


Matter in Chemistry

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1 IA H Hydrogen 1 1.01																	VII A 17 He Helium 2 4.00														
2 IIA Li Lithium 3 6.94 Be Beryllium 4 9.01																	VII A 17 Ne Neon 10 20.18														
3 Na Sodium 11 22.99																	VII A 17 Ar Argon 18 39.95														
4 K Potassium 19 39.10 Ca Calcium 20 40.08	3 IIIB Sc Scandium 21 44.96	4 IVB Ti Titanium 22 47.88	5 VB V Vanadium 23 50.94	6 VIB Cr Chromium 24 52.00	7 VIIB Mn Manganese 25 54.94	8 VIII Fe Iron 26 55.85	9 VIII Co Cobalt 27 58.93	10 VIII Ni Nickel 28 58.69	11 IB Cu Copper 29 63.55	12 IIB Zn Zinc 30 65.39	Ga Gallium 31 69.72	Ge Germanium 32 72.61	As Arsenic 33 74.92	Se Selenium 34 78.96	Br Bromine 35 79.90	Kr Krypton 36 83.80															
5 Rb Rubidium 37 85.47 Sr Strontium 38 87.62	Y Yttrium 39 88.91	Zr Zirconium 40 91.22	Nb Niobium 41 92.91	Mo Molybdenum 42 95.94	Tc Technetium 43 (98)	Ru Ruthenium 44 101.07	Rh Rhodium 45 102.91	Pd Palladium 46 106.42	Ag Silver 47 107.87	Cd Cadmium 48 112.41	In Indium 49 114.82	Sn Tin 50 118.71	Sb Antimony 51 121.76	Te Tellurium 52 127.60	I Iodine 53 126.90	Xe Xenon 54 131.29															
6 Cs Caesium 55 132.91 Ba Barium 56 137.33	Lanthanide Series																														
7 Fr Francium 87 (223) Ra Radium 88 (226)	Actinide Series																														
																	La Lanthanum 57 138.91	Ce Cerium 58 140.12	Pr Praseodymium 59 140.90	Nd Neodymium 60 144.24	Pm Promethium 61 (145)	Sm Samarium 62 150.36	Eu Europium 63 151.96	Gd Gadolinium 64 157.25	Tb Terbium 65 158.92	Dy Dysprosium 66 162.50	Ho Holmium 67 164.93	Er Erbium 68 167.26	Tm Thulium 69 168.93	Yb Ytterbium 70 173.04	Lu Lutetium 71 174.96
																	Ac Actinium 89 227.02	Th Thorium 90 232.03	Pa Protactinium 91 231.03	U Uranium 92 238.02	Np Neptunium 93 (237)	Pu Plutonium 94 (244)	Am Americium 95 (243)	Cm Curium 96 (247)	Bk Berkelium 97 (247)	Cf Californium 98 (251)	Es Einsteinium 99 (254)	Fm Fermium 100 (257)	Md Mendelevium 101 (258)	No Nobelium 102 (259)	Lr Lawrencium 103 (260)



