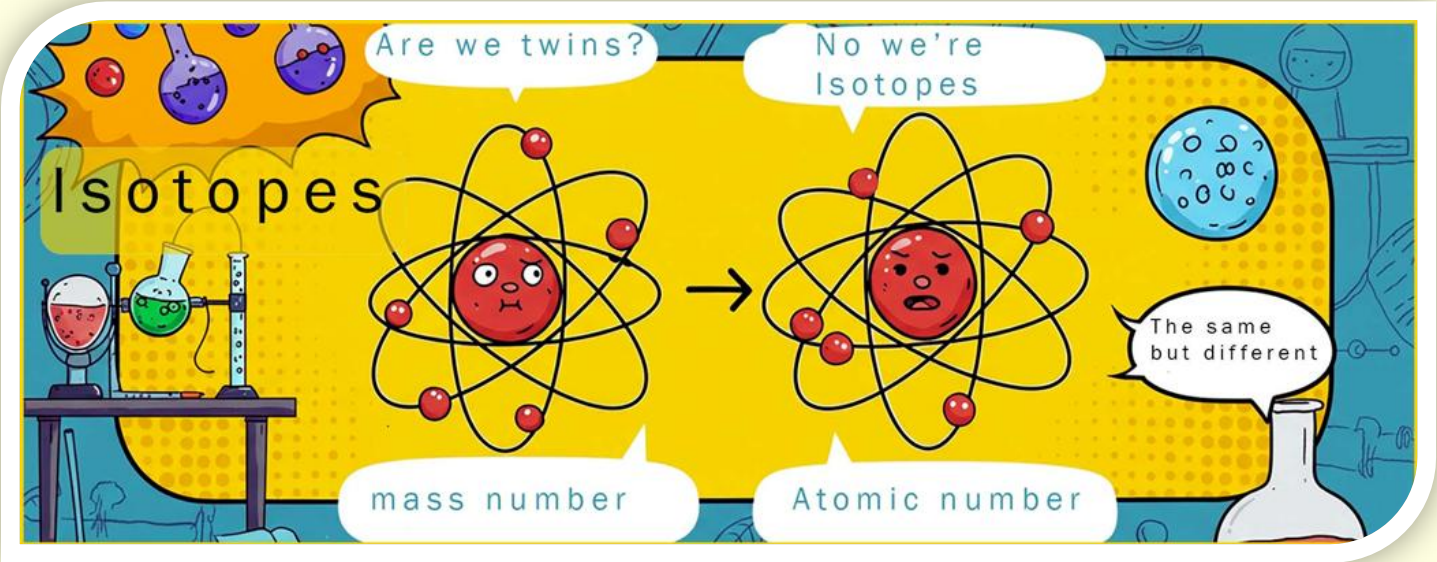


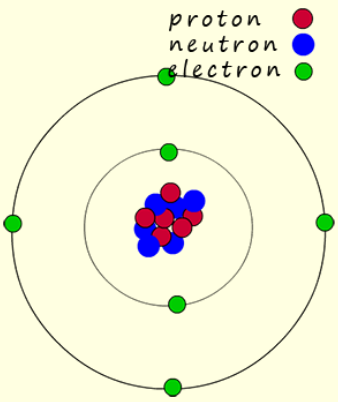
Answer all the questions below then check your answers.

1 Carbon has 3 isotopes. The chemical symbol for these is shown below:

$$^{12}_{6}C \qquad ^{13}_{6}C \qquad ^{14}_{6}C$$

a. What is the atomic number for each isotope?
b. How many protons and electrons does each isotope have?
c. What is the electron arrangement for each isotope?
d. Calculate the number of neutrons in each isotope.
e. What is an isotope?
f. What can you say about the chemical reactivity of each isotope? How will they differ from each other?

2. Below is an atomic structure diagram for the ^{12}C isotope. Draw similar diagrams for ^{13}C and ^{14}C isotopes



3. When carbon burns it will form the gas carbon dioxide. A word and symbolic equation for this reaction is shown below:

$$\text{Carbon}_{(s)} + \text{oxygen}_{(g)} \longrightarrow \text{carbon dioxide}_{(g)}$$

$$C_{(S)} + O_{2(g)} \longrightarrow CO_{2(g)}$$

a. Assuming that the isotope that burns is ^{12}C, calculate the M_r of the carbon dioxide gas that forms.

b. If the ^{13}C isotope was burned instead of the ^{12}C how would the carbon dioxide be different?

