

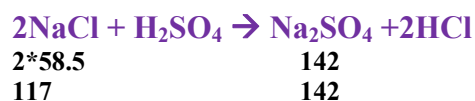
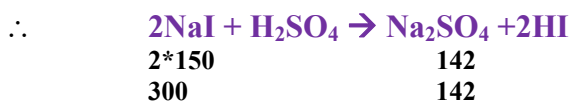
1. A mixture of Sodium Iodide and sodium chloride gave, with sulphuric acid, sodium sulphate equal to the weight of the original mixture. Find the percentage composition of the mixture.

Solution:

First let us write the balanced chemical Reactions:



We know that Molecular weights of NaI, Na₂SO₄, NaCl, H₂SO₄ are 150,142,58.5 and 98 respectively



Let the weight of mixture = 1 g
 Weight of NaI in the mixture = 'x' g
 Weight of NaCl in the mixture = (1-x) g
 Now, 300 g of NaI give Na₂SO₄ = 142 g

So,

$$'x' \text{ g of NaI give Na}_2\text{SO}_4 = \frac{142}{300} x$$

Similarly,

$$117\text{g of NaCl give Na}_2\text{SO}_4 = 142 \text{ g}$$

$$(1-x) \text{ g of NaCl give Na}_2\text{SO}_4 = \frac{142}{300} (1-x)$$

Weight of Na₂SO₄ formed = Weight of original mixture

$$\frac{142}{300} x + \frac{142}{300} (1-x) = 1$$

Solving for x, we get

$$x = 0.2886 \text{ g}$$

$$\text{Weight of NaI} = 0.2886$$

$$\% \text{NaI in mixture} = \frac{0.2886}{1} \times 100 = 28.86\%$$

$$\% \text{NaCl in mixture} = 100 - 28.86 = 71.14\%$$

2. A 2.0 L container at 25°C contain 1.25 mol of O₂ and 3.2 mol of C

(a) What is the initial pressure in the flask?

(b) If the carbon and oxygen react as completely as possible to form CO, what will be final pressure in the container?

Solution:

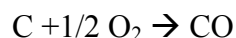
(a) The container contains 1.25 mole of O₂ and 3.2 mol of C. Since only oxygen is gaseous and carbon will not exert any pressure.

Hence, n=1.25 mol, V = 2.0 L, T=273+25 = 298 K

$$\therefore P = \frac{nRT}{V} = \frac{(1.25 \text{ mol}) \cdot (0.0821 \text{ L atm mol}^{-1} \text{K}^{-1}) \cdot (298 \text{ K})}{(2.0 \text{ L})}$$
$$= 15.3 \text{ atm}$$

So, the Initial Pressure in the flask = **15.3 atm**

(b) The Reaction is



According to the equation, 1 mol of CO will be produced for every ½ mole of O₂ used

½ mole of O₂ gives CO = 1mole

1.25 mole of O₂ gives CO = 1*2*1.25

$$= 2.5 \text{ mol}$$

The Final pressure is

$$P = \frac{nRT}{V} = \frac{(2.50 \text{ mol}) \cdot (0.0821 \text{ L atm mol}^{-1} \text{K}^{-1}) \cdot (298 \text{ K})}{(2.0 \text{ L})}$$

$$= 30.6 \text{ atm}$$

So, the final Pressure in the container = **30.6 atm**

3. Determine the molarity of a solution made by dissolving 20.0 g of NaOH in sufficient water to yield a 482 cm³ solution.

Solution:

Molarity is defined as number of moles of solute (NaOH) per liter of solution (water).

To work this problem, you need to be able to calculate the number of moles of sodium hydroxide (NaOH) and be able to convert cubic centimeters into liters.

First, let's calculate the number of moles of NaOH that are in 20.0 grams.

The atomic masses of Na, H and O are 23.0, 1.0 and 16.0 respectively

So:

1 mol NaOH weighs $23.0 \text{ g} + 16.0 \text{ g} + 1.0 \text{ g} = 40.0 \text{ g}$

So the number of moles in 20.0 g is:

moles of NaOH = $20.0 \text{ g} \times 1 \text{ mol}/40.0 \text{ g} = 0.500 \text{ mol}$

1 liter is 1000 cm^3 , so the volume of solution is:

$$= 482 \text{ cm}^3 \times 1 \text{ liter}/1000 \text{ cm}^3 = 0.482 \text{ liter}$$

Simply divide the number of moles by the volume of solution to get the molarity:

molarity = $0.500 \text{ mol} / 0.482 \text{ liter}$

$$= 1.04 \text{ mol/liter}$$

$$= 1.04 \text{ M}$$

Hence molarity = **1.04 M**

4. The element boron consists of two isotopes, $^{10}_5\text{B}$ and $^{11}_5\text{B}$. Their masses, based on the carbon scale, are 10.01 and 11.01, respectively. The abundance of $^{10}_5\text{B}$ is 20.0% and the abundance of $^{11}_5\text{B}$ is 80.0%. What is the atomic mass of boron?

