

Matter in Chemistry

IA 1 H Hydrogen 1 1.01																	VIII A 18 He Helium 2 4.00						
IIA 2 Li Lithium 3 6.94	Be Beryllium 4 9.01																	III A 13 B Boron 5 10.81	IVA 14 C Carbon 6 12.01	V A 15 N Nitrogen 7 14.01	VIA 16 O Oxygen 8 16.00	VII A 17 F Fluorine 9 19.00	Ne Neon 10 20.18
3 Na Sodium 11 22.99	Mg Magnesium 12 24.31																	Aluminum 13 Al 26.98	IV A 14 Si Silicon 14 28.09	V A 15 P Phosphorus 15 30.97	VIA 16 S Sulphur 16 32.06	VII A 17 Cl Chlorine 17 35.45	Ar Argon 18 39.95
4 K Potassium 19 39.10	Ca Calcium 20 40.08	III B 3 Sc Scandium 21 44.96	IV B 4 Ti Titanium 22 47.88	V B 5 V Vanadium 23 50.94	VI B 6 Cr Chromium 24 52.00	VII B 7 Mn Manganese 25 54.94	VIII 8 Fe Iron 26 55.85	VIII 9 Co Cobalt 27 58.93	VIII 10 Ni Nickel 28 58.69	IB 11 Cu Copper 29 63.55	II B 12 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	Hf Hafnium 72 178.49	Ta Tantalum 73 180.95	W Tungsten 74 183.85	Re Rhenium 75 186.21	Os Osmium 76 190.23	Ir Iridium 77 192.22	Pt Platinum 78 195.08	Au Gold 79 196.97	Hg Mercury 80 200.59	Tl Thallium 81 204.38	Pb Lead 82 207.20	Bi Bismuth 83 208.98	Po Polonium 84 (209)	At Astatine 85 (210)	Rn Radon 86 (222)						
7 Fr Francium 87 (223)	Ra Radium 88 (226)	Actinide Series	Rf Rutherfordium 104 (261)	Db Dubnium 105 (262)	Sg Seaborgium 106 (263)	Bh Bohrium 107 (262)	Hs Hassium 108 (265)	Mt Meitnerium 109 (266)	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)

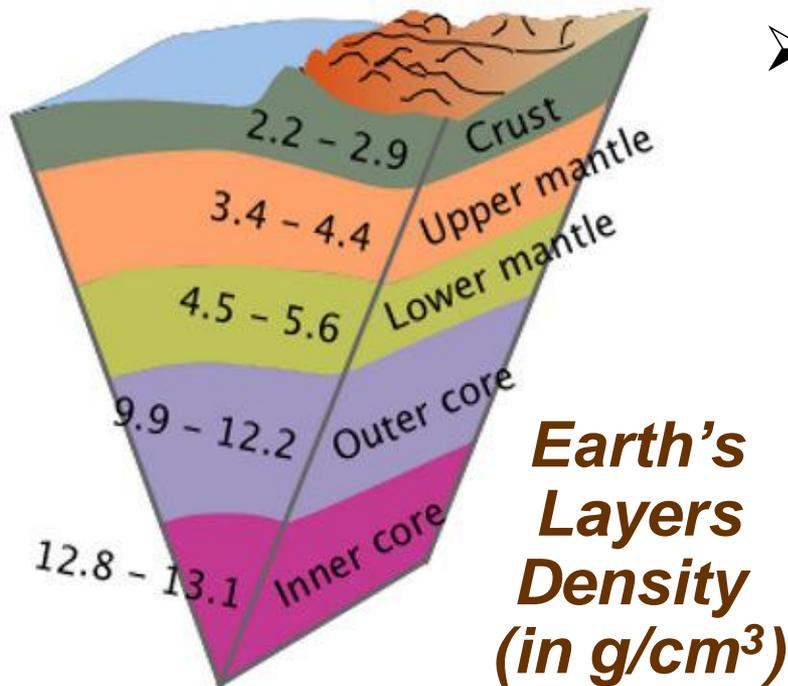
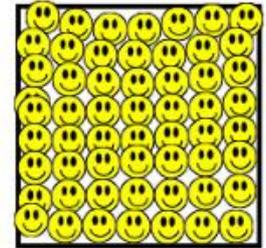
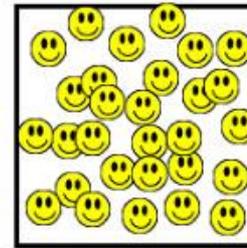
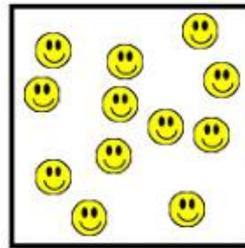


