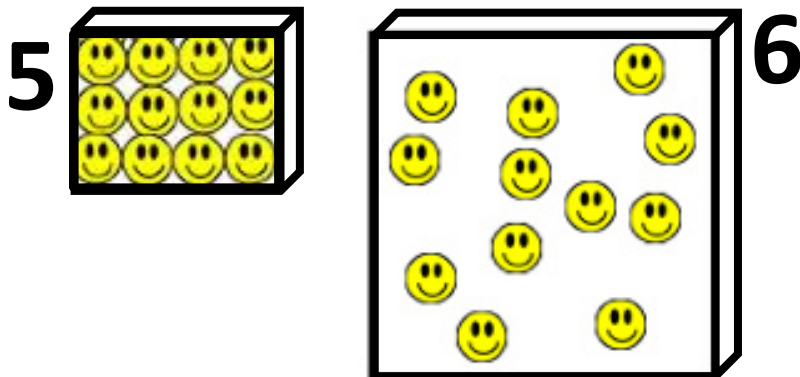
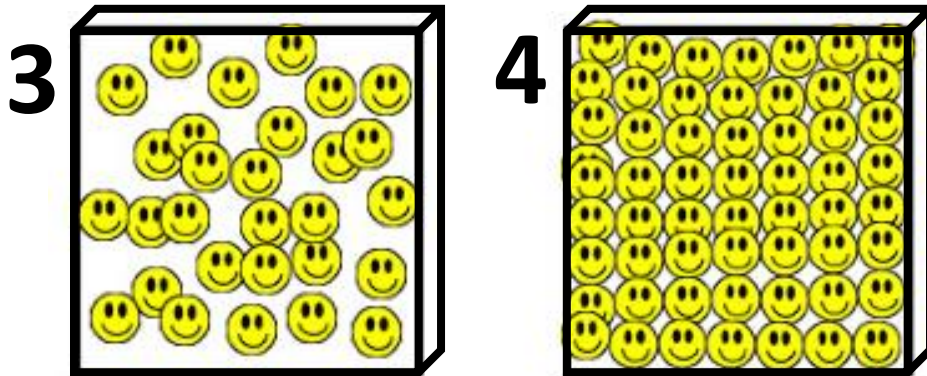
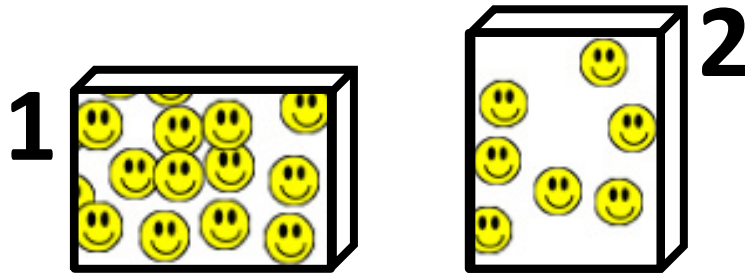


# Which of the following objects...



- ...have the **same** volume?
- ...have the **same** density?
- ...have **different** mass?
- ...have **different** volume?
- ...have the **same** mass?
- ...have **different** density?

(note: all atoms here are the same)

# Matter in Chemistry

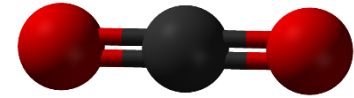
Ordinary matter is composed of atoms and groups of atoms *bonded* together, called molecules.

- There are many different types of atoms.
- Consequently, there are many possible combinations of two or more atoms that can chemically bond.

