Chemistry: Chapter 12 Reacting masses
Combined Science (Chemistry Part): Chapter 12 Reacting masses

Section 12.1

|!|EMA031212001O|!|
1 mole of calcium chloride contains

A. 1 mole of calcium chloride molecules.
B. 6.02×10^{23} calcium atoms and $2 \times 6.02 \times 10^{23}$ chlorine atoms.
C. $\frac{1}{2} \times 6.02 \times 10^{23}$ calcium ions and 6.02×10^{23} chloride ions.
D. 6.02×10^{23} calcium ions and $2 \times 6.02 \times 10^{23}$ chloride ions.

□

##D The formula of calcium chloride is $CaCl_2$. One mole of $CaCl_2$ contains one mole of calcium ions (not atom) and 2 moles of chloride ions (not atoms). As 1 mole represents 6.02×10^{23} formula units of particles, D is correct.##

|!|EMA031212002O|!|
Which of the following is the unit for formula mass?

A. Gram
B. Mole
C. No unit
D. Mass unit

□

##C Formula mass is only a comparative value in the C-12 scale. It is not the exact mass of the atom, molecule or even the formula unit.##

|!|EMA031212003O|!|
What is the molar mass of tetrachloromethane, CCl_4?

A. 1.0 mol
B. 1.0 g mol^{-1}
C. 154.0 mol
D. 154.0 g mol^{-1}

□

##D Relative molecular mass of tetrachloromethane = $12.0 + 4 \times 35.5 = 154.0$. Molar mass is the mass per mole of a substance, so molar mass of tetrachloromethane is 154.0 g mol^{-1}.##

|!|EMA031212004O|!|
Which of the following substances contains the least number of ions?

A. 0.7 mole of Na_2O
B. 0.9 mole of CaO
C. 0.5 mole of Al_2O_3
D. 0.8 mole of $MgCl_2$

□

##B

Substance	Number of moles of ions (mol)
0.7 mole of Na_2O	$0.7 \times 3 = 2.1$
0.9 mole of CaO	$0.9 \times 2 = 1.8$
0.5 mole of Al_2O_3	$0.5 \times 5 = 2.5$
0.8 mole of $MgCl_2$	$0.8 \times 3 = 2.4$

##

|!|EMA031212005O|!|
Which of the following statements is correct about 0.4 mole of aluminium oxide?

A. There are 0.4 mole of Al^{2+} ions and 0.4 mole of O^{2-} ions.
B. There are 0.8 mole of Al^{+} ions and 0.4 mole of O^{2-} ions.
C. There are 0.8 mole of Al^{3+} ions and 1.2 moles of O^{2-} ions.
D. There are 1.2 moles of Al^{3+} ions and 0.8 mole of O^{2-} ions.

##C The formula of aluminium oxide is Al_2O_3. One mole of Al_2O_3 contains two moles of Al^{3+} ions and three moles of O^{2-} ions. Therefore, 0.4 mole of Al_2O_3 contains $2 \times 0.4 = 0.8$ mole of Al^{3+} ions and $3 \times 0.4 = 1.2$ moles of O^{2-} ions.##

|!|EMB031212006O|!|
A mixture of copper(II) sulphate and copper(II) bromide contains 0.3 mole of sulphate ions and 0.6 mole of bromide ions. How many moles of copper(II) ions are in the mixture?

A. 0.6 mol
B. 0.8 mol
C. 0.9 mol
D. 1.1 mol

##A The formula of copper(II) sulphate is $CuSO_4$. 1 mole of $CuSO_4$ contains 1 mole of Cu^{2+} ions and 1 mole of SO_4^{2-} ions. Therefore, 0.3 mole of SO_4^{2-} ions implies the presence of 0.3 mole of Cu^{2+} ions; the formula of copper(II) bromide is $CuBr_2$. 1 mole of $CuBr_2$ contains 1 mole of Cu^{2+} ions and 2 moles of Br^{-} ions. Therefore, 0.6 mole of Br^- ions implies the presence of $\frac{0.6}{2}$ = 0.3 mol of Cu^{2+} ions. Hence, there is 0.3 + 0.3 = 0.6 mol of Cu^{2+} ions in the mixture.##

|!|EMB031212007O|!|
Which of the following statements is correct?

