Mental Math Review Exercises - Multiplication

This worksheet contains fifty multiplication exercises in five sets of 10 problems. There are also suggestions to help you gain speed and accuracy with your mental multiplication. You can practice this worksheet several times, but you should also create more calculations for yourself. You should not use a calculator on this worksheet; however, it can be very helpful to rewrite the numbers in a different way to help you "see" the calculation more clearly.

Warm-up Exercises

Basic multiplication drills are very good. Without using a calculator, multiply each of the numbers up to 20 by each of the single digit numbers (1 through 9). For example:

3 x 13	4 x 13	5 x 13	6 x 13	7 x 13	8 x 13	9 x 13

Especially important are the multiplication "tables" using the numbers 15, 25, and 75.

3 x 15	4 x 15	5 x 15	6 x15	7 x 15	8 x 15	9 x 15
3 x 25	4 x 25	5 x 25	6 x 25	7 x 25	8 x 25	9 x 25
3 x 75	4 x 75	5 x 75	6 x 75	7 x 75	8 x 75	9 x 75

Distribution

Rearranging multiplication problems often simplifies the process when using "big" numbers. Look at the following examples for inspiration:

15 x 75 = (10 + 5) x 75 = (10 x 75) + (5 x 75) = 750 + 375 = 1125

9 x 14 = (10 – 1) x 14 = (10 x 14) – (1 x 14) = 140 – 14 = 126

7 x 18 = (10 – 3) x 18 = (10 x 18) – (3 x 18) = 180 – 54 = 126

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Fractions

Converting decimal numbers to fractions can make it easier to complete math operations with the numbers. For example, the number 0.30 is the fraction $\frac{3}{10}$. When you mentally multiply a number by 0.3, complete the operation in two steps:

- First, multiply the number by 3,
- Then, divide by 10.

For example: Multiply the number 1.5 by 0.30.

$$0.30 \ \text{x}\ 1.5 = \frac{3}{10} \times 1.5$$

1. 3 x 1.5 = 4.5
2. 4.5 / 10 = 0.45

The final answer is 0.45

Set 1 – Use the skill shown above to perform these calculations *without a calculator.*

1.	0.1 x 2.0 =	5.	0.9 x 3.0 =	8.	0.4 x 1.5 =
2.	0.2 x 4.0 =	6.	0.1 x 4.5 =	9.	0.3 x 7 =
3.	0.4 x 4.0 =	7.	0.2 x 2.5 =	10.	0.9 x 6 =
4.	0.3 x 3.0 =				

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When multiplying two fractions, multiply the numerators by each other and the denominators by each other. Complete this in two steps:

- multiply the numerators by each other and put that answer in the numerator of the answer, then
- multiply the denominators by each other and put that answer in the denominator of the answer.

Study this example: $\frac{2}{3} \times \frac{3}{8}$

- first, multiply 2 and 3 and put 6 in the numerator of the answer. $\frac{2}{3} \times \frac{3}{8} = \frac{6}{}$
- Then, multiply 3 and 8 and put 24 in the denominator of the answer. $\frac{2}{3} \times \frac{3}{8} = \frac{6}{24}$

  Notice that the answer can be simplified to a decimal number. $\frac{6}{24} = \frac{1}{4} = 0.25$

Here is another example:

Often, you will find yourself multiplying numbers such as 0.3 x 0.4

This operation can be re-written as $\frac{3}{10} \times \frac{4}{10} = \frac{12}{100} = 0.12$

Another way to see this operation is just like those on the previous page.

- First, multiply 3 x 4.
- Then, divide the answer by 10, twice.

Set 2 – Use the skill shown above to perform these calculations *without a calculator.*

1.	0.1 x 0.6 =	5.	0.9 x 0.4 =	8.	0.4 x 0.3 =
2.	0.2 x 0.5 =	6.	0.1 x 0.2 =	9.	0.3 x 0.8 =
3.	0.4 x 0.5 =	7.	0.2 x 0.2 =	10.	0.9 x 0.9 =
4.	0.3 x 0.2 =				

Scientific Notation

With small or large numbers, it is usually useful to rewrite the number in scientific notation before using it in math operations.