Solution:

Although from the periodic table we find that the atomic number of boron is 5, its atomic mass is nearer to 11 than to 10, reflecting the fact that the heavier isotope is more abundant than the lighter isotope.

The percentages of multiple isotopes must add up to 100%.

Apply the following equation to the problem:

$$\text{atomic mass of B} = (X1) * (\% \text{ of } X1) + (X2) * (\% \text{ of } X2)$$

Where $X1 = \text{Atomic mass of Isotope } ^{10}_5\text{B}$ and

$X2 = \text{Atomic mass of Isotope } ^{11}_5\text{B}$

Substituting for boron in this equation:

$$\begin{aligned}\text{atomic mass of B} &= 10.01 \times 20.0/100 + 11.01 \times 80.0/100 \\ &= 2.00 + 8.81 \\ &= 10.81\end{aligned}$$

Hence Atomic Mass of Boron is **10.81**

5. Draw all of the structural isomers of C_6H_{14} .

Solution:

Since there are six carbon atoms, hence it is hexane.
This can be a straight chain isomer, with no branches.



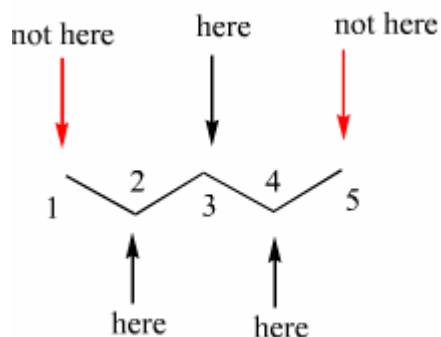
Now we need to think about drawing the branched isomers.

To do that, we draw the main chain minus one carbon.

Since main chain is 6 carbons long, subtract one carbon to give five (pentane).

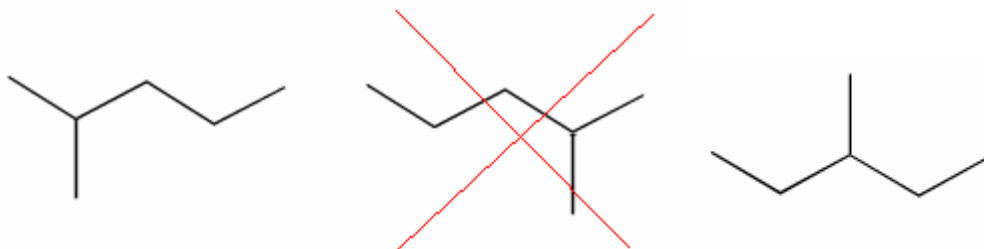
We now have to add a one-carbon unit (a methyl group) to the pentane and make as many isomers as we can.

Let see all the possibilities where we can add methyl groups

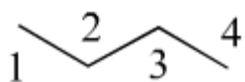


if we add the methyl group at 1 or 5 carbon, we again get the straight chain hexane isomer we have already drawn earlier.

In the *five-carbon* chain, there are three spots available to add i.e., at 2, 3, and 4 carbons. However, if you draw one isomer with a methyl group at the two carbon, drawing another with the methyl at the 4 carbon would give the same exact molecule. It will be mirror image. So we should just draw one of them.



Lets do it for the *four-carbon* chain. We will have to either add two one carbon methyl groups, or one two carbon ethyl group, to a butane.

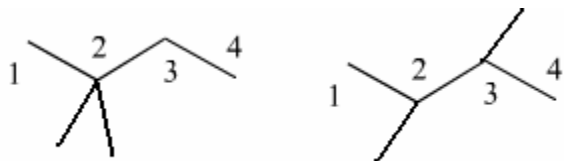


In this case, adding a two-carbon unit to either the number two or number three carbon gives an identical structure to one previously drawn.

So let's add the 2 methyl groups.

We can add both methyls to the number two carbon (or both to the three carbon--they will be the same molecule), or you can add one methyl to the 2 and one to the three. Again, you don't add to the end of the chains.

So we get two more isomers with the four carbon chain.