IA 1	H Hydrogen 1 1.01	IIA 2	Li Lithium 3 6.94	Be Beryllium 4 9.01	III A 13	B Boron 5 10.81	IIIA 14	C Carbon 6 12.01	IVA 15	N Nitrogen 7 14.01	VIA 16	O Oxygen 8 16.00	VIIA 17	F Fluorine 9 19.00	VIIIA 18	He Helium 2 4.00																								
2	Na Sodium 11 22.99	Mg Magnesium 12 24.31	Al Aluminium 13 26.98	Si Silicon 14 28.09	P Phosphorus 15 30.97	S Sulphur 16 32.06	Cl Chlorine 17 35.45	Ar Argon 18 39.95	3	K Potassium 19 39.10	Ca Calcium 20 40.08	Sc Scandium 21 44.96	Ti Titanium 22 47.88	V Vanadium 23 50.94	Cr Chromium 24 52.00	Mn Manganese 25 54.94	Fe Iron 26 55.85	Co Cobalt 27 58.93	Ni Nickel 28 58.69	Cu Copper 29 63.55	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													
4	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	5	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)			
6	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 59 140.91	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 65 158.93	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	6	Ac Actinium 89 227.03	Th Thorium 90 232.04	Pa Protactinium 91 231.04	U Uranium 92 238.03	Np Neptunium 93 237.05	Pu Plutonium 94 244.06	Am Americium 95 243.06	Cm Curium 96 247.07	Bk Berkelium 97 247.07	Cf Californium 98 251.08	Es Einsteinium 99 (252)	Fm Fermium 100 (257)	Md Mendelevium 101 (258)	No Nihonium 102 (289)	Lr Lawrencium 103 (260)
7	Ac Actinium 89 227.03	Th Thorium 90 232.04	Pa Protactinium 91 231.04	U Uranium 92 238.03	Np Neptunium 93 237.05	Pu Plutonium 94 244.06	Am Americium 95 243.06	Cm Curium 96 247.07	Bk Berkelium 97 247.07	Cf Californium 98 251.08	Es Einsteinium 99 (252)	Fm Fermium 100 (257)	Md Mendelevium 101 (258)	No Nihonium 102 (289)	Lr Lawrencium 103 (260)																									

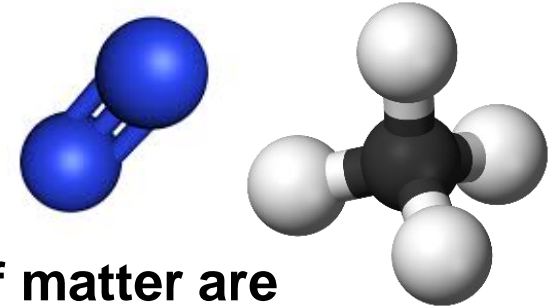


# Molecule

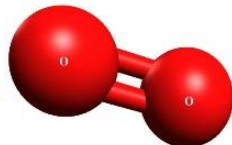
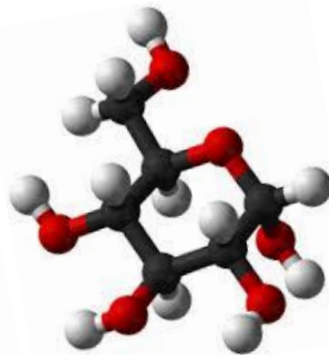
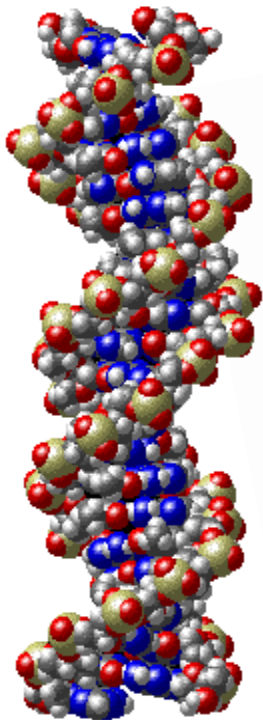


Molecules are neutral groups of two or more atoms held together by chemical bonds.

- Molecules can be thought of as the **smallest identifiable physical unit** of a chemical substance.