Look at this example: 0.6 x 0.09

One way to perform the calculation is to use fractions.

$$\frac{6}{10} \times \frac{9}{100} = \frac{54}{1000} = 0.054$$

Another way is to rewrite the numbers in scientific notation. Remember the rules for multiplying numbers in scientific notation.

- First, multiply the numbers
- Then, add the exponents on the tens

$(6 \times 10^{-1}) \times (9 \times 10^{-2}) = (6 \times 9) \times (10^{-1} \times 10^{-2}) = 54 \times 10^{-3} = 5.4 \times 10^{-2} = 0.054$

The final answer might appear as a decimal number (standard notation), or it might be shown in scientific notation. Practice rewriting numbers in scientific notation. Also, practice converting numbers back to standard notation.

Set 3 – Use the skill shown above to perform these calculations *without a calculator.*

1.	0.4 x 0.06 =	5.	0.6 x 0.06 =	8.	0.4 x 0.12 =
2.	0.3 x 0.09 =	6.	0.2 x 0.15 =	9.	0.2 x 0.75 =
3.	0.7 x 0.02 =	7.	0.3 x 0.25 =	10.	0.5 x 0.1s6 =
4.	0.5 x 0.08 =				

Chemistry Calculations using Molarity

Use the math skills on the previous pages to solve these mental math calculations. The questions mimic the multiple-choice questions on the AP Chemistry exam. Notice that the molar mass, or formula mass, of a compound is usually supplied to you. Remember, all of these calculations can be completed without a calculator. However, in questions 6 through 10 you may need to estimate the final answer.

Set 4

1. Calculate the number of moles of HCl in 100.0 mL of 0.500 M solution.
2. Calculate the number of moles of Cu^{2+} in 400.0 mL of 0.300 M $CuSO_4$ solution.
3. Calculate the number of moles of Na^{1+} in 300.0 mL of 0.30 M Na_2CO_3 solution.
4. Calculate the number of moles of KOH in 200 mL of 0.300 M solution.
5. Calculate the number of moles of Ag^{1+} and NO_3^{1-} present in 900 mL of 6.0 M $AgNO_3$.
6. Calculate the number of grams of HCl needed to make 100.0 mL of a 0.20 M solution. The molar mass of HCl is 36.46 g mol^{-1}.
7. Calculate the mass of copper (II) sulfate pentahydrate, $CuSO_4{\cdot}5H_2O$, present in 200.0 mL of 2.5 M solution. The formula weight of copper sulfate is 250 g mol^{-1}.
8. Calculate the mass of solute needed to make 200 mL of a 0.20 M Na_2CO_3 solution (106 g mol^{-1}).
9. The molar mass of KOH is 56.1 g mol^{-1}. Calculate the number of grams of the compound present in 400 mL of a 1.5 M solution.
10. Calculate the mass of silver nitrate, $AgNO_3$, in 500 mL of a 0.5 M solution (molar mass 170 g mol^{-1}).

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More Chemistry Calculations using Molarity

Use all the math skills on the previous pages to solve these mental math calculations.

Set 5

1. Calculate the number of moles of HCl in 80.0 mL of 0.500 M solution.
2. Calculate the number of moles of Cu^{2+} in 250.0 mL of 0.300 M $CuSO_4$ solution.
3. Calculate the number of moles of Na^{1+} in 200.0 mL of 0.75 M Na_2CO_3 solution.
4. Calculate the number of moles of KOH in 160.0 mL of 0.500 M solution.
5. Calculate the number of moles of Ag^{1+} and $NO_3{}^{1-}$ present in 500 mL of 0.15 M $AgNO_3$.
6. Calculate the number of grams of HCl needed to make 200.0 mL of a 0.15 M solution. The molar mass of HCl is 36.46 g mol^{-1}.
7. Calculate the mass of copper (II) sulfate pentahydrate, $CuSO_4{\cdot}5H_2O$, present in 50.0 mL of 0.20 M solution. The formula weight of copper sulfate is 250 g mol^{-1}.
8. Calculate the mass of solute needed to make 250 mL of a 0.40 M Na_2CO_3 solution (106 g mol^{-1}).
9. The molar mass of KOH is 56.1 g mol^{-1}. Calculate the number of grams of the compound present in 50.0 mL of a 0.40 M solution.
10. Calculate the mass of silver nitrate, $AgNO_3$, in 60.0 mL of a 0.50 M solution (molar mass 170 g mol^{-1}).

