

George Tucker

18/01/2021

This is placeholder text to assist in the turnitin submission of Chemistry exam - please disregard if not important

Exam held on 18/01/20201

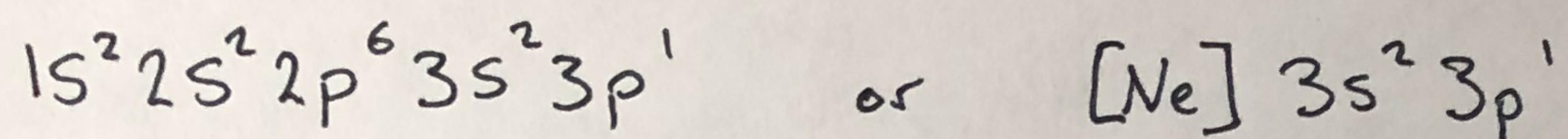
By George Tucker

Student Number: 1906898

- 1.) Within the nucleus of an atom are the nucleons; protons and neutrons. The proton has a relative charge of +1 whilst the neutron carries no charge.

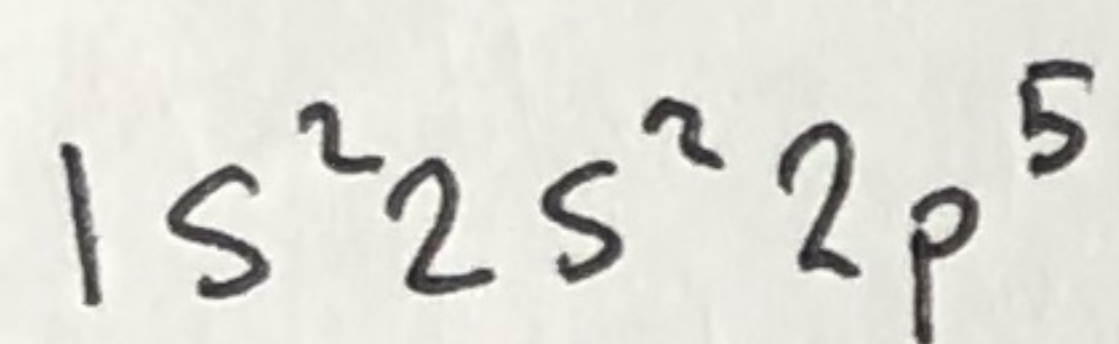
For an element within the periodic table, the atomic number is equal to the number of protons in the nucleus. This dictates the element (an atom with atomic number 1 will always be hydrogen). The mass number is the total number of nucleons in the nucleus (protons + neutrons). An isotope is an atom that has a different number of neutrons within the nucleus, and therefore, a different mass number. For example, Hydrogen and its isotopes deuterium and tritium: ${}^1_1\text{H}$, ${}^2_1\text{H}$, ${}^3_1\text{H}$, respectively.

2.) Aluminium has 13 protons and will have 13 electrons. Its electronic structure would then be:



Aluminium has 3 electrons in its outer shell, which it can lose in order to reach the nearest full shell configuration - that of neon. Therefore, it has a valency of +3

Fluorine has 9 protons and will have 9 electrons. So its electronic structure will be:



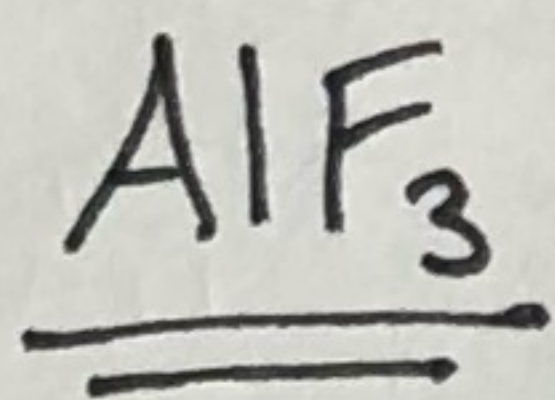
Fluorine needs to obtain 1 electron to achieve a full outer shell. Therefore, it has a valency of -1.

Aluminium fluoride.

Al will form Al^{3+} as valency is 3.

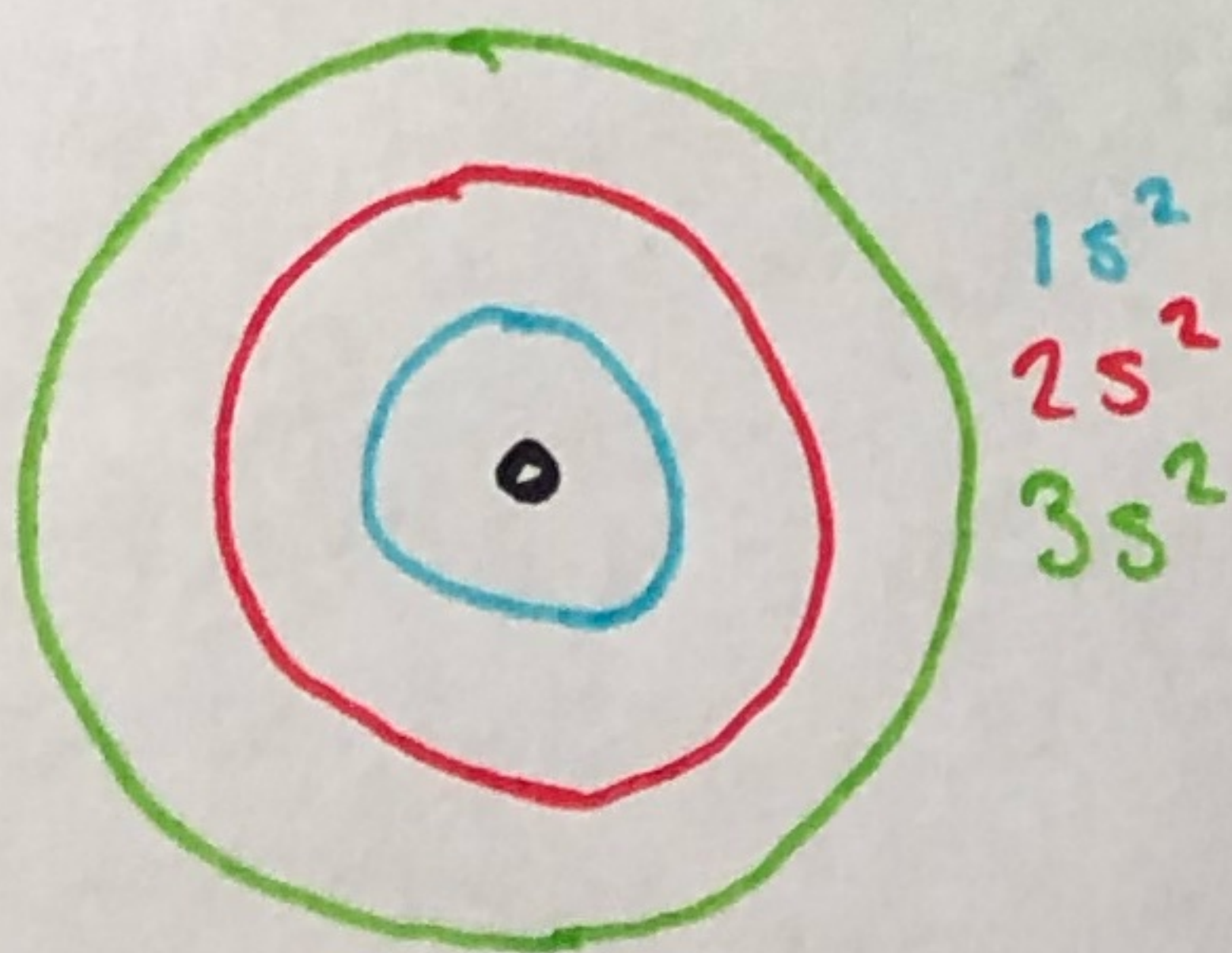
F will form F^- as valency is -1

To balance charges, aluminium fluoride formula will be:



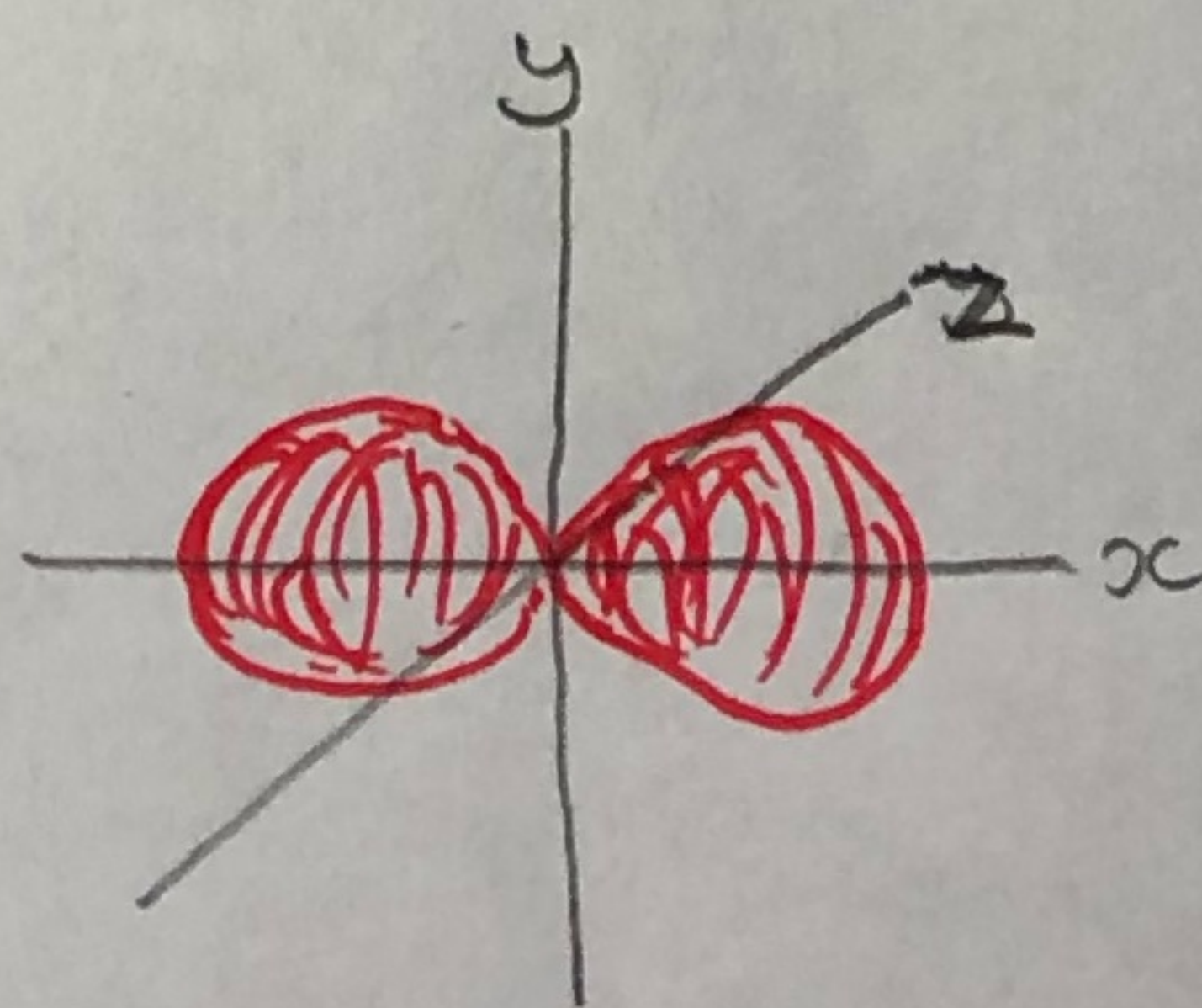
3.) Al electronic config: $1s^2 2s^2 2p^6 3s^2 3p^1$

