**"Teaching innovatively (with focus on ICT) and its impact on the quality of education"**

# Teaching activity n°2

| Title | CHEMICAL REACTIONS |
|-------|--------------------|
| Nation | ITALY |
| Subject | CHEMISTRY |

### LEARNING OBJECTIVES

- to define a chemical change

- to recognize a chemical change and distinguish it from a physical one

- to read a chemical equation

- to write chemical equations

- to balance chemical equations

- to classify chemical reactions

- to write formation and combustion reactions for given compounds.

- to recognize the limitant reactant

- to make stoichiometric calculations: from mass to moles, from moles to mass, yield, masses needed for complete reactions (from a given quantity of a reactant)

# ACTIVITY PLANNING

| Step 1 | **The difference between chemical and physical  transformations**<br><br>1$^{st}$ part of a power point presentation(slides 1-10)<br><br>Exercises (file 1 and file 2 ,  file conplete)- see **Attachments** |
|---|---|
| **Step 2** | **Chemical Reaction**<br><br>**Chemical Equation**<br><br>**Law of Conservation of Mass**<br><br>2$^{nd}$ part of a power point presentation(slides 11-26)<br><br>Exercise(file 2.1)- see **Attachments** |
| **Step 3** | **Type of Reactions**<br>3$^{nd}$ part of a power point presentation(slides 27- 35)<br>**Students work in groups**<br>❖  write chemical equation from the nouns of chemical compounds<br>❖  balance them<br>❖  write the nouns of the compounds of a given chemical equation<br><br>Exercises (file 3 and file 4)- see **Attachments** |
| **Step 4** | **STOICHIOMETRIC CALCULATIONS**<br>4$^{nd}$ part of a power point presentation(slides 36- 46)<br><br>Students work<br><br>exercises on stoichiometric calculations (file 5)- see **Attachments** |
| **Step 5** | **STOICHIOMETRIC CALCULATIONS:**<br><br>Homework:<br>-exercises on stoichiometric calculations (file  6)- see **Attachments** |
| **Step 6** | LABORATORY:<br><br>SOME CHEMICAL REACTIONS |
| **Step 7** | WRITTEN TEST (file5.1)- see **Attachments** |

# Attachments:

**File 1**

**Work in pairs and write down your answers**

1)What is a physical change?

2)What is a chemical change?

3)How are bonds involved in the chemical change?

4)How would you define a chemical reaction?

**File 2**

**Work in pairs and write down your answers**

1) What are reactants and products in a chemical reaction?

2)What does the arrow represent in a chemical equation?

Why can we read a chemical equation both in terms of molecules and moles?

4)Why do we balance a chemical equation?

5) What does it mean to balance a chemical equation?

**File complete**

Complete the following setences:

In a physical transformation...................... (no change takes place in the identity of the substance)

A chemical transformation takes place when....................(atoms in the reactants are rearranged to form new substabces)(old bonds are broken and new bonds are formed)( at least one new substance is formed)

We can realize that a chemical reaction is taking place when...........( there is a change in colour, a gas or a solid is formed in a solution,  heat is produced or the system is cooled down,.)

A chemical equation is balanced when........................(the number of atoms of each species is the same on both sides of the equation)

We need to balance an equation because.....................(In any ordinary chemical reaction, matter is not created nor destroyed)

The limiting reactant is .........................(the substance that ends up first) (the reactant that produces less amount of one product)

The actual yield is.............(the amount of product actually recovered from an experiment )

The theoretical yield is...................(the maximum amount of product that could be produced from the reactant.)

The percent yield is......................(the actual yield compared to the maximum (theoretical yield) possible).

**Soluzioni esercizi guidati**

given a chemical equation:

Please,read it.

Is it balanced?

Can you balance it?

