

Dalton's Atomic Theory

all matter is made of small indivisible particles called atoms

all atoms of the same element are identical to each other

atoms of different elements are different

atoms combine in simple integer ratios to form compounds

every compound has a definite composition

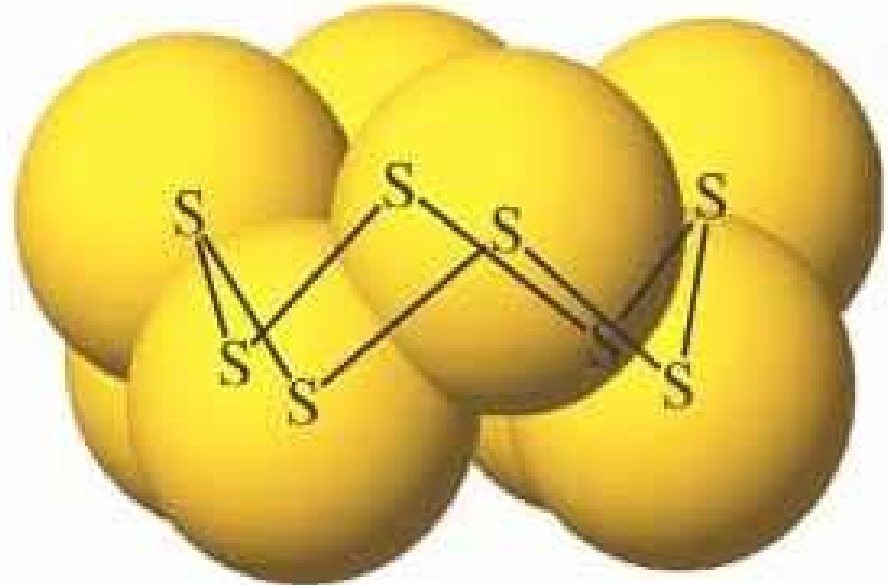
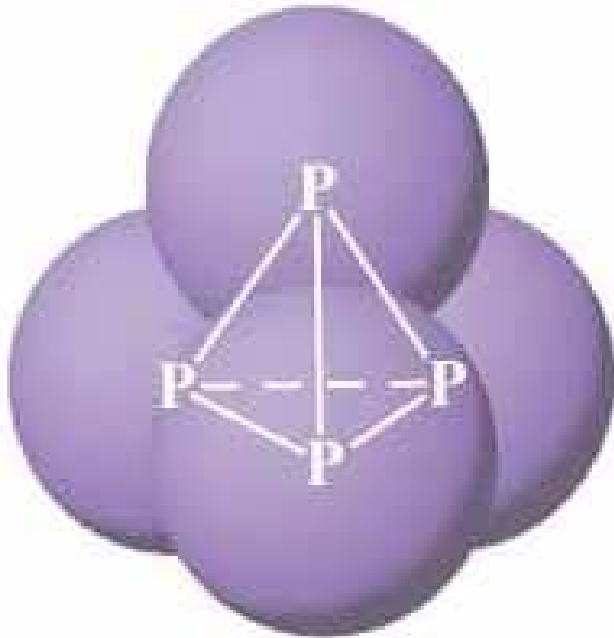
different compounds can be made from the same elements
but in different proportions

in a reaction atoms recombine but are not created or destroyed

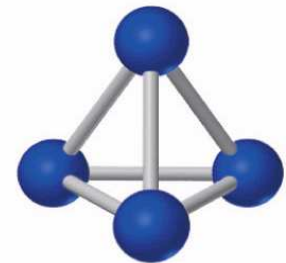
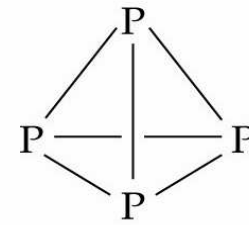
Elements