A. One mole of oxygen gas contains the same number of atoms as there are in one mole of neon gas at room conditions.
B. One mole of magnesium contains the same number of atoms as there are in one mole of iodine at room conditions.
C. One mole of chlorine gas and one mole of bromine gas have the same number of molecules and atoms.
D. One mole of sodium has the same mass as there are in one mole of potassium.

##C A is wrong because oxygen is diatomic while neon is monoatomic, so one mole of oxygen and one mole of neon do not have the same number of atoms. B is wrong because at room conditions, one mole of I_2 contains two moles of I atoms, but there is only one mole of magnesium atoms. D is wrong because sodium and potassium have different masses, so one mole (same number of atoms) of the two metals will not have the same mass.##

|!|EMA031212008O|!|
What is the mass of 2.3 moles of aluminium oxide?

A. 124.8 g
B. 234.6 g
C. 367.5 g
D. 417.4 g

□

##B The formula of aluminium oxide is Al_2O_3. Formula mass of $Al_2O_3 = 2 \times 27.0 + 3 \times 16.0 = 102.0$. Mass of 2.3 moles of $Al_2O_3 = 102.0 \times 2.3 = 234.6$ g ##

|!|EMB031212009O|!|
M is a metal in Group I. 0.5 mole of the metal sulphate weighs 71.05 g. Find the relative atomic mass of *M*.

A. 19.0
B. 23.0
C. 27.0
D. 31.0

□

##B The formula of this metal sulphate is M_2SO_4. Let the relative atomic mass of *M* be *m*. Formula mass of $M_2SO_4 = 2m + 32.1 + 16.0 \times 4 = 2m + 96.1$. As number of moles (mol) = $\frac{\text{mass (g)}}{\text{malar mass (g mol}^{-1})}$, $0.5 = \frac{71.05}{2m + 96.1}$,

$m = 23$
The relative atomic mass of metal *M* is 23.##

|!|EMA031212010O|!|
Which of the following substances has the smallest mass?

A. 0.8 mole of $CaBr_2$
B. 1 mole of C_4H_{10}
C. 1.5 moles of Fe_2O_3
D. 1.9 moles of K

□

##B

Substance	Mass
0.8 mole of $CaBr_2$	$0.8 \times (40.1 + 79.9 \times 2) = 159.9$ g
1 mole of C_4H_{10}	$1 \times (4.0 \times 12 + 1.0 \times 10) = 58.0$ g
1.5 moles of Fe_2O_3	$1.5 \times (55.8 \times 2 + 16.0 \times 3) = 239.4$ g
1.9 moles of K	$1.9 \times 39.1 = 74.3$ g

##

|!|EMB031212011O|!|
How many shared electrons in 35.5 g of chlorine gas at room conditions?

A. 1.51×10^{23}
B. 3.01×10^{23}
C. 6.02×10^{23}
D. 1.20×10^{24}

##C A chlorine molecule is made up of two chlorine atoms. Number of moles of 35.5 g of chlorine gas = $\frac{35.5}{35.5 \times 2}$ mol = 0.5 mol. The two atoms share two electrons together to form a single bond. Hence, one chlorine molecule has two shared electrons and one mole of chlorine molecules has two moles of shared electrons. So, number of shared electrons in 0.5 mole of chlorine gas = $0.5 \times 2 \times 6.02 \times 10^{23} = 6.02 \times 10^{23}$.##

|!|EMA031212012O|!|
How many moles of aluminium ions are present in 17.12 g of aluminium sulphate?

