## Dear student of 2nd ESO A:

J am contacting you to invite you to solve the greatest riddles of the structure of matter. This is an urgent matter and J would really appreciate if you could come to my virtual home at Paris 51, rue de Montmorency during the second term. Your reward will be... eternal.

But I warn you, my home is a peculiar place where monsters roam so watch out.

Best regards.

## **UNIT 4: STRUCTURE OF MATTER**

4885

#### **RULES:**

Your mission is to complete the puzzles of the manor to reach the final exam.

In this exam, you will be asked for the name of your host. If you answer correctly, you will win a reward!

Clues about you guest's identity can be obtained by doing the side quests the manor will propose you.

Monsters are wandering this virtual manor, so dont be noisy or they will attack you (lowering your marks)!

You will have to study at home sometimes to prepare the contents and we will solve your doubts in classroom.

Paragraphs in cursive of your documents are comments of your guest that mean nothing. They are only fictional comments or curiosities about the lesson.

#### **RULES:**

Besides this adventure, you will have to prepare a project about some groups and elements of the periodic table. Instructions will be given to you. You will have to prepare a 5-10 minutes presentation to explain your project to your classmates.

## **RULES:**

TEAM N°	GROUPS OF THE PERIODIC TABLE	ELEMENTS TO STUDY	
	1, 2	Sodio(Na), Potasio(K), Magnesio(Mg), Calcio(Ca)	
	4, 5, 6	Titanio(Ti), Vanadio(V), Cromo(Cr), Wolframio(W)	
	7, 8, 9, 10	Hierro (Fe), Cobalto(Co), Níquel(Ni), Platino(Pt)	
	11, 12	Cobre (Cu), Plata(Ag), Oro(Au), Zinc(Zn)	
	13, 14	Boro(B), Aluminio(Al), Carbono( C), Silicio (Si)	
	15, 16	Nitrógeno(N), Fósforo(P), Oxígeno(O), Azufre(S)	
	17, 18	Fluor(F), Cloro(Cl), Helio(H), Neon(Ne)	

And now...

...Welcome to my manor.





#### YOU HAVE FOUND DOCUMENT 1



#### SIMPLE SUBSTANCES

#### PURE SUBSTANCES

#### COMPOUNDS



**ACTIVITY 1.- Indicate if these are simple substances or compounds:** 

Sodium chloride Sugar \* Copper wire Oxygen gas Water



**ACTIVITY 1.- Indicate if these are simple substances or compounds:** 

Sodium chloride Sugar Copper wire Oxygen gas Water Compound Compound Simple substance Simple substance Compound



#### YOU HAVE FOUND THE IRON KEY











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#### SIZE COMPARISON

Particle	Mass (kg)	Unit mass	Charge (C)	Unit charge
Electron (e-)	9.11·10 <sup>-31</sup>	0	<b>-1</b> .6·10 <sup>-19</sup>	-1
Proton (p+)	1.67·10 <sup>-27</sup>	1	1.6·10 <sup>-19</sup>	+1
Neutron (n°)	1.67·10 <sup>-27</sup>	1	0	0





**ACTIVITY 2.-** An atom has 3 protons, 3 electrons and 4 neutrons:

a) What is its mass?

b) What mass would it have if there have not electrons?

c) What is the charge of the atom?

d) What charge would it have if it only had two electrons?



**ACTIVITY 2.-** An atom has 3 protons, 3 electrons and 4 neutrons:

a) What is its mass? ( $3 \cdot 1.67 \cdot 10^{-27} + 3 \cdot 9.11 \cdot 10^{-31} + 4 \cdot 1.67 \cdot 10^{-27}$ ) kg = 1,17  $\cdot 10^{-26}$  kg

b) What mass would it have if there have not electrons? Practically the same

c) What is the charge of the atom? Charge = +3 + (-3) = 0

d) What charge would it have if it only had two electrons? Charge = +3 + (-2) = +1