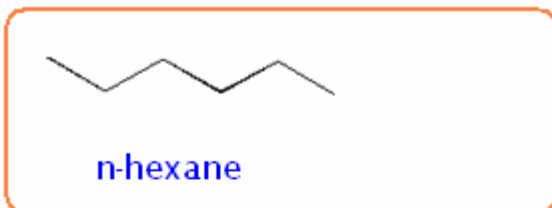
We have now drawn out the *six, five, and four* carbon chains.

Now, we could try to go to three carbons, and then add three methyl groups.

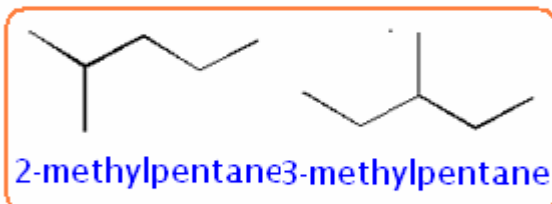
But in this case, doing so turns out to be only repeating structures that which we have already drawn.

so now let's arrange all the isomers

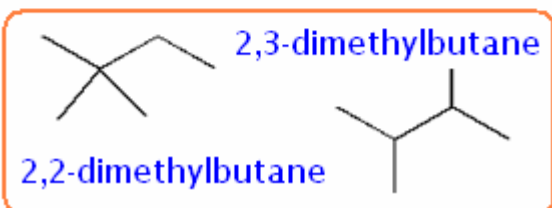
6-Carbon Chain



5-Carbon Chain



4-Carbon Chain



Since each one has a different name, all of these are different isomers.

6. α particles accelerated by 3×10^5 Volt bombarded a Boron target. This results in a nuclear reaction which is given by,



If the combined energy of ${}^{13}\text{C}$ & H^1 is 5×10^5 eV, calculate energy, frequency and λ of γ rays. 1×10^5 eV energy is used in penetrating of the nucleus.

Given, $H = 1.008$ amu, $He = 4.0026$ amu, $B = 10.0129$ amu, $C = 13.0036$ amu.

SOLUTION:

$$\begin{aligned} \text{Energy supplied to } \alpha \text{ particle} &= q \times V \\ &= 2 \times 1.602 \times 10^{-19} \times 3 \times 10^5 \text{ J} \\ &= \frac{2 \times 1.602 \times 10^{-19} \times 3 \times 10^5}{1.602 \times 10^{-19}} \text{ eV} \\ &= 6 \times 10^5 \text{ eV.} \end{aligned}$$

The energy given is used up to overpower the penetration of nucleus and imparting energy to C and H atoms, i.e., 1×10^5 eV + 5×10^5 eV = 6×10^5 eV.

Thus extra energy given to α particles is used in imparting velocity to C and H and to overpower the forces of repulsion. The mass decayed during the course of reaction is responsible for emission of γ rays.

$$\begin{aligned}\text{Total mass before reaction} \\ &= 4.0026 + 10.0129 \\ &= 14.0155 \text{ amu.}\end{aligned}$$

$$\begin{aligned}\text{Total mass after reaction} \\ &= 13.0036 + 1.008 \\ &= 14.0116 \text{ amu.}\end{aligned}$$

$$\begin{aligned}\text{Therefore, mass decay during reaction} &= 14.0155 \text{ amu} - 14.0116 \text{ amu.} \\ &= 0.0039 \text{ amu.}\end{aligned}$$

$$\begin{aligned}\text{Therefore, total energy given out} &= 0.0039 \times 931 \text{ MeV.} \\ &= 3.6309 \text{ MeV.} \\ &= 3.6309 \times 10^6 \text{ eV.} \\ &= 3.6309 \times 10^6 \times 1.602 \times 10^{-19} \text{ J.} \\ &= \mathbf{5.816 \times 10^{-13} \text{ J.}}\end{aligned}$$

$$\therefore \text{Total Energy} = \mathbf{5.816 \times 10^{-13} \text{ J}}$$

Also,

$$E = h \times \nu$$

$$\text{So, } 5.816 \times 10^{-13} = 6.625 \times 10^{-34} \times \nu$$

Hence,

$$\nu = \mathbf{8.77 \times 10^{20} \text{ Hz.}}$$

$$\therefore \text{Frequency} = \mathbf{8.77 \times 10^{20} \text{ Hz}}$$

But $\nu = c/\lambda$ or $\lambda = c/\nu$

$$\text{So, } \lambda = (3.0 \times 10^8)/(8.77 \times 10^{20})$$

$$\text{Or, } \lambda = \mathbf{3.4 \times 10^{-13} \text{ m.}}$$

$$\therefore \text{Wavelength} = \mathbf{3.4 \times 10^{-13} \text{ m}}$$