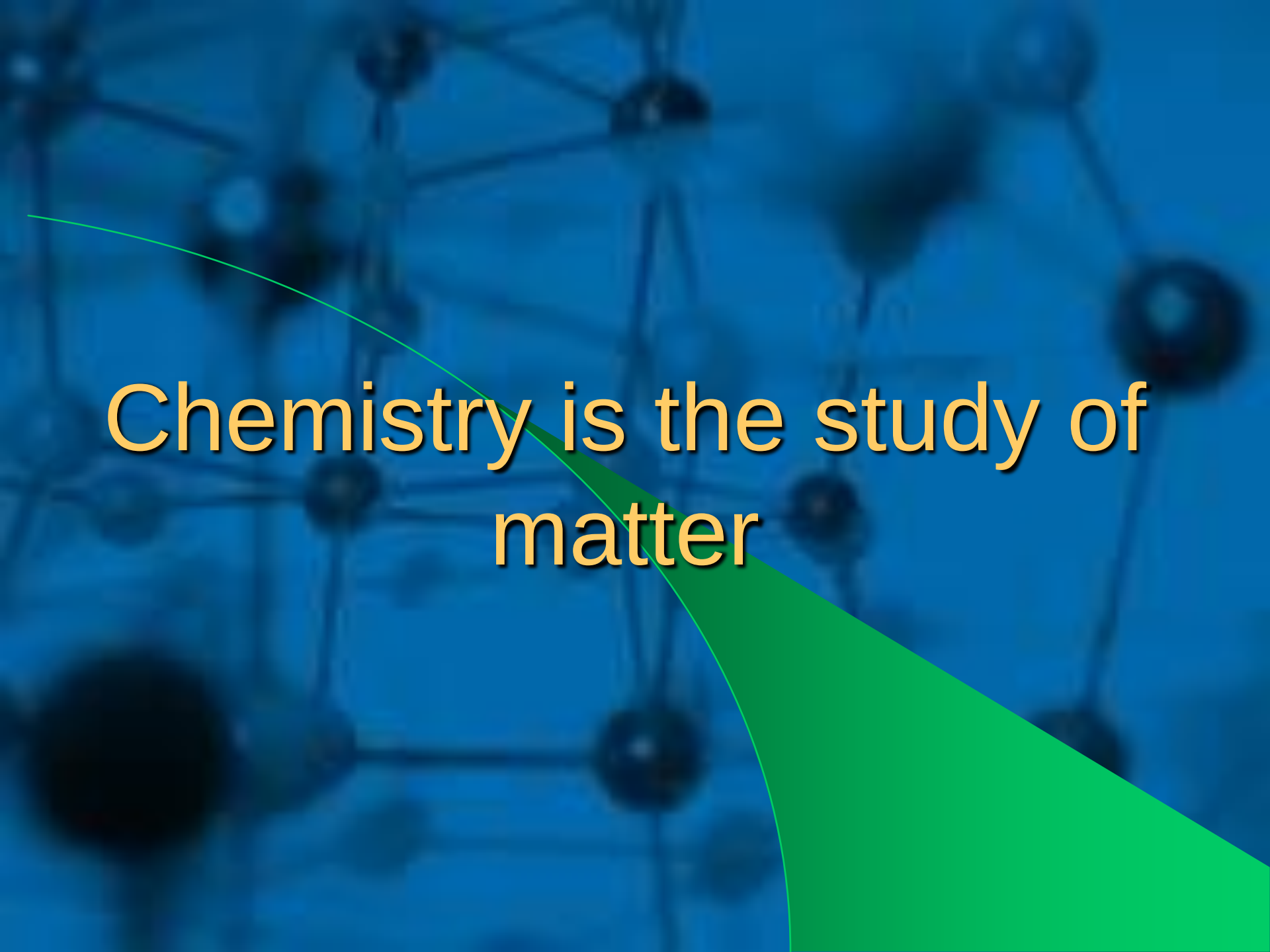


The background is a blue-tinted image of a molecular structure, showing a network of dark spheres (atoms) connected by thin lines (bonds). A bright green wedge-shaped graphic element originates from the bottom right corner and points towards the center of the text.

Chemistry is the study of
matter

Learning Objectives

- Define the three states of matter
- Define element and compound
- Distinguish between mixture and compound
- Describe difference between “physical” and “chemical”
- Identify physical and chemical changes
- Distinguish between intensive and extensive properties

CHEMISTRY

- Chemistry is the science that describes matter: its properties, the changes it undergoes
- Important questions:
 - How do substances combine to form others?
 - What are the energies involved
 - How are these substances made up in detail
 - What factors are involved in determining stability and so on
 - What is the make-up or composition of matter?
 - Why does matter have certain qualities?
 - Does matter undergo changes, and what kind?
 - Can it be produced from other types of matter?
 - What can we make with matter?