YOU NEED THE IRON KEY TO OPEN THIS DOOR







**ACTIVITY 3.- Indicate what of these situations contain atoms:** 

a) A piece if iron
b) A ray of sunlight
c) A bacteria
d) Water
e) A diamond
f) A thunder
g) Air



**ACTIVITY 3.- Indicate what of these situations contain atoms:** 

a) A piece if iron
b) A ray of sunlight
c) A bacteria
d) Water
e) A diamond
f) A thunder
g) Air

Contains atoms Does not contains atoms Contains atoms Contains atoms Contains atoms Does not contains atoms Contains atoms



#### LIBRARY

NOW YOU CAN SOLVE THE PUZZLE OF THE MUSIC ROOM.









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WELCOME TO MY MUSIC ROOM.

PREPARE YOURSELVES.

THE TRIAL WILL START SHORTLY.

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**MUSIC ROOM: 2. ATOMS AND SUBATOMIC PARTICLES** QUESTION 1.-Indicate if these are simple substances or compounds:

Oxygen Ammonia Ozone

Mercury Alcohol 96° Oil Lead pipe Plastic Carbon

**QUESTION 2.-Choose how do you believe atoms are:** 

a) Positive spheres with negative charges stucked in them.
b) Negative spheres with positive charges stucked in them.
c) Positive nuclei with negative charges orbiting them.
d) Negative nuclei with positive charges orbiting them.

**QUESTION 3.-Indicate what of these situations contain atoms:** 

A sparkA bacteriaA piece of woodA flowerThe echoRain dropsYour hair

QUESTION 4.-Explain the differences when we speak about an atom of oxygen and we speak about the chemical element oxygen.

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**MUSIC ROOM: 2. ATOMS AND SUBATOMIC PARTICLES** QUESTION 1.-Indicate if these are simple substances or compounds:

	Oxygen	(S)	Mercury (S)	Lead pipe (S)
ð	Ammonia	(C)	Alcohol 96° (C)	Plastic (C
	Ozone	(S)	Oil (C)	Carbon (S)

**QUESTION 2.-Choose how do you believe atoms are:** 

a) Positive spheres with negative charges stucked in them.
b) Negative spheres with positive charges stucked in them.
c) Positive nuclei with negative charges orbiting them.
d) Negative nuclei with positive charges orbiting them.

**QUESTION 3.-Indicate what of these situations contain atoms:** 

A spark A bacteria A piece of wood rer The echo Rain drops Your hair

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QUESTION 4.-Explain the differences when we speak about an atom of oxygen and we speak about the chemical element oxygen.

# CONGRATULATIONS. YOU HAVE BEATEN THE TRIAL YOU HAVE FOUND DOCUMENT 2 AND THE BRONZE KEY



THE STREET



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SIDE QUEST: PREPARE A ONE-PAGE DOCUMENT EXPLAINIG DALTON'S ATOMIC THEORY AND ITS POSTULATES.

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ACTIVITY 4.- Draw an atom with 5 protons and 6 neutrons in the nucleus. How many electrons should you put in to make it neutral?

ACTIVITY 5.- Do you think that an atom could have less neutrons than protons? Explain it.

ACTIVITY 6.- According to the text, if the size of the atomic nucleus were the size of a 30 cm ball, what would be the size of the atom?



ACTIVITY 4.- Draw an atom with 5 protons and 6 neutrons in the nucleus. How many electrons should you put in to make it neutral?





ACTIVITY 4.- Draw an atom with 5 protons and 6 neutrons in the nucleus. How many electrons should you put in to make it neutral?

ACTIVITY 5.- Do you think that an atom could have less neutrons than protons? Explain it.

An atom can not have less neutrons than protons because neutrons act as a barrier that avoid protons to repel each other.

ACTIVITY 6.- According to the text, if the size of the atomic nucleus were the size of a 30 cm ball, what would be the size of the atom?

As the atom has a size 10.000 times bigger than its nucleus, if the ball a radium of 15 cm, the atom will have a size of 150.000 cm or 1500 m.