S sub shells:



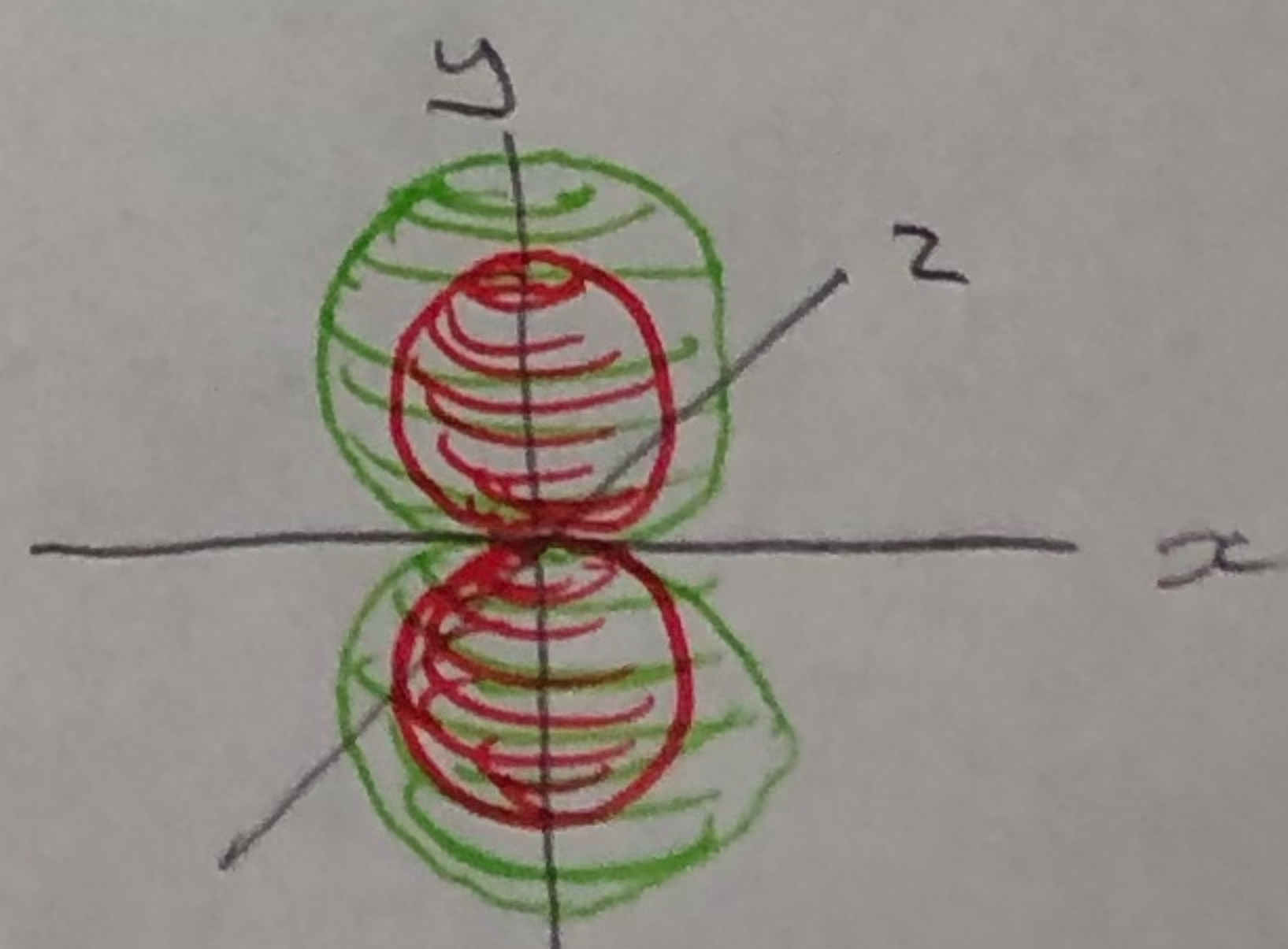
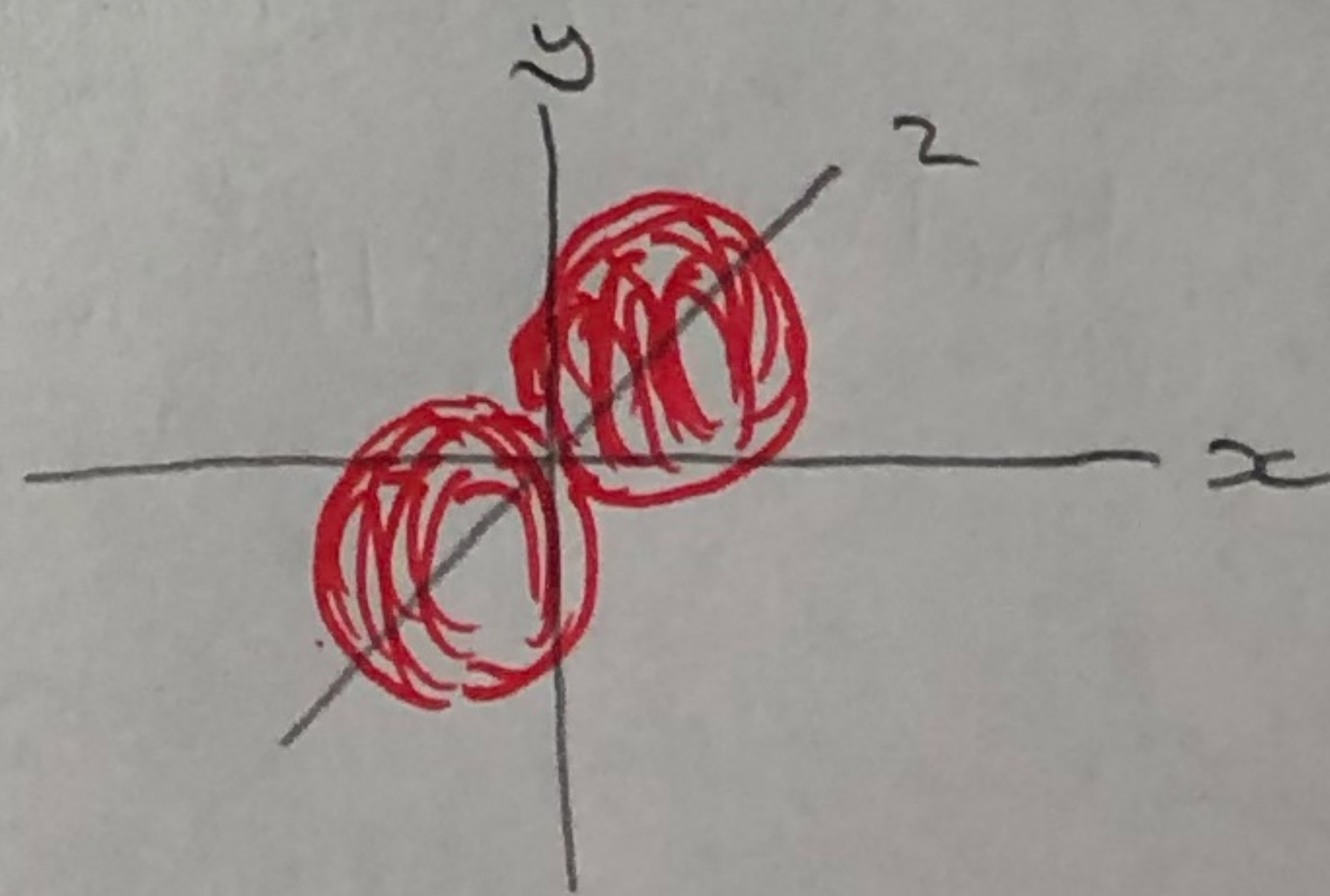
S sub shells are spherical, all diagrams indicate areas of space where electrons are likely to be found.

