GRAYS TUITION CENTRE – Online Tutoring

WEEK: 22

Week Beginning: 17-8-20

Subject: SCIENCE

Year: 9

Lesson Objective:

- Go over homework
- Questions

Keywords/ Concepts

- Mole, relative formula mass

Class Worksheets

- Questions

Homework

- Questions

Additional Notes

- Attach all the classroom worksheets and homework worksheets to this lesson plan and email together.
- Assume the students don't have revision guides and workbooks. Attach all the pages you want them to have.

Relative Formula Mass

Calculating relative formula mass is straight forward enough, but things can get a bit more confusing when you start working out the percentage compositions of compounds.

Compounds Have a Relative Formula Mass, M_r

If you have a compound like $MgCl_2$ then it has a relative formula mass, M_r, which is just the relative atomic masses of all the atoms in the molecular formula added together.

You can find the relative atomic mass (A_r) of an element from the periodic table — it's the same as its mass number. See page 18 for more.

EXAMPLE:

Find the relative formula mass of $MgCl_2$.

1) Look up the relative atomic masses of all the elements in the compound on the periodic table. (In the exams, you might be given the A_r you need in the question.)
A_r of Mg = 24 and the A_r of Cl = 35.5.
2) Add up all the relative atomic masses of the atoms in the compound.
$Mg + (2 \times Cl) = 24 + (2 \times 35.5) = 95$ So M_r of $MgCl_2$ = 95

There are two chlorine atoms in $MgCl_2$, so the relative atomic mass of chlorine needs to be multiplied by 2.

You Can Calculate the % Mass of an Element in a Compound

This is actually dead easy — so long as you've learnt this formula:

$$\text{Percentage mass of an element in a compound} = \frac{A_r \times \text{number of atoms of that element}}{M_r \text{ of the compound}} \times 100$$

EXAMPLE:

Find the percentage mass of sodium in sodium carbonate, Na_2CO_3.

A_r of sodium = 23, A_r of carbon = 12, A_r of oxygen = 16

M_r of $Na_2CO_3 = (2 \times 23) + 12 + (3 \times 16) = 106$

$$\text{Percentage mass of sodium} = \frac{A_r \times \text{number of atoms of that element}}{M_r \text{ of the compound}} \times 100 = \frac{23 \times 2}{106} \times 100 = 43\%$$

You might also come across more complicated questions where you need to work out the percentage mass.

EXAMPLE:

A mixture contains 20% iron ions by mass. What mass of iron chloride ($FeCl_2$) would you need to provide the iron ions in 50 g of the mixture? A_r of Fe = 56, A_r of Cl = 35.5.

1) Find the mass of iron in the mixture.

The mixture contains 20% iron by mass, so in 50 g there will be $50 \times \frac{20}{100} = 10$ g of iron.

2) Calculate the percentage mass of iron in iron chloride.

$$\text{Percentage mass of iron} = \frac{A_r \times \text{number of atoms of that element}}{M_r \text{ of the compound}} \times 100 = \frac{56}{56 + (2 \times 35.5)} \times 100 = 44.09...\%$$

3) Calculate the mass of iron chloride that contains 10 g of iron.

Iron chloride contains 44.09% iron by mass, so there will be 10 g of iron in $10 \div \frac{44.09...}{100} = 23$ g

So you need 23 g of iron chloride to provide the iron in 50 g of the mixture.

The Mole and Mass

The mole can be pretty confusing. I think it's the word that puts people off. It's difficult to see the relevance of the word "mole" to anything but a small burrowing animal.

"The Mole" is Simply the Name Given to an **Amount** of a Substance

1) Just like "a million" is this many: 1 000 000; or "a billion" is this many: 1 000 000 000, so "the Avogadro constant" is this many: 602 000 000 000 000 000 000 000 or 6.02×10^{23}. And that's all it is. Just a number.

2) One mole of any substance is just an amount of that substance that contains an Avogadro number of particles — so 6.02×10^{23} particles. The particles could be atoms, molecules, ions or electrons.

The symbol for the unit 'moles' is 'mol'.

3) So why is such a long number like the Avogadro constant used? The answer is that the mass of that number of atoms or molecules of any substance is exactly the same number of grams as the relative atomic mass (A_r) or relative formula mass (M_r) of the element or compound.

4) In other words, one mole of atoms or molecules of any substance will have a mass in grams equal to the relative formula mass (A_r or M_r) for that substance. Here are some examples:

Carbon has an A_r of 12.
So one mole of carbon weighs exactly 12 g.

