

# SNC1D CHEMISTRY

## ATOMS, ELEMENTS, & COMPOUNDS

### The Periodic Table (P.188-193)

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### The Early Periodic Table

By the 1780s, chemists wondered why some elements, such as oxygen, were gases, while others, such as gold, were metals. To complicate matters, by the 1860s, the list of known elements had grown to 63. No one knew if that list included all the elements that existed or whether there were hundreds or even thousands more that were still undiscovered. Many chemists continued to search for a unifying pattern among the elements.



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### The Early Periodic Table

In 1867, Russian scientist Dmitri Mendeleev found the pattern. He did it by gathering all the information that he could about the known elements and writing it down on cards, using one element per card. The information included properties such as estimates of the mass of the atoms of each element, colour, density, melting point, and what each element did or did not react with.



Sodium, Na  
Atomic Mass 23.0  
Colour: silver-grey  
Density: 0.97 g/cm<sup>3</sup>  
Reactivity: reacts violently with water

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## The Early Periodic Table

He then arranged the cards in order of increasing mass, sorting the cards into rows and columns, based on similarities in the elements' properties. This arrangement of cards formed a table. Within Mendeleev's table, and for the first time in history, a complete pattern of the elements emerged. His early periodic table made the study of chemistry manageable!



Sodium, Na  
 Atomic Mass 23.0  
 Colour: silver-grey  
 Density: 0.97 g/cm<sup>3</sup>  
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## The Early Periodic Table

In Mendeleev's table, all the cards representing metals ended up on one side, and all the non-metals ended up on the other. Metalloids were in the middle. Even most of the elements that were gases at room temperature were grouped together. When Mendeleev did not find an element with the right properties to put in a column, he left a gap – the gap represented an element that was yet to be discovered.



Sodium, Na  
 Atomic Mass 23.0  
 Colour: silver-grey  
 Density: 0.97 g/cm<sup>3</sup>  
 Reactivity: reacts violently with water

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## The Early Periodic Table

Mendeleev had so much confidence in his arrangement that he boldly predicted the physical and chemical properties of the elements that would occupy each gap. Doubters were convinced when new elements, such as gallium (Ga) and germanium (Ge), were discovered several years later with properties almost exactly as Mendeleev had predicted.



Sodium, Na  
 Atomic Mass 23.0  
 Colour: silver-grey  
 Density: 0.97 g/cm<sup>3</sup>  
 Reactivity: reacts violently with water

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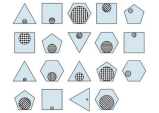
### Activity: Solving a Puzzle

**BACKGROUND**  
Mendeleev's first attempt at arranging elements into a table was much like trying to put together a puzzle that was missing pieces. In this activity, you will try to assemble the pieces of a puzzle to help you identify the properties of the missing piece.

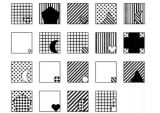


**MATERIALS**  
Handouts of puzzles A and B.

**A**



**B**



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### Activity: Solving a Puzzle

**INSTRUCTIONS**

- Puzzle A shows 19 pieces from an original set of 20. A single piece is missing. Your mission is to arrange the 19 pieces into rows and columns according to their properties, identifying as many trends as you can.
- When all the pieces are in place, the missing piece will become obvious to you, just as the missing elements were clear to Mendeleev. Sketch the missing piece, showing all its properties.
- Puzzle B has more differentiating properties than does puzzle A, so it is a little more complex. Try this one next (if there is time)!

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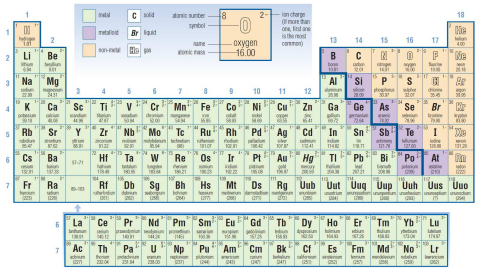
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### The Modern Periodic Table

Today we use a table based on Mendeleev's table. In the modern periodic table (P.576 and 577), elements are listed from left to right and top to bottom according to a property called atomic number.



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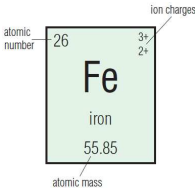
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### The Modern Periodic Table

Each element has its own square on the periodic table. The information given in the square is not always the same on different versions of the periodic table, but the element's name, symbol, and atomic number are almost always given. The square to the right shows two other pieces of information: atomic mass and ion charge.



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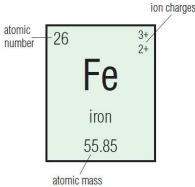
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### The Modern Periodic Table

**NOTE!**  
The first letter of every chemical symbol is a capital letter (i.e. N for nitrogen). If there is a second letter, it is always lowercase (i.e. Fe for iron). The rules for capitalization are very important – Co stands for the element cobalt whereas CO represents the poisonous compound carbon monoxide.