4. Chlorine has 2 isotopes, these are

$$^{35}_{17}Cl \qquad ^{37}_{17}Cl$$

a. Complete the table below for each isotope.

isotope	Number of protons	Number of electrons	Number of neutrons	Electron arrangement
$^{35}_{17}Cl$				
$^{37}_{17}Cl$				

b. How are the two isotopes different from each other?

c. The ^{35}Cl isotope is more common than the ^{37}Cl isotope. In fact 75% of all the chlorine atoms are ^{35}Cl and 25% are the heavier ^{37}Cl isotope. Use the formula below to calculate the relative atomic mass of chlorine.

$$\text{Relative formula} = \frac{(\%\text{ abundance of isotope 1} \times \text{mass}) \times (\%\text{ abundance of isotope2} \times \text{mass})}{100}$$

d. Hydrogen has 3 isotopes, these are:

$$^{1}_{1}H \qquad ^{2}_{1}H \qquad ^{3}_{1}H$$

Hydrogen reacts with chlorine according to the equation below:

$$\text{Hydrogen} + \text{chlorine} \leftrightharpoons \text{hydrogen chloride}$$

$$H_2 + Cl_2 \leftrightharpoons 2HCl$$

i. Draw 2 possible molecules that could be formed when chlorine reacts with hydrogen to form hydrogen chloride gas.

5. The element boron has 2 naturally occurring isotopes. These are:

isotope	% abundance
^{10}B	20
^{11}B	80

a. Calculate the relative atomic mass of boron using the information in the table.

6. The element neon has 3 naturally occurring isotopes. These are:

isotope	% abundance
^{20}Ne	90.92
^{21}Ne	0.3
^{22}Ne	8.78

a. Calculate the relative atomic mass of neon using the information in the table.

7. Lead has four stable isotopes: lead-204, lead-206, lead-207, and lead-208. If their relative abundances are 1.4%, 24.1%, 22.1%, and 52.4% respectively, calculate the relative atomic mass of lead.

8. An unknown heavy metal, X, has two isotopes with the following data:

Isotope 1: Mass = 184, Abundance = 37.4%

Isotope 2: Mass = 186, Abundance = 62.6%

Calculate the relative atomic mass of element X

9. Mercury has seven stable isotopes. The most abundant isotope is mercury-202, with an abundance of 29.86%. Given that the relative atomic mass of mercury is 200.6, outline the steps to determine if any of the other isotopes are likely to have a mass number below 200.

10. Uranium has several isotopes, including uranium-235 (0.72% abundance) and uranium-238 (99.27% abundance). Calculate the relative atomic mass of uranium.

Answers

1 Carbon has 3 isotopes. The chemical symbol for these is shown below:

$$^{12}_{6}C \qquad ^{13}_{6}C \qquad ^{14}_{6}C$$

a. What is the atomic number for each isotope? 6

b. How many protons and electrons does each isotope have? 6

c. What is the electron arrangement for each isotope? 2,4

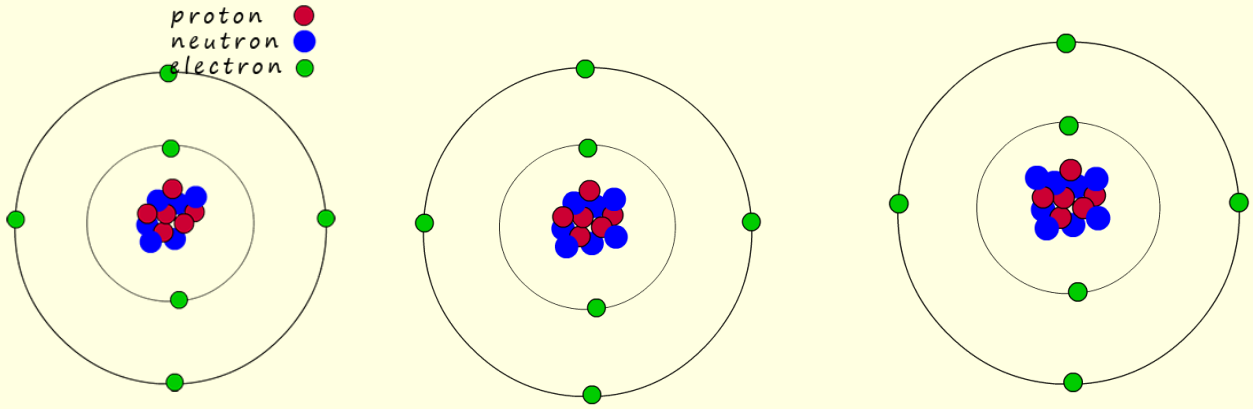
d. Calculate the number of neutrons in each isotope. 6, 7, 8

e. What is an isotope? Element with the same number of protons but different number of neutrons OR element with the same atomic number but a different mass number.

f. What can you say about the chemical reactivity of each isotope? How will they differ from each other? Chemical reactivity depends on electron arrangement, all isotopes have identical electron arrangements so identical chemical reactions.

