a place of mind

FACULTY OF EDUCATION

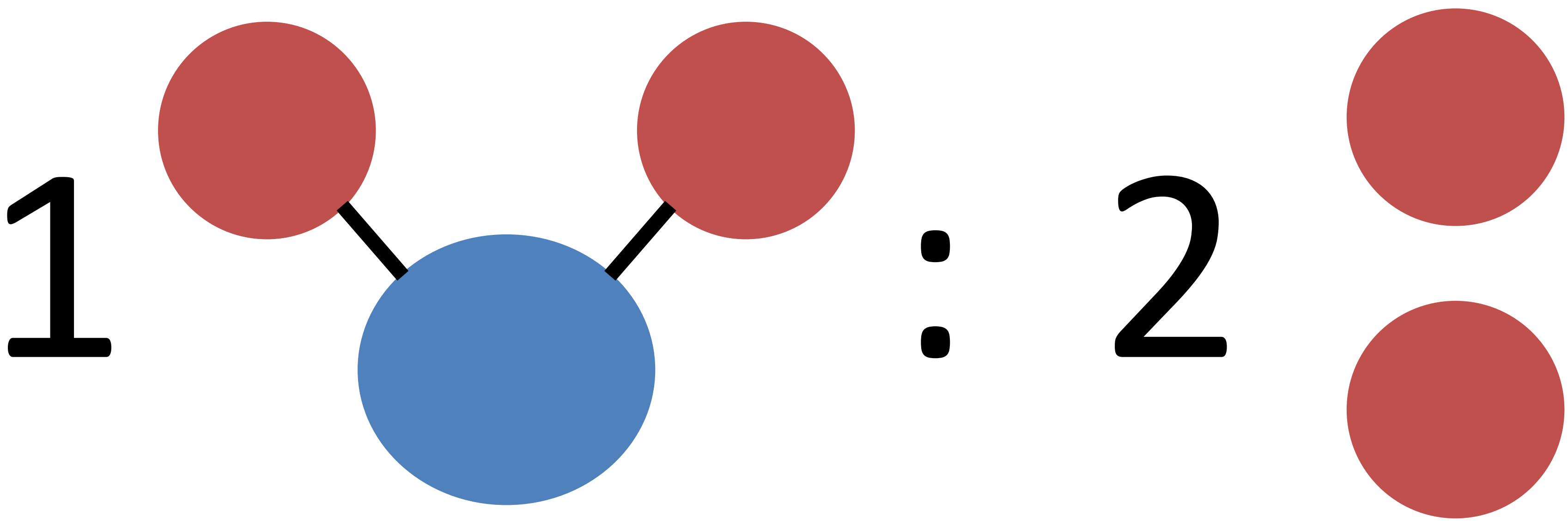
Department of
Curriculum and Pedagogy

Chemistry
Stoichiometry: Mole Ratios

Science and Mathematics Education
Research Group

Supported by UBC Teaching and Learning Enhancement Fund 2012-2013

Mole Ratios



Mole Ratios I

How many moles of H atoms are in a mole of H_2O molecules?

A. 1 mol H

B. 2 mol H

C. 2.0 mol H

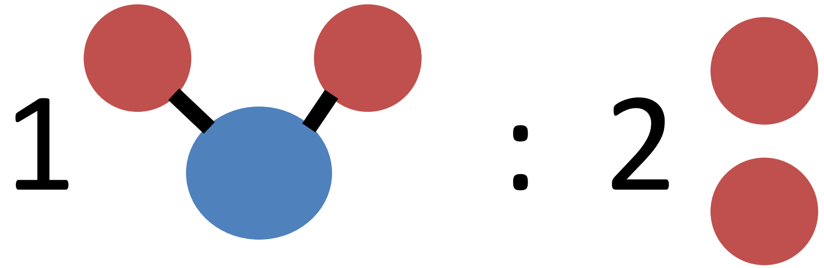
D. 2.0 g H

E. None of the above

Solution

Answer: B

Justification: For every molecule of water, there are 2 hydrogen atoms. Thus, for every mole of water, there are 2 moles of hydrogen atoms.