A. 0.005 mol
B. 0.01 mol
C. 0.05 mol
D. 0.1 mol

##D Formula mass of $Al_2(SO_4)_3 = 27.0 \times 2 + (32.1 + 16.0 \times 4) \times 3 = 342.3$
Number of moles of $Al_2(SO_4)_3$ = $\frac{17.12}{342.3}$ mol = 0.05 mol. As 1 mole of $Al_2(SO_4)_3$ contains 2 moles of Al^{3+} ions, 0.05 mole of $Al_2(SO_4)_3$ contains $2 \times 0.05 = 0.1$ mole of Al^{3+} ions.##

|!|EMA031212013O|!|
Calculate the mass of sulphur which contains the same number of atoms as 8.1 g of magnesium does?

A. 5.3 g
B. 10.7 g
C. 16.0 g
D. 21.4 g

##B Number of moles of 8.1 g of magnesium = $\frac{8.1}{24.3}$ mol = 0.33 mol. Mass of sulphur = 0.33×32.1 g = 10.7 g.##

|!|EMB031212014O|!|
Which of the following substances contains the same number of ions as 2.34 g of sodium chloride does?

A. 2.984 g of potassium chloride
B. 3.125 g of zinc chloride

C. 3.598 g of calcium sulphate
D. 5.529 g of magnesium bromide

□

##A Number of moles of NaCl = $\frac{2.34}{23.0+35.5}$ mol = 0.04 mol

As 1 mole of NaCl contains 2 moles of ions, the number of moles of ions in 2.34 g of NaCl = 0.04 × 2 = 0.08 mole

Formula	Number of moles of ions
KCl	$\frac{2.984}{23.0+35.5}$ ➡ 2 = 0.08
$ZnCl_2$	$\frac{3.125}{65.4+35.5\times 2}$ ➡ 3 = 0.069
$CaSO_4$	$\frac{3.598}{40.1+35.5+16.0\times 4}$ ➡ 2 = 0.053
$MgBr_2$	$\frac{5.529}{24.3+79.9\times 2}$ ➡ 3 = 0.090

##

|!|EMB031212015O|!|
If 2.4 g of oxygen contains *x* atoms at room conditions, then how many atoms are present in 12.0 g of helium?

A. 5*x*
B. 10*x*
C. 20*x*
D. 30*x*

□

##C Number of moles of oxygen = $\frac{2.4}{16.0\times 2}$ mol = 0.075 mol

Number of moles of oxygen atoms = 0.075 × 2 mol = 0.15 mol = *x*

On the other hand, number of moles of helium = $\frac{12.0}{4.0}$ mol = 3.0 mol

Since 0.15 mol of oxygen contains *x* atoms, so 3 mol of helium contains $\frac{3x}{0.15}$ = 20*x* atoms.##

|!|EMB031212016O|!|
If 1 mole of XO_3 contains the same number of atoms as 72 g of XH_4, What is the relative atomic mass of *X*?

A. 72.0
B. 86.0
C. 90.0
D. 102.0

□

##B Let *x* be the relative atomic mass of *X*. 1 mole of XO_3 contains 4 moles of atoms. 1 mole of XH_4 contains 5 moles of atoms.

Number of moles of atoms in 72 g of XH_4 = $\frac{72}{x+4} \times 5$

Since 1 mole of XO_3 contains 4 moles of atoms

$\therefore \frac{72}{x+4}$ ➡ $5 = 4$

$x = 86$##

|!|EMB031212017O|!|

If two moles of ozone, O_3 contain y atoms, how many atoms are present in one mole of oxygen gas?

A. $\frac{2y}{3}$

B. $\frac{y}{3}$

C. $\frac{y}{2}$

D. $\frac{y}{6}$

□

##B Two moles of ozone contain six moles of oxygen atoms. Therefore, $\frac{y}{6}$ represents one mole of oxygen atoms. One mole of oxygen gas contains two moles of oxygen atoms, and thus it has $2 \times \frac{y}{6}$ atoms = $\frac{y}{3}$ atoms.##

|!|EMA031212018O|!|

Which of the following statements are about one mole of propane, C_3H_8, and one mole of propene, C_3H_6, is correct?

A. They have equal masses.
B. They have the same number of molecules.
C. They have the same number of atoms.
D. They have the same boiling point.