Density

- **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/m^3

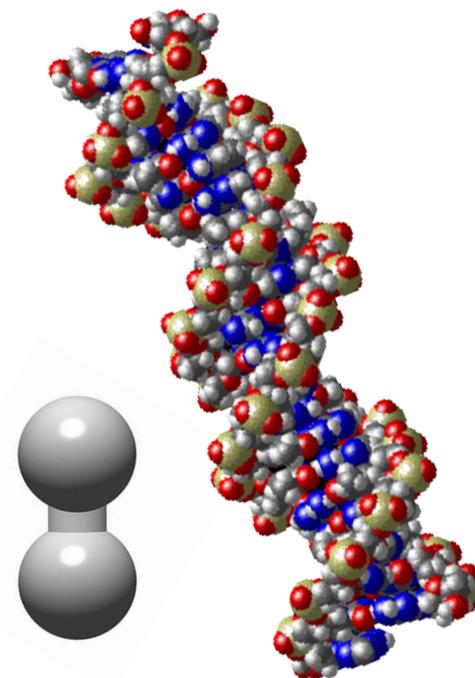
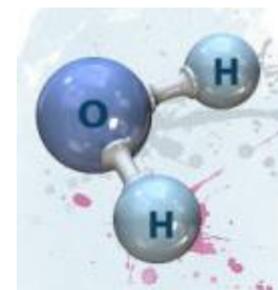


- The density of a material varies with temperature and pressure (this variation is typically small for solids and liquids but much greater for gases).
- In general, lowering the temperature results in density increase
- Increasing the pressure also results in density increase

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**.



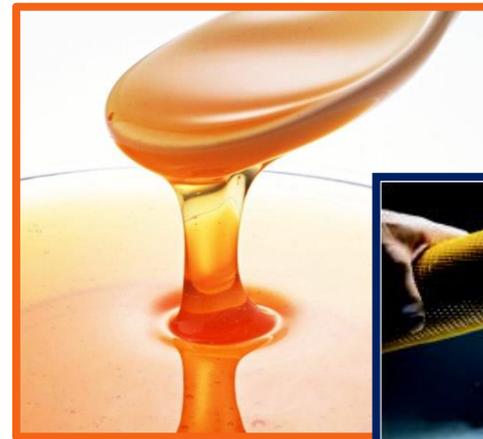
Chemical Substance

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



glass

gold ingots



honey

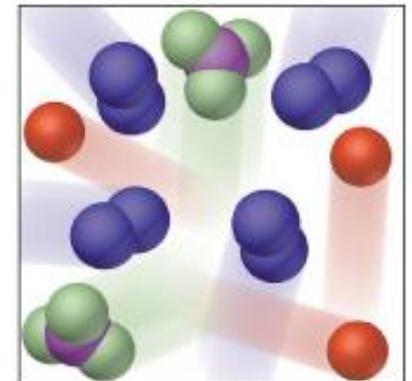
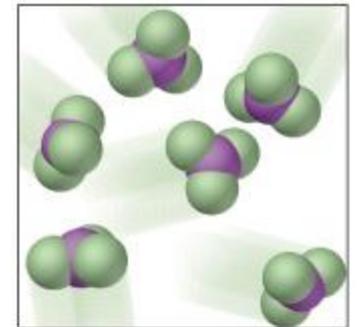
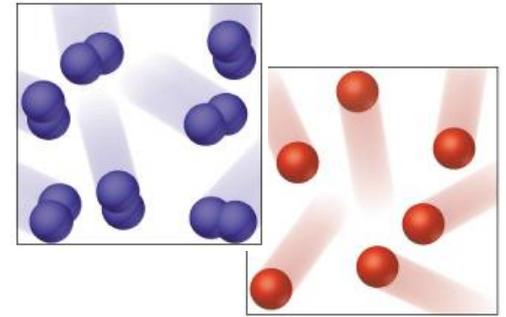
liquid nitrogen



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.