P sub shells:



2 p subshells,
6 electrons

3 p subshell
1 electron

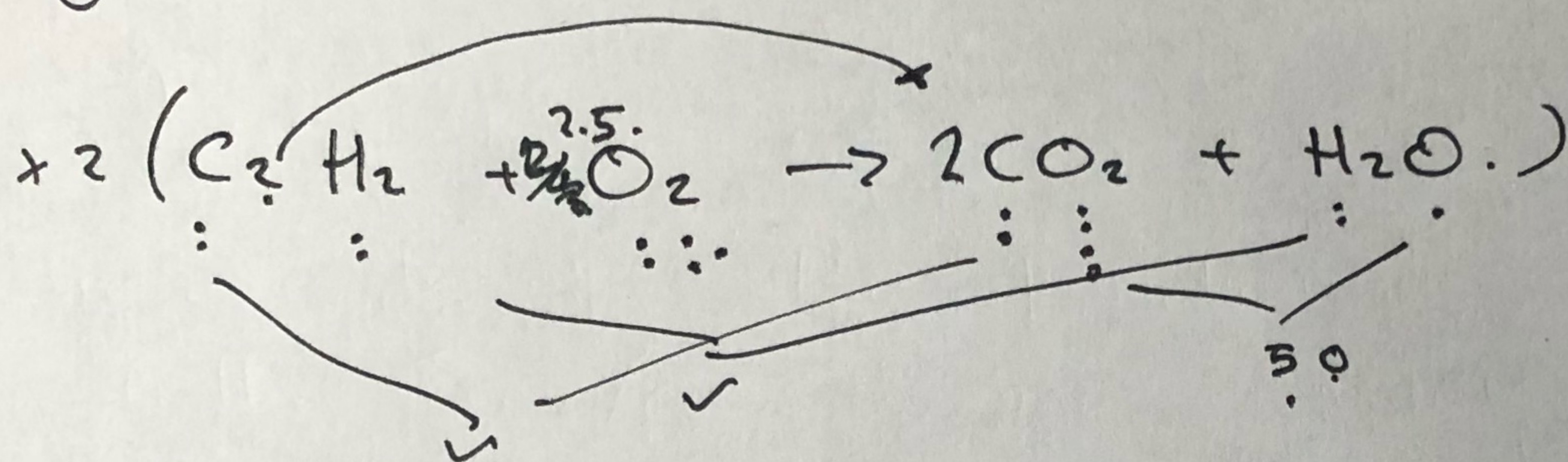


4.) The heat of formation for a compound (ΔH_f°) is defined as the enthalpy change when 1 mole of a compound is formed from its elements under standard conditions, with all products/reactants in their standard states.

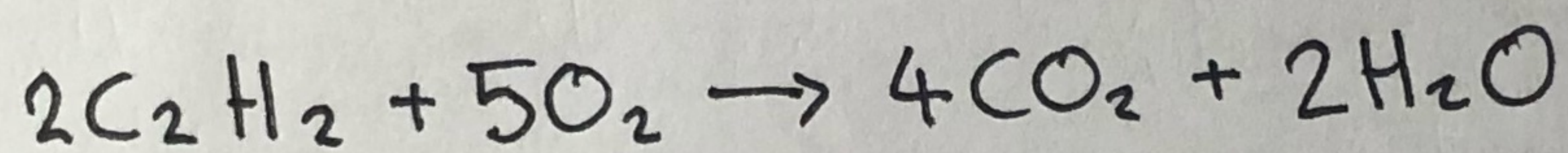
An endothermic reaction is one that absorbs heat from its surroundings. It is indicated by positive ΔH values.

An exothermic reaction is one that releases heat to its surroundings. It is indicated by negative values for ΔH of a reaction.

Acetylene: C_2H_2 .



balanced equation for acetylene:



$$\Delta H = \Delta H_f \text{ products} - \Delta H_f \text{ reactants.}$$

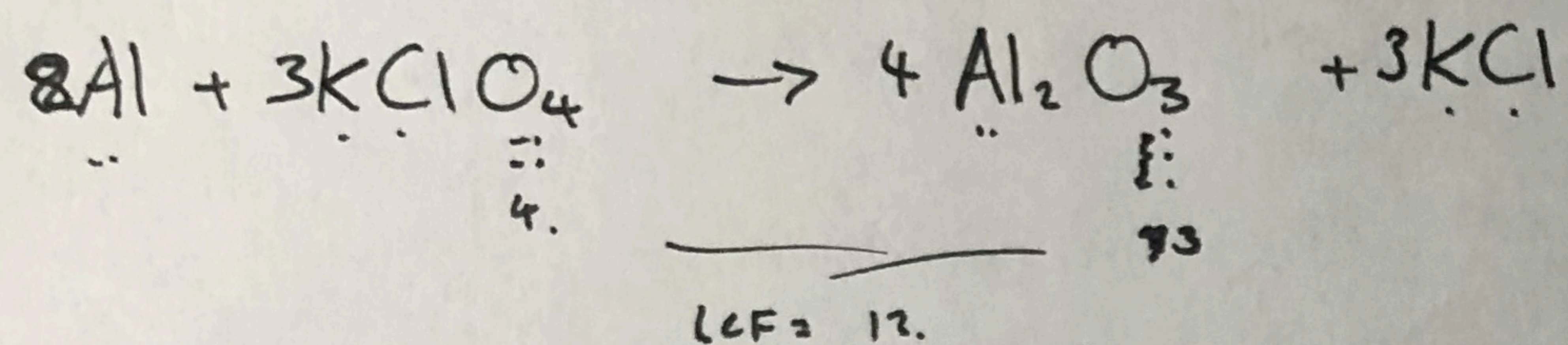
$$= \underbrace{(4 \times -393.5) + (-241.8 \times 2)}_{\text{products}} - \underbrace{2 \times 227}_{\text{reactants.}}$$

$$= -2057.6 - 454$$

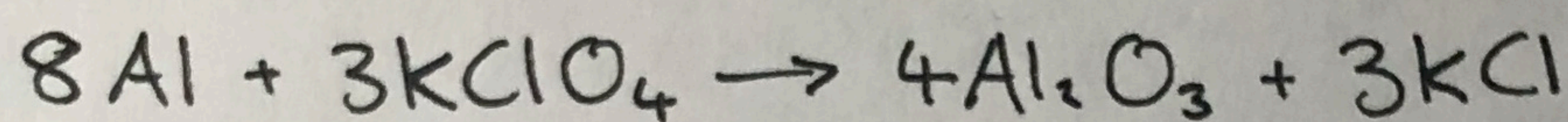
$$= -2511.6 \text{ kJ}$$

5.) Stoichiometry is the expression of the ratios of different products/reactants in a chemical reaction.

This affects reactions such as acetylene combustion as if there is not enough oxygen compared to acetylene, for example then incomplete combustion will occur. Different products such as CO or C may be produced, and less energy may be released.



Balanced reaction:

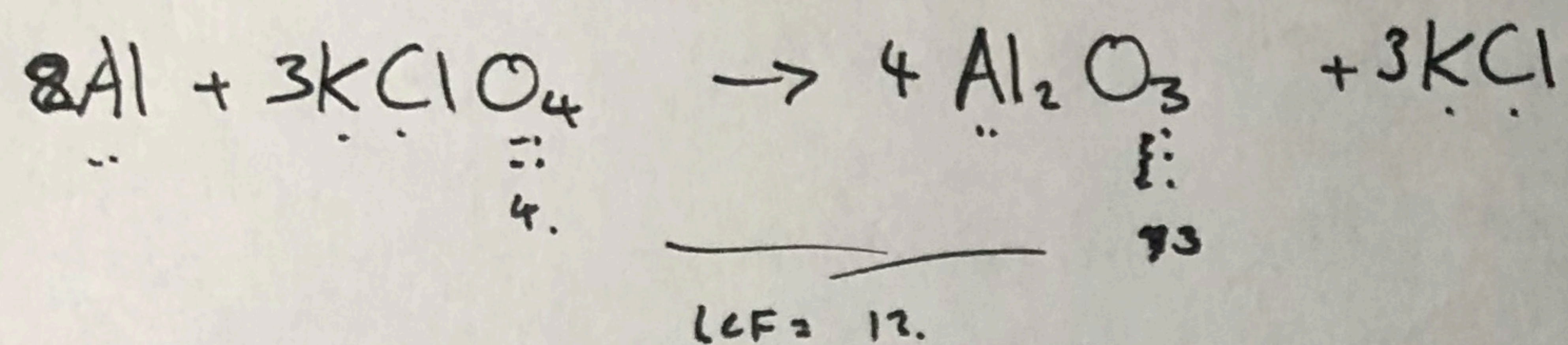


% of Al:

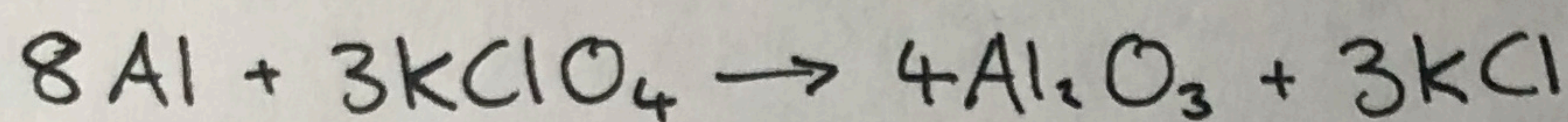
$$\begin{aligned} & \frac{27 \times 8}{27 \times 8 + 3 \times (39 + 35.5 + (4 \times 16))} \times 100 \\ &= \frac{261}{261 + 3 \times (138.5)} \times 100 \\ &= \frac{261}{261 + 415.5} \times 100 \\ &= 38.58\% \end{aligned}$$

5.) Stoichiometry is the expression of the ratios of different products/reactants in a chemical reaction.