□

##B For any substances, one mole contains 6.02 x 10^{23} particles. Boiling point is not related to the quantity of a substance.##

|!|EMB031212019O|!|

Which of the following statements is INCORRECT?

A. One mole of carbon has a mass of 12.0 g.
B. The mass of one mole of chlorine gas equals to the relative atomic mass of chlorine in grams.
C. One mole of sodium chloride contains two moles of ions.
D. 1 dm^3 of a 1.0 mol dm^{-3} bromine liquid has one mole of bromine molecules.

□

##B As chlorine gas is formed by diatomic molecules, one mole of chlorine gas contains two moles of chlorine atoms. Hence, the mass of one mole of chlorine gas is twice of the relative atomic mass of chlorine in grams.##

|!|EMA031212020O|!|
What is the mass of two moles of chlorine molecules?

A. 70.0 g
B. 71.0 g
C. 84.0 g
D. 142.0 g

##D The mass of one mole of chlorine atoms is 35.5 g, as a chlorine molecule has two chlorine atoms, the mass of one mole of chlorine molecules = 2 × 35.5 g = 71.0 g. Therefore, two moles of chlorine molecules = 2 × 71.0 g = 142.0 g.##

|!|EMA031212021O|!|
What is the number of moles of carbon atoms in 4.7 g of ethane, C_2H_6?

A. 0.182 mol
B. 0.283 mol
C. 0.278 mol
D. 0.314 mol

##D Number of moles of ethane = $\frac{4.7}{12.0 \times 2 + 1.0 \times 6}$ mol = 0.157 mol. As one mole of ethane contains two moles of carbon atoms, 0.157 mol of ethane contains 0.157 × 2 mol = 0.314 mol of carbon atoms.##

|!|EMA031212022O|!|
What is the formula mass of iron(II) sulphate-7-water, $FeSO_4 \cdot 7H_2O$?

A. 151.9
B. 169.9
C. 229.9
D. 277.9

##D Formula mass of $FeSO_4 \cdot 7H_2O$ = 55.8 + 32.1 + 16.0 × 4 + 7 × (1.0 × 2 + 16.0) = 277.9.##

|!|EMA031212023O|!|
What is the number of moles of 160.0 g sodium hydroxide?

A. 0.25 mol
B. 1 mol
C. 4 mol
D. 40 mol

##C Number of moles of sodium hydroxide = $\frac{160.0}{23.0 + 16.0 + 1.0}$ mol = 4 mol.##

|!|EMA031212024O|!|
How many moles of calcium ions are present in 200.2 g of calcium carbonate?

A. 0.5 mol
B. 1 mol
C. 2 mol
D. 4 mol

□

##C Number of moles of calcium carbonate = $\frac{200.2}{40.1 + 12.0 + 16.0 \times 3}$ mol = 2 mol
As 1 mole of calcium carbonate contains 1 mole of calcium ions, 2 moles of calcium carbonate contain 2 moles of calcium ions.##

|!|EMB031212025O|!|
One mole of a substance
A. has the same relative atomic mass as carbon-12.
B. is the amount containing the Avogadro constant of formula units.
C. contains 6.02×10^{23} atoms.
D. is the smallest amount of a substance which could exist on its own under room conditions.

□

##B##

|!|EMA031212026O|!|
One mole of sodium oxide contains
A. 1 mole of molecules.
B. 2 moles of anions.
C. 2 moles of cations.
D. 4 moles of ions.

□

##C The chemical formula of sodium oxide is Na_2O, which contains 2 moles of sodium ions in every mole of sodium oxide.##

|!|EMA031212027O|!|
The formula mass of a compound
A. is measured in grams.
B. has a unit of g mol^{-1}.
C. is always a whole number.
D. is the mass of one formula unit of the compound on the $^{12}C = 12.000\ 00$ scale.

□

##D##

|!|EMB031212028O|!|
A mixture of magnesium chloride and magnesium sulphate contains 0.6 mole of chloride ions and 0.2 mole of sulphate ions. The number of moles of magnesium ions present is
A. 0.4 mol.
B. 0.5 mol.
C. 0.8 mol.