Things to memorize

Take the time to memorize the following information. You will benefit more from learning the patterns, than from simply memorizing facts.

SOLUBILITY RULES

Always soluble if in a compound	Except with
Alkali ions, NH_4^+	No exceptions
$NO_3^-, C_2H_3O_2^-, ClO_4^-, ClO_2^-$	No exceptions
Cl^-, Br^-, I^-	Pb^{2+}, Ag^+
SO_4^{2-}	$Pb^{2+}, Ag^+, Hg_2^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}$

If a substance does not fall into one of the four rules above, then assume it is insoluble and should be written as a molecule (not dissociated). This isn't perfect, but will cover most situations, unless you are given other information in the question to know whether it is soluble or insoluble.

POLYATOMIC IONS

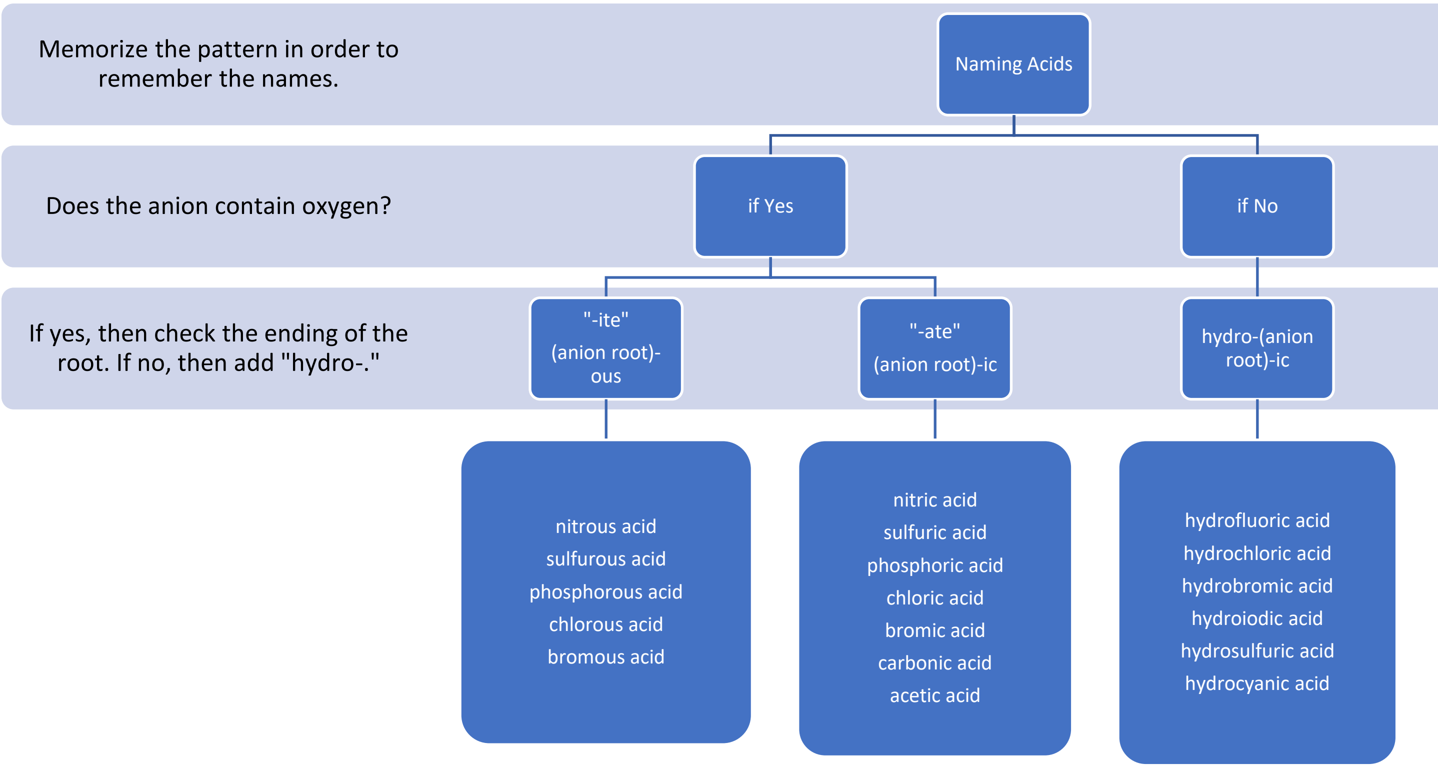
Learn the four highlighted "-ate" ions below.