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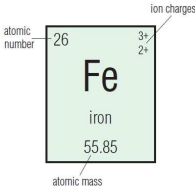
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### The Modern Periodic Table – Atomic Number

**Atomic number** is the number of protons in an atom of an element. The first element, hydrogen (H), has atomic number 1. This means that every hydrogen atom has one proton in its nucleus. The next element in the periodic table is helium (He), which has atomic number 2. All helium atoms have two protons. This increase continues through the entire table.



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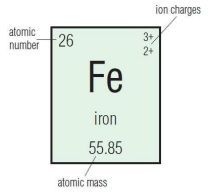
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 The Modern Periodic Table – Atomic Number

**ATOMIC NUMBER**

- the number of protons in an atom of an element
- different for every element



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 The Modern Periodic Table – Atomic Number

**PRACTICE (Use the periodic table on P.576 & 577)**

1. Find the atomic number of each of the following elements:

(a) C      6  
 (b) O      8  
 (c) Na     11  
 (d) Si     14  
 (e) S      16

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 The Modern Periodic Table – Atomic Number

**PRACTICE (Use the periodic table on P.576 & 577)**

2. How many protons are in atom of each of the following elements?

(a) lithium      3  
 (b) nitrogen     7  
 (c) fluorine      9  
 (d) aluminum    13  
 (e) copper        29

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### The Modern Periodic Table – Atomic Number

#### PRACTICE (Use the periodic table on P.576 & 577)

3. Name the element with following number of protons.

- (a) 1     hydrogen
- (b) 2     helium
- (c) 10    neon
- (d) 19    potassium
- (e) 20    calcium

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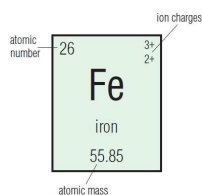
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### The Modern Periodic Table – Atomic Mass

**Atomic mass** is the average mass of an element's atoms. Atomic mass is given in **atomic mass units (amu)**. From the diagram we see that iron has an atomic mass of 55.85 amu. From the periodic table, we see that the atomic mass of hydrogen is 1.01 amu. This means that iron atoms are about 55.85 times heavier than hydrogen atoms.



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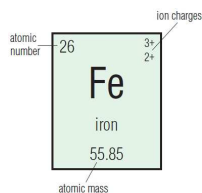
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### The Modern Periodic Table – Atomic Mass

#### NOTE!

Atomic masses are always expressed as decimal fractions. One reason for this is that, except for fluorine, atoms of the same element have different numbers of neutrons. As a result, atoms of the same element with different numbers of neutrons have different masses.



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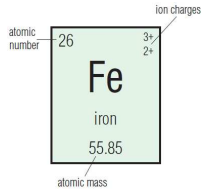
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 The Modern Periodic Table – Atomic Mass

**ATOMIC MASS (amu)**  
 ❖ the average mass of an element's atoms



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 The Modern Periodic Table – Atomic Mass

**PRACTICE (Use the periodic table on P.576 & 577)**

4. Find the atomic mass for each of the following elements.

(a) H 1.01 amu  
 (b) He 4.00 amu  
 (c) N 14.01 amu  
 (d) F 19.00 amu  
 (e) Ca 40.08 amu

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 The Modern Periodic Table – Atomic Mass

**PRACTICE (Use the periodic table on P.576 & 577)**

5. Name the element with the following atomic mass.

(a) 12.01 amu carbon  
 (b) 16.00 amu oxygen  
 (c) 39.10 amu potassium  
 (d) 83.80 amu krypton  
 (e) 126.90 amu iodine

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**The Modern Periodic Table – Ion Charge**

**Ion charge** is the electric charge that an atom takes on when it loses or gains electrons. An atom (or group of atoms) that has gained or lost electrons is called an **ion**. When this happens, one of two types of ions results – a positively charged ion, or **cation**, or a negatively charged ion, or **anion**.

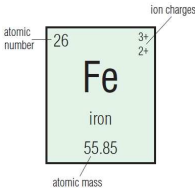


Diagram of an iron atom (Fe) showing its atomic number (26), atomic mass (55.85), and common ion charges (3+ and 2+).

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**The Modern Periodic Table – Ion Charge**

**NOTE!**  
Elements that can form similar ions are grouped together in the periodic table. Metals generally lose electrons and become positive ions. Many non-metals can gain electrons and so become negative ions. Some elements, like helium, do not form ions. For these elements, no ion charges are shown in their squares in the periodic table.

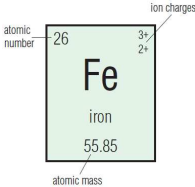


Diagram of an iron atom (Fe) showing its atomic number (26), atomic mass (55.85), and common ion charges (3+ and 2+).