- 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

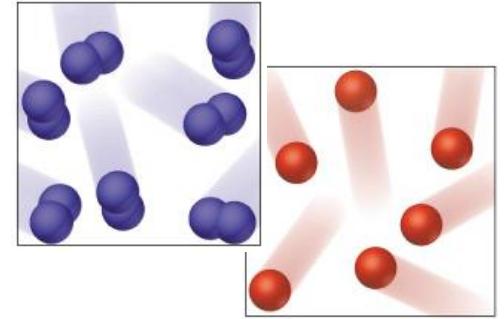
liquid nitrogen



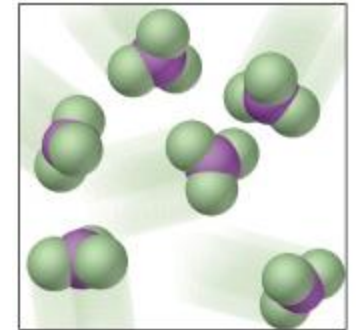
All ordinary matter can be classified *chemically* as either a *pure substance* or a *mixture*.

# Classification of Substances

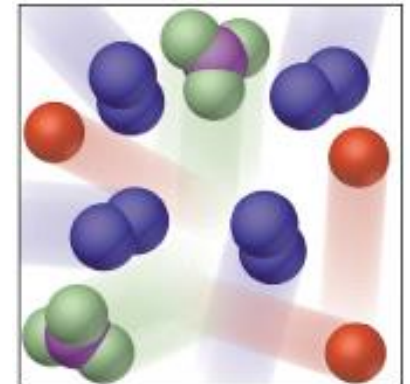
- **Elements**: substances that are made from **one type of atom** only.  
How many types are there?



- **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 bonded.