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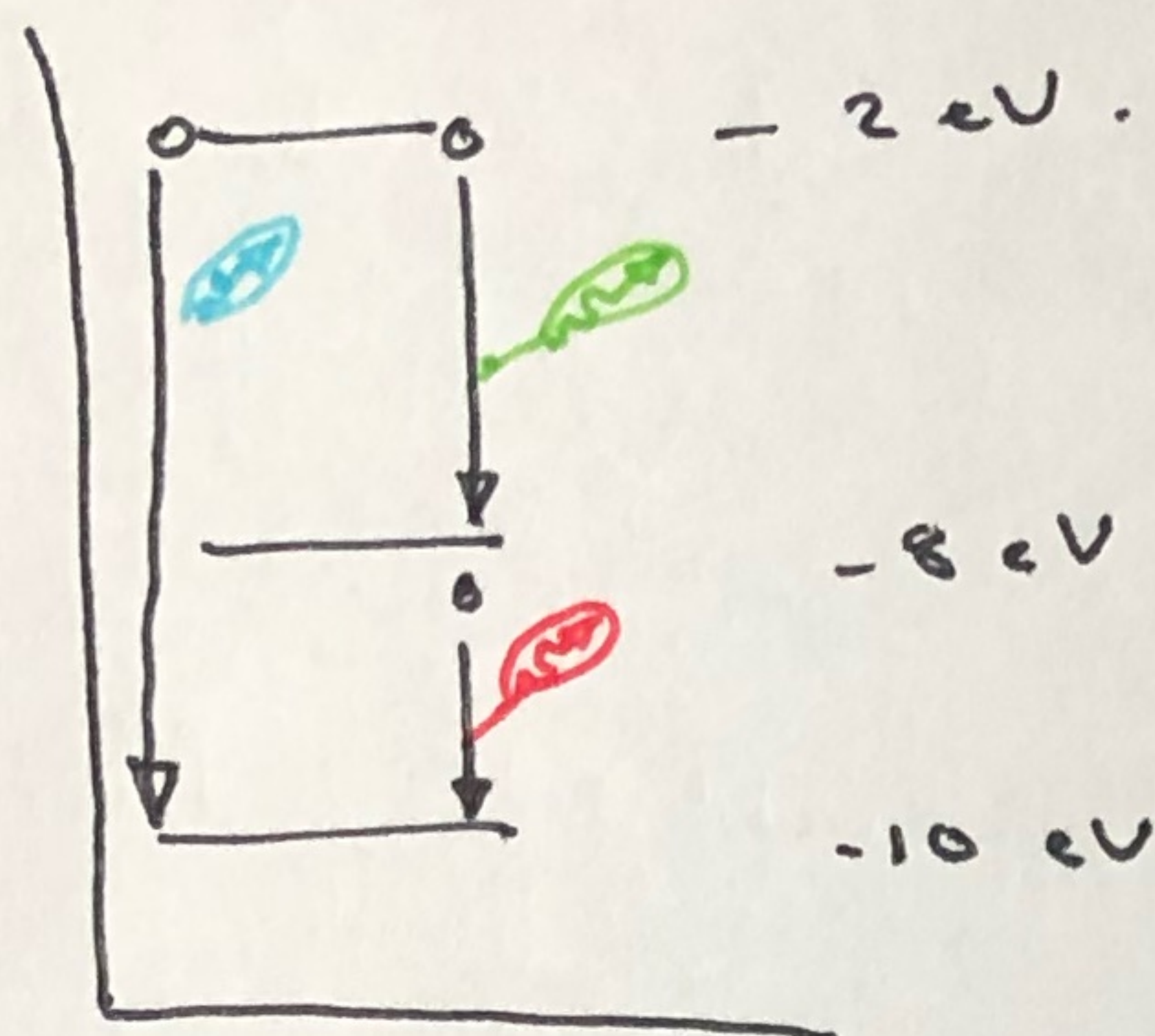
Balanced reaction:



% of Al:

$$\begin{aligned} & \frac{27 \times 8}{27 \times 8 + 3 \times (39 + 35.5 + (4 \times 16))} \times 100 \\ &= \frac{261}{261 + 3 \times (138.5)} \times 100 \\ &= \frac{261}{261 + 415.5} \times 100 \\ &= 38.58\% \end{aligned}$$

6.) The origins of lines observed is the release of photons of certain frequencies by atoms de-exciting. When atoms de-excite towards a ground state, electrons move through discrete energy levels whilst simultaneously releasing a photon. The two are linked by the equation $\Delta E = hf$.

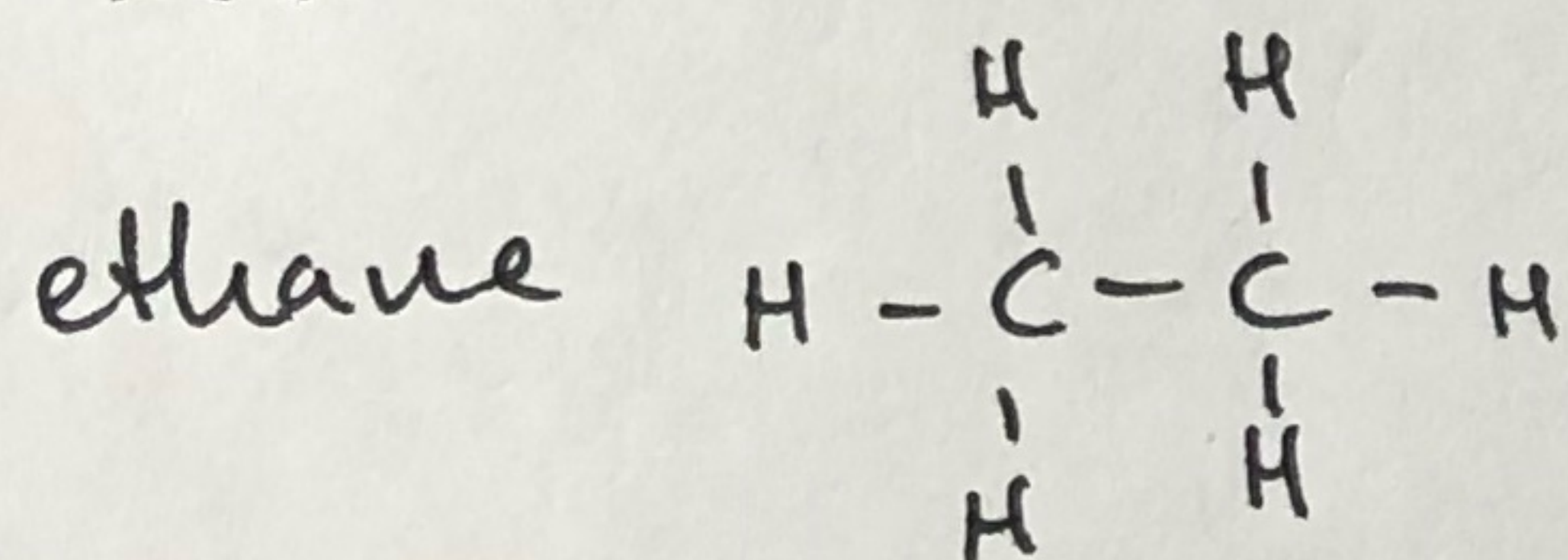


Different atoms have different energy levels and, therefore, emit different line spectra.

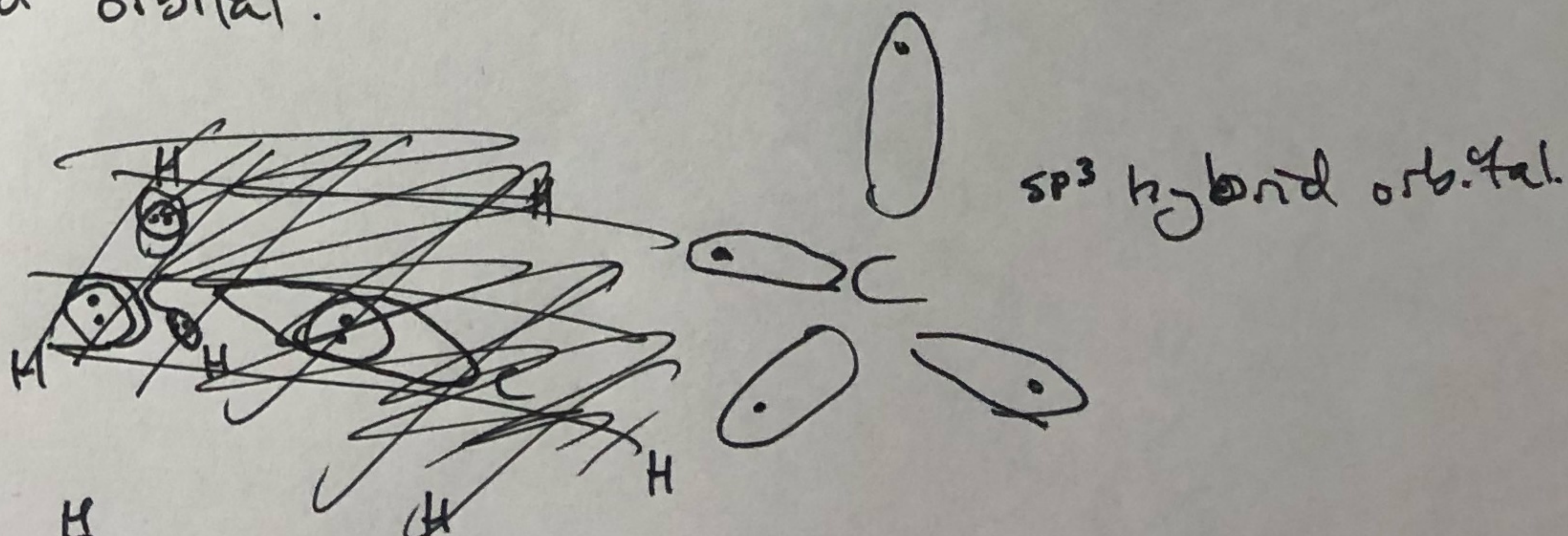
Barium, Strontium and Sodium can produce lines in the visible spectrum allowing them to be used in pyrotechnic/illuminating compositions.

These lines could be enhanced by affecting the temperature of reaction and reducing the amount of black body radiation produced through heat.