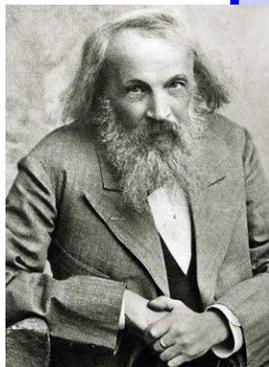


Periodic Table of Elements

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18																	
1	H Hydrogen 1.00794	Atomic # Symbol Name Atomic Mass																	2	He Helium 4.002602															
3	Li Lithium 6.941	4	Be Beryllium 9.012182	Metals														Nonmetals																	
11	Na Sodium 22.98976928	12	Mg Magnesium 24.3050	Alkali metals	Alkaline earth metals	Lanthanoids	Actinoids	Transition metals	Poor metals	Other nonmetals	Noble gases			13	B Boron 10.811	14	C Carbon 12.0107	15	N Nitrogen 14.0067	16	O Oxygen 15.9994	17	F Fluorine 18.9984032	18	Ne Neon 20.1797										
19	K Potassium 39.0983	20	Ca Calcium 40.078	21	Sc Scandium 44.955912	22	Ti Titanium 47.887	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 74.92160	34	Se Selenium 78.96	35	Br Bromine 79.904	36	Kr Krypton 83.798
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
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)
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)

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

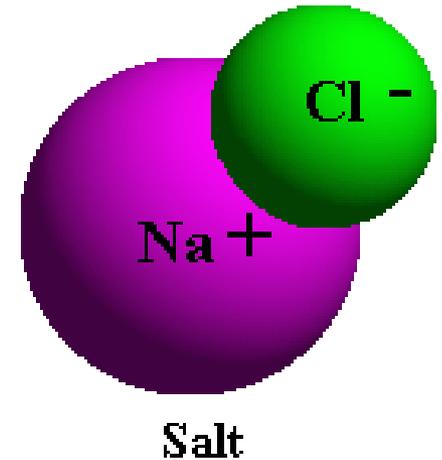
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57	La Lanthanum 138.90547	58	Ce Cerium 140.116	59	Pr Praseodymium 140.90768	60	Nd Neodymium 144.242	61	Pm Promethium (145)	62	Sm Samarium 150.36	63	Eu Europium 151.964	64	Gd Gadolinium 157.25	65	Tb Terbium 158.92535	66	Dy Dysprosium 162.500	67	Ho Holmium 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**.

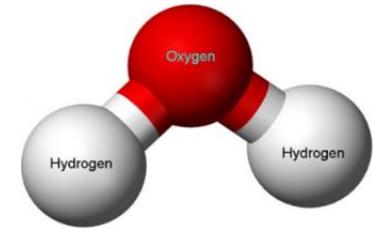
Elements, Compounds, Mixtures

- 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.



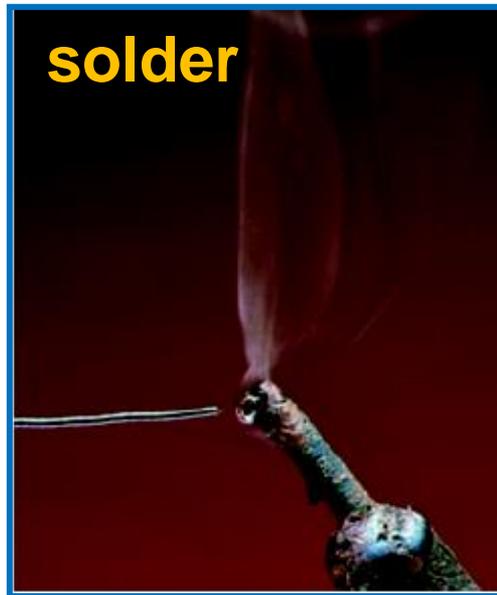
Water is a
compound



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?