# Periodic Table of Elements

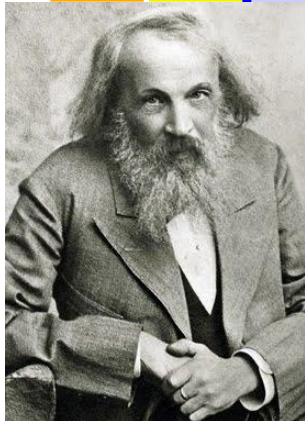
today, there are **118** known elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18																																																																											
1 <b>H</b> Hydrogen 1.00794	Atomic # Symbd Name Atomic Mass																2 <b>He</b> Helium 4.002602																																																																											
3 <b>Li</b> Lithium 6.941	4 <b>Be</b> Beryllium 9.012182	<table border="1"> <tr> <td><b>C</b> Solid</td> <td colspan="10"><b>Metals</b></td> <td colspan="5"><b>Nonmetals</b></td> </tr> <tr> <td><b>Hg</b> Liquid</td> <td><b>Alkali metals</b></td> <td><b>Alkaline earth metals</b></td> <td>Lanthanoids</td> <td>Transition metals</td> <td>Poor metals</td> <td>Other nonmetals</td> <td colspan="4"><b>Noble gases</b></td> <td></td><td></td><td></td><td></td><td></td><td></td> </tr> <tr> <td><b>H</b> Gas</td> <td></td><td></td><td>Actinoids</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> <tr> <td><b>Rf</b> Unknown</td> <td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> </table>																<b>C</b> Solid	<b>Metals</b>										<b>Nonmetals</b>					<b>Hg</b> Liquid	<b>Alkali metals</b>	<b>Alkaline earth metals</b>	Lanthanoids	Transition metals	Poor metals	Other nonmetals	<b>Noble gases</b>										<b>H</b> Gas			Actinoids															<b>Rf</b> Unknown																		5 <b>B</b> Boron 10.811	6 <b>C</b> Carbon 12.0107	7 <b>N</b> Nitrogen 14.0067	8 <b>O</b> Oxygen 15.9994	9 <b>F</b> Fluorine 18.9984032	10 <b>Ne</b> Neon 20.1797
<b>C</b> Solid	<b>Metals</b>										<b>Nonmetals</b>																																																																																	
<b>Hg</b> Liquid	<b>Alkali metals</b>	<b>Alkaline earth metals</b>	Lanthanoids	Transition metals	Poor metals	Other nonmetals	<b>Noble gases</b>																																																																																					
<b>H</b> Gas			Actinoids																																																																																									
<b>Rf</b> Unknown																																																																																												
11 <b>Na</b> Sodium 22.98976928	12 <b>Mg</b> Magnesium 24.3050																	13 <b>Al</b> Aluminium 26.9815386	14 <b>Si</b> Silicon 28.0855	15 <b>P</b> Phosphorus 30.973762	16 <b>S</b> Sulfur 32.065	17 <b>Cl</b> Chlorine 35.453	18 <b>Ar</b> Argon 39.948																																																																					
19 <b>K</b> Potassium 39.0983	20 <b>Ca</b> Calcium 40.078	21 <b>Sc</b> Scandium 44.955912	22 <b>Ti</b> Titanium 47.867	23 <b>V</b> Vanadium 50.9415	24 <b>Cr</b> Chromium 51.9961	25 <b>Mn</b> Manganese 54.938045	26 <b>Fe</b> Iron 55.845	27 <b>Co</b> Cobalt 58.933195	28 <b>Ni</b> Nickel 58.6934	29 <b>Cu</b> Copper 63.546	30 <b>Zn</b> Zinc 65.38	31 <b>Ga</b> Gallium 69.723	32 <b>Ge</b> Germanium 72.64	33 <b>As</b> Arsenic 74.92160	34 <b>Se</b> Selenium 78.96	35 <b>Br</b> Bromine 79.904	36 <b>Kr</b> Krypton 83.798																																																																											
37 <b>Rb</b> Rubidium 85.4678	38 <b>Sr</b> Strontium 87.62	39 <b>Y</b> Yttrium 88.90585	40 <b>Zr</b> Zirconium 91.224	41 <b>Nb</b> Niobium 92.90638	42 <b>Mo</b> Molybdenum 95.96	43 <b>Tc</b> Technetium (97.9072)	44 <b>Ru</b> Ruthenium 101.07	45 <b>Rh</b> Rhodium 102.90550	46 <b>Pd</b> Palladium 106.42	47 <b>Ag</b> Silver 107.8682	48 <b>Cd</b> Cadmium 112.411	49 <b>In</b> Indium 114.818	50 <b>Sn</b> Tin 118.710	51 <b>Sb</b> Antimony 121.760	52 <b>Te</b> Tellurium 127.60	53 <b>I</b> Iodine 126.90447	54 <b>Xe</b> Xenon 131.293																																																																											
55 <b>Cs</b> Caesium 132.9054519	56 <b>Ba</b> Barium 137.327	57-71		72 <b>Hf</b> Hafnium 178.49	73 <b>Ta</b> Tantalum 180.94788	74 <b>W</b> Tungsten 183.84	75 <b>Re</b> Rhenium 186.207	76 <b>Os</b> Osmium 190.23	77 <b>Ir</b> Iridium 192.217	78 <b>Pt</b> Platinum 195.084	79 <b>Au</b> Gold 196.966569	80 <b>Hg</b> Mercury 200.59	81 <b>Tl</b> Thallium 204.3833	82 <b>Pb</b> Lead 207.2	83 <b>Bi</b> Bismuth 208.98040	84 <b>Po</b> Polonium (208.9824)	85 <b>At</b> Astatine (209.9871)	86 <b>Rn</b> Radon (222.0176)																																																																										
87 <b>Fr</b> Francium (223)	88 <b>Ra</b> Radium (226)	89-103		104 <b>Rf</b> Rutherfordium (261)	105 <b>Db</b> Dubnium (262)	106 <b>Sg</b> Seaborgium (266)	107 <b>Bh</b> Bohrium (264)	108 <b>Hs</b> Hassium (277)	109 <b>Mt</b> Meitnerium (268)	110 <b>Ds</b> Darmstadtium (271)	111 <b>Rg</b> Roentgenium (272)	112 <b>Uub</b> Ununbium (285)	113 <b>Uut</b> Ununtrium (284)	114 <b>Uuq</b> Ununquadium (289)	115 <b>Uup</b> Ununpentium (288)	116 <b>Uuh</b> Ununhexium (292)	117 <b>Uus</b> Ununseptium	118 <b>Uuo</b> Ununoctium (294)																																																																										