D. 1.0 mol.

☐

##B Since 1 formula unit of $MgCl_2$ contains 1 Mg^{2+} ions, 1 formula unit of $MgSO_4$ also contains 1 Mg^{2+} ions, so the number of moles of magnesium ions present = $\left(\frac{0.6}{2} + 0.2\right)$ mol = 0.5 mol.##

|!|EMA031212029O|!|
Which of the following represents the mass of an oxygen molecule?

A. 16.0 g
B. 16.0 × 2 g
C. $\frac{16.0}{6.02 \times 10^{23}}$ g
D. $\frac{16.0 \times 2}{6.02 \times 10^{23}}$ g

☐

##D##

Section 12.2

|!|EMB031212030O|!|
What is the percentage by mass of chlorine in 11.8 g of aluminium chloride?

A. 20.2%
B. 56.8%
C. 72.4%
D. 79.8%

☐

##D Formula mass of $AlCl_3$ = 27.0 + 35.5 × 3 = 133.5
Percentage by mass of chlorine = $\frac{3 \times 35.5}{133.5}$ × 100% = 79.8%.##

|!|EMA031212031O|!|
What is the percentage by mass of C in $C_6H_{12}O_6$?

A. 37.5%
B. 40.0%
C. 50.0%
D. 67.5%

☐

##B Percentage by mass of C = $\frac{6 \times 12.0}{6 \times 12.0 + 12 \times 1.0 + 6 \times 16.0}$ × 100% = 40.0%.##

|!|EMA031212032O|!|
What is the mass of iron in 15 g of iron(II) sulphate-7-water, $FeSO_4 \cdot 7H_2O$?

A. 0.2 g
B. 3.0 g
C. 6.2 g
D. 20.0 g

☐

##B Fraction by mass of Fe in $FeSO_4 \cdot 7H_2O$

$$= \frac{55.8}{(55.8 + 32.1 + 16.0 \times 4) + 7 \times (1.0 \times 2 + 16.0)} = 0.20$$

Mass of Fe in $FeSO_4 \cdot 7H_2O = 0.20 \times 15$ g = 3.0 g.##

|!|EMB031212033O|!|
The chloride of a metal *X* has the formula XCl_3 and contains 65.6% by mass of chloride. Find the relative atomic mass of *X*.

A. 12.2
B. 18.6
C. 34.4
D. 55.8

□

##D Percentage by mass of *X* in $XCl_3 = 100\% - 65.6\% = 34.4\%$. Let *a* be the relative atomic mass of *X*.

$$\text{Fraction by mass of } X \text{ in } XCl_3 = \frac{\text{relative atomic mass of } X \times 1}{\text{formula mass of } XCl_3}$$

$$\frac{34.4}{100} = \frac{a}{a + 35.5 \times 3}$$

$a = 55.8$##

|!|EMA031212034O|!|
Given that the relative atomic mass of *X* is 48.0. What is the percentage by mass of *X* in CaX_2O_7?

A. 33.31%
B. 38.69%
C. 46.11%
D. 47.98%

□

##B Percentage by mass of *X*

$$= \frac{\text{relative atomic mass of } X \times \text{no. of atoms of } X \text{ in } CaX_2O_7}{\text{formular mass of } CaX_2O_7} \times 100\%$$

$$= \frac{48.0 \times 2}{48.0 \times 2 + 16.0 \times 7 + 40.1} \times 100\%$$

= 38.69%##

|!|EMB031212035O|!|
An element forms a compound X_2Cl_3 which contains 25% by mass of chlorine. What is the relative atomic mass of the element *X*?

A. 39.9
B. 79.9
C. 106.5
D. 159.8

□

##D Let *x* be the relative atomic mass of the element *X*.
Percentage by mass of *X* =

$$\frac{\text{relative atomic mass of } X \times \text{no. of atoms of } X \text{ in } X_2Cl_3}{\text{formular mass of } X_2Cl_3} \times 100\%$$

$1 - 0.25 = \frac{2x}{2x + 3 \times 35.5}$

$x = 159.8$##

|!|EMB031212036O|!|
An ore sample contained 60% Al_2O_3 by mass. The other ingredients did not contain aluminium. Which of the following was the percentage by mass of aluminium in the sample?

