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Section A

1 Particles of similar mass contained in a nucleus are:

Protons

Neutrons

The Atomic number refers to the amount of Protons in the nucleus of an atom + so defines its place in the Periodic Table

The mass number or Atomic weight defines the total number of Protons + Neutrons in a nucleus

an Isotope is a different form of the same element with a different amount of Neutrons
i.e. Uranium 235 + Uranium 238

2 Magnesium (Mg) $1s^2 2s^2 2p^6 3s^2$ Mg Valence 2
Chlorine (Cl) $1s^2 2s^2 2p^6 3s^2 3p^5$ Cl Valence 5

Valence is in reference to the number of electrons found in the outer shell and available for chemical bonding

Mg: .Cl: .:

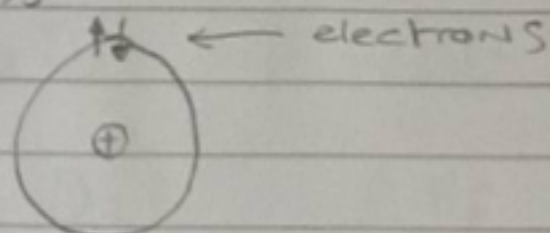
given Cl has one space + Mg has 2 free electrons
1 Mg will attach to 2 Cl $\therefore$
formula is

MgCl₂

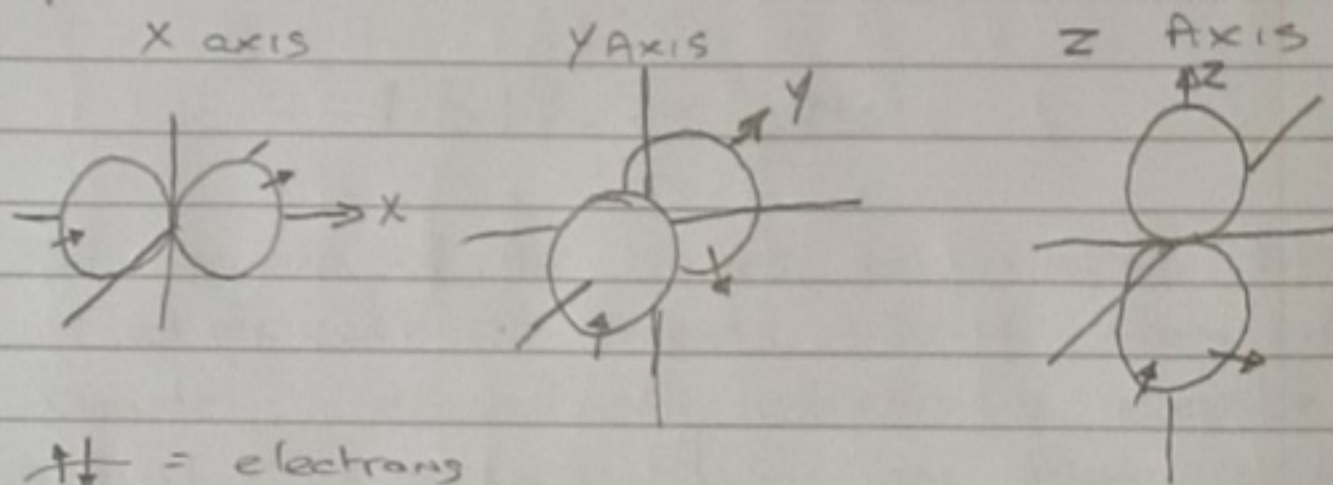
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$1s^2, 2s^2, 3s^2$

3



$2p^6$

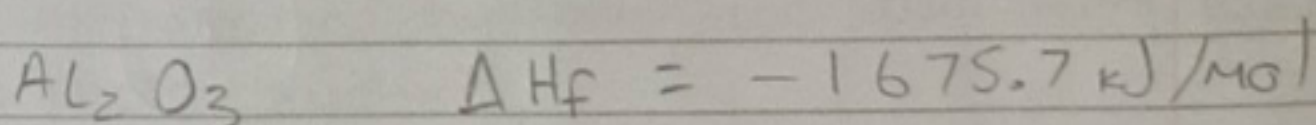
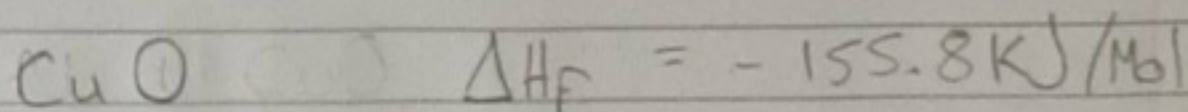