atomic- most elements exist as individual atoms

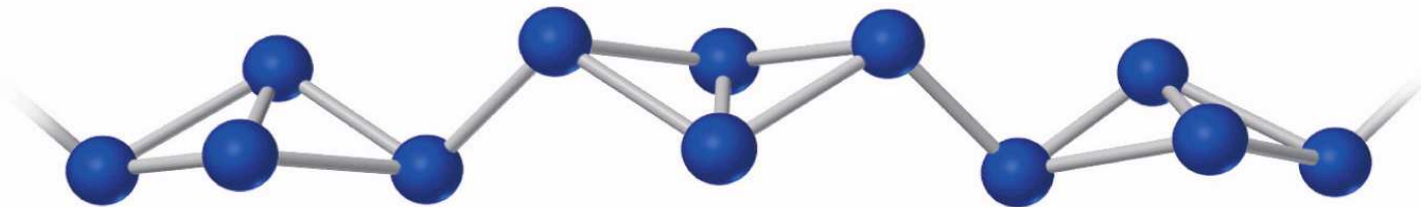
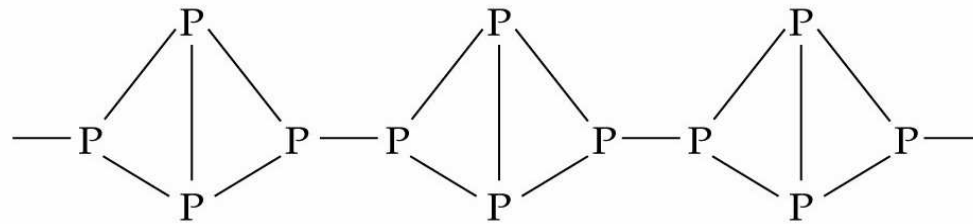
molecular- some elements exist as atoms joined together by covalent bonds



Allotropes

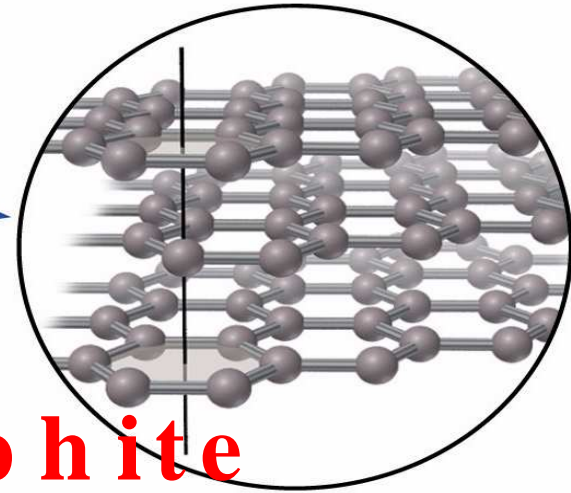


White phosphorus



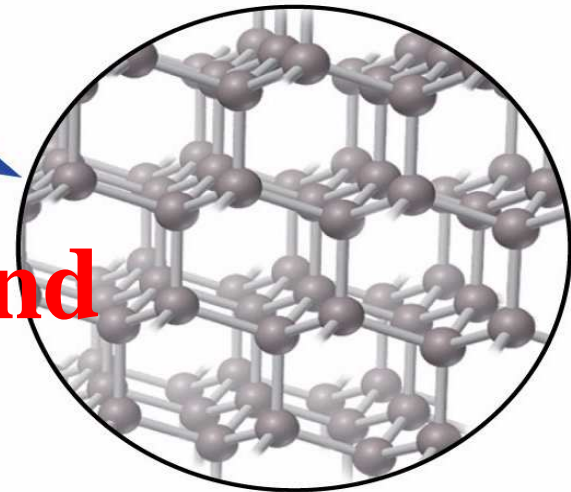
Red phosphorus

Other Allotropes carbon



(a)