A. 24.0%
B. 31.8%
C. 52.9%
D. 60.0%

□

##B The percentage by mass of aluminium in $Al_2O_3 = \frac{27.0 \times 2}{27.0 \times 2 + 16.0 \times 3} = 52.9\%$,
The percentage by mass of aluminium in the ore sample = 52.9% × 0.6 = 31.8%.##

|!|EMB031212037O|!|
An element X forms an oxide X_2O which contains 11.2% of oxygen by mass. The relative atomic mass of X is

A. 14.0.
B. 23.0.
C. 63.4.
D. 108.0.

□

##C Let the relative atomic mass of X be a.
Fraction by mass of oxygen in $X_2O = \frac{\text{relative atomic mass of oxygen} \times 1}{\text{formula mass of } X_2O}$

$\frac{11.2}{100} = \frac{16.0}{2a + 16.0}$
$a = 63.4$ ##

Section 12.3
|!|EMA031212038O|!|
Which of the following is a molecular formula?

A. Mg
B. CH_4
C. NaCl
D. NH_4Cl

□

##B CH_4 represents the molecules of methane. Mg represents the atoms of magnesium metal. NaCl and NH_4Cl are ionic compounds, so they are not molecular formulae.##

|!|EMA031212039O|!|

Which of the following is the structural formula of a molecule?

A. K^+Cl^-
B. O=C=O
C. CH_2O
D. CCl_4

##B It indicates how carbon and oxygen atoms are arranged in the CO_2 molecule. A is the ionic formula of KCl; CH_2O may be a molecular formula or an empirical formula, CCl_4 is a molecular formula.##

|!|EMA031212040O|!|
Which of the following is the ionic formula of iron(II) sulphate-7-water?

A. $FeSO_4 \cdot 7H_2O$
B. $Fe^{2+}SO_4^{2-} \cdot 7H_2O$
C. $FeSO_{11}H_{14}$
D. $Fe(H_2O)_7^{2+}SO_4^{2-}$

##B B is the ionic formula showing the charges of ions in the compound. A is the formula and does not show the charges of any ions present. C is the empirical formula while D is not a correct formula.##

Section 12.4
|!|EMA031212041O|!|
What is the empirical formula for a compound having the following composition by mass?

Element	Composition by mass (%)
Aluminium	15.79%
Sulphur	28.07%
Oxygen	56.14%

A. $Al_2S_3O_9$
B. $Al_2S_3O_{12}$
C. $AlSO_4$
D. Al_2SO_4

##B Assume there is 100 g of compound, then, there will be 15.79 g of Al, 28.07 g of S, and 56.14 g of O.

	Al	S	O
Masses (g)	15.79	28.07	56.14
Number of moles (mol)	$\frac{15.79}{27.0} = 0.585$	$\frac{28.07}{32.1} = 0.874$	$\frac{56.14}{16.0} = 3.51$
Relative number of moles	$\frac{0.585}{0.585} = 1$	$\frac{0.874}{0.585} = 1.50$	$\frac{3.51}{0.585} = 6$
Relative number of moles of atoms (in whole number ratio)	$1 \times 2 = 2$	$1.5 \times 2 = 3$	$6 \times 2 = 12$

∴the empirical formula of the compound is $Al_2S_3O_{12}$.##

|!|EMA031212042O|!|
What is the empirical formula for a compound having 92.3% by mass of carbon and 7.7% by mass of hydrogen?

A. CH_2
B. C_2H
C. C_2H_2
D. CH

##D Assume there is 100 g of compound, then, there will be 92.3 g of C and 7.7 g of H.