FEST
Foundation for Education, Science and Technology

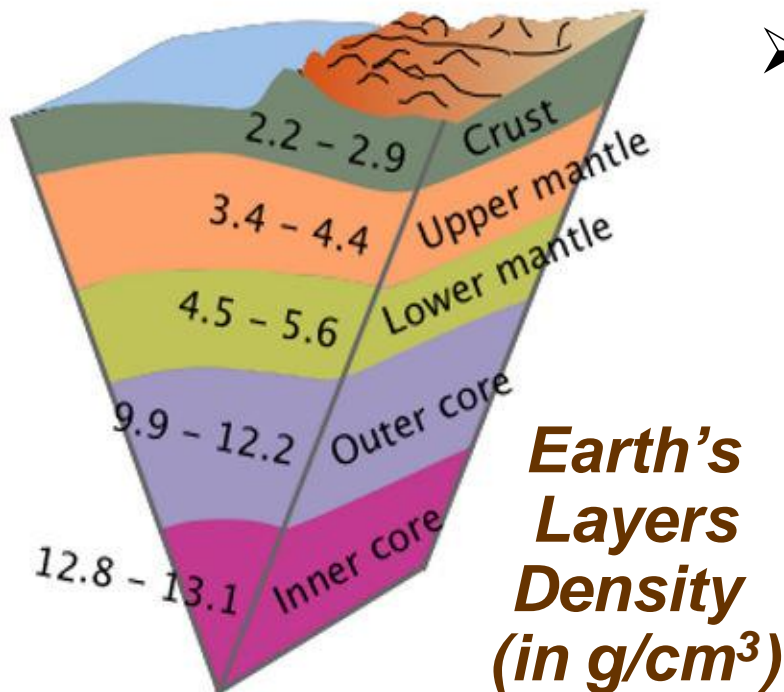
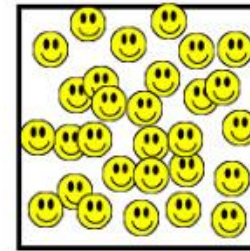
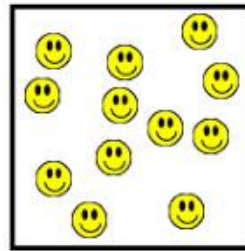


Density

- **Density** is a measure of how much matter is contained in a unit of volume:

➤ $\text{density} = \frac{\text{mass}}{\text{volume}}$

➤ SI unit is **kg/m³**

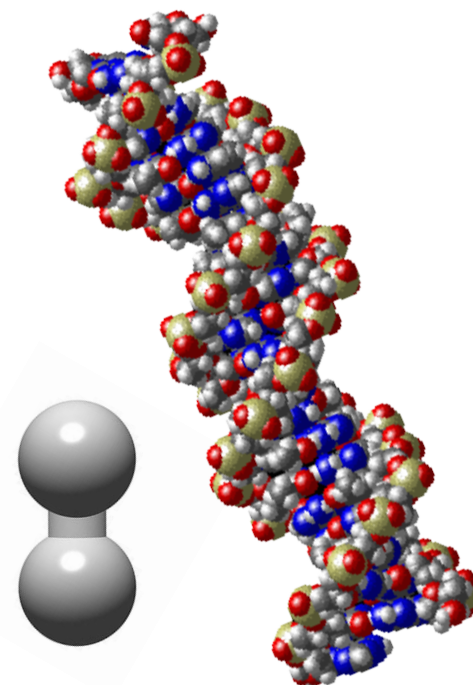


- The density of a material varies with temperature and pressure (this variation is typically small for solids and liquids but much greater for gases).
- In general, lowering the temperature results in density increase
- Increasing the pressure also results in density increase

Matter in Chemistry

Ordinary matter is composed of atoms and groups of atoms *bonded* together, called molecules.

- There are **many different types of atoms**, and consequently, there are **many possible combinations of two or more atoms** that can chemically bond.
- Molecules as components of matter are common in organic substances. They also make up most of the oceans and atmosphere.
- However, the **majority of familiar solid substances on Earth**, including most of the minerals that make up the crust, mantle, and core of the Earth, contain many chemical bonds, but **are not made of identifiable molecules**.



Chemical Substance

A chemical *substance* is a form of matter that has a definite chemical composition throughout and distinct characteristic properties.