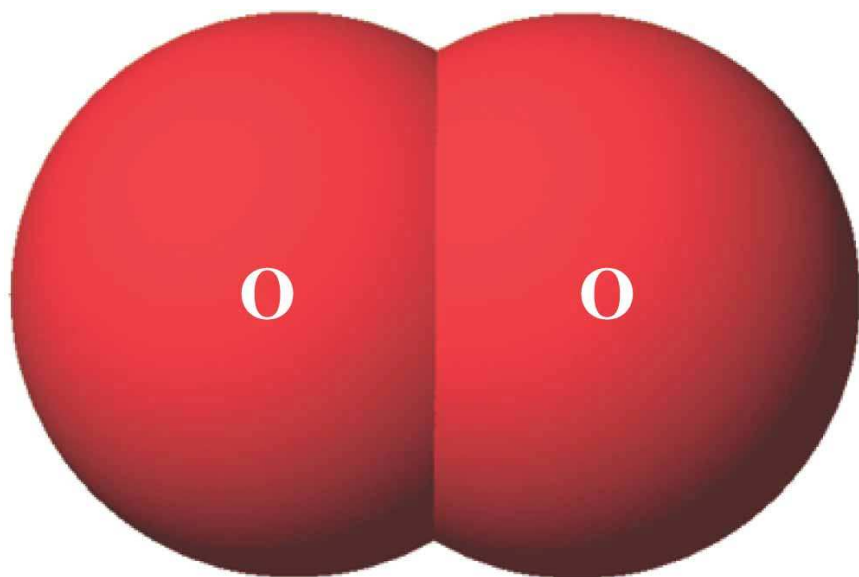
g r a p h i t e



(b)

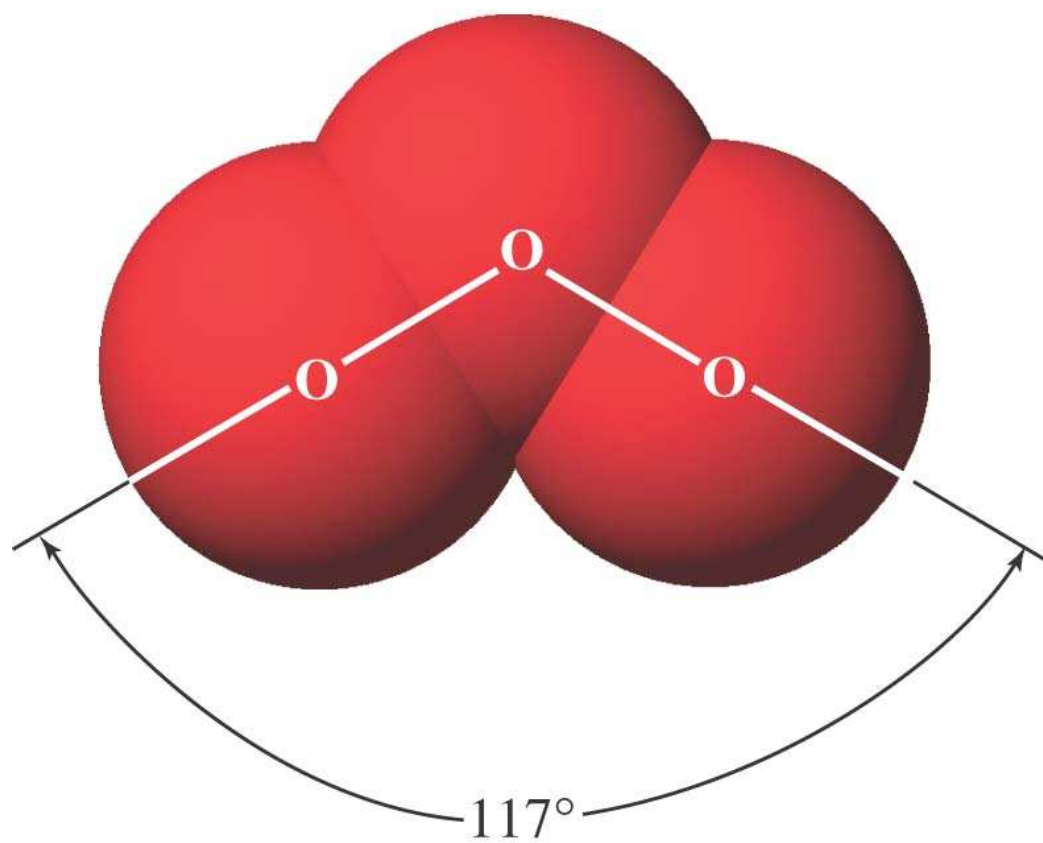
d i a m o n d

One More



An O₂ molecule.

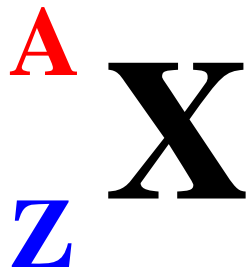
© 2004 Thomson/Brooks Cole



An O₃ molecule.

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Atomic Symbols



Example

109

Ag

47

protons ?

electrons?

neutrons?