	C	H
Masses (g)	92.3	7.7
Number of moles (mol)	$\frac{92.3}{12.0} = 7.69$	$\frac{7.7}{1.0} = 7.7$
Relative number of moles	$\frac{7.69}{7.69} = 1$	$\frac{7.7}{7.69} \approx 1$

∴the empirical formula of the compound is CH.##

|!|EMB031212043O|!|
A compound is formed when 40.0 g of element *X* reacts completely with 69.0 g of element *Y*. What is the empirical formula of the compound? (Given that the relative atomic masses of *X* and *Y* are 20.0 and 23.0 respectively.)

A. X_2Y_3
B. X_3Y_2
C. XY
D. XY_3

##A The compound contains $\frac{40.0}{20.0}$ mol = 2.0 mol of *X* and $\frac{69.0}{23.0}$ mol = 3.0 mol of *Y*.##

|!|EMB031212044O|!|
13.70 g of an oxide of metal *X* (relative atomic mass = 207.0) reacts with excess hydrogen to produce 1.44 g of water. What is the empirical formula of the oxide?

A. *X*O
B. XO_2
C. X_2O
D. X_3O_4

##D Let the formula of the oxide of *X* be X_aO_b.

	$X_aO_b + H_2 \rightarrow a\,X + b\,H_2O$			
Mass (g)	13.70			1.44

Number of moles of water (H_2O) produced = $\frac{1.44}{1.0 \times 2 + 16.0}$ mol= 0.08 mol

The number of moles of the oxide of X = $\frac{13.70}{207.0a + 16.0b} = \frac{0.08}{b}$

$13.7b = 16.56a + 1.28b$

$\frac{a}{b} = \frac{3}{4}$

So, the empirical formula of the oxide of X is X_3O_4.##

Section 12.5

|!|EMB031212045O|!|

Complete combustion of 1.86 g of an organic compound Y gave 2.64 g of carbon dioxide and 1.62 g of water as the only products. If the relative molecular mass of Y is equal to 62, what is its molecular formula?

A. $C_2H_6O_2$
B. CH_3O
C. CHO
D. $C_3H_9O_3$

□

##A

Since all the C in CO_2 and H in H_2O came from the compound Y,

mass of C in the compound = $2.64 \times \frac{12.0}{12.0 + 16.0 \times 2}$ g = 0.72 g,

mass of H in the compound = $1.62 \times \frac{1.0 \times 2}{1.0 \times 2 + 16.0}$ g = 0.18 g,

the rest of the compound must be oxygen.

So, mass of O in the compound = (1.86 – 0.72 – 0.18) g = 0.96 g

	C	H	O
Masses (g)	0.72	0.18	0.96
Number of moles (mol)	$\frac{0.72}{12.0}$ = 0.06	$\frac{0.18}{1.0}$ = 0.18	$\frac{0.96}{16.0}$ = 0.06
Relative number of moles	$\frac{0.06}{0.06}$ = 1	$\frac{0.18}{0.06}$ = 3	$\frac{0.06}{0.06}$ = 1

∴The empirical formula of compound Y is CH_3O.

Let the molecular formula be of compound Y $(CH_3O)_n$, where n is a whole number.

Relative molecular mass of $(CH_3O)_n$ = 62

n (12.0 + 1.0 × 3 + 16.0) = 62

n = 2

∴molecular formula of compound Y is $C_2O_6O_2$.##

|!|EMB031212046O|!|

Which of the following data are necessary for the determination of the molecular formula of a compound containing carbon and hydrogen only?

(1) The formula mass of the compound
(2) The composition by mass of the compound
(3) The relative atomic masses of carbon and hydrogen

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. All of them

##D##

Section 12.6

|!|EMA031212047O|!|

20.7 g of lead metal reacts with excess oxygen gas to form lead(II) oxide on strong heating. What is the mass of this solid product formed?