7.) Alkane:

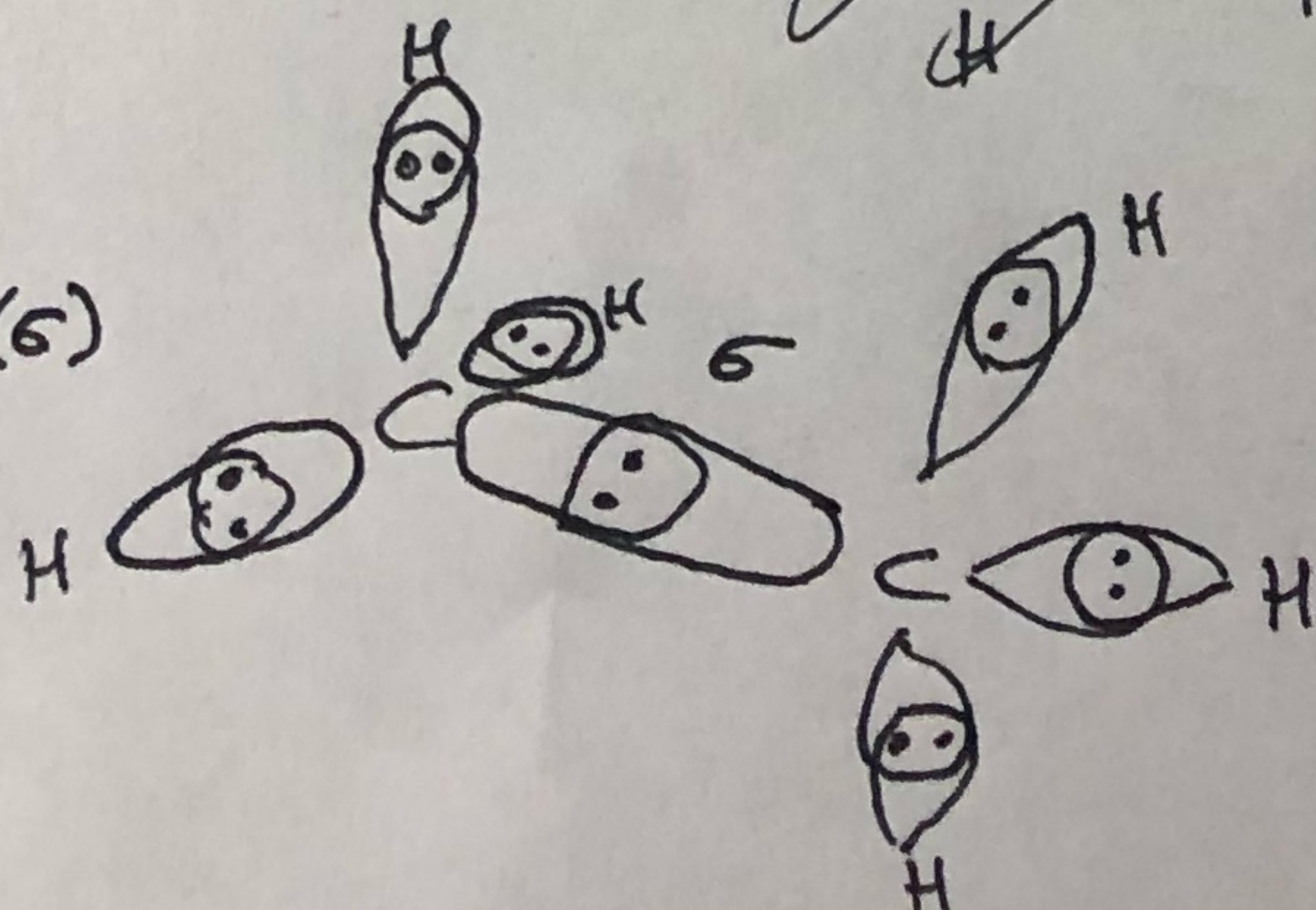


has an sp^3 hybrid orbital:

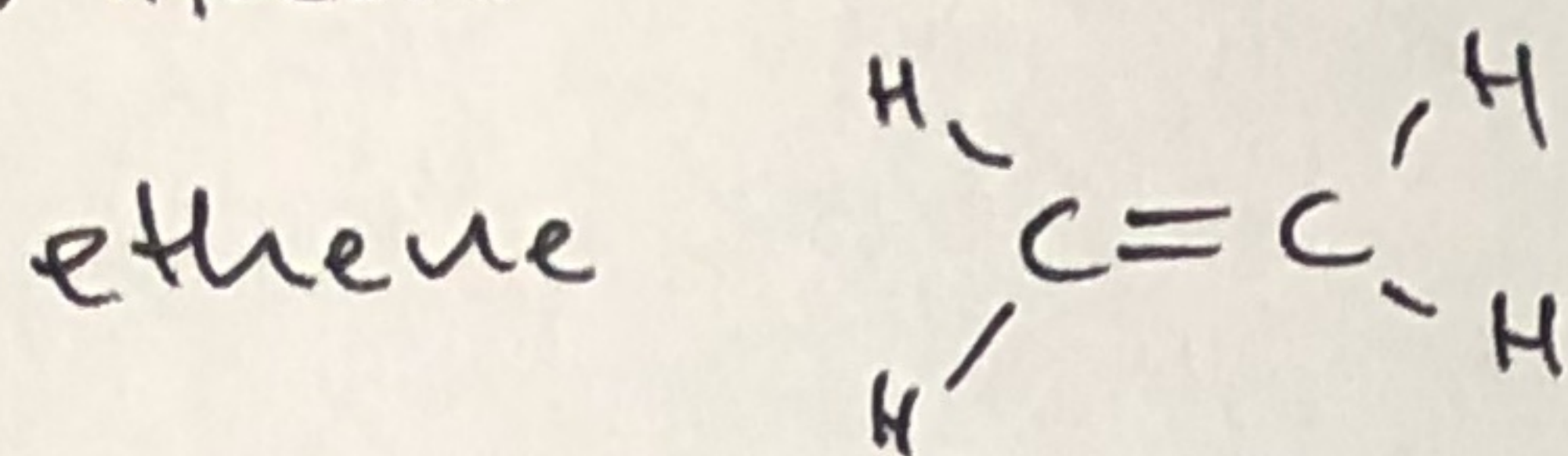


sp^3 bonding in ethane:

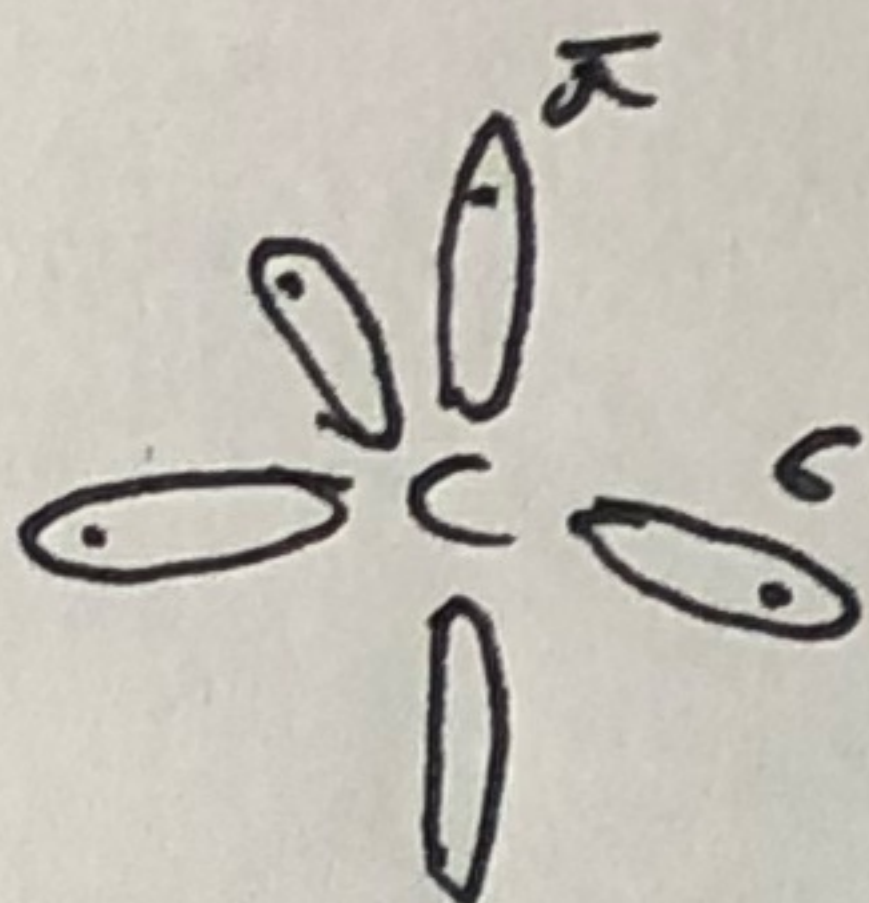
consists of sigma (σ) bond between carbon atoms,



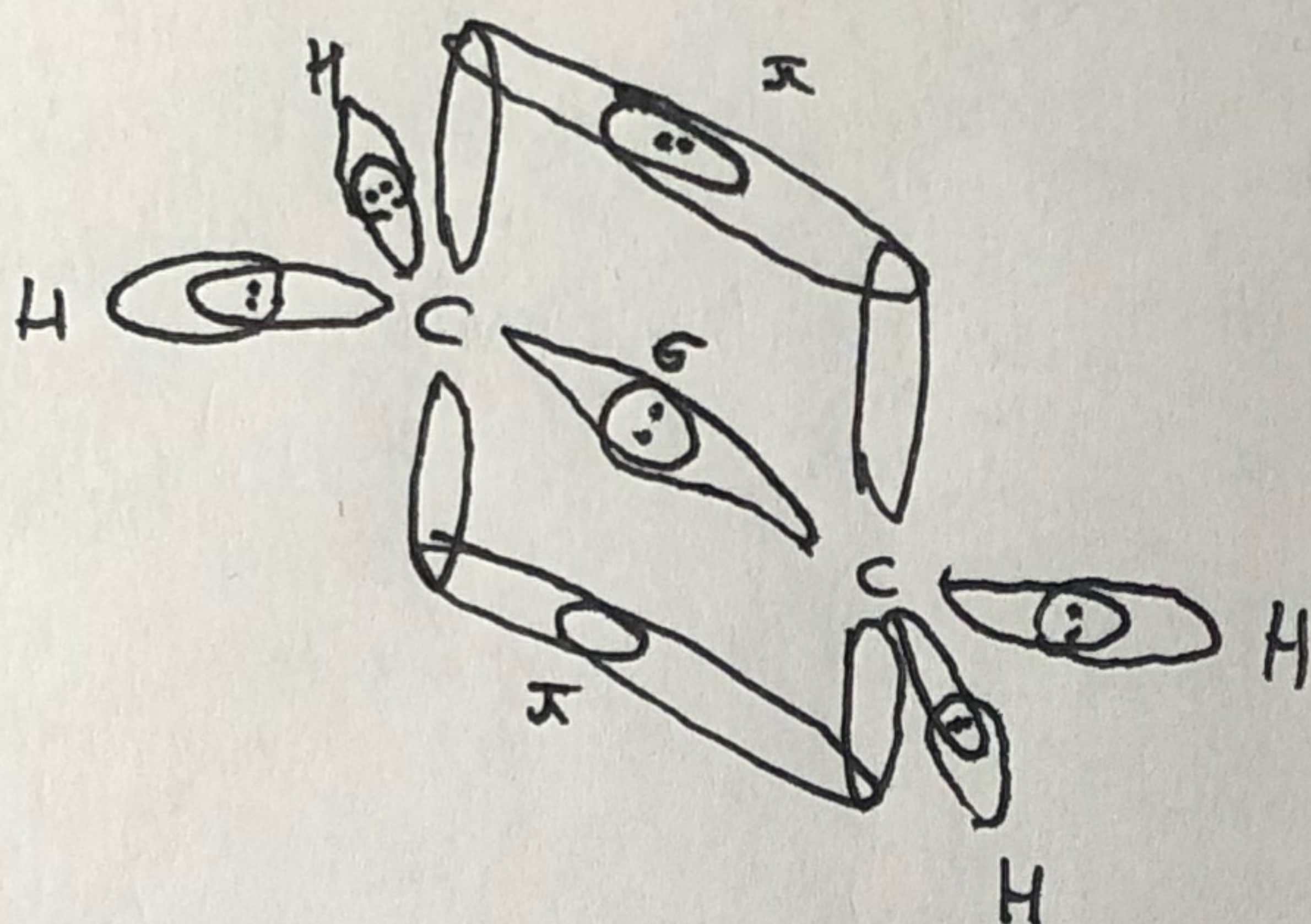
7.) Alkene:



alkenes contain sp^2 hybrid orbitals:

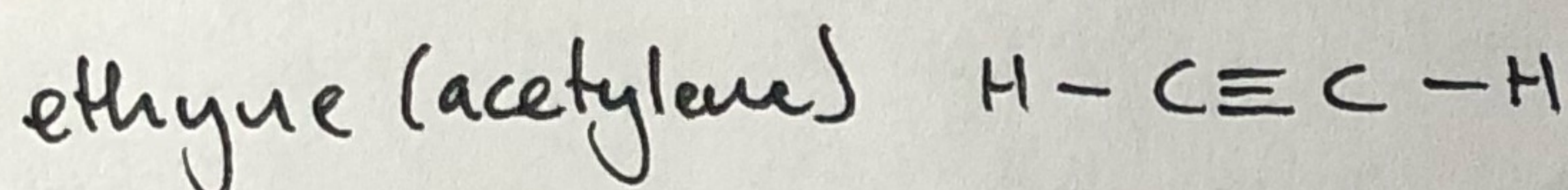


example in ethane:

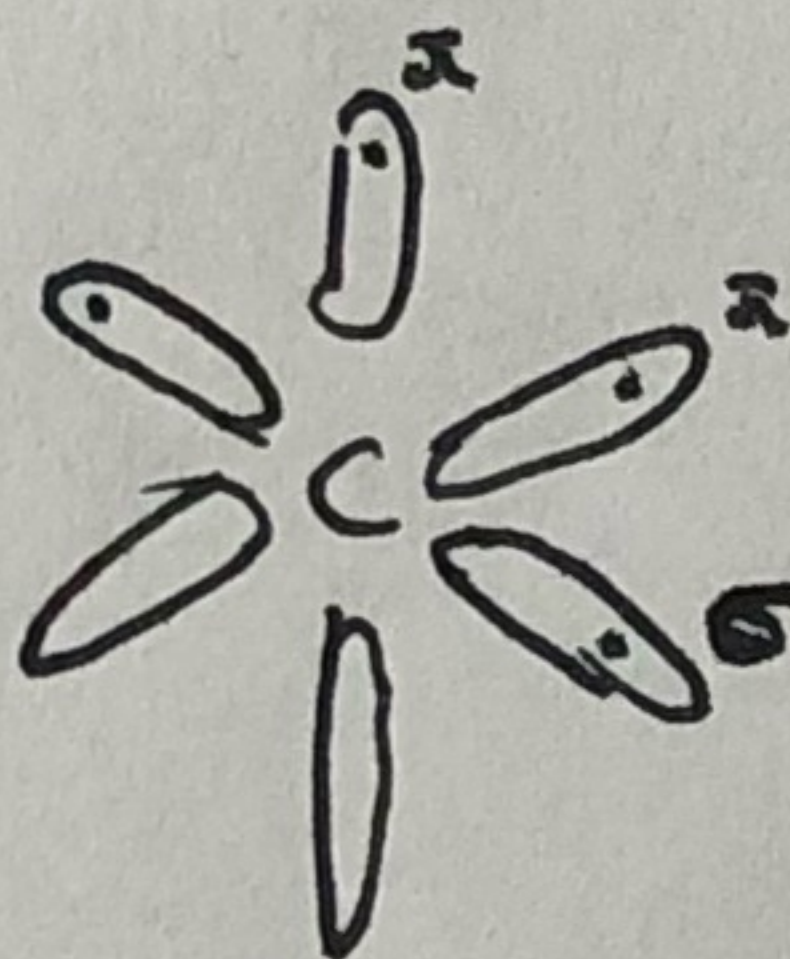


The sp^2 hybrid orbital consists of 1 sigma σ bond and 1 pi (π) bond between atoms. This pi bond can appear above or below the sigma bond.

Alkyne:

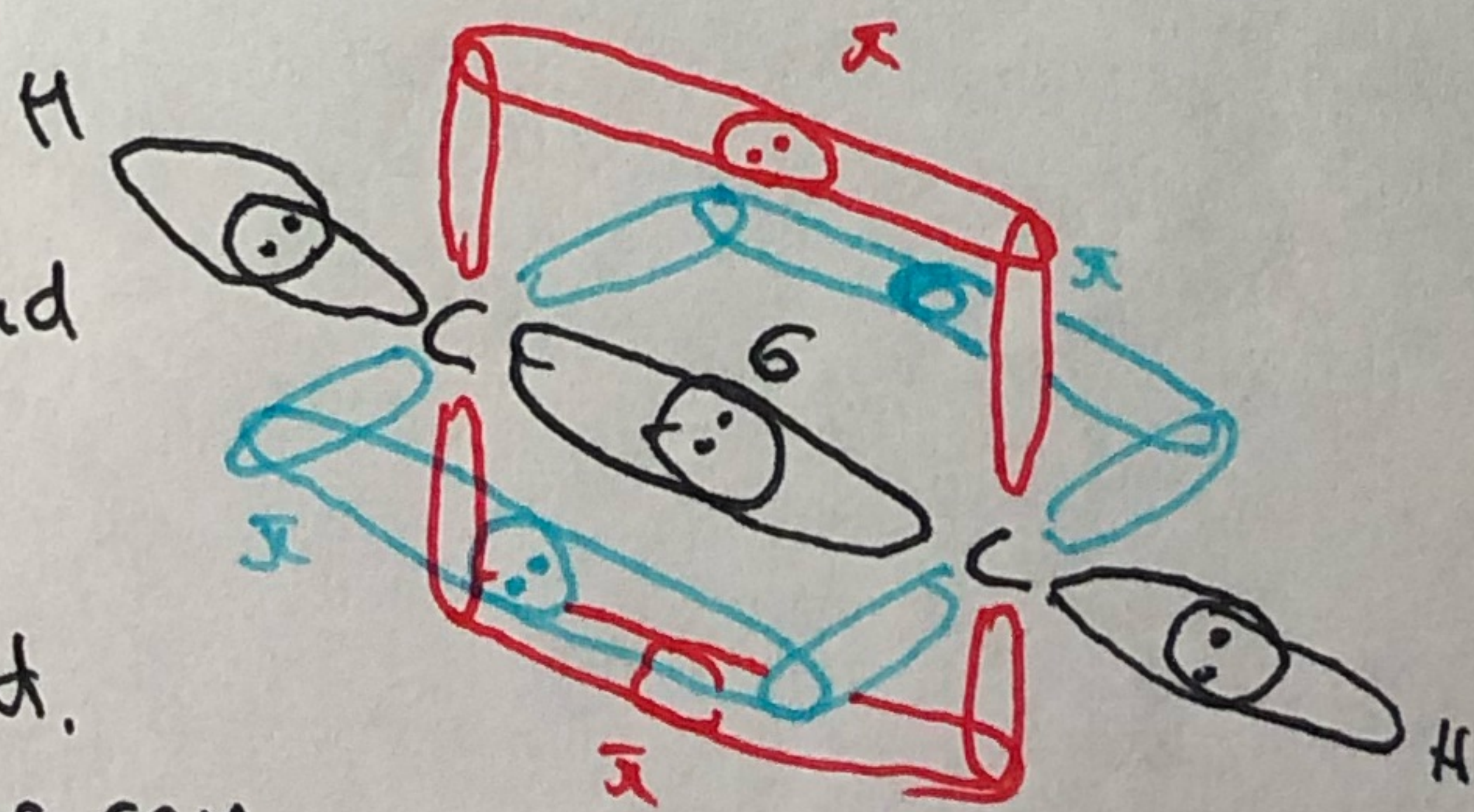


alkynes contain sp hybrid orbitals:

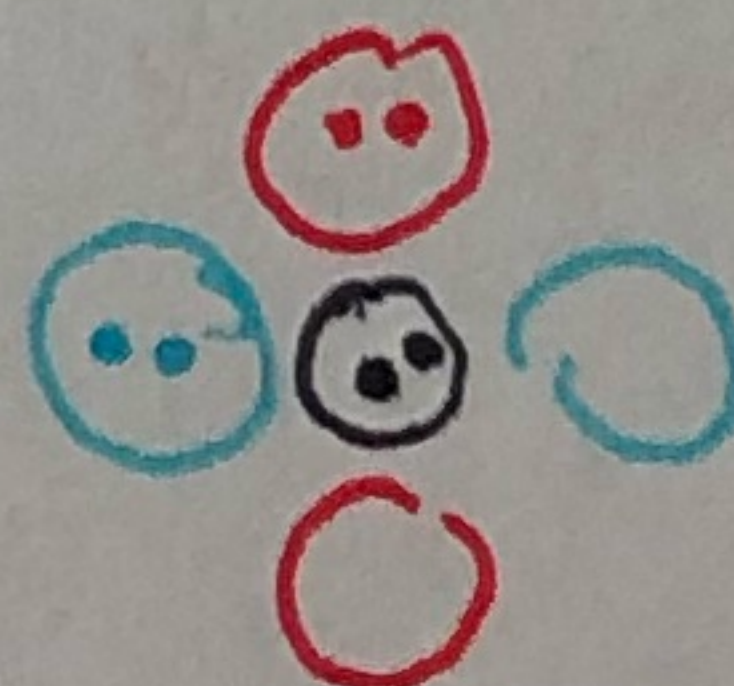


example in ethyne:

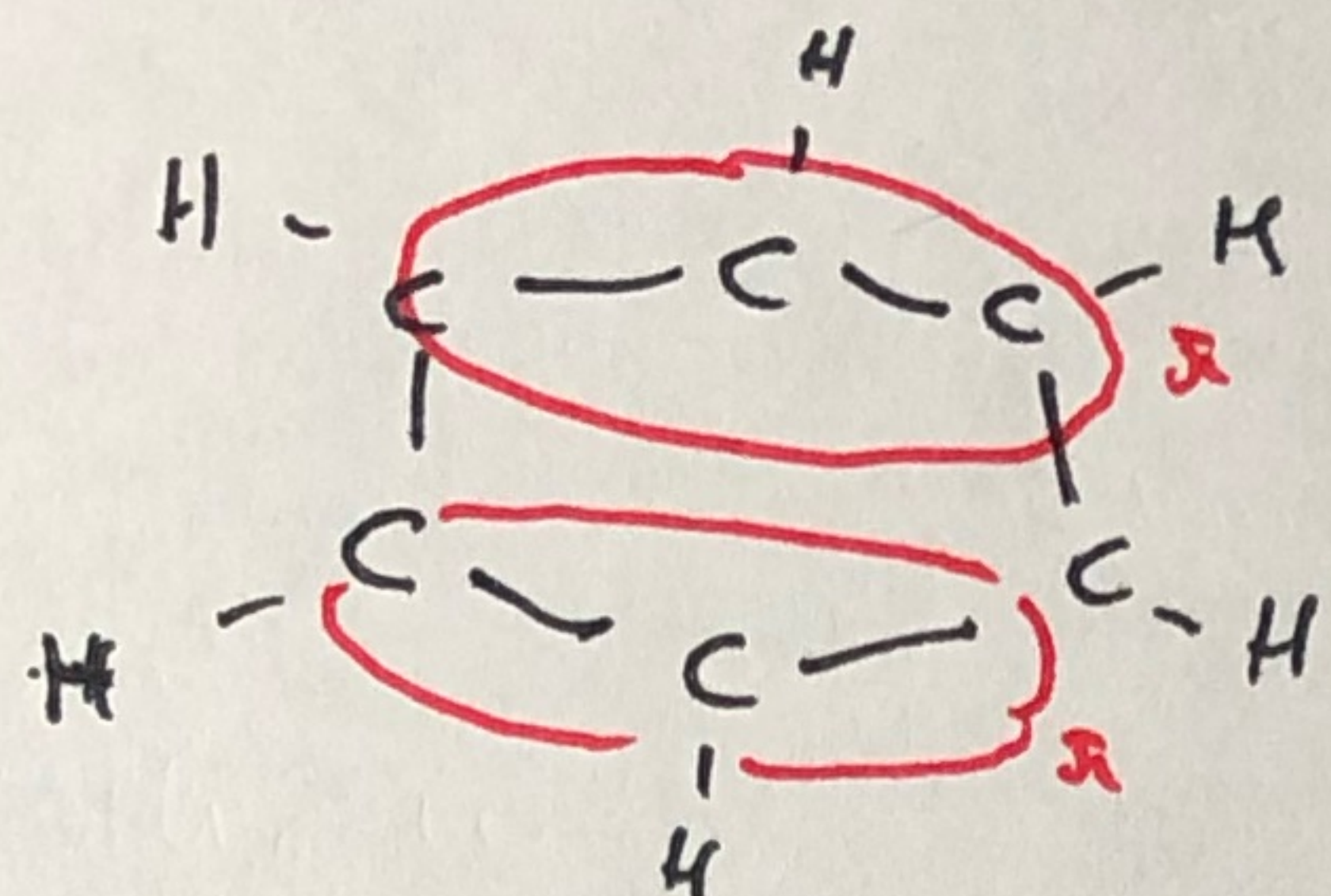
sp hybrid orbital consists of 1 sigma bond and 2 pi bonds. One can appear above or below the sigma bond, whilst the other one can appear to the left or right of it.



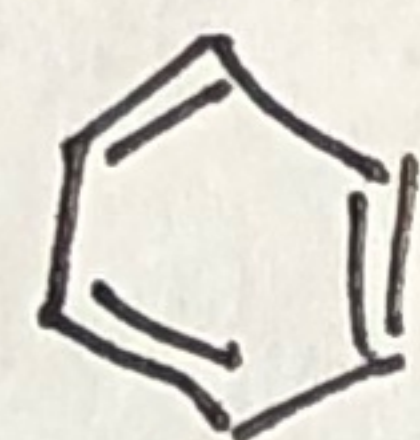
end view:



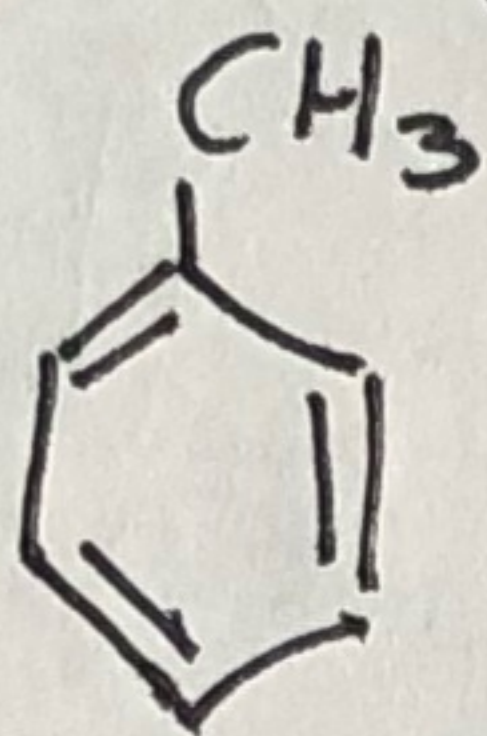
7.) Benzene consists of a ring of 6 carbon and hydrogen atoms. The carbon atoms are bonded with a sigma and pi bond. However the pi bonds form a ring of de-localised electrons above or below the structure:



~~The~~ Toluene is a benzene ring with one of the hydrogens substituted for a methyl group (CH_3).

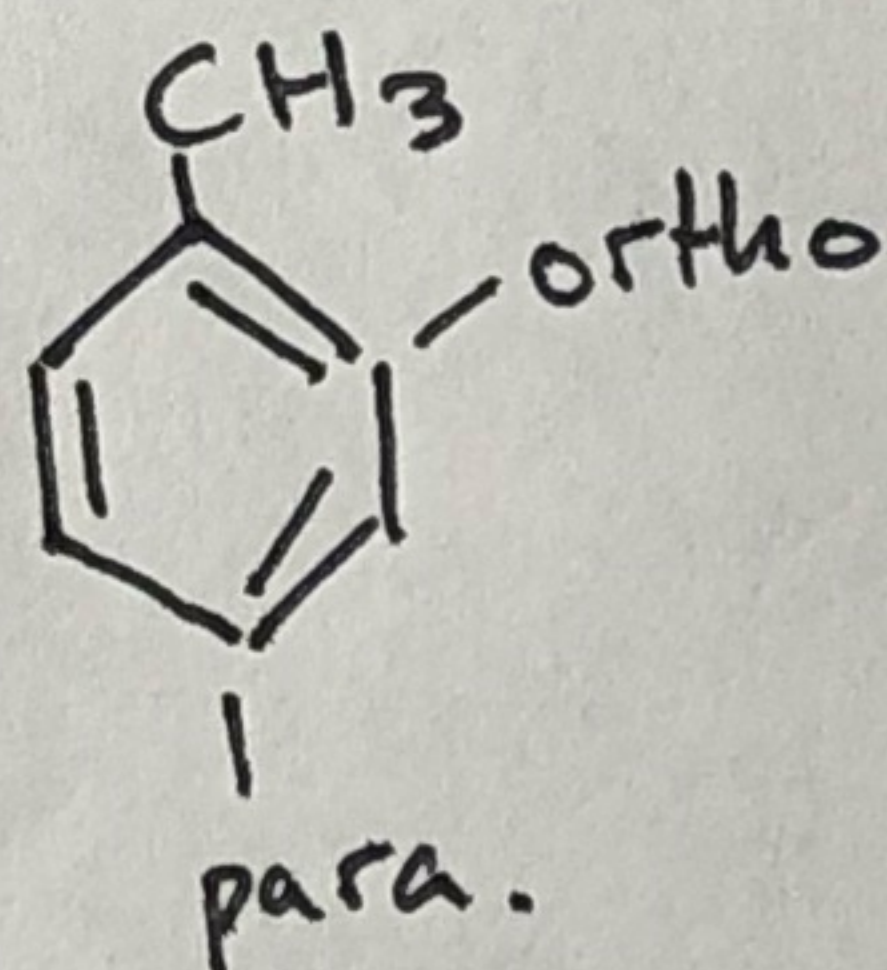


Benzene.