The answer is not C because ratios don't have significant figures. For example, it isn't possible for there to be 2.2 hydrogen atoms for every molecule of water. Thus a decimal is not needed.

Mole Ratios II

What mole ratio would you use when calculating how many moles of Hydrogen atoms are in 4.0 g of acetic acid (CH_3CO_2H)?

A. $\frac{3\ mol\ H}{1\ mol\ CH_3CO_2H}$

B. $\frac{1\ mol\ CH_3CO_2H}{60.1\ g}$

C. $\frac{4\ mol\ CH_3CO_2H}{3\ mol\ H}$

D. $\frac{1\ mol\ CH_3CO_2H}{4\ mol\ H}$

E. $\frac{4\ mol\ H}{1\ mol\ CH_3CO_2H}$

Solution

Answer: E

Justification: The answer could not be A or C because there are in total 4 hydrogen atoms in 1 molecule of acetic acid. Thus, for 1 mole of acetic acid, there would be 4 moles of hydrogen.

The answer is not B because that is the molar mass of acetic acid, not the mole ratio that the question was looking for.

Finally, the answer was not D, because the mole ratio is in the wrong orientation to cancel out the units properly.

$$4.0\ g\ CH_3CO_2H \times \frac{1\ mol\ CH_3CO_2H}{60.1\ g\ CH_3CO_2H} \times \boxed{\frac{4\ mol\ H}{1\ mol\ CH_3CO_2H}}$$

Mole Ratios III

$$H_2CrO_4 + AgNO_3 \rightarrow Ag_2CrO_4 + HNO_3$$

59.0 g	169.9 g	165.9 g	63.0 g

The masses of all the reactants and products in the above equation are shown. How many moles of each reactant and product are used/made?

A. 0.5 mol / 1.5 mol / 1.0 mol / 1.0 mol

B. 0.5 mol / 1.0 mol / 1.0 mol / 0.5 mol

C. 0.5 mol / 1.0 mol / 0.5 mol / 1.0 mol

D. 1.0 mol / 1.0 mol / 1.0 mol / 1.0 mol

E. None of the above

Solution

Answer: C

Justification: To calculate the number of moles of a substance you need to use molar mass to convert the mass of the substance to the number of moles of the substance.

For H_2CrO_4, the calculation would be:

$$59.0\ g \times \frac{1\ mol}{118.0\ g} = 0.5\ mol$$

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Solution

Answer: C

Justification: The moles of the rest of the reactants and products are thus:

H_2CrO_4 +	$AgNO_3$ →	Ag_2CrO_4 +	HNO_3
59.0 g	169.9 g	165.9 g	63.0 g
118.0 g/mol	169.9 g/mol	331.8 g/mol	63.0 g/mol
0.5 mol	1.0 mol	0.5 mol	1.0 mol

Mole Ratios IV

H_2CrO_4 + $AgNO_3$ → Ag_2CrO_4 + HNO_3

0.5 mol | 1 mol | 0.5 mol | 1 mol

What is the mole ratio between $AgNO_3$ and Ag_2CrO_4?

A. 1 mol $AgNO_3$ / 0.5 mol Ag_2CrO_4

B. 2 mol $AgNO_3$ / 1 mol Ag_2CrO_4

C. 1 mol Ag_2CrO_4 / 2 mol $AgNO_3$

D. All of the above

E. None of the above

Solution

Answer: D

Justification: The reaction started with 1 mole $AgNO_3$ which produced 0.5 moles of $AgCrO_4$.

All of the answers given present some form of a 2:1 ratio which is the correct ratio between the reactant and the product.

Mole Ratios V

H_2CrO_4 + $AgNO_3$ → Ag_2CrO_4 + HNO_3

0.5 mol   1 mol   0.5 mol   1 mol

Knowing the amount of moles of each reactant and product, what coefficients would you use to balance the above equation?

A. 0.5 / 1 / 0.5 / 1

B. 1 / 2 / 1 / 2

C. 3 / 6 / 3 / 6

D. All of the above

E. None of the above

Solution

Answer: B

Justification: All of the given answers show the correct ratios between the reactants and products. B is the best solution however because the coefficients have been reduced to the lowest whole number ratio.