glass

gold ingots



honey

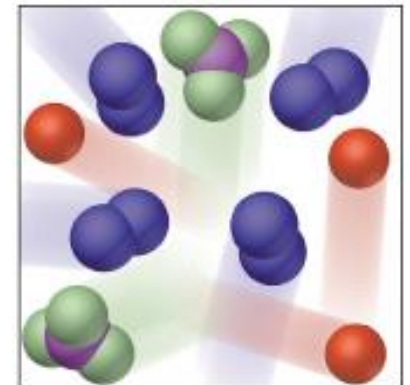
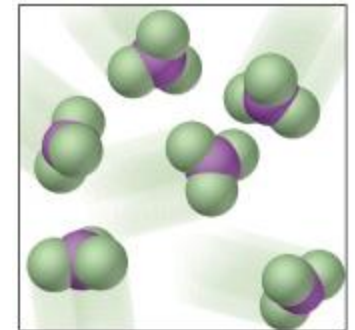
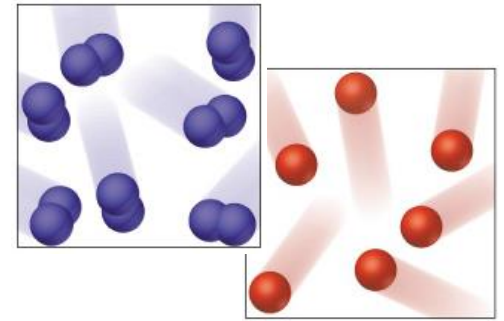
liquid nitrogen



All ordinary matter can be classified as either a *pure substance* or a *mixture*.

Classification of Substances

- Elements: substances that are made from **one type of atom** only.
- Compounds: substances that are made from **more than one** type of atom **chemically bonded** together.
- Mixtures: substances that are made from **more than one** type of atom **combined physically**, but not chemically.



Chemical Element

A **chemical element** consists of a **single type of atom** distinguished by its *atomic number*.

- Some elements can occur as more than a single chemical substance (*allotropes*): oxygen exists as both *diatomic oxygen* (O_2) and *ozone* (O_3).
- Native elements copper and gold were known in primitive human societies; iron was being extracted (smelted) as early as 1500 BC.
- Nearly all of the naturally-occurring elements were discovered by 1900.
- There are **118 known elements**, about 80 of which are *stable* (they do not change by radioactive decay into other elements). There are **94 naturally occurring** elements and **24 synthetic (man-made)** elements.
- The number of possible elements is not known.



Periodic Table of Elements

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
1	1 H Hydrogen 1.00794	Atomic # Symbol Name Atomic Mass																2 He Helium 4.002602	
2	3 Li Lithium 6.941	4 Be Beryllium 9.012182																	10 Ne Neon 20.1797
3	11 Na Sodium 22.98976928	12 Mg Magnesium 24.3050																	18 Ar Argon 39.948
4	19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.955912	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938045	26 Fe Iron 55.845	27 Co Cobalt 58.933195	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.64	33 As Arsenic 74.9216	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.798	
5	37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90585	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.96	43 Tc Technetium (97.9072)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.90550	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.90447	54 Xe Xenon 131.293	
6	55 Cs Caesium 132.9054519	56 Ba Barium 137.327	57–71		72 Hf Hafnium 178.49	73 Ta Tantalum 180.94788	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.084	79 Au Gold 196.966569	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2	83 Bi Bismuth 208.98040	84 Po Polonium (209.9824)	85 At Astatine (209.9871)	86 Rn Radon (222.0176)
7	87 Fr Francium (223)	88 Ra Radium (226)	89–103		104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (277)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (271)	111 Rg Roentgenium (272)	112 Uub Ununbium (285)	113 Uut Ununtrium (284)	114 Uuq Ununquadium (289)	115 Uup Ununpentium (288)	116 Uuh Ununhexium (292)	117 Uus Ununseptium	118 Uuo Ununoctium (294)

C Solid

Hg Liquid

H Gas

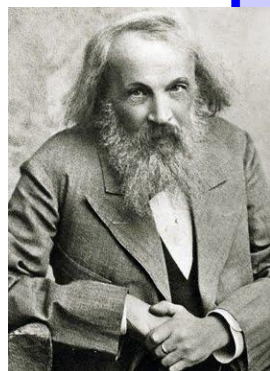
Rf Unknown

Metals					Nonmetals	
Alkali metals	Alkaline earth metals	Lanthanoids	Transition metals	Poor metals	Other nonmetals	Noble gases
		Actinoids				

For elements with no stable isotopes, the mass number of the isotope with the longest half-life is in parentheses.