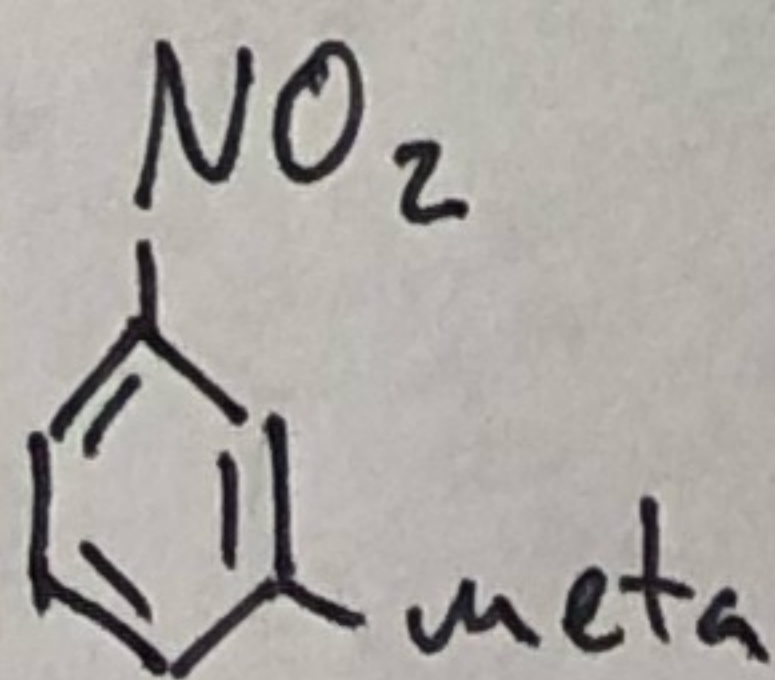
Toluene.

Introduced groups on the ring can affect further substitutions by affecting the charge of the benzene ring. Making it more likely for electrophilic attack in certain areas. CH_3 is electron inducting and will make carbons in the ortho/para locations more negative.



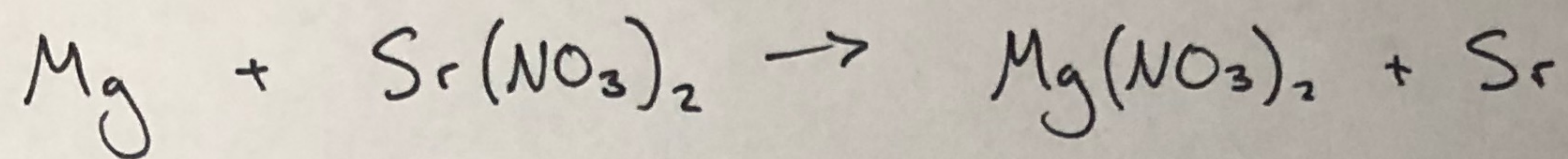
- CH_3 ortho/para directing.

NO_2 is electron withdrawing and will make carbon atoms in the meta location more negative, increasing the likelihood of electrophilic substitution at these areas.



- NO_2 is meta directing.

8.) An explosive molecule contains both fuel and oxidiser within itself. A pyrotechnic composition contains fuel and oxidiser within separate ingredients within the composition.



$$\frac{24.3}{24.3 + 87.62 + (2 \times (14 + 48))} \times 100$$

$$= \frac{24.3}{235.62} \times 100$$

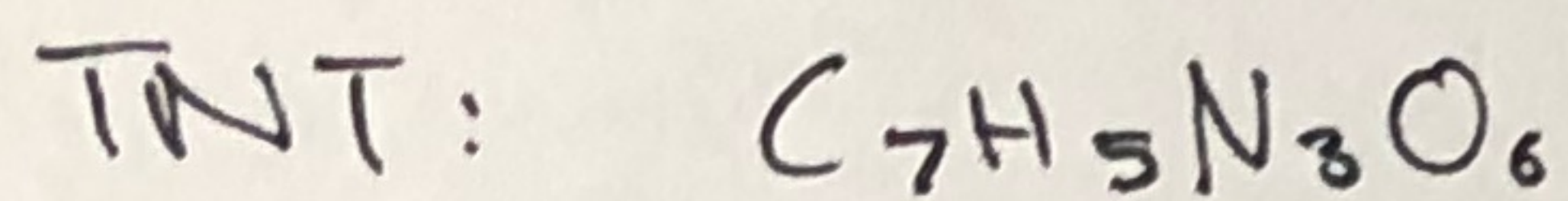
$$= 10.19\% \text{ Mg and therefore } 89.81\% \text{ Sr}(\text{NO}_3)_2 \text{ by weight.}$$

Other factors affecting rate of reaction of mixture:

- Temp of reaction - higher temps increase reaction time.
- Particle sizes - smaller particles have greater collective surface area increasing reaction time.
- Particle shape - jagged particles increase surface area compared to smooth particles.
- Degree of mixing - proximity of reactants next to each other may increase reaction.

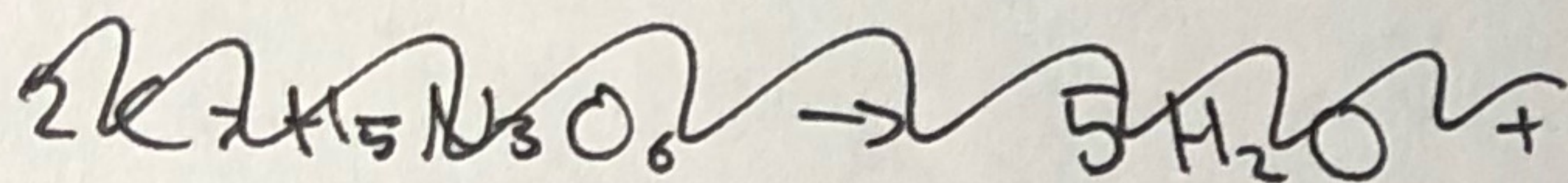
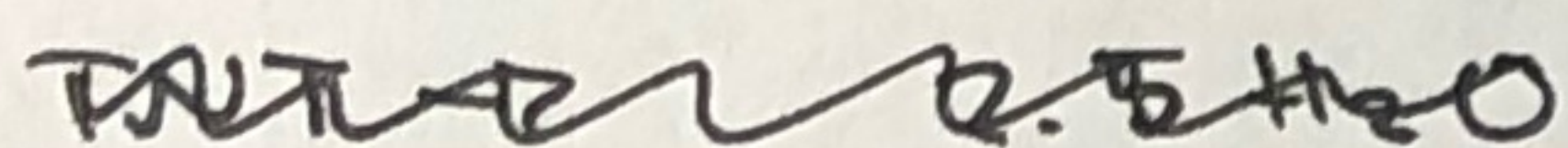
8.) Decomposition products can be predicted using the normal or modified Kristiakowsky - Wilson rules. Depending on whether the oxygen balance is above or below -40% respectively.

oxygen balance $\Omega = \frac{[d - (2a) - (\frac{b}{2})]}{M} \times 1600$ where $a = C$ $b = H$ $c = N$ $d = O$
 $M = \text{molecular mass}$



~~$$\Omega = \frac{6 - (2 \times 7) - (\frac{5}{2})}{227} \times 1600$$~~

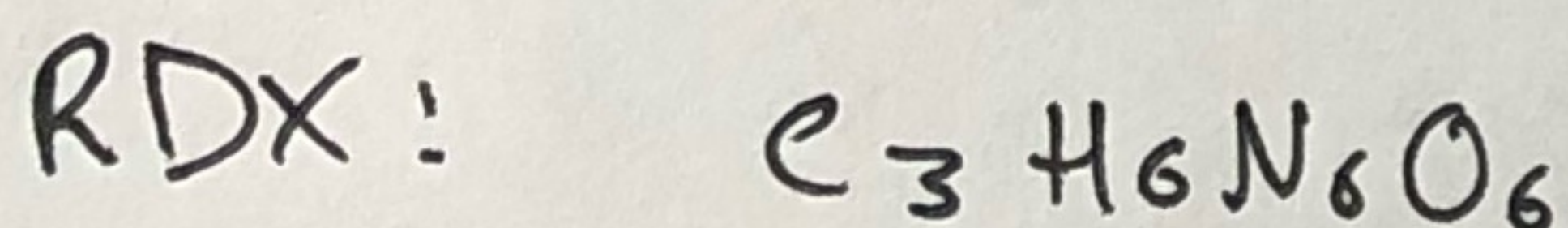
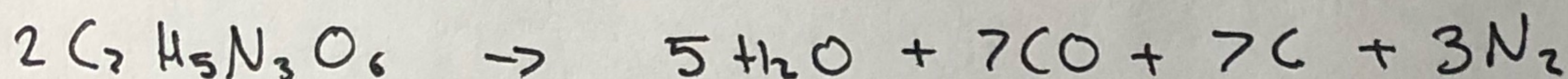
~~52.86%~~ $\therefore$ modified rules used.



$$\Omega = \frac{6 - (2 \times 7) - (\frac{5}{2})}{227} \times 1600$$

$= -74.01\%$ $\therefore$ modified rules used.

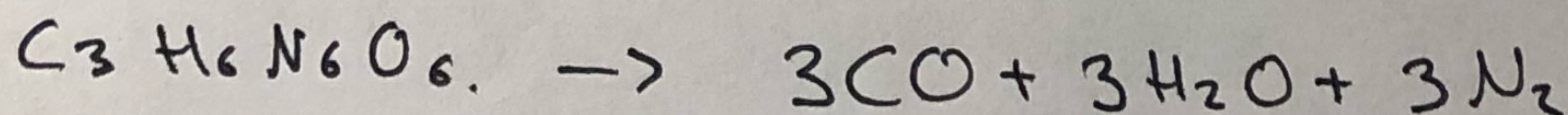
- Convert $H_2 \rightarrow H_2O$
- Convert $C \rightarrow CO$
- Use remaining O to convert $CO \rightarrow CO_2$



$$\Omega = \frac{6 - (2 \times 3) - (\frac{6}{2})}{222} \times 1600$$

$= -21.62\%$ $\therefore$ normal rules used:

- Convert $C \rightarrow CO$
- Use remaining O to form H_2O
- Change $CO \rightarrow CO_2$
- Nitrogen $\rightarrow N_2$



8.) Using this information you can calculate the heat of explosion using ΔH_f° for the different reactions. You can also see how many moles of gas are produced in each reaction. With this information the explosive power index for each explosive can be calculated using the following equation:

$$\text{Power index} = \frac{Q (\text{heat of explosion}) \times V (\text{volume of gaseous products})}{Q (\text{picric acid}) \times V (\text{picric acid})}$$

Which would then allow them to be compared to each other.