A. 11.1 g
B. 22.3 g
C. 33.4 g
D. 44.6 g

##B The chemical equation is

	$2Pb(s) + O_2(g) \rightarrow 2PbO(s)$		
Mole ratio	1	–	1
Number of moles (mol)	$\frac{20.7}{207.0}$ = 0.1	–	= 0.1

As the number of moles of PbO(s) produced is 0.1 mol, its mass
= 0.1 × (207.0 + 16.0) g
= 22.3 g##

|!|EMA031212048O|!|

The mass of zinc oxide required to obtain 0.8 mole of zinc by carbon reduction is

A. 3.26 g.
B. 6.51 g.
C. 32.6 g.
D. 65.1 g.

##D The chemical equation is

	$2ZnO(s) + C(s) \rightarrow 2Zn(s) + CO_2(g)$			
Mole ratio	1	–	1	–
Number of moles (mol)	0.8	–	0.8	–

Therefore, 0.8 mole of ZnO(s) is required. Its mass
= 0.8 × (65.4 + 16.0) g
= 65.1 g##

|!|EMA031212049O|!|

3.9 g of potassium reacts with excess water. What is the mass of the gaseous product formed?

A. 0.1 g
B. 0.2 g
C. 1.0 g
D. 2.0 g

□

##A The chemical equation is

	$2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2(g)$			
Mole ratio	2	–	1	–
Number of moles (mol)	$\frac{3.9}{39.1}$ = 0.1	–	$\frac{0.1}{2}$ = 0.05	–

The mass of hydrogen formed = 0.05 × 2 g = 0.1 g##

|!|EMA031212050O|!|
M is a metal discovered recently. 19.2 g of *M* reacts completely with 4.8 g of oxygen to form an oxide, M_2O. Find the relative atomic mass of *M*.

A. 24.0
B. 28.0
C. 32.0
D. 64.0

□

##C The chemical equation is

	$4M(s) + O_2(g) \rightarrow 2M_2O(s)$		
Mole ratio	4	1	–
Number of moles (mol)	0.15 × 4	$\frac{4.8}{32.0}$	–
	= 0.6	= 0.15	–

Molar mass of *M* = $\frac{19.2}{0.6}$ g mol^{-1} = 32.0 g mol^{-1}
The relative atomic mass of *M* is 32.0.##

|!|EMA031212051O|!|
To reduce 7.2 g of iron(III) oxide completely, how many grams of carbon is required?

A. 0.52 g
B. 0.81 g
C. 1.36 g
D. 2.20 g

□

##B The chemical equation is

	$2Fe_2O_3(s) + 3C(s) \rightarrow 4Fe(s) + 3CO_2(g)$			
Mole ratio	2	3	–	–

Number of mole (mol)	$\frac{7.2}{55.8\times 2+16.0\times}$ = 0.045	$0.045 \times \frac{3}{2}$ = 0.0675	–	–

Therefore, to reduce 7.2 g of iron(III) oxide, 0.0675 mole of carbon is required. The mass of carbon is = 0.0675 × 12.0 = 0.81 g.##

Each question below consists of two separate statements. Decide whether each of the two statements is true or false; if both are true, then decide whether or not the second statement is a *correct* explanation of the first statement. Then select one option from A to D according to the following table:

A. Both statements are true and the 2nd statement is a correct explanation of the 1st statement.
B. Both statements are true and the 2nd statement is NOT a correct explanation of the 1st statement.
C. The 1st statement is false but the 2nd statement is true.
D. Both statements are false.

Section 12.1

|!|EMB031212052O|!|

The mass of calcium is twice as that of chlorine in calcium chloride.	In one mole of calcium chloride, there are one mole of calcium ions and two moles of chloride ions.

☐

##C The chemical formula of calcium chloride is $CaCl_2$.##

|!|EMB031212053O|!|

12 g of carbon-12 contain 1 mole of carbon-12 atoms.	One mole of any substances contains 6.02×10^{23} particles.

☐

##B 12 g of carbon-12 contain 1 mole of carbon-12 atoms because 1 mole of a substance is equal to the amount of the substance which contains as many particles as the number of atoms in 12 g of carbon-12.##

|!|EMB031212054O|!|

One mole of water has the same mass as one mole of carbon dioxide.	One mole of water contains the same number of atoms as one mole of carbon dioxide.

☐

##C##

Sections 12.2−12.3

|!|EMA031212055O|!|

NaCl is an empirical formula.	NaCl shows the simplest whole number ratio of the ions present.

☐

##A##