Atomic orbitals found in Mg Atom

- 4 heat of formation of a chemical Compound is the change in energy when one mole of the compound is formed from its elements an Endothermic reaction will absorb heat and so will have a positive Enthalpy change An exothermic reaction will exude heat and so will have a negative Enthalpy change i.e. it is lost from system $\therefore$ negative
- $$Al + CuO = Al_2O_3$$

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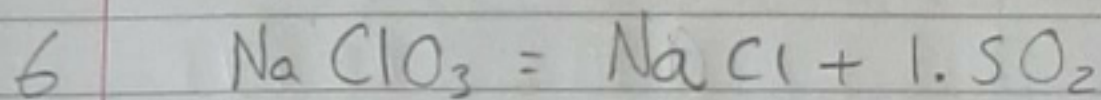
$$\Delta H_f = -1675.7 + 155.8$$

$$= 1519.9 \text{ kJ/mol}$$

5 The origin of the lines in infrared spectra of chemical compounds comes from dipole change, essentially electrons elevate to a higher energy shell + on their return to the original shell (following 'stretch') they give out infrared spectra following vibration

Methane (CH_4) has 2 main outputs a strong output at 3000 cm^{-1} and a smaller at 1350 cm^{-1}

ethane (C_2H_6) has 3 observable outputs its major output around $2900 - 3000 \text{ cm}^{-1}$ A smaller output at $1400 - 1500 \text{ cm}^{-1}$ and its smallest at approximately 800 cm^{-1}



$$\text{O}_2 \text{ Vol per mole} = \frac{33.6}{\text{MW}}$$

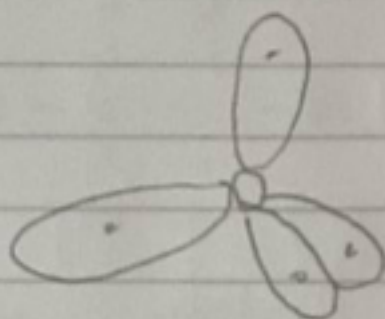
$$\therefore \frac{33.6}{106.4} = \text{Volume of Oxygen Produced} = 0.3158$$

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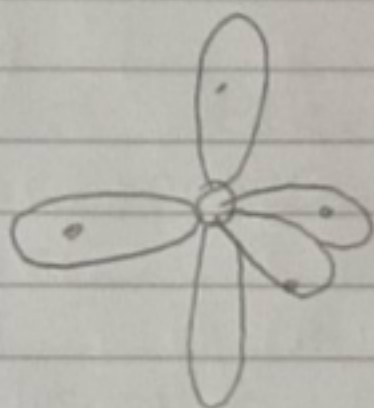
Section B

- 1 Nonaromatic hydrocarbons will form hybrid orbitals such as

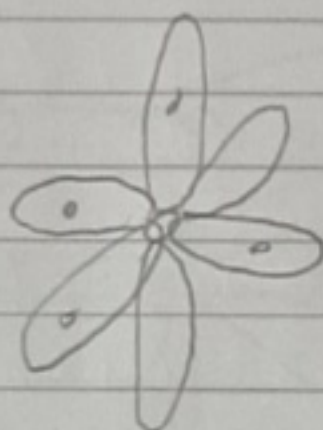
sp^3 hybrid



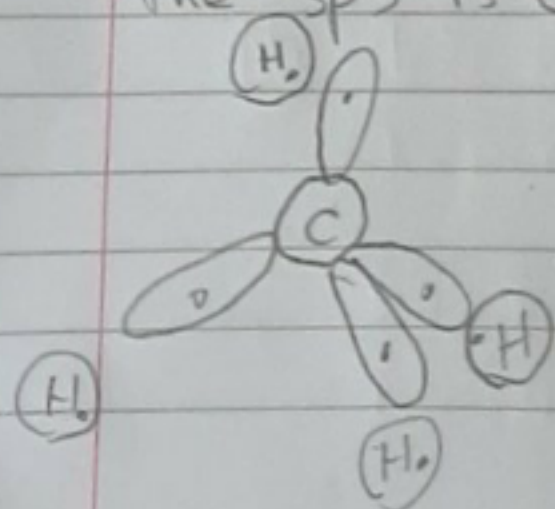
sp^2 hybrid



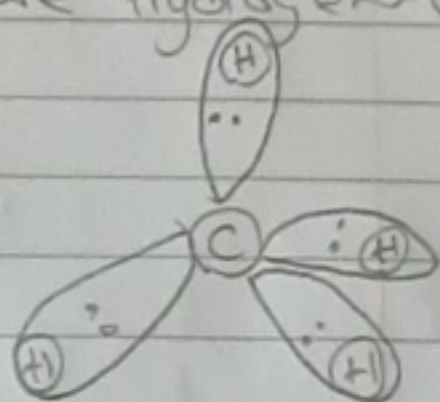
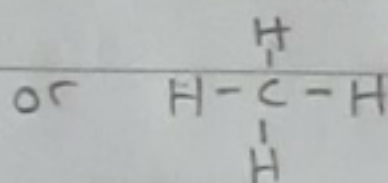
sp hybrid