# MUSIC ROOM

NOW YOU CAN SOLVE THE PUZZLE OF THE FAMILY WING.











# THIS IS A SAFE PLACE. ENJOY THE INTERACTIVE ANIMATION.



#### CONGRATULATIONS.

#### YOU HAVE FOUND THE SILVER KEY.



#### SIDE QUEST: PREPARE A DOCUMENT ABOUT THE RUTHERFORD'S EXPERIMENT USED TO EXPLAIN ITS ATOMIC MODEL.



YOU ARE DOING IT WELL. THE MANOR WILL BE MORE DIFFICULT NOW.





YOU NEED THE SILVER KEY TO OPEN THIS DOOR

















ACTIVITY 7.- Chloride has Z=17 and A=35. Calculate its nucleus composition and how many electrons does it have.

ACTIVITY 8.- An atom with 20 protons and mass number 40, how many neutrons and electrons does it have?

ACTIVITY 9.- Do you think that an atom with Z=7 can have as an isotope another atom with Z=8? Explain it.



ACTIVITY 7.- Chloride has Z=17 and A=35. Calculate its nucleus composition and how many electrons does it have.

Z= #protons = 17 A= #protons+#neutrons=35  $\rightarrow$  #neutrons=35-17=18 The atom is neutral  $\rightarrow$  #electrons=#protons=17



ACTIVITY 8.- An atom with 20 protons and mass number 40, how many neutrons and electrons does it have?

**#neutrons= A - #protons= 40-20=20** The atom is neutral  $\rightarrow$  #electrons=#protons=20

ACTIVITY 9.- Do you think that an atom with Z=7 can have as an isotope another atom with Z=8? Explain it.



No, because Z= #protons and they are different elements.







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Changing neutrons  $\rightarrow$  ISOTOPES





**Changing electrons**  $\rightarrow$  **IONS** 





ACTIVITY 10.- How many electrons have to gain or lose the neutral calcium and nitrogen atoms to transform into the ions Ca<sup>2+</sup> and N<sup>3-</sup>.

ACTIVITY 11.- An ion of an atom of aluminium (Z=13, A=27) contains 10 electrons. Indicate the charge of the ion and how many neutrons does this atom have.



ACTIVITY 10.- How many electrons have to gain or lose the neutral calcium and nitrogen atoms to transform into the ions Ca<sup>2+</sup> and N<sup>3-</sup>.

Ca has to lose 2 electrons to become 2+ N has to gain 3 electrons to become 3-

ACTIVITY 11.- An ion of an atom of aluminium (Z=13, A=27) contains 10 electrons. Indicate the charge of the ion and how many neutrons does this atom have.

Charge is the difference between protons and electrons: 13-10 = +3#neutrons= A - Z = 27-13=14



### NOW YOU CAN SOLVE THE PUZZLE OF THE GREENHOUSE.

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YOU NEED THE SILVER KEY TO OPEN THIS DOOR







#### WELCOME TO MY GREENHOUSE.

PREPARE YOURSELVES.

THE TRIAL WILL START SHORTLY.



**GREENHOUSE: 4. ATOMIC AND MASS NUMBER. ISOTOPES AND IONS QUESTION 1.-If a neutral atom has 16 protons and 16 neutrons, how many electrons will it have? What will be its atomic and mass numbers?** 

QUESTION 2.-Potassium(K) has Z=19 and A=39. Calculate its protons, neutrons, and electrons.

QUESTION 3.-Copper(Cu) has Z=29 and 30 neutrons. Calculate its protons and mass number(A).

#### **QUESTION 4.-Indicate what isotopes are:**

a) Atoms of the same element with different number of electrons

b) Atoms of the same element with different number of protons

c) Atoms of the same element with different number of neutrons

d) Atoms of the same element with different number of these particles

#### **QUESTION 5.-Indicate what ions are:**



a) Atoms which have gained or have lost electrons.b) Atoms which have gained or have lost protons.c) Atoms which have gained or have lost neutrons.