One less oxygen turns the name to "-ite," and two less oxygens turns the name to "hypo-*blank*-ite," and adding one oxygen will turn the name into "per-*blank*-ate."

-hypo (2 less O)	-ite (1 less O)	-ate	per- (1 more O)
	Nitrite (NO_2^-)	Nitrate (NO_3^-)	
	Sulfite (SO_3^{2-})	Sulfate (SO_4^{2-})	
	Phosphite (PO_3^{3-})	Phosphate (PO_4^{3-})	
Hypochlorite (ClO^-)	Chorite (ClO_2^-)	Chlorate (ClO_3^-)	Perchlorate (ClO_4^-)
Hypobromite (BrO^-)	Bromite (BrO_2^-)	Bromate (BrO_3^-)	Perbromate (BrO_4^-)
Hypoiodite (IO^-)	Iodite (IO_2^-)	Iodate (IO_3^-)	Periodate (IO_4^-)

Additional ions to remember:

Formula	Name
NH_4^+	Ammonium
OH^-	Hydroxide
CN^-	Cyanide
$C_2H_3O_2^-$	Acetate
CO_3^{2-}	Carbonate
MNO_4^-	Permanganate
HCO_3^-	Bicarbonate



ACIDS

List of strong acids to memorize. Assume all other acids are weak.

Formula	Name
$HCl\ (aq)$	Hydrochloric acid
$HBr\ (aq)$	Hydrobromic acid
$HI\ (aq)$	Hydroiodic acid
$HNO_3\ (aq)$	Nitric acid
$H_2SO_4\ (aq)$	Sulfuric acid
$HClO_3\ (aq)$	Chloric acid
$HClO_4\ (aq)$	Perchloric acid

List of common acids to memorize.

Formula	Name
$HCl\ (aq)$	Hydrochloric acid
$HNO_2\ (aq)$	Nitrous acid
$HNO_3\ (aq)$	Nitric acid
$H_2SO_3\ (aq)$	Sulfurous acid
$H_2SO_4\ (aq)$	Sulfuric acid
$H_3PO_4\ (aq)$	Phosphoric acid
$H_2CO_3\ (aq)$ or $CO_2\ (aq)$	Carbonic acid
$CH_3COOH\ (aq)$ or $HC_2H_3O_2\ (aq)$	Ethanoic acid (acetic acid)

The following question is from the 2017 AP Chemistry Free Response section (found at https://apcentral.collegeboard.org/pdf/ap-chemistry-frq-2017.pdf). In a previous chemistry class, you learned all the skills and techniques necessary to solve the problem. Do your best to complete the problem, showing all calculations and work involved in arriving at your answers. If you are not able to complete the problem entirely, don't worry! We will learn each topic in great detail throughout the course of this upcoming year.