In the case of an Alkane such as Methane the sp^3 is C and attached are Hydrogen (C_nH_{2n+2})



this becomes $\rightarrow$



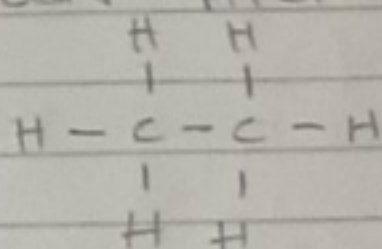
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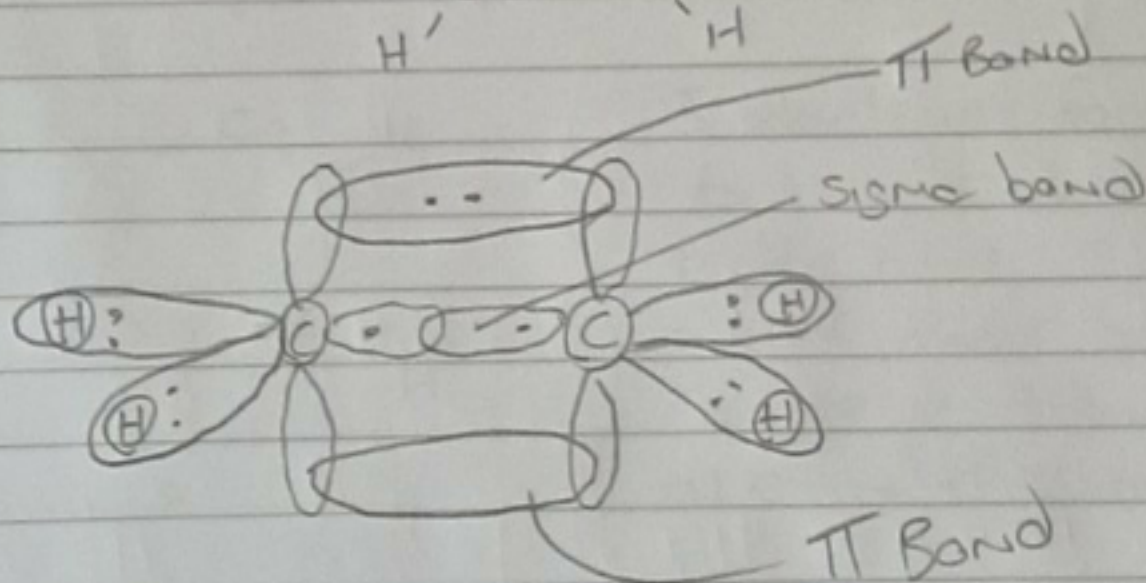
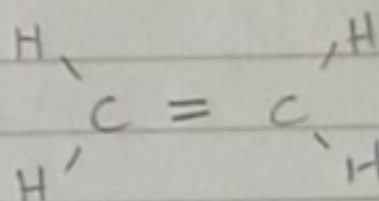
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IN the case of ethane it would require the combination of 2 off sp^3 hybrids where carbon atoms are required to bond



Alkanes are covalent bonded

IN the case of Alkenes ($C_n H_{2n}$) an sp^2 is applied
i.e. ethene



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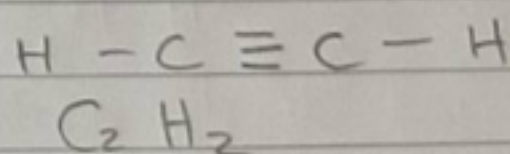
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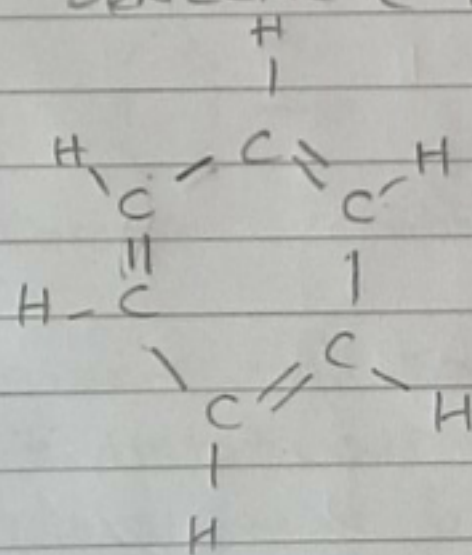
In the case of Alkynes An sp hybrid orbital is used + culminates in the implication of Multiple π Bonds

an example maybe found in acetylene (ethyne)