QUESTION 1.-If a neutral atom has 16 protons and 16 neutrons, how many electrons will it have? What will be its atomic and mass numbers? #electrons=#protons=16; Atomic number=Z=16; Mass number=A=32

QUESTION 2.-Potassium(K) has Z=19 and A=39. Calculate its protons, neutrons, and electrons. #protons=Z=19; #neutrons=A-Z=39-19=20; #electrons=#protons=19

QUESTION 3.-Copper(Cu) has Z=29 and 30 neutrons. Calculate its protons and mass number(A). **#protons=Z=29; Mass number=#protons+#neutrons=29+30=59** 

**QUESTION 4.-Indicate what isotopes are:** 

a) Atoms of the same element with different number of electrons

- b) Atoms of the same element with different number of protons
- c) Atoms of the same element with different number of neutrons
- d) Atoms of the same element with different number of these particles

**QUESTION 5.-Indicate what ions are:** 



a) Atoms which have gained or have lost electrons.
b) Atoms which have gained or have lost protons.
c) Atoms which have gained or have lost neutrons.

GREENHOUSE: 4. ATOMIC AND MASS NUMBER. ISOTOPES AND IONS QUESTION 6.-If we have <sup>14</sup>, N, <sup>31</sup>, P,<sup>108</sup>, Ag.

a) Indicate the composition of its nuclei.

b) How many electrons have they?

#### **QUESTION 7.-Copy and complete:**

Atom	Z	Α	Protons	Neutrons	Electrons
С	6	12			
Zn	30			36	
Hg			80	120	
Br		80			35

QUESTION 8.-An ion of an Aluminium atom (Z=13 A=27) contains 10 electrons. Indicate the charge and the neutrons of this atom.

QUESTION 9.-Which of these atoms of elements are isotopes between each other? Justify your answer.

**GREENHOUSE:** 4. ATOMIC AND MASS NUMBER. ISOTOPES AND IONS QUESTION 6.-If we have  ${}^{14}{}_7$ N,  ${}^{31}{}_{15}$ P,  ${}^{108}{}_{47}$ Ag. a) Indicate the composition of its nuclei. N= 7p, 7n P=15p, 16n Ag=47p, 61n

b) How many electrons have they? N=7 P=15 Ag=47

#### **QUESTION 7.-Copy and complete:**

Atom	Z	Α	Protons	Neutrons	Electrons
С	6	12	6	6	6
Zn	30	66	30	36	30
Hg	80	200	80	120	80
Br	35	80	35	45	35

QUESTION 8.-An ion of an Aluminium atom (Z=13 A=27) contains 10 electrons. Indicate the charge and the neutrons of this atom. Charge: #protons-#electrons=13-10=+3 Neutrons=A-Z=27-13=14

QUESTION 9.-Which of these atoms of elements are isotopes between each other? Justify your answer.

 ${}^{23}_{11}A {}^{19}_{9}B {}^{22}_{11}C {}^{39}_{19}D {}^{40}_{19}E$ 

### CONGRATULATIONS.

#### YOU HAVE FOUND THE GOLD KEY.





#### YOU WILL HAVE TO SHOW YOUR PROJECTS ABOUT THE PERIODIC TABLE SHORTLY



SIDE QUEST: PREPARE A DOCUMENT ABOUT THREE ARTIFICIAL ISOTOPES AND ITS USES.









### YOU HAVE FOUND DOCUMENT 3



#### METALS

#### NON-METALS

- They are **shiny**.

- They are **good conductors** of both heat and electricity.

- They can be bent without breaking (they are **malleable** and **ductile**).

- They are **solid** at room temperature, except mercury, which is liquid.

- They are hard and strong.

- They have a high density.

- They tend to release electrons and become positive ions (**cations**).

- Examples: Sodium (Na), Iron (Fe), Copper (Cu).

- They are **dull** (not shiny).

- They are poor conductors of heat and electricity (they are **insulators**).