Atomic Mass (a relative scale)

element	relative mass
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a magnesium atom is
about 2x the mass of carbon

Mg	about 24 u
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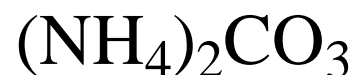
O	about 16 u
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$^{12}_6\text{C}$	12.00000 u (atomic mass units)
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an oxygen atom is about
1.33x the mass of carbon-12

Calculations Based on Formulas

Atom Counting

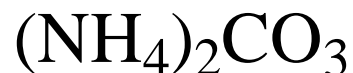


Molar Mass- sum of all atoms masses in a compound
for $(\text{NH}_4)_2\text{CO}_3$

Note: all atomic masses
rounded to two decimal places

Percent Composition

How much each element contributes to the molar mass



$$\% \text{ O} = \frac{48.00 \text{ u}}{96.11 \text{ u}} \times 100 = 49.94 \%$$

$$2 \times 14.01 = 28.02 \text{ u}$$

$$8 \times 1.01 = 8.08 \text{ u}$$

$$1 \times \text{C} = 12.01 \text{ u}$$

$$3 \times \text{O} = \underline{48.00 \text{ u}}$$

$$96.11 \text{ u}$$

% as an Identity- Dimensional Analysis Q1

What mass of oxygen is contained in 385 g of $(\text{NH}_4)_2\text{CO}_3$?

since % O = 49.94%

Another Way

$$2 \times 14.01 = 28.02 \text{ u}$$

$$8 \times 1.01 = 8.08 \text{ u}$$

$$1 \times \text{C} = 12.01 \text{ u}$$

$$3 \times \text{O} = \underline{48.00 \text{ u}}$$

$$96.11 \text{ u}$$

The mol concept

**Since the atomic mass scale is relative,
taking the molar mass in grams of
any substance is taking the same number
of atoms/molecules, etc.**

We call that number "a mol"

Since the molar mass of ammonium carbonate is 96.11 u,
1 mol of ammonium carbonate weighs 96.11 g and contains
the same number of particles as 12.01 g of carbon.

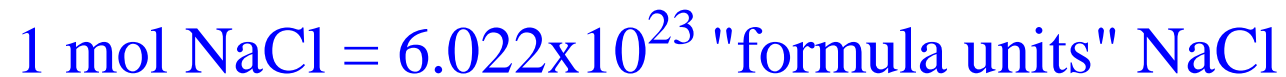
As Identities

Q2

How many mols is 156 g of ammonium carbonate?

Avogadro's Number

the number represented by the word "mol"



Problem Q3

How many molecules are contained in 165 g of CO₂?

Diagram the problem

g CO₂ \longrightarrow molecules CO₂

With atom counting

Q4

How many O atoms are contained in 165 g of CO₂?

Q5

4.83 g Br₂ to mols

2.31×10^{-4} mol H₂SO₄ to grams

Q5 CONT.

4.55×10^{24} molecules $\text{C}_2\text{H}_6\text{O}$ to grams

35.5 mg C_8H_{18} to atoms of H

Empirical (simplest) Formula

simplest integer ratio of atoms in a compound



atoms of each = # mols each atom

From % Composition Data

Q6a

A compound is analyzed to contain 22.45% C, 2.830% H, and 74.17% O by mass.

Determine the empirical formula.

- 1.** assume 100.0 grams of compound
(this directly converts % into grams)
- 2.** calculate mols of each atom

Continuing

3. divide the smallest number of mols into all the mols of atoms

$$1.869 \text{ mol C} / 1.869 = 1 \text{ C}$$

$$2.80 \text{ mol H} / 1.869 = 1.5 \text{ H}$$

$$4.636 \text{ mol O} / 1.869 = 2.5 \text{ O}$$

Molecular Formula



all have the same empirical formula, CH_2

To determine the true molecular formula:

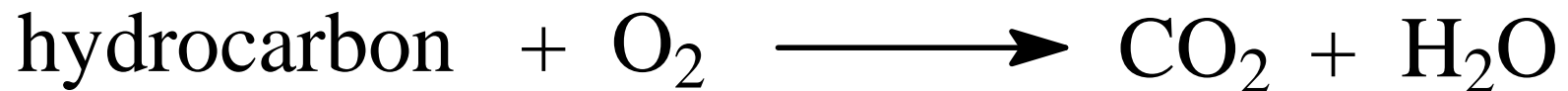
Q6b

- If the molar mass of the compound in 3a. Is 321.21 g/mol, determine the true molecular formula.