Chemistry as revelation or creation

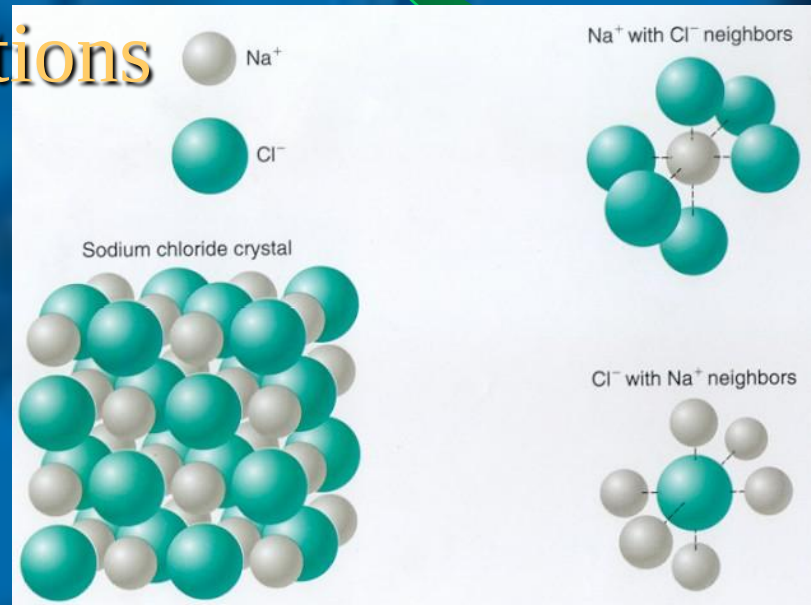
- Much of chemistry is about discovering and understanding the world
- Other chemists emphasize creation: making new materials for improving our lot
- Chemistry has its roots in alchemy, which laid the foundation for modern science

The Nature Of Matter

- All matter is made of something, even if it looks like nothing.
- We make classifications according to its properties, both chemical and physical

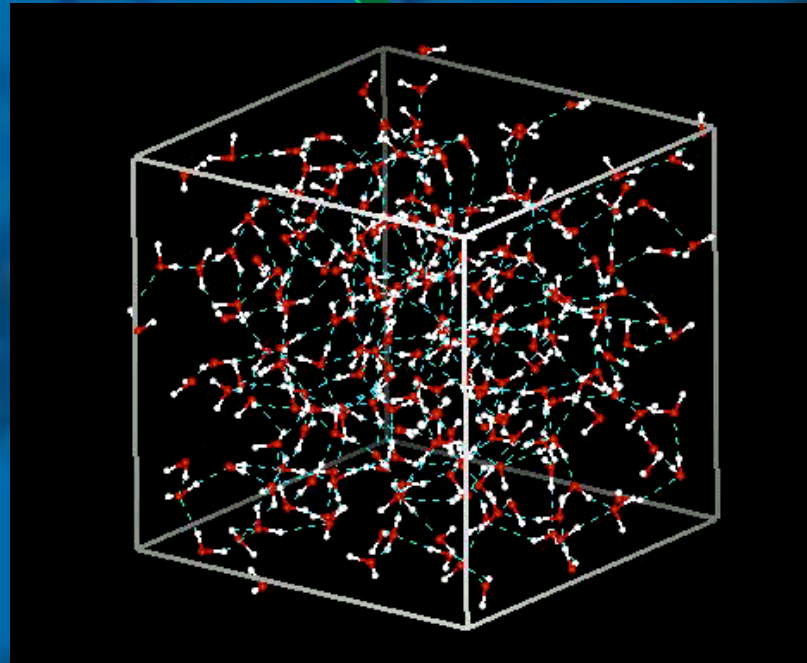
States of Matter: sorting by strength of interaction