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**The Modern Periodic Table – Ion Charge**

**ION CHARGE**

- ❖ electric charge an atom takes on when it loses or gains electrons
- ❖ loses electrons  $e^{-}$  + ve ion (cation)
- ❖ gains electrons  $e^{-}$  - ve ion (anion)

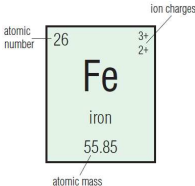


Diagram of an iron atom (Fe) showing its atomic number (26), atomic mass (55.85), and common ion charges (3+ and 2+).

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### The Modern Periodic Table – Ion Charge

#### PRACTICE (Use the periodic table on P.576 & 577)

6. What is the electric charge on an ion of each of the following elements?

- (a) Li 1+
- (b) Be 2+
- (c) N 3-
- (d) S 2-
- (e) Al 3+

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### The Modern Periodic Table – Ion Charge

#### PRACTICE (Use the periodic table on P.576 & 577)

7. Although the element hydrogen is a non-metal, it is located on the left side of the periodic table. Explain how placing hydrogen in this position relates to its ion charge.

hydrogen only has one electron

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### The Modern ... – Standard Atomic Notation

We can represent the numbers of subatomic particles by using **standard atomic notation**, an internationally recognized system used to communicate information about an atom. Using this notation, we write the chemical symbol of the atom and place the atomic number to the lower left and the mass number to the upper left.

#### STANDARD ATOMIC NOTATION

$$\begin{matrix} A \\ Z \\ X \end{matrix}$$

A = atomic mass = # p's + # n's  
 Z = atomic number = # p's  
 X = chemical symbol

**NOTE!** # e's = # p's = Z (since atoms are electrically neutral)  
 # n's = A - Z

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### The Modern ... – Standard Atomic Notation

**PRACTICE**

8. Express the following elements using standard atomic notation.

- Hydrogen
- Carbon
- Magnesium
- Sulphur
- Potassium

${}^1_1\text{H}$       ${}^{12}_6\text{C}$       ${}^{24}_{12}\text{Mg}$       ${}^{32}_{16}\text{S}$       ${}^{39}_{19}\text{K}$

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### The Modern ... – Standard Atomic Notation

**PRACTICE**

9. How many electrons, protons, and neutrons are there in the following atoms?

	<b>4</b> He	<b>16</b> O	<b>28</b> Si	<b>31</b> P	<b>40</b> Ca	<b>70</b> Ga	<b>75</b> As
	2	8	14	15	20	31	33
<b>#p</b>	2	8	14	15	20	31	33
<b>#e</b>	2	8	14	15	20	31	33
<b>#n</b>	2	8	14	16	20	39	42

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### The Modern Periodic Table

Each horizontal row in the periodic table is called a **period**. A number written on the left side of the table identifies each period. The properties of elements that are in the same period can be very different.

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### The Modern Periodic Table

Each vertical column in the periodic table represents a different **group** or **chemical family**. Each group has its own number, written at the top of the table. Elements in the same group have similar properties – including the same number of electrons in their outmost orbit.

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### The Modern Periodic Table

Most elements are either metals (green box) or non-metals (gold box). They are separated by a dark line that looks like a staircase. Hydrogen is the only exception. Elements along the staircase – the metalloids (purple box) – have properties in between those of metals and non-metals.

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### The Modern Periodic Table

**MODERN PERIODIC TABLE**

- ❖ based on table created by Dmitri Mendeleev
- ❖ helps to explain/predict physical and chemical properties
- ❖ elements are arranged in order of atomic number (# of protons)
- ❖ table organized into 7 rows (**periods**) and 18 columns (**groups**)
- ❖ elements in same group (**chemical family**) have similar chemical/physical properties
- ❖ metals – left and centre; non-metals – right; metalloids – in between

**NOTE!**  
Hydrogen is located in the metals but it behaves as a non-metal.

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 The Modern Periodic Table

**PRACTICE (Use the periodic table on P.576 & 577)**

10. Give the names and symbols for the elements found at these locations.

(a) Period 3, Group 1    sodium    Na  
 (b) Period 2, Group 13    boron    B  
 (c) Period 4, Group 11    copper    Cu  
 (d) Period 5, Group 17    iodine    I

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 The Modern Periodic Table

**PRACTICE (Use the periodic table on P.576 & 577)**

11. Give the period and group for each of the following elements.

(a) Mg    3, 2  
 (b) Si    3, 14  
 (c) Cl    3, 17  
 (d) He    1, 18  
 (e) Au    6, 11

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 ✓ Check Your Learning

**TEXTBOOK**  
 P.190 Q.1-3  
 P.193 Q.1-4  
 P.195 Q.1-2

**WIKI (CHEMISTRY)**  
 1DCHEM - WS3 (The Periodic Table)

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