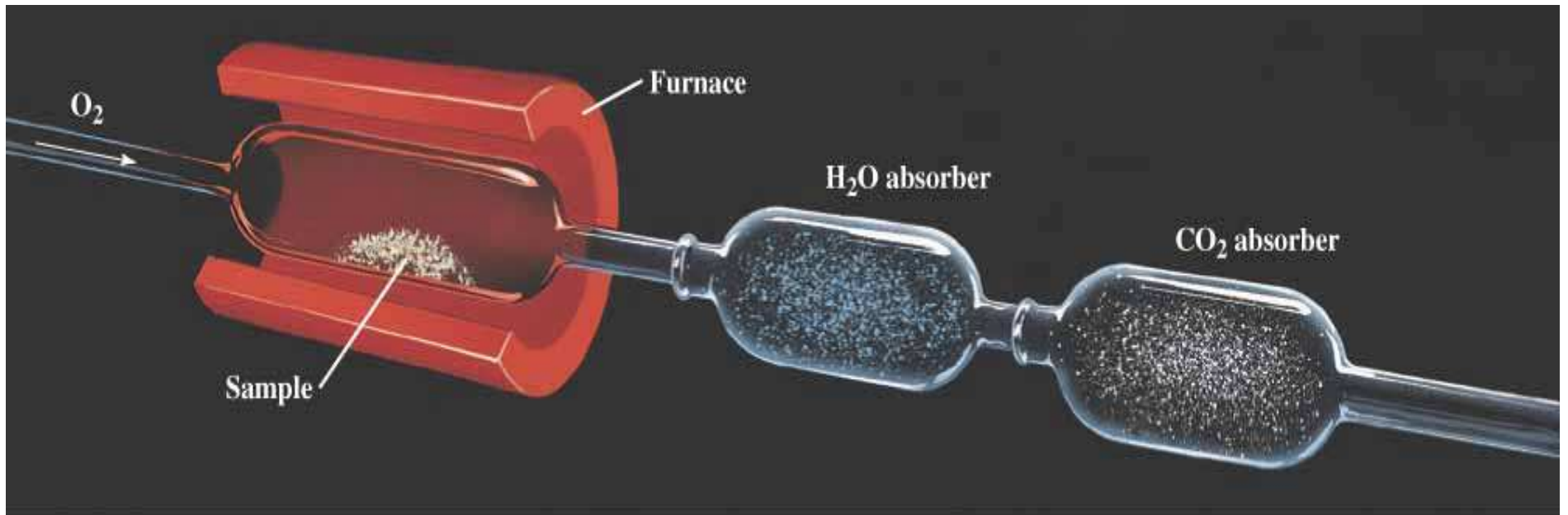
Empirical Formulas from Combustion Analysis

**Combustion of 0.2581 g of a hydrocarbon (contains only C and H)
yields 0.8395g CO₂ and 0.2578 g H₂O.**

Determine the empirical formula for the hydrocarbon.



How it's Done

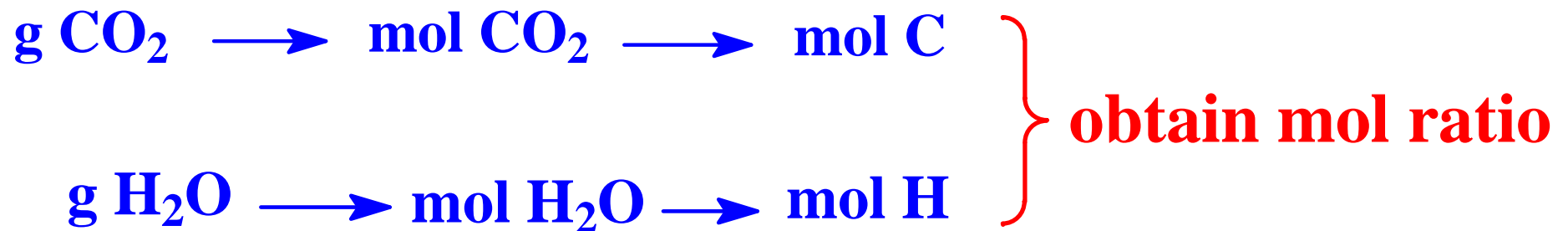


A Problem to Illustrate

Q7

Combustion of 0.2581 g of a hydrocarbon (contains only C and H) yields 0.8395g CO₂ and 0.2578 g H₂O.

