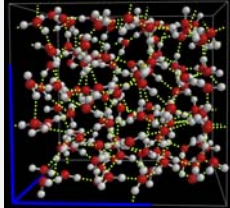
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### Effect of $T$ on water density

Why does the density **rise** from 0 °C to 4 °C?  
Why does the density **fall** from 4 °C to higher temperatures?



A ball-and-stick model of water molecules, similar to the one in slide 25, but with a different arrangement of hydrogen bonds.

Density (g ml<sup>-1</sup>)

Temperature (°C)	Density (g ml <sup>-1</sup> )
-8	0.9170
-6	0.9175
-4	0.9180
-2	0.9185
0	0.9998
2	0.9999
4	1.0000
6	0.9999
8	0.9998
10	0.9997

Water

Ice

Temperature (°C)

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