What does it mean to balance an equation?
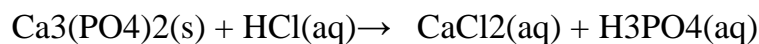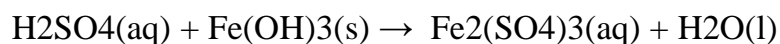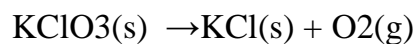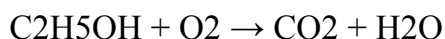
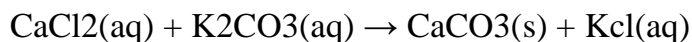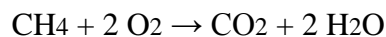Why is it necessary to balance chemical equations?

If we have .....grams of.........., how much product...... can we obtain?

If we have .....grams of.......... and ........grams of............, which is the limiting reactant?

What is the actual yield?..........

**File 2.1**

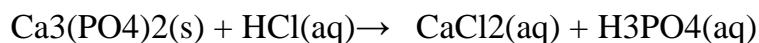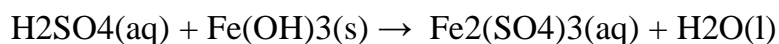Balance the following equations and give the names of the compounds :

$CH_4 + 2 O_2 \rightarrow CO_2 + 2 H_2O$

$SO_2 + H_2O \rightarrow H_2SO_3$

$CaCl_2(aq) + K_2CO_3(aq) \rightarrow CaCO_3(s) + Kcl(aq)$

$C_2H_5OH + O_2 \rightarrow CO_2 + H_2O$

$KClO_3(s) \rightarrow KCl(s) + O_2(g)$

$H_2SO_4(aq) + Fe(OH)_3(s) \rightarrow Fe_2(SO_4)_3(aq) + H_2O(l)$

$BaCO_3(s) + HBr(aq) \rightarrow BaBr_2(aq) + H_2O(l) + CO_2(g)$

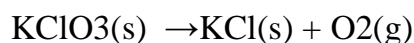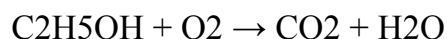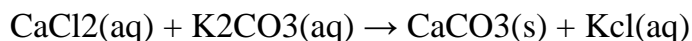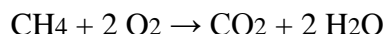$Ca_3(PO_4)_2(s) + HCl(aq) \rightarrow CaCl_2(aq) + H_3PO_4(aq)$

Balance the following equations after having written them:

- Sodium reacts with oxygen to produce sodium oxide

– Hydrochloric Acid reacts with Sodium Carbonate to produce Carbon Dioxide, Water, and Sodium Chloride

– Ammonium chloride reacts with potassium hydroxide to produce ammonia,potassium chloride and water

– iron oxide(III) reacts with water to produce iron hydroxide

– sulfuric acid reacts with iron(III) hydroxide to produce iron(III) sulfate and water

– magnesium sulfide reacts with hydrochloric acid to produce magnesium chloride and sulfane

**File 3**

Balance the following equations and give the names of the compounds :
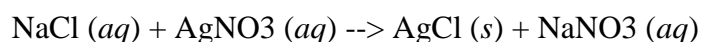
$CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$

$SO_2 + H_2O \rightarrow H_2SO_3$

$CaCl2(aq) + K2CO3(aq) \rightarrow CaCO3(s) + Kcl(aq)$

$C2H5OH + O2 \rightarrow CO2 + H2O$

$KClO3(s) \rightarrow KCl(s) + O2(g)$

$H2SO4(aq) + Fe(OH)3(s) \rightarrow Fe2(SO4)3(aq) + H2O(l)$

$BaCO3(s) + HBr(aq) \rightarrow BaBr2(aq) + H2O(l) + CO2(g)$

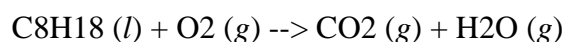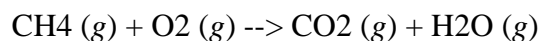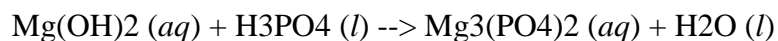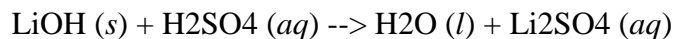$Ca3(PO4)2(s) + HCl(aq) \rightarrow CaCl2(aq) + H3PO4(aq)$

