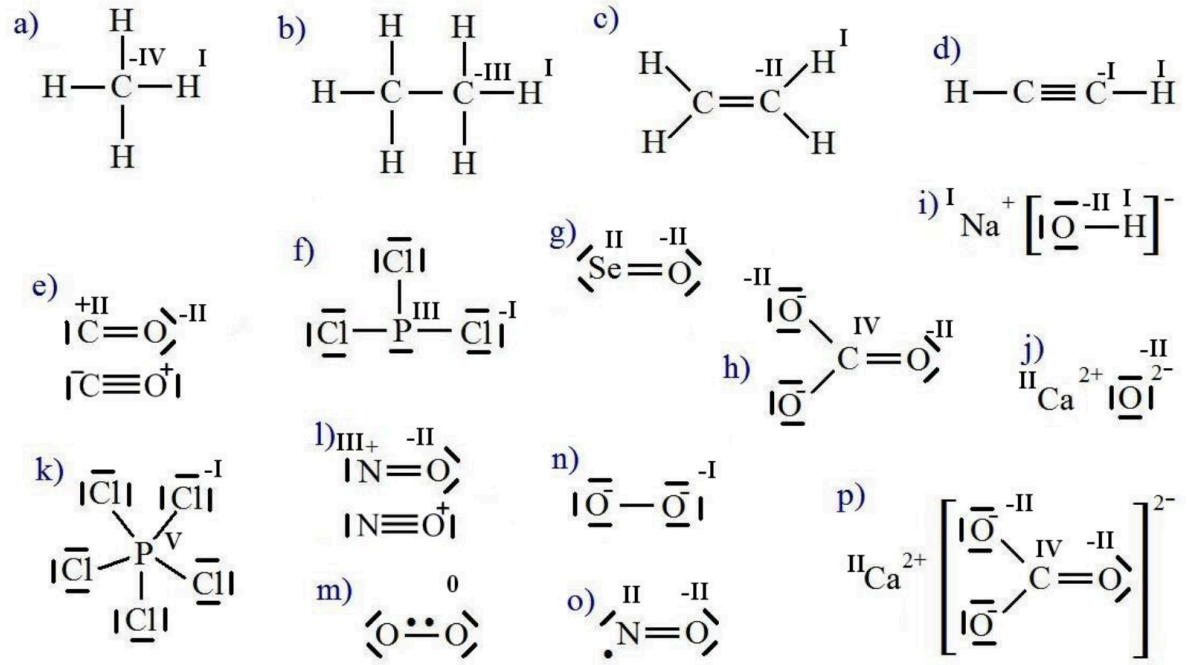
Exercises 6

Exercise 6.1

Give the Lewis formulas of the following molecules and ions and indicate the oxidation numbers of the atoms.

a) CH_4	*b*) C_2H_6	*c*) C_2H_4	*d*) C_2H_2
e) CO	*f*) PCl_3	*g*) SeO	*h*) CO_3^{2-}
i) NaOH	*j*) CaO	*k*) PCl_5	*l*) NO^+
m) O_2	*n*) O_2^{2-}	*o*) NO	*p*) $CaCO_3$

Solution:



When the oxidation number is given only once, it means that elements of the same type have the same oxidation number.

Species k) do not respect the octet or duet rule. For species m), O_2, Lewis structures do not allow both the double bond and the biradical character to be represented. This is one of their limitations.
Species i), j) and p) have ionic bonds.
Two possibilities have been drawn for species e) and l).
One of these possibilities violates the octet rule, but the other places a positive formal charge on O (the oxidation numbers remain the same) and implies a triple bond for this atom. Neither of these possibilities is therefore ideal, but we generally prefer the one that respects the octet rule for elements in the first two periods. This is another example of a limitation of Lewis structures.

Exercise 6.2

In general, which is more easily polarizable, an anion or a cation?

Solution:
An anion is generally larger than a cation, so it has a larger electron cloud. The latter therefore deforms more easily, and an anion is generally more easily polarizable than a cation.

Exercise 6.3
Without looking up the electronegativities, but based on the trends of the periodic table, which atom(s) attract electrons the most in the following molecules: CO_2, NO, LiH, HCl, BF_3.

Solution:
The trends for electronegativities are: 1) a continuous decrease going left and down the periodic table, 2) F therefore has the greatest electronegativity.
So the atom that attracts the most electrons is:
O (more to the right than C) for CO_2 ;
O (more to the right than N) for NO;
H (higher than Li) for LiH;
Cl (more to the right than H) for HCl;
F (the most electronegative element) for BF_3.

Exercise 6.4
What type of bond do you expect for the following substances: 1) NaBr, 2) P_4, 3) SiO_2 and 4) $CaCl_2$?

Solution:
The atoms of 1) and 4) differ widely in their electronegativity. The bonds are therefore ionic. In 2) and 3), the electronegativities are close (identical for 2). Their bonds are therefore covalent.

Exercise 6.5
What type of bond do you expect in an alloy of titanium and zinc?

Solution:
Zinc and titanium have low and comparable electronegativities. There will therefore be metallic connections between the atoms. (A metallic bond involves a very large number of atoms, on the order of several million.)

Exercise 6.6
Which of the following molecules and ions are radicals? Nitric oxide NO, dioxygen O_2, ammonia NH_3, peroxynitrite $ONOO^-$, lime CaO and superoxide ion O_2^-.

Solution:
Just count the number of valence electrons. If this is odd, which is the case for NO and O_2^-, we have a radical. Peroxynitrite $ONOO^-$, an isomer of nitrate, has an even number of electrons and it is not a radical. O_2 is a special case, it is a biradical. The oxygen atom has two single electrons, its electronic configuration is $[He]2s^2 2p_x^2 2p_y^1 2p_z^1$.