Nitrogen gas, N_2, has an M_r of 28 (2×14).
So one mole of N_2 weighs exactly 28 g.

Carbon dioxide, CO_2, has an M_r of 44 ($12 + [2 \times 16]$).
So one mole of CO_2 weighs exactly 44 g.

5) This means that 12 g of carbon, or 28 g of N_2, or 44 g of CO_2, all contain the same number of particles, namely one mole or 6.023×10^{23} atoms or molecules.

The Mole and Mass

So you now you know what a mole is, you probably want to know how to work out the number of moles in a given mass of a substance, right? Well you're in luck...

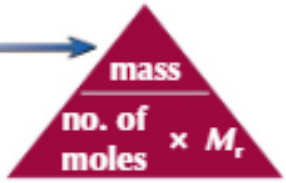
Nice Formula to Find the Number of Moles in a Given Mass:

$$\text{Number of moles} = \frac{\text{mass in g (of an element or compound)}}{M_r \text{ (of the element or compound)}}$$

EXAMPLE: **How many moles are there in 66 g of carbon dioxide (CO_2)?**

1) Calculate the M_r of carbon dioxide. M_r of $CO_2 = 12 + (16 \times 2) = 44$
2) Use the formula above to find out how many moles there are. No. of moles = Mass (g) ÷ M_r = 66 ÷ 44 = 1.5 mol

You can rearrange the equation above using this handy formula triangle. You could use it to find the mass of a known number of moles of a substance, or to find the M_r of a substance from a known mass and number of moles. Just cover up the thing you want to find with your finger and write down what's left showing.



EXAMPLE: **What mass of carbon is there in 4 moles of carbon dioxide?**

There are 4 moles of carbon in 4 moles of CO_2.

Cover up 'mass' in the formula triangle. That leaves you with 'no. of moles × M_r'.

So the mass of 4 moles of carbon = 4 × 12 = 48 g

In a Chemical Reaction, Mass is Always Conserved

1) During a chemical reaction no atoms are destroyed and no atoms are created.
2) This means there are the same number and types of atoms on each side of a reaction equation.
3) Because of this, no mass is lost or gained — we say that mass is conserved during a reaction. For example:

$$2Li + F_2 \rightarrow 2LiF$$

In this reaction, there are 2 lithium atoms and 2 fluorine atoms on each side of the equation.

4) By adding up the relative formula masses of the substances on each side of a balanced symbol equation, you can see that mass is conserved. The total M_r of all the reactants equals the total M_r of the products.

EXAMPLE:

Show that mass is conserved in this reaction: $2Li + F_2 \rightarrow 2LiF$.

1) Add up the relative formula masses on the left-hand side of the equation.
$2 \times M_r(Li) + 2 \times M_r(F) = (2 \times 7) + (2 \times 19) = 14 + 38 = 52$
2) Add up the relative formula masses on the right-hand side of the equation.
$2 \times M_r(LiF) = 2 \times (7 + 19) = 2 \times 26 = 52$

The total M_r on the left hand side of the equation is equal to the total M_r on the right hand side, so mass is conserved.

There's more about balanced symbol equations on p.21.

Classwork

1. O_2
2. Cl_2
3. CO_2
4. NH_3
5. Al_2O_3
6. $CaCO_3$
7. $Ca(OH)_2$
8. $MgSO_4 \cdot 7H_2O$
9. B_2H_6
10. Na_2CO_3
11. $Fe_2(SO_4)_3$
12. $Zn(OH)_2$
13. $Ca(HCO_3)_2$
14. $Ca(HCO_3)_2$
15. $Na_2CO_3 \cdot 10H_2O$

Percentage by mass

1. Determine the mass percent of each element in $Al_2(SO_4)_3$.

2. What mass of $CaCl_2$ will contain 15.0 g of chlorine?

3. What is the mass of oxygen in a 25.0 g sample of TiO_2?

4. Which substance has a greater percent by mass of hydrogen: C_4H_8 or C_8H_{18}?

Mole Questions

1. How many moles are there in 44 g of CO_2? How many molecules is this?

2. How many molecules are there in 79 g of Fe_2O_3? How many atoms is this?

3. What is the mass of 2.5 moles of Na_2O?

4. What is mass of 2.34 moles of Platinum?

5. How many moles are there in 132 g of CO_2