On occasion it is permissible to use a fraction over 2 (ex. 13/2) as a coefficient to prevent the other coefficients in the equation from getting very large.

Mole Ratios VI

$$Rb + S_8 \rightarrow Rb_2S$$

Balance the above equation.

What is the mole ratio between S_8 and Rb?

A. 1 mol Rb / 8 mol S_8

B. 16 mol Rb/ 8 mol S_8

C. 1 mol S_8 / 16 mol Rb

D. 1 mol S_8 / 2 mol Rb

E. B and D

Solution

Answer: C

Justification: The balanced chemical equation is shown below with the coefficients of 16 / 1 / 8.

The answer is not A because the equation would have been balanced incorrectly to get that ratio.

The answer is not B, D, or E because the subscript 8 in S_8 is not part of the mole ratio between the two reactants. Rather, it tells you that there are 8 atoms of S in 1 molecule of S_8. Only the coefficients are part of the mole ratio.

The mole ratio between S_8 and Rb is thus 16 mol of Rb for every 1 mol of S_8.

$$\boxed{16}\,Rb + \boxed{1}\,S_8 \rightarrow 8\,Rb_2S$$

Mole Ratios VII

$$B_2O_3 + \quad H_2O \rightarrow \quad H_3BO_3$$

Balance the above equation.

If 14.0g of B_2O_3 was used, what would the calculation look like to determine the amount of moles of H_3BO_3 that would be produced?

A. $14.0\ g \times \frac{2\ mol}{1\ mol}$

B. $14.0\ g \times \frac{1\ mol}{61.8\ g} \times \frac{2\ mol}{1\ mol}$

C. $14.0\ g \times \frac{1\ mol}{69.6\ g} \times \frac{2\ mol}{3\ mol}$

D. $14.0\ g \times \frac{1\ mol}{69.6\ g} \times \frac{1\ mol}{2\ mol}$

E. None of the above

Solution

Answer: E

Justification: Based on the balanced chemical equation, the mole ratio between B_2O_3 and H_3BO_3 was a 1:2 ratio.

$$B_2O_3 + 3H_2O \rightarrow 2H_3BO_3$$

Thus C is incorrect since the mole ratio that it used was 3:2.

The remaining answers had some combination of the mole ratios and the molar masses of B_2O_3 and H_3BO_3. It was easy to mix up what compound each mole ratio and molar mass referred to because the compounds were not explicitly stated in the calculation.

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Solution

Answer: E

Justification:

The correct calculation needed to convert:

g of B_2O_3 ⟶ mol of B_2O_3 ⟶ mol of H_3BO_3

$$14.0\ g\ B_2O_3 \times \frac{1\ mol\ B_2O_3}{69.6\ g} \times \frac{2\ mol\ H_3BO_3}{1\ mol\ B_2O_3}$$

Good Practice Tip: To prevent mixing up which term refers to either the reactant or the product, it is a good idea to write which compound you are referring to in each step.

Mole Ratios VIII

$$Sb_2S_3 + \quad O_2 \rightarrow \quad Sb_2O_3 + \quad SO_2$$

Balance the above equation.

How many liters of oxygen would you need (at STP) to react to produce 30.0 g of Sb_2O_3?

A. 10.4 L

B. 3.02×10^3 L

C. 672 L

D. 0.512 L

E. None of the above

Solution

Answer: A

Justification: The correct balanced equation is shown below:

$$2Sb_2S_3 + 9O_2 \rightarrow 2Sb_2O_3 + 6SO_2$$

The correct calculation needed to convert:

g of Sb_2O_3 ⟶ mol of Sb_2O_3 ⟶ mol of O_2 ⟶ L of O_2

The conversion factors that you need to achieve these steps are as follows:

$$30.0\ g\ Sb_2O_3 \times \frac{1\ mol\ Sb_2O_3}{291.5\ g} \times \frac{9\ mol\ O_2}{2\ mol\ Sb_2O_3} \times \frac{22.4\ L}{1\ mol\ O_2}$$