Worksheet for the use of the video Happy Atoms in a flipped classroom activity

Aims of the activity

This amusing video can be used to introduce students to the logic underlying different chemical bonds and to explain the meaning of a chemical formula.
Though it never mentions electronegativity, it can be a good starting point to explain such a concept in a simple, intuitive, manner.

The activity is divided into three moments:
1) Watch the video and answer some questions (at home, but also in class if you prefer)
2) Work on the periodic table to understand how ionic compounds are formed (in class – 1h)
3) Work on the periodic table to understand how covalent compounds are formed (in class – 1h)

Prerequisites for the activity

Students should already know:
- What atoms are and their basic features (atomic number and weight)
- The arrangement of electrons in shells around the nucleus and what the valence shell is
- The basic organization of the periodic table
- The difference between elements and compounds

FIRST ACTIVITY: WATCH THE VIDEO AND VERIFY YOUR COMPREHENSION

After having watched the video, answer the following questions:

1) *Match each of the following definitions to the **first, second or third** kind of chemical bond that you saw in the video*

a) Ionic bond: it arises when one atom donates one (or more) electrons to another one so that the two acquire net opposite charges that make them attract one another.

b) Covalent apolar bond: it is formed by two atoms which equally share one (or more) couple of electrons

c) Covalent polar bond: it is formed by two atoms which share one (or more) couple of electrons in an unbalanced way, so that they acquire partial opposite charges

2) *True or false*

a) Two atoms of the same element can form an ionic bond T F

b) Two atoms having the same number of electrons in their outer shell will not form an ionic bond T F

c) Two atoms of the same element can form a covalent apolar bond T F

3) *Choose the correct option.*

An atom is stable when:

a) It has 8 electrons

b) It has 1 electron in its outer shell

c) It has 8 electrons in its outer shell

d) It has 7 electrons

SECOND ACTIVITY: IONIC COMPOUNDS

1) T**he octect rule**
By collectively reviewing students' answers (particularly reflecting on question n. 3) it will come natural to derive the rule.

2) **Which are the most stable ones?**
Students can now be invited to find the most stable elements on the periodic table, according to the rule (noble gases).

3) **What about the others?**
Students can be invited to find the easiest way for the other elements to "resemble" noble gases (for this phase choose elements of the first, second, third, sixth and seventh group, the pronest to give away or acquire electrons).
Examples: **Li, Ba, S, Al, I**

4) **Who gives and who takes?**
Now provide the students with couples of elements usually forming ionic bonds and ask them to establish which of the two will donate the electrons and which will accept them. Ask them also how many electrons will be passed or accepted by each atom and, consequently, which ions will be formed.
Examples: **Na and F,**
K and O,
Mg and O,
Ca and Cl,
B and F,

5) **It must be neutral: the chemical formula**.
Starting from the obtained results students are now invited to write the chemical formulas of their compounds, balancing the ratio between negative and positive charges.

THIRD ACTIVITY: COVALENT BONDS

It could be useful to watch the video again in class, before starting the activity.

1) **Do elements always exchange electrons?**
Let your students recall the other kind of bond they have been shown in the video (covalent bond) and its different features, comparing it to the ionic bond (sharing vs donation)

2) **How do elements "choose" one bond or another?**
Drive the class discussion so that students eventually come to the intuitive concept that atoms of various elements have different abilities to attract electrons: if you combine a "strong" atom with a "weak" one they will exchange electrons forming an ionic bond; but if their strength is comparable, no one wins this sort of tug-of-war and the only solution is sharing electrons.

3) **How do I decide which kind of bond will be formed?**
It's time to simply introduce electronegativity as a measure of an atom ability to attract the bond electrons.
Let students notice on the periodic table which elements are more or less electronegative. Now keep again the couple of elements you have used for point n.4) in the second activity and ask your students to calculate the difference between the electronegativity of the two elements in every ionic compound.

Examples:	**Na and F in NaF**	**3.98 – 0.93 = 3.05**
	K and O in K_2O	**3.44 – 0.82 = 2.62**
	Mg and O in MgO	**3.44 – 1.31 = 2.13**
	Ca and Cl in $CaCl_2$	**3.16 – 1.00 = 2.16**
	B and F in BF_3	**3.98 – 2.04 = 1.94**

You can now state a threshold value (1.8) for such electronegativity difference for the formation of an ionic bond.

4) **What happens below such threshold?**
Give your students couples of elements for which the difference in electronegativity is very small, and let them conclude that they will form covalent bonds (apolar, in this case).

Examples: **C and H**
C and S
H and P
H and As

Now give them couples of elements for which the difference in electronegativity is intermediate, and let them conclude they will form a polar covalent bond.

Examples: **H and O**
P and O
H and F
Si and O