Balance the following equations after having written them:

- Sodium reacts with oxygen to produce sodium oxide

– Hydrochloric Acid  reacts with Sodium Carbonate to produce Carbon Dioxide, Water, and   Sodium Chloride

– Ammonium chloride reacts with potassium hydroxide  to produce ammonia,potassium chloride and water

–  iron oxide(III) reacts with water to produce iron hydroxide

– sulfuric acid reacts with iron(III) hydroxide  to produce iron(III) sulfate and water

– magnesium sulfide reacts with hydrochloric acid to produce magnesium chloride and sulfane

**File 4**

Balance the following equations. Give the names of the reactants and the products:

  LiOH (*s*) + H2SO4 (*aq*) --> H2O (*l*) + Li2SO4 (*aq*)

  Mg(OH)2 (*aq*) + H3PO4 (*l*) --> Mg3(PO4)2 (*aq*) + H2O (*l*)

  CH4 (*g*) + O2 (*g*) --> CO2 (*g*) + H2O (*g*)

  C8H18 (*l*) + O2 (*g*) --> CO2 (*g*) + H2O (*g*)

  NaCl (*aq*) + AgNO3 (*aq*) --> AgCl (*s*) + NaNO3 (*aq*)

  CH3COOH (*aq*) + NaHCO3 (*s*) --> CO2 (*g*) + H2O (*l*) + NaCH3COO (*aq*)

Balance the following equations,after having written them. Determine the molecular formula and the molecular weight of each species.

  Nitrogen monoxide reacts with ozone (trioxide) to produce nitrogen dioxide and oxygen molecules.

  Iron (III) oxide reacts with zinc metal to produce iron metal and zinc (II) oxide.

  Hydrobromic acid reacts with aluminum metal to produce hydrogen gas and aluminum bromide.

**File 5**

1)Balance the following equation and choose the quantity which is the sum of the coefficients of the reactants and products.

$P_2H_4 \rightarrow$ _____ $PH_3 +$ ____ $P_4$

a) 12
b) 16
c) 9
d) 14
e) 15

2)Balance the following equation and choose the quantity which is the sum of the coefficients of the products.

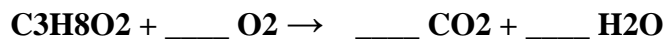____ $CS_2 +$ ____ $Cl_2 \rightarrow$ ____ $CCl_4 +$ ____ $S_2Cl_2$

a) 3
b) 6
c) 5
d) 2
e) 4

3)Balance the following equation and choose the quantity which is the sum of the coefficients of reactants and products.
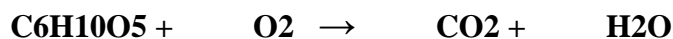
____ $PtCl_4 +$ ____ $XeF_2 \rightarrow$ ____ $PtF_6 +$ ____ $ClF +$ ____ $Xe$

a) 16
b) 13
c) 18
d) 12
e) 14

4)Balance the following equation. What is the sum of the coefficients of the reactants and products?

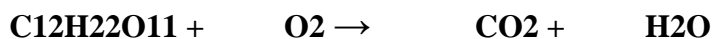$C_3H_8O_2 +$ ____ $O_2 \rightarrow$ ____ $CO_2 +$ ____ $H_2O$

a) 9
b) 15
c) 17
d) 10
e) 12

5)Balance the following equation. What is the sum of the coefficients of the reactants?