- They are weak and brittle

(quebradizo ,frágil). - They tend to catch

electrons and become negative ions (**anions**).

- Examples: Fluorine (F), Sulfur (S), Nitrogen (N).

#### **NOBLE GASSES**

- They are practically inert.

- All noble gases have the maximum number of electrons possible in their outer shell (2 for helium, 8 for all others) making them **stable**.

- They are used to provide an inert atmosphere and noble gases are used as a filler gas for light bulbs.

- They are Helium (He), Neon (Ne), Argon (Ar), Krypton (Kr), Xenon (Xe) and Radon (Rn).



ACTIVITY 12.- Identify the Lame or the symbol of these elements: S, K, Ag, Au, Mg, Al, Ca, P, CU, Zn, Hg, Helrum, carbon, Oxygen, Silicon, Silver, Mercury, Cobalt and Potassium.

ACTIVITY 12.- Identify the name or the symbol of these elements: S, K, Ag, Au, Mg, Al, Ca, P, Cu, Zn, Hg, Helrum, Carbon, Oxygen, Silicon, Silver, Mercury, Cobalt and Potassium.

S= Sulfur (Azufre) Ag= Silver (Plata) Mg= Magnesium (Magnesio) Ca= Calcium (Calcio) Cu= Copper (Cobre) Hg= Mercury (Mercurio) Carbon= C (Carbono) Silicon= Si (Silicio) K= Potassium (Potasio) Au= Gold (Oro) Al= Aluminum (Aluminio) P= Phosphorus (Fósforo) Zn= Zinc (Zinc) Helium= He (Helio) Oxygen= O (Oxígeno) Cobalt= Co (Cobalto)

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BOUND	ATOMS BOUNDED	ESTRUCTURE OBTAINED
COVALENT	Non-metal with Non-metal	Molecule or crystal structure
IONIC	Metal with Non-metal	Crystal structure
METALLIC	Metal with metal	Crystal structure







#### IONIC

Metal with Non-metal - They **dissolve** easily in **water** and other polar solvents.

- Dissolved in water or molten, they can **conduct electricity** because the crystal lattice has broken down and the ions can move. They cannot conduct electricity in solid state.

- They use to be **hard** and **solid** substances with high melting and boiling point due to the force of the electrostatic bonds.

#### COVALENT

Non-metal with Non-metal - They are very hard and have high melting and boiling points. - They do not

- They are

insoluble in all solvents.

#### METALLIC

Metal with metal

- They are **insoluble** in all solvents.
- They **conduct** electricity.

- They have variable melting and boiling points.





ACTIVITY 13.- Indicate the physical state at room temperature and the electric conductivity of these molecules:  $H_2$ ,  $Cl_2$ ,  $O_2$ ,  $N_2$  and  $NH_3$ .

ACTIVITY 14.- Indicate if these substances made by the following atoms will be molecules or crystals: a) Chloride and Calcium b) Sulfur and Hydrogen c) Nitrogen and Hydrogen d) Oxygen and Iron

**ACTIVITY 15.- Relate the following terms with the sentences:** 

AtomsMoleculesCrystalsa) Substances make only of non-metallic atoms.b) They are always solid at room temperature.c) They make the inert gasses.d) They are made of a big number of atoms.
### **DINING ROOM**

ACTIVITY 13.- Indicate the physical state at room temperature and the electric conductivity of these molecules:  $H_2$ ,  $Cl_2$ ,  $O_2$ ,  $N_2$  and  $NH_3$ .

Gasses. They are covalent substances.

ACTIVITY 14.- Indicate if these substances made by the following atomswill be molecules or crystals:a) Chloride and CalciumCb) Sulfur and HydrogenMc) Nitrogen and HydrogenMd) Oxygen and IronC

**ACTIVITY 15.- Relate the following terms with the sentences:** 

Atoms Molecules Crystals
a) Substances make only of non-metallic atoms.
b) They are always solid at room temperature.
c) They make the inert gasses.
d) They are made of a big number of atoms.