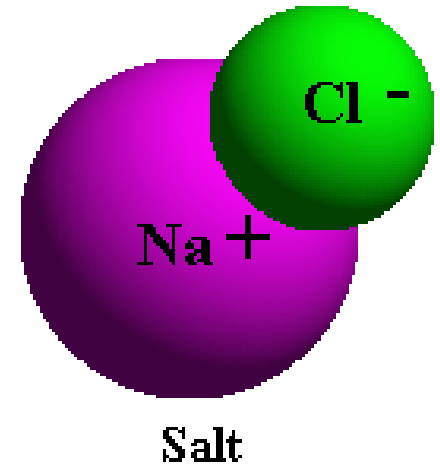
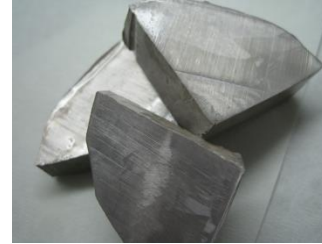
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57 La Lanthanum 138.90547	58 Ce Cerium 140.116	59 Pr Praseodymium 140.90768	60 Nd Neodymium 144.242	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92535	66 Dy Dysprosium 162.500	67 Ho Holmium 164.93032	68 Er Erbium 167.259	69 Tm Thulium 168.93421	70 Yb Ytterbium 173.054	71 Lu Lutetium 174.9668
89 Ac Actinium (227)	90 Th Thorium 232.03806	91 Pa Protactinium 231.03588	92 U Uranium 238.02891	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)



Elements and Compounds

- Sodium is an **element**.
- Chlorine is an **element**.
- When **sodium** and **chlorine** **bond** they make up the **compound sodium chloride**, commonly known as **table salt**.



Compounds have different properties than the elements that make them up:

for example, table salt has different properties than **sodium**, an **explosive metal**, and **chlorine**, a **poisonous gas**.

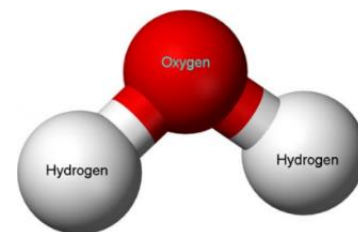
Elements, Compounds, Mixtures

- Hydrogen is an **element**.
- Oxygen is an **element**.
- When **hydrogen** and **oxygen** **bond** they make the **compound** **water**.
- When **salt** and **water** are **combined**, a **mixture** is created.

Components in mixtures
retain their individual
properties.



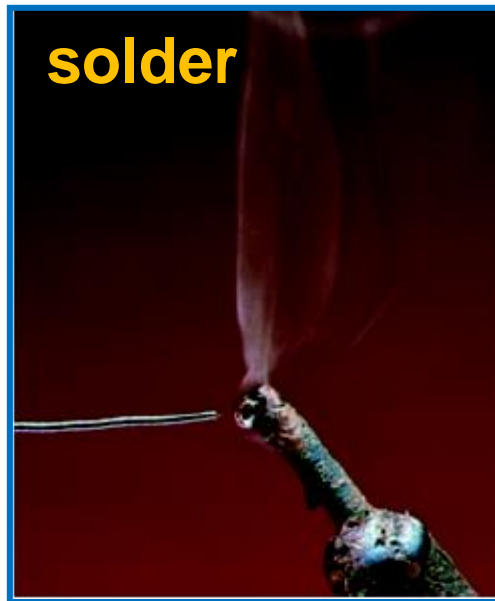
Water is a
compound



Ocean water
is a **mixture**

Types of Mixtures

- **Homogenous** – composition of the mixture is the same throughout; only one phase of matter is present.



- **Heterogeneous** – composition is not uniform throughout.



Fun with Liquids

Have you ever heard the phrase "oil and water don't mix"?



The term
“miscibility”
describes how well
two substances
mix. “Immiscible”
liquids do not mix.
When combined
together, they form
layers.

WHY?