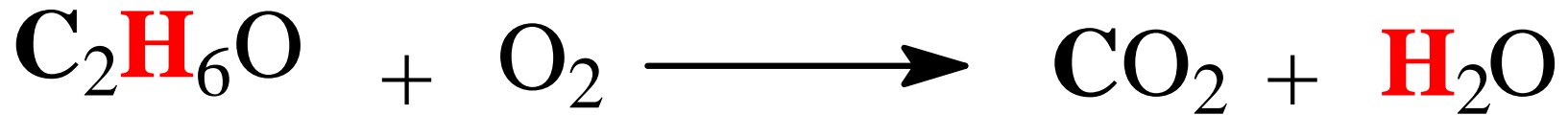
Determine the empirical formula for the hydrocarbon.



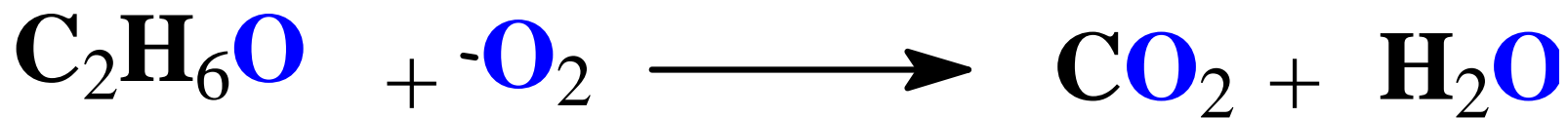
Solution

Q7

Oxygen-containing Fuels



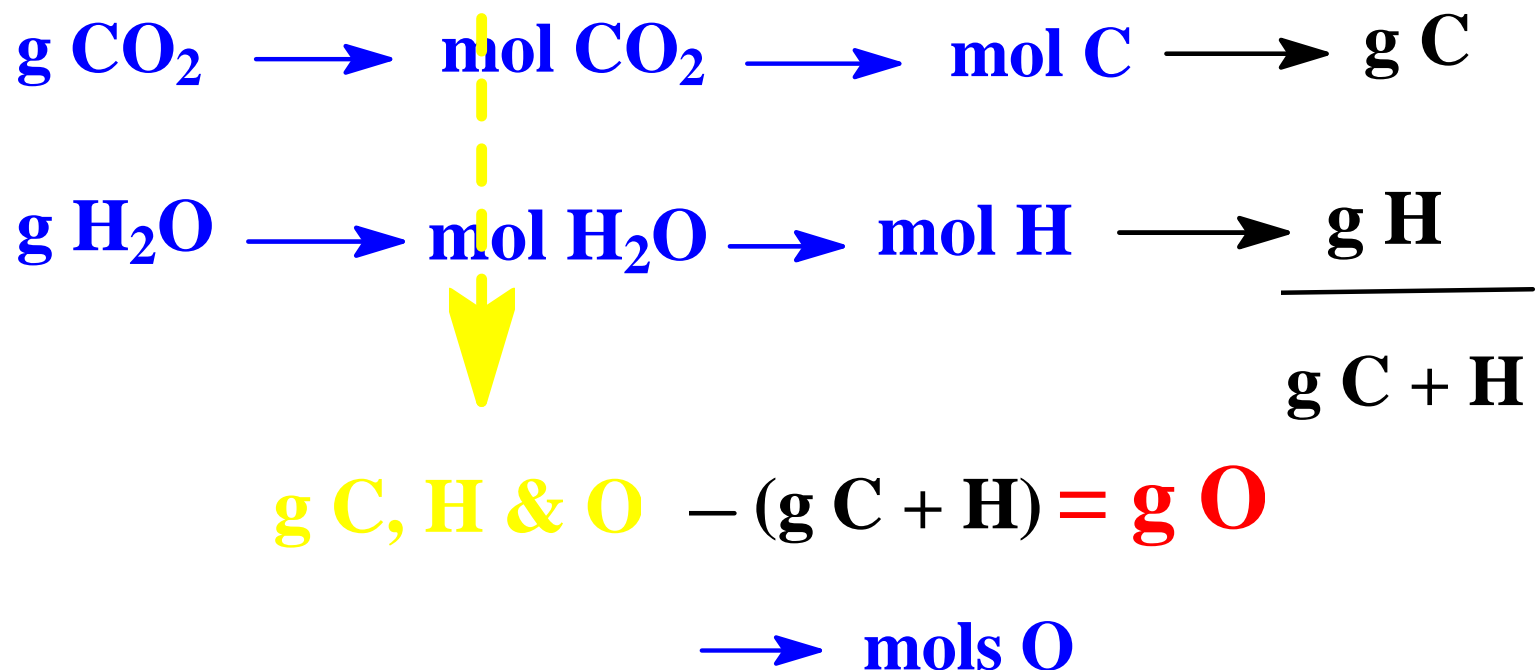
but where does the **O** come from in the products?