Molecules Crystals Atoms Crystals

# **DINING ROOM**

### NOW YOU CAN SOLVE THE PUZZLE OF THE KITCHEN.



YOU NEED THE GOLD KEY TO OPEN THIS DOOR







5

**KITCHEN: 5. CHEMICAL BONDS: MOLECULES AND CRYSTALS** QUESTION 1.-Why do you think that dissolved or molten ionic crystals are conductors of electricity and they are not when they are in solid state?

QUESTION 2.-Indicate which type of bonds will these pair of elements<br/>form:<br/>S and NaCl and OK and Fe

F and Ca

H and Cl

QUESTION 3.-Indicate if these substances are isolated atoms, molecules or crystals: Diamond, Helium, Nitrogen, Quartz, Carbon dioxide, Gold, Hidrogen, Common salt

### **QUESTION 4.-Indicate which substances are ionic or covalent:**

Substance	Solubility	Conductivity	Fusion temperature
А	YES	NO	700 °C
В	NO	NO	-80 °C
С	NO	NO	1250 °C

**KITCHEN: 5. CHEMICAL BONDS: MOLECULES AND CRYSTALS** QUESTION 1.-Why do you think that dissolved or molten ionic crystals are conductors of electricity and they are not when they are in solid state?

Because when dissolved, ionic crystals separates in ions and these ions can move freely when a voltage is applied.

**QUESTION 2.-Indicate which type of bonds will these pair of elements** 

form: S and Na	Ionic	Cl and O	Covalent	K and Fe Metalic
F and Ca	Ionic	H and Cl	Covalent	

QUESTION 3.-Indicate if these substances are isolated atoms, molecules or crystals: Diamond, Helium, Nitrogen, Quartz, Carbon dioxide, Gold, Hidrogen, Common salt

QUESTION 4.-Indicate which substances are ionic or covalent:

	Substance	Solubility	Conductivity	Fusion temperature
	А	YES	NO	700 °C
	В	NO	NO	-80 °C
24+	С	NO	NO	1250 °C

### CONGRATULATIONS.

### YOU HAVE FOUND THE CRYSTAL KEY.





### YOU ARE NEAR THE END OF THIS ADVENTURE. YOU CAN LEAD NOW TO THE SALOON AND SHOW YOUR PROJECTS.



SIDE QUEST: COMPLETE THE TASK OF THE PAGE 103 "THE CARBON FOOTPRINT".



YOU NEED THE CRYSTAL KEY TO OPEN THIS DOOR









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ACTIVITY 16.- Search for 5 solid elements at room temperature and indicate if they are metals or non-metals.

ACTIVITY 17.- Metals are ductile (they can be deformed and we can make wires with them). Based on this property, indicate if these substances are metals or not:



ACTIVITY 18.- Search on the Internet information that allow you to know which four elements are the most important in the living beings:

ACTIVITY 16.- Search for 5 solid elements at room temperature and indicate if they are metals or non-metals.

ACTIVITY 17.- Metals are ductile (they can be deformed and we can make wires with them). Based on this property, indicate if these substances are metals or not:



**CHONPS** 



YOU HAVE COMPLETE ALL THE RIDDLES OF MY MANOR. NOW, YOU WILL FACE THE FINAL TRIAL.

IF YOU CAN WRITE MY NAME IN YOUR EXAM, YOU WILL BE REWARDED.

# THE LAST DOOR



# THE LAST DOOR



## THE PHILOSOPHER'S STONE



#### THE PHILOSOPHER'S STONE

#### IF YOU HAVE DISCOVERED MY NAME, YOUR REWARD IS MY MAGNUS OPUS.

#### **MY PHILOSOPHER'S STONE**

THIS LEGENDARY SUBSTANCE ALLOW YOU TO EAT IN PHYSICS AND CHEMISTRY CLASSES AND YOU CAN CHOOSE YOUR PARTNER AND POSITION IN CLASS.