**C6H10O5 + \_\_\_\_ O2  →  \_\_\_\_ CO2 + \_\_\_\_ H2O**

a)  6
b)  11
c)  18
d)  3

e)  7

6)Balance the following equation. What is the sum of the coefficients of the reactants?

**C12H22O11 + \_\_\_\_ O2 →  \_\_\_\_ CO2 + \_\_\_\_ H2O**

a)  10
b)  9
c)  36
d)  12
e)  13

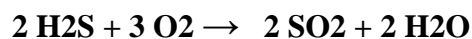7)Which statement is false for the balanced equation given below?
(Atomic weights: N = 14.01, O = 16.00).

**N2 + 2 H2→  N2H4**
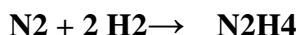
a)  One molecule of H2 requires 1/2 molecule of nitrogen
b)  One mole of H2 will produce 16.0 g of N2H4
c)  The reaction of 2 molecules of H2 will produce one molecule of N2H4
d)  The reaction of 14.0 g of N2 will produce 1/2 mole of N2H4
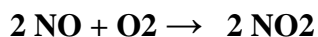e)  The reaction of 2.0 g of H2 will produce 1 mole of N2H4

8) Which statement is false for the balanced equation given below?
(Atomic weights: H = 1.008, O = 16.00, S = 32.06).

**2 H2S + 3 O2 →  2 SO2 + 2 H2O**

a)  The reaction of 34 g of H2S requires 48 g of O2
b)  The reaction of 3 molecules of O2 requires 2 molecules of H2S
c)  The reaction of three moles of O2 will produce 36 g of water
d)  The reaction of one mole O2 will produce 2/3 mole of water
e)  The reaction of 2 moles of H2S will produce 64 g of sulfur dioxide

9)Which statement is false for the balanced equation given below?
(Atomic weights: N = 14.01, O = 16.00).

**2 NO + O2 → 2 NO2**

a) One mole of NO will produce 46 g of NO2
b) One mole of O2 will produce two moles of NO2
c) The reaction of 32 g of O2 will produce 2 moles of NO2
d) Two molecules of NO react with one molecule of O2
e) 32 g of O2 will react with 30 g of NO

10)How many grams of Si3N4 can be produced from 0.46 moles of N2?
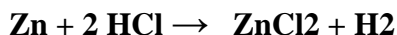(Atomic weights: Si = 28.09, N = 14.01).

**3 Si + 2 N2 → Si3N4**
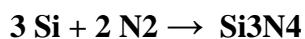
a) 28
b) 64
c) 16
d) 32
e) 24

**File 6**

Task (g)

1)A bronze alloy contains Zn and Cu. The zinc reacts with HCl but copper does not. A 0.5065 g sample of an alloy reacts with excess HCl to produce 0.0985 g $ZnCl_2$. What is the percent of zinc in the alloy?
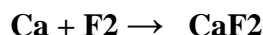(Atomic weights: Cu = 63.55, Zn = 65.38, Cl = 35.45, H = 1.008).

**$Zn + 2\ HCl \rightarrow\ ZnCl_2 + H_2$**

a) 9.33
b) 8.75
c) 10.1
d) 8.34
e) 8.98

2)The mass of $CaF_2$ that results from the reaction of 3.00 g of calcium and 2.00 g of fluorine is 4.02 g. What is the percent yield?
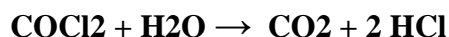(Atomic weights: Ca = 40.08, F = 19.00).

**$Ca + F_2 \rightarrow\ CaF_2$**

a) 97.8
b) 96.5
c) 99.0
d) 95.0
e) 98.5

3)How many moles of HCl are produced from 3.24 g of $COCl_2$ according to the following reaction?
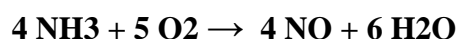(Atomic weights: C = 12.00, H = 1.008, Cl = 35.45).