2. Below is an atomic structure diagram for the ^{12}C isotope. Draw similar diagrams for ^{13}C and ^{14}C isotopes

Carbon-12 carbon-13 carbon-14



3. When carbon burns it will form the gas carbon dioxide. A word and symbolic equation for this reaction is shown below:

$$\text{Carbon}_{(s)} + \text{oxygen}_{(g)} \longrightarrow \text{carbon dioxide}_{(g)}$$

$$C_{(S)} + O_{2(g)} \longrightarrow CO_{2(g)}$$

a. Assuming that the isotope that burns is ^{12}C, calculate the M_r of the carbon dioxide gas that forms. 44

b. If the ^{13}C isotope was burned instead of the ^{12}C how would the carbon dioxide be different? Chemically identical, but would be heavier, M_r of 45 instead of 44.

4. Chlorine has 2 isotopes, these are

$$^{35}_{17}Cl \qquad ^{37}_{17}Cl$$

a. Complete the table below for each isotope.

isotope	Number of protons	Number of electrons	Number of neutrons	Electron arrangement
$^{35}_{17}Cl$	17	17	18	2,8,7
$^{37}_{17}Cl$	17	17	20	2,8,7

b. How are the two isotopes different from each other? ^{37}Cl has 2 extra neutrons.

c. The ^{35}Cl isotope is more common than the ^{37}Cl isotope. In fact 75% of all the chlorine atoms are ^{35}Cl and 25% are the heavier ^{37}Cl isotope. Use the formula below to calculate the relative atomic mass of chlorine.

$$\text{Relative formula mass} = \frac{(\%\text{ abundance of isotope 1} \times \text{mass}) \times (\%\text{ abundance of isotope2} \times \text{mass})}{100}$$

$$\text{Atomic mass} = \frac{(35 \times 75) + (37 \times 25)}{100} = 35.5$$

d. Hydrogen has 3 isotopes, these are:

$$^{1}_{1}H \qquad ^{2}_{1}H \qquad ^{3}_{1}H$$

Hydrogen reacts with chlorine according to the equation below:

$$\text{Hydrogen} + \text{chlorine} \leftrightharpoons \text{hydrogen chloride}$$

$$H_2 + Cl_2 \leftrightharpoons 2HCl$$

i. Draw 2 possible molecules that could be formed when chlorine reacts with hydrogen to form hydrogen chloride gas.

$H-{}^{35}Cl$ $H-{}^{37}Cl$

5. The element boron has 2 naturally occurring isotopes. These are:

isotope	% abundance
^{10}B	20
^{11}B	80

a. Calculate the relative atomic mass of boron using the information in the table.

$$\text{Atomic mass} = \frac{(10 \times 80) + (11 \times 20)}{100} = 10.2$$

6. The element neon has 3 naturally occurring isotopes. These are:

isotope	% abundance
^{20}Ne	90.92
^{21}Ne	0.3
^{22}Ne	8.78

a. Calculate the relative atomic mass of neon using the information in the table.

$$\text{Atomic mass} = \frac{(20 \times 90.92) + (21 \times 0.3) + (22 \times 8.78)}{100} = 20.17$$

7. Lead has four stable isotopes: lead-204, lead-206, lead-207, and lead-208. If their relative abundances are 1.4%, 24.1%, 22.1%, and 52.4% respectively, calculate the relative atomic mass of lead.

$A_r = (204 \times 0.014) + (206 \times 0.241) + (207 \times 0.221) + (208 \times 0.524) = 207.2$

8. An unknown heavy metal, X, has two isotopes with the following data:

Isotope 1: Mass = 184, Abundance = 37.4%

Isotope 2: Mass = 186, Abundance = 62.6%

Calculate the relative atomic mass of element X

$A_r = (184 \times 0.374) + (186 \times 0.626) = 185.6$

9. Mercury has seven stable isotopes. The most abundant isotope is mercury-202, with an abundance of 29.86%. Given that the relative atomic mass of mercury is 200.6, outline the steps to determine if any of the other isotopes are likely to have a mass number below 200.

Assume the remaining 70.14% of abundance is distributed amongst the other six isotopes. If all six had a mass above 202, the average mass of the element would exceed the given relative atomic mass (200.6). Therefore, at least one of the other isotopes must have a mass number below 200 to balance the weighted average.

10. Uranium has several isotopes, including uranium-235 (0.72% abundance) and uranium-238 (99.27% abundance). Calculate the relative atomic mass of uranium.

$A_r = (235 \times 0.0072) + (238 \times 0.9927) = 238.03$