94 naturally occurring elements and 24 synthetic (man-made)

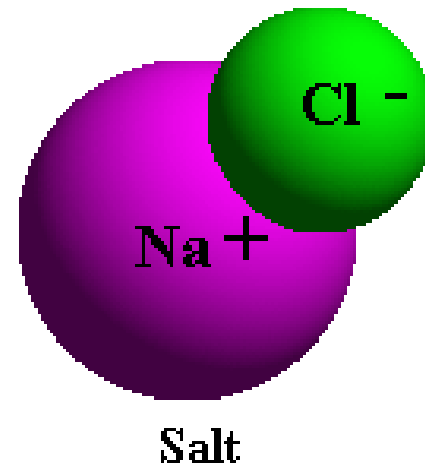
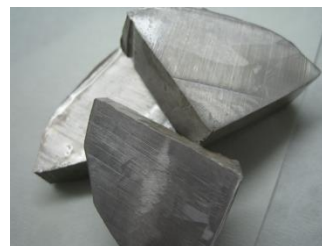
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57 <b>La</b> Lanthanum 138.90547	58 <b>Ce</b> Cerium 140.116	59 <b>Pr</b> Praseodymium 140.90785	60 <b>Nd</b> Neodymium 144.242	61 <b>Pm</b> Promethium (145)	62 <b>Sm</b> Samarium 150.36	63 <b>Eu</b> Europium 151.964	64 <b>Gd</b> Gadolinium 157.25	65 <b>Tb</b> Terbium 158.92535	66 <b>Dy</b> Dysprosium 162.500	67 <b>Ho</b> Holmium 164.93032	68 <b>Er</b> Erbium 167.259	69 <b>Tm</b> Thulium 168.93421	70 <b>Yb</b> Ytterbium 173.054	71 <b>Lu</b> Lutetium 174.968
89 <b>Ac</b> Actinium (227)	90 <b>Th</b> Thorium 232.03806	91 <b>Pa</b> Protactinium 231.03588	92 <b>U</b> Uranium 238.02891	93 <b>Np</b> Neptunium (237)	94 <b>Pu</b> Plutonium (244)	95 <b>Am</b> Americium (243)	96 <b>Cm</b> Curium (247)	97 <b>Bk</b> Berkelium (247)	98 <b>Cf</b> Californium (251)	99 <b>Es</b> Einsteinium (252)	100 <b>Fm</b> Fermium (257)	101 <b>Md</b> Mendelevium (258)	102 <b>No</b> Nobelium (259)	103 <b>Lr</b> 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**.

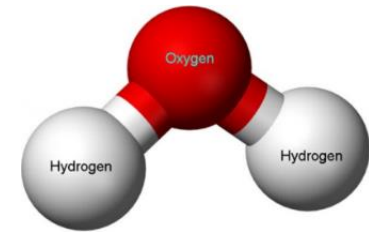
# Elements, Compounds, Mixtures

- 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**

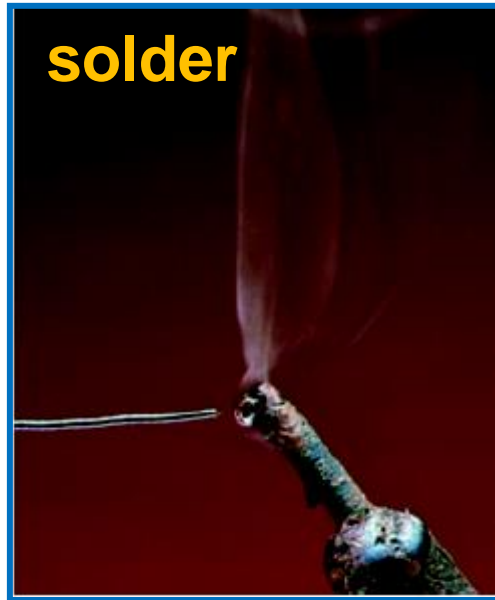


Ocean water is a **mixture**



# Types of Mixtures

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



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