**$COCl_2 + H_2O \rightarrow\ CO_2 + 2\ HCl$**

a) 0.0812
b) 0.0328
c) 0.158
d) 0.0655
e) 0.131

4)How many grams of NO can be produced from 0.68 g of $NH_3$ according to the following reaction?
(Atomic weights: N = 14.01, H = 1.008, O = 16.00).

**$4\ NH_3 + 5\ O_2 \rightarrow\ 4\ NO + 6\ H_2O$**

a) 1.2
b) 0.80
c) 0.600
d) 1.8
e) 0.40

**5)How many moles of HCl are produced from 3.24 g of COCl$_2$ according to the following reaction?**
**(Atomic weights: C = 12.00, H = 1.008, Cl = 35.45).**

$$COCl_2 + H_2O \rightarrow CO_2 + 2\ HCl$$

   a)  0.0812
   b)  0.0328
   c)  0.158
   d)  0.0655
   e)  0.131

6)How many grams of NO can be produced from 0.68 g of NH$_3$ according to the following reaction?
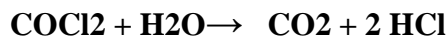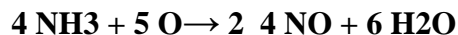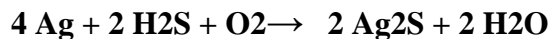(Atomic weights: N = 14.01, H = 1.008, O = 16.00).

$$4\ NH_3 + 5\ O \rightarrow 2\ 4\ NO + 6\ H_2O$$

   a)  1.2
   b)  0.80
   c)  0.600
   d)  1.8
   e)  0.40

**7)Silver tarnishes in the presence of hydrogen sulfide according to the following equation. How much Ag$_2$S is produced from a mixture of 0.950 g Ag, 0.140 g H$_2$S and 0.0800 g O$_2$?**
**(Atomic weights: Ag = 107.89, O = 16.00, H = 1.008, S = 32.06).**

$$4\ Ag + 2\ H_2S + O_2 \rightarrow 2\ Ag_2S + 2\ H_2O$$

   a)  1.21
   b)  1.45
   c)  1.32
   d)  1.02
   e)  1.07

# File 5.1- WRITTEN TEST

**1.Identify the chemical change in the following:**

> Your answer:
> - burning paper
> - cutting a piece of thread
> - melting ice in a glass
> - boiling water in a pan

**2.What is the coefficient needed for Al when the equation Al + Cl$_2$ = AlCl$_3$ is balanced?**

> Your answer:
> -2
> -1
> -3
> -6

**3.How many grams are in 1.5 moles of P?**

> Your answer:
> - 23 g
> - 46.5 g
> - 47 g
> - 22.5 g

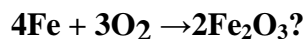**4.How many moles are in 18.2 g of CO$_2$?**

> Your answer:
> - 41.4 moles
> - 2.42 moles
> - 0.414 moles
> - 801 moles

5.What is the mass in grams of 0.250 moles of CH$_4$?

> Your answer:
> -4.00 g
> -64.0 g
> -4.0 g
> -4 g

**6.What are the possible mole factors for Fe and O$_2$ in the equation**
$$4Fe + 3O_2 \rightarrow 2Fe_2O_3?$$

Your answer:
-1 mole Fe/1 mole $O_2$ and 1 mole $O_2$/1 mole Fe
-4 mole Fe/2 mole $Fe_2O_3$
-4 mole Fe/1 mole $O_2$ and 1 mole $O_2$/4 mole Fe
-4 mole Fe/3 mole $O_2$ and 3 mole $O_2$/4 mole Fe

**7.Consider the reaction $N_2 + 3H_2 = 2NH_3$ How many moles of $H_2$ are needed to completely react 56 g of $N_2$?**

Your answer:
1-.0 moles of $H_2$
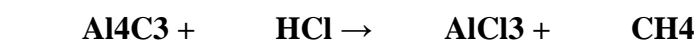-3.0 moles of $H_2$
-2.0 moles of $H_2$
-6.0 moles of $H_2$