O must be done a different way!

Combustion of 6.313 g of a compound containing C,H, and O yields 5.048 g CO₂ and 3.099 g H₂O.

Determine the empirical formula for this compound



Q8

Combustion of 6.313 g of a compound containing C,H, and O yields 5.048 g CO₂ and 3.099 g H₂O.

Determine the empirical formula for this compound

Naming Ionic Compounds

1. Cations (+ ions, metals)

First check the periodic table to see if the metal forms more than one ion (charge). If so, you must figure out which one it is and use a Roman numeral in its name to indicate.

2. Monoatomic anions (negative ions derived from non-metals)

All end in "ide"

Examples

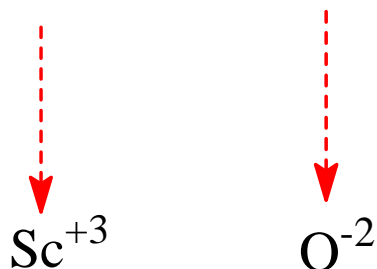


we must figure out which one

Writing Formulas from Names

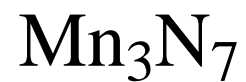
scandium oxide

1. Write ions



2. Compounds are neutral
total(+) = total (-)

Try These



And These

chromium (III) iodide

barium phosphide

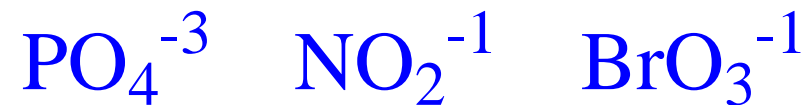
gold (I) sulfide

titanium (IV) oxide

aluminum nitride

Polyatomic Ions

**an ion that is made of several(many) atoms bonded to each other
that behaves as a single particle**



Ions to Know

- **ANIONS**

- **-1**

- perchlorate ClO_4^{-1}
- chlorate ClO_3^{-1}
- chlorite ClO_2^{-1}
- hypochlorite ClO^{-1}
- *note: also Br and I*
- nitrate NO_3^{-1}
- nitrite NO_2^{-1}
- permanganate MnO_4^{-1}
- acetate $\text{C}_2\text{H}_3\text{O}_2^{-1}(\text{CH}_3\text{COO})$
- hydroxide OH^{-1}
- cyanide CN^{-1}

- **-2**

- sulfate SO_4^{-2}
- sulfite SO_3^{-2}
- carbonate CO_3^{-2}
- chromate CrO_4^{-2}
- chromite CrO_3^{-2}
- dichromate $\text{Cr}_2\text{O}_7^{-2}$

- **-3**

- phosphate PO_4^{-3}
- phosphate PO_3^{-3}

- **acid anions**

- hydrogen carbonate (*bicarbonate*) HCO_3^{-1}
- hydrogen sulfate (*bisulfate*) HSO_4^{-1}

- **CATIONS**

- ammonium NH_4^{+1}

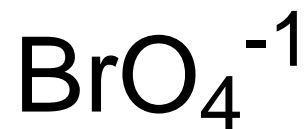
Ions Derived from the Chart

"ite" ending means one less O than "ate" ending

"per...ate" means one more O than "ate"

"hypo...ite" means one less O than "ite"

name these ions



Using the Periodic Table



selenium is in the same group (directly below) as sulfur



What is the formula for the arsenate ion?

Name or write formulas for the following

copper (I) sulfate

strontium bromite

Ag_2O

Au_2CrO_4

$\text{Ba}(\text{C}_2\text{H}_3\text{O}_2)_2$

scandium arsenate