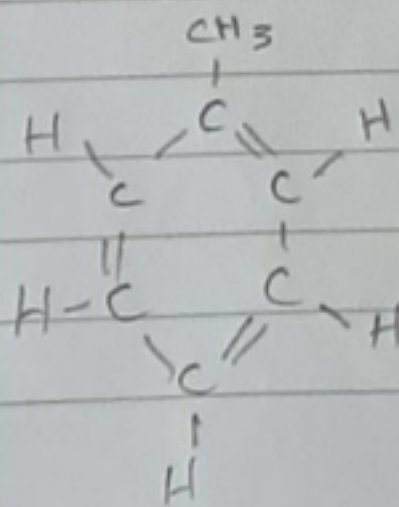
Simple Aromatic Hydrocarbons such as Benzene and toluene are in a ring format

Benzene (C_6H_6)



3 electrons form sigma bonds to two Carbon atoms and 1 H and 2 electrons given their orbital position above + below the molecule are in π Bonds

toluene

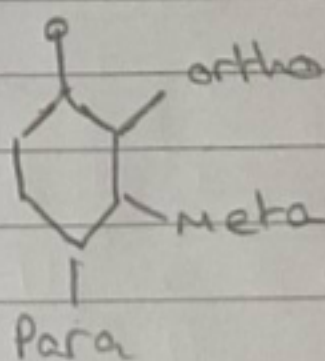


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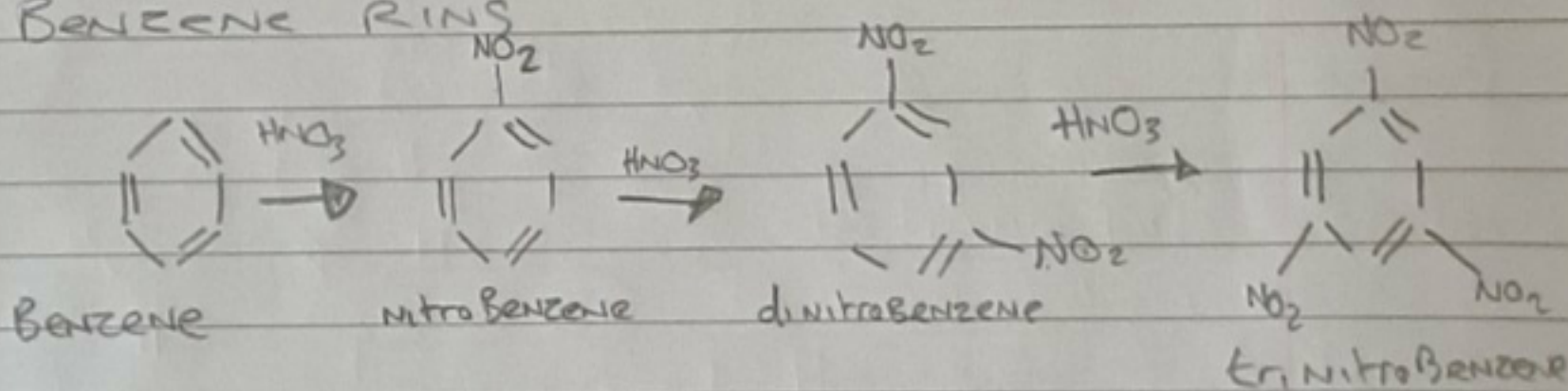
Section B

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Introduction of a substituent will cause Aromatic Substitution to occur depending on its relative direction



The application of a nitro-group for instance would culminate in a meta-directing substituent eg. with each application of HNO_3 a substitution will occur on the BENZENE RING



given full saturation of the meta directing substituent has been applied no more Nitro may be Absorbed

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Section B

2

Phosphorous is a Hygroscopic non metal
in Period 3 of the Periodic Table
it has an Atomic number of 15
so has the following shell structure

$1s^2 2s^2 2p^6 3s^2 3p^3$
its valence is 3

Phosphorous is hence a very reactive material
in its purest form however Phosphorous
has many Allotropes

above approximately 280°C Phosphorous Gas
has a simple structure

as it cools the solid formed will depend
on the pace of cooling + condensation

if the process is fast it will produce white
phosphorous

a slow process will produce Red Phosphorous
+ if a slow process is performed under immense
pressure there is possibility to produce the
most stable form Black phosphorous

Phosphorous has a Deep rooted history
in ONE white phosphorous in munitions
such as grenades + Red phosphorous in
signaling smokes due to its high yield
factor from Hygroscopy