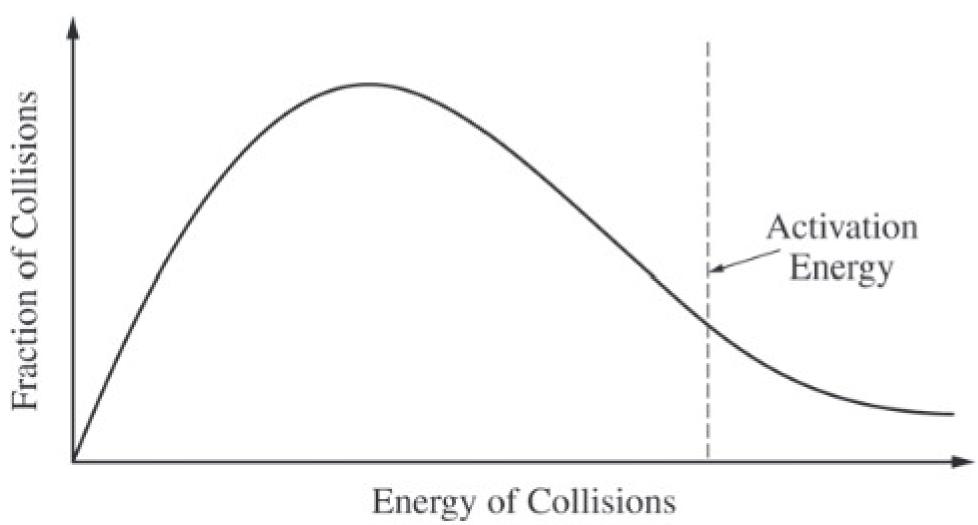
$$CS_2\ (g) + 3Cl_2\ (g) \rightarrow CCl_4\ (aq) + S_2Cl_2\ (g)$$

1. Carbon tetrachloride, $CCl_4(g)$, can be synthesized according to the reaction represented above. A chemist runs the reaction at a constant temperature of $120°\mathrm{C}$ in a rigid 25.0 L container.
   a. Chlorine gas, $Cl_2(g)$ is initially present in the container at a pressure of 0.40 atm.
      i. How many moles of $Cl_2\ (g)$ are in the container?

      ii. How many grams of carbon disulfide, $CS_2\ (g)$, are needed to react completely with the $Cl_2\ (g)$?

   b. At $30°\mathrm{C}$ the reaction is thermodynamically favorable, but no reaction is observed to occur. However, at $120°\mathrm{C}$, the reaction occurs at an observable rate.
      i. Explain how the higher temperature affects the collisions between the reactant molecules so that the reaction occurs at an observable rate of $120°\mathrm{C}$.

      ii. The graph below shows a distribution for the collision energies of reactant molecules at $120°\mathrm{C}$. Draw a second curve on the graph that shows the distribution for the collision energies of reactant molecules at $30°\mathrm{C}$.



c. S_2Cl_2 is a product of the reaction.

   i. In the box below, complete the Lewis electron-dot diagram for the S_2Cl_2 molecule by drawing in all of the electron pairs.

      Cl S S Cl

   ii. What is the approximate value of the Cl-S-S bond angle in the S_2Cl_2 molecule that you drew in part (c)(i)? (If the two Cl-S-S bond angles are not equal, include both angles.)

d. $CCl_4\ (g)$ can also be produced by reacting $CHCl_3\ (g)$ with $Cl_2\ (g)$ at 400℃ as represented by the equation below.

$$CHCl_3\ (g) + Cl_2\ (g) \rightarrow CCl_4\ (g) + HCl\ (g)$$

At the completion of the reaction a chemist successfully separates the $CCl_4\ (g)$ from the $HCl\ (g)$ by cooling the mixture to 70℃, at which temperature the $CCl_4\ (g)$ condenses while the $HCl\ (g)$ remains in the gaseous state.

   i. Identify all types of intermolecular forces present in $HCl\ (l)$.

   ii. What can be inferred about the relative strength of the intermolecular forces in $CCl_4\ (l)$ and $HCl\ (l)$? Justify your answer in terms of the information above.