**8.Complete and balance the following combustion reaction**
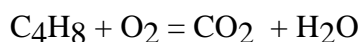
$C_4H_8 + O_2 = CO_2 + H_2O$

Your answer:
-$C_4H_8 + O_2 = 4CO_2 + 4H_2 O$
-$C_4H_8 + O_2 = 4CO_2 + H_2 O$
-$C_4H_8 + 6O_2 = 4CO_2 + 4H_2O$
-$C_4H_8 + O_2 = CO_2$

9.Balance the following equation. What is the sum of the coefficients of the reactants and products?

_____ $Al_4C_3$ + _____ HCl → _____ $AlCl_3$ + _____ $CH_4$

a) 24
b) 12
c) 16
d) 20
e) 18

**10.Acrylonitrile ($CH_2CHCN$) is used in the production of synthetic fibers by reacting propylene, ammonia and air. Balance the equation and determine the sum of the coefficients of the products and reactants.**

_____ $CH_2CHCH_3$ + _____ $NH_3$ + _____ $O_2$→_____ $CH_2CHCN$ + _____ $H_2O$

a) 15

b) 9
c) 14
d) 8
e) 12

**11.Silver nitrate solution reacts with calcium chloride solution according to the equation. What mass of AgCl would be formed by mixing together a solution containing 12.6 g of AgNO$_3$ and 8.40 g of CaCl$_2$?**
**(Atomic weights: Ag = 107.87; Ca = 40.08; Cl = 35.45; N = 14.01).**

$$2\,AgNO3 + CaCl2 \rightarrow Ca(NO3)2 + 2\,AgCl$$

a) 11.2
b) 9.2
c) 9.8
d) 10.6
e) 11.8

**12.The mass of AlCl$_3$ formed when 1.00 g of aluminum reacts with 12.00 g of iodine is 10.5 g. What is the percent yield?**
**(Atomic weights: Al = 26.98, I = 126.9).**

$$2\,Al + 3\,I2 \rightarrow 2\,AlI3$$

a) 81.7
b) 79.9
c) 82.3
d) 78.8
e) 80.9

**13.Disulfur dichloride is used to vulcanize rubber. How many grams of S$_2$Cl$_2$ can be formed when 6.000 g of sulfur reacts with 6.000 g of chlorine?**
**(Atomic weights: S = 32.06, Cl = 35.45).**

$$S8 + 4\,Cl2 \rightarrow 4\,S2Cl2$$

a) 10.72
b) 12.60
c) 11.84
d) 11.43
e) 12.00

**14.How many grams of H$_2$ are produced by the reaction of 0.256 mol of H$_3$PO$_4$ according to the following equation?**
**(Atomic weights: Cr = 52.00, H = 1.008, P = 30.97, O = 16.00).**

$$2\,Cr + 2\,H3PO4 \rightarrow 2\,CrPO4 + 3\,H2$$

a) **0.889**
b) **0.676**
c) **1.05**
d) **0.768**
e) **0.940**

**15. Silver sulfadiazine burn-treating cream creates a barrier against bacterial invasion and releases antimicrobial agents directly into the wound. What mass of silver oxide is required to prepare 225 g of silver sulfadiazine, $AgC_{10}H_9N_4SO_2$, from sulfadiazine, $C_{10}H_{10}N_4SO_2$? (Atomic weights: Ag = 107.87; C = 12.01; N = 14.01; S = 32.06; O = 16.00; H = 1.008).**

$Ag_2O + 2\ C_{10}H_{10}N_4SO_2 \rightarrow 2\ AgC_{10}H_9N_4SO_2 + H_2O$

a) 73.0
b) 63.0
c) 69.0
d) 57.0
e) 67.0