- Solid: strong interactions
- Fixed shape
- Not compressible
- Rigid
- Dense



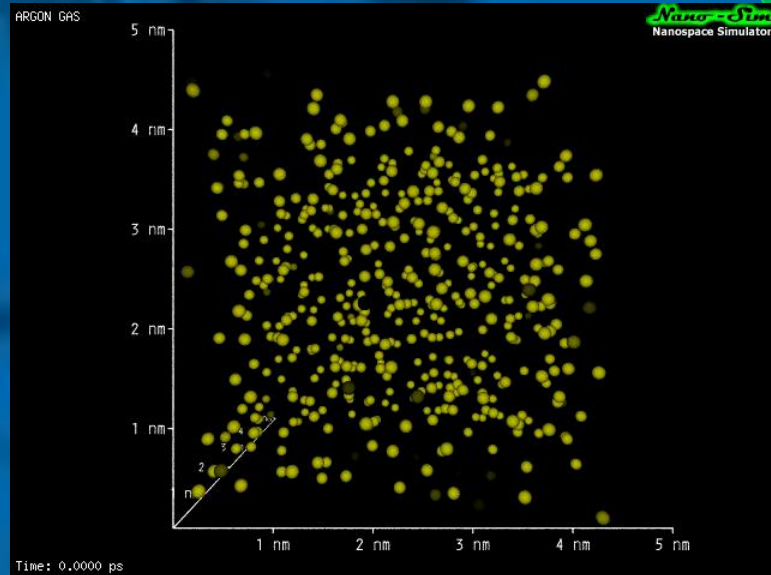
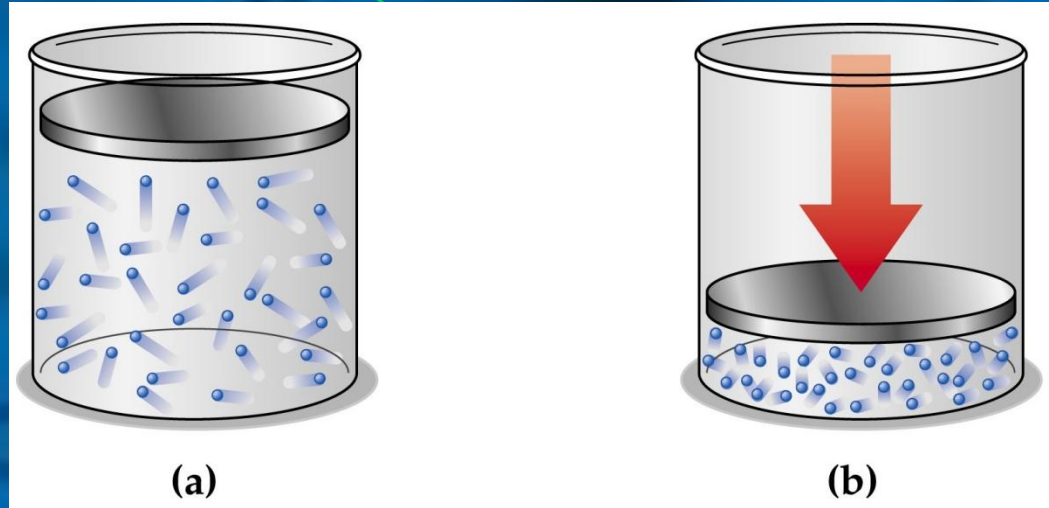
Liquid: medium interactions

- Liquid
- Not rigid
- Assumes shape of container
- Not compressible
- Dense

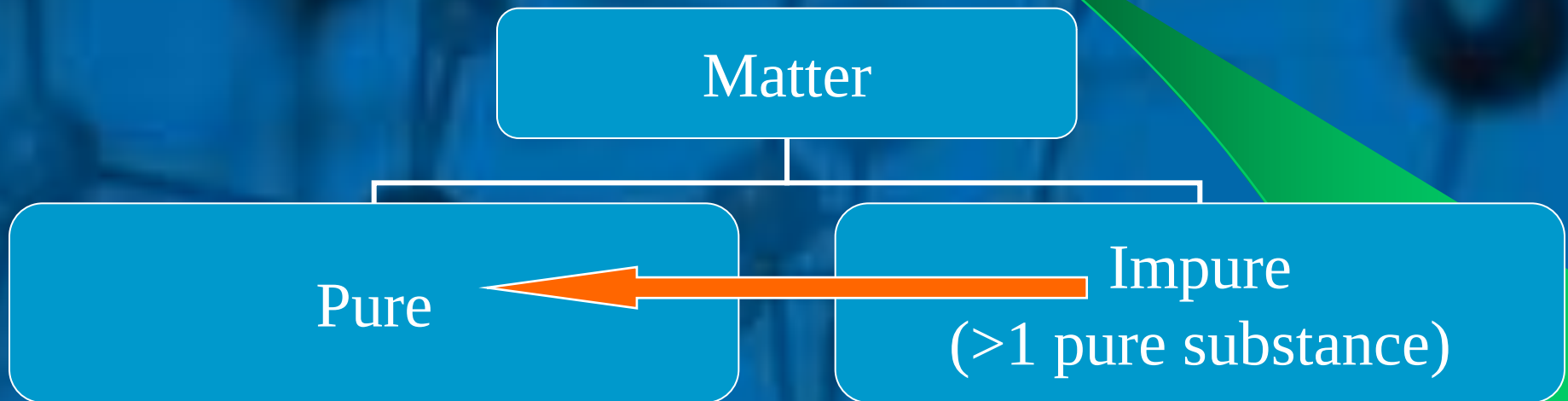


Gas: no interactions

- Not rigid
- Completely fills container
- Compressible
- Low density



Sorting by separability: physical



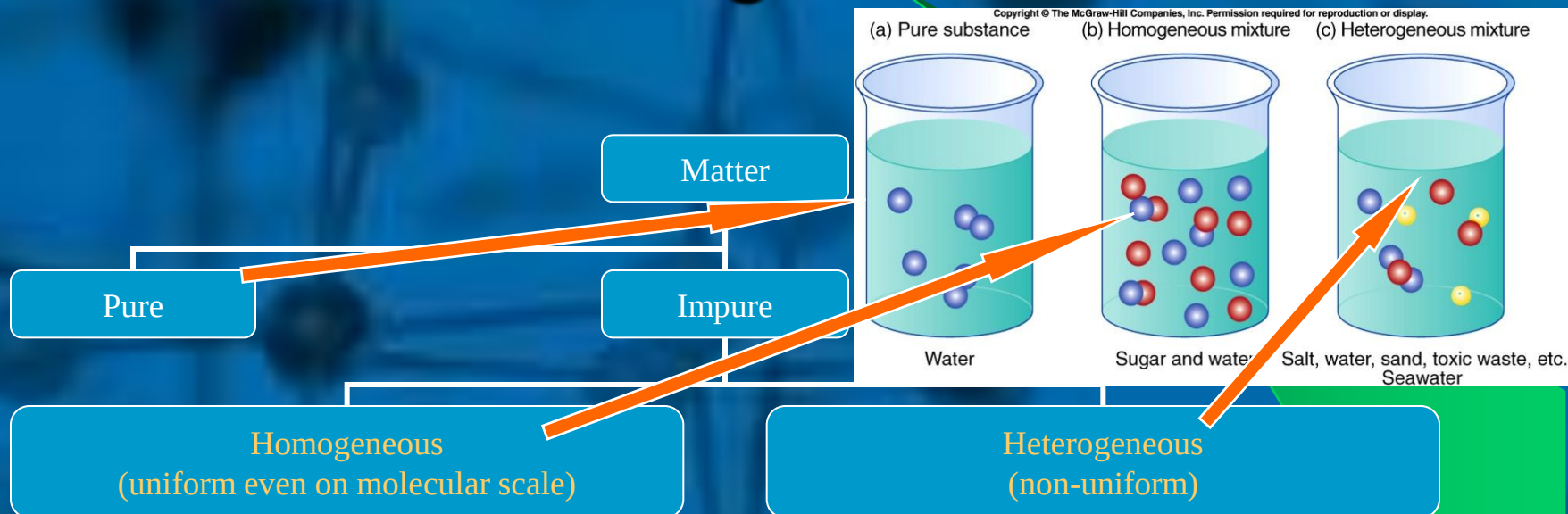
- Pure matter cannot be separated by physical means
- Impure matter can be separated by physical means
- Another word for impure matter is mixture – a solution is a common example of a mixture

What are physical means

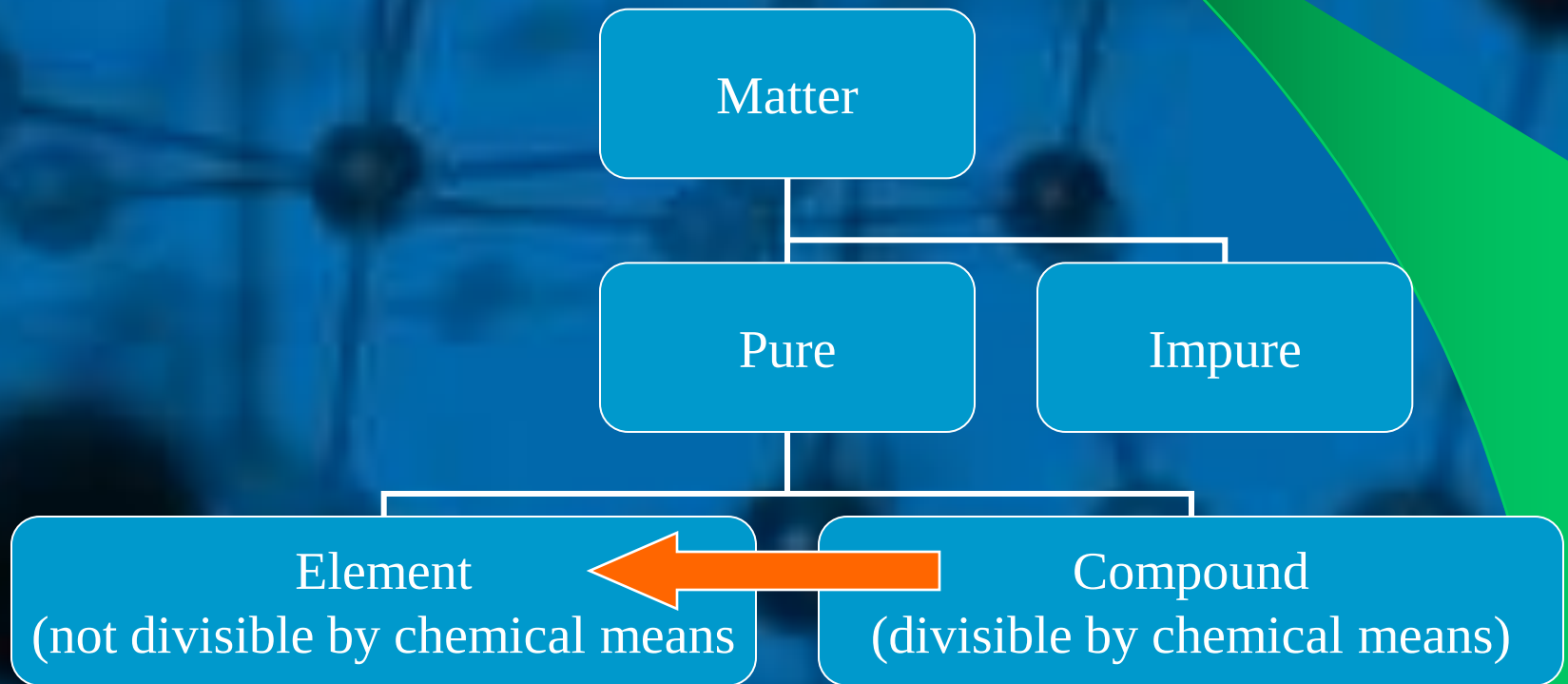
- Filtration and centrifuge (liquids and solids)
- Crystallization (solutions)
- Distillation (solutions of liquids)
- Magnetism (magnetic from non-magnetic)
- Chromatography (gases and liquids)



Mixtures are either homogeneous or heterogeneous



Sorting by separability: chemical



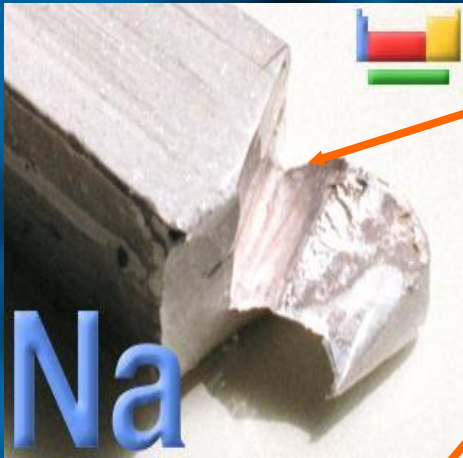
Compounds are not mixtures

- Compounds have specific compositions (ratio of elements always the same - NaCl)
- Mixtures have variable composition
- Compounds have properties different from those of elements
- Mixtures have similar properties to those of constituents

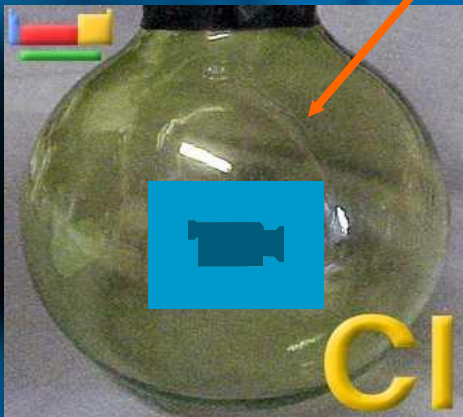
Sodium chloride is made from sodium and chlorine

•ELEMENTS:

- Sodium: metal, very reactive

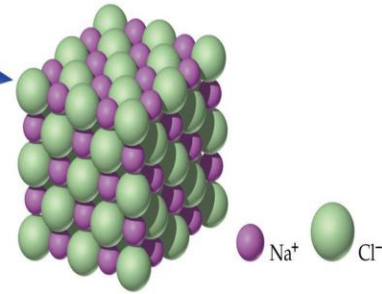


- Chlorine: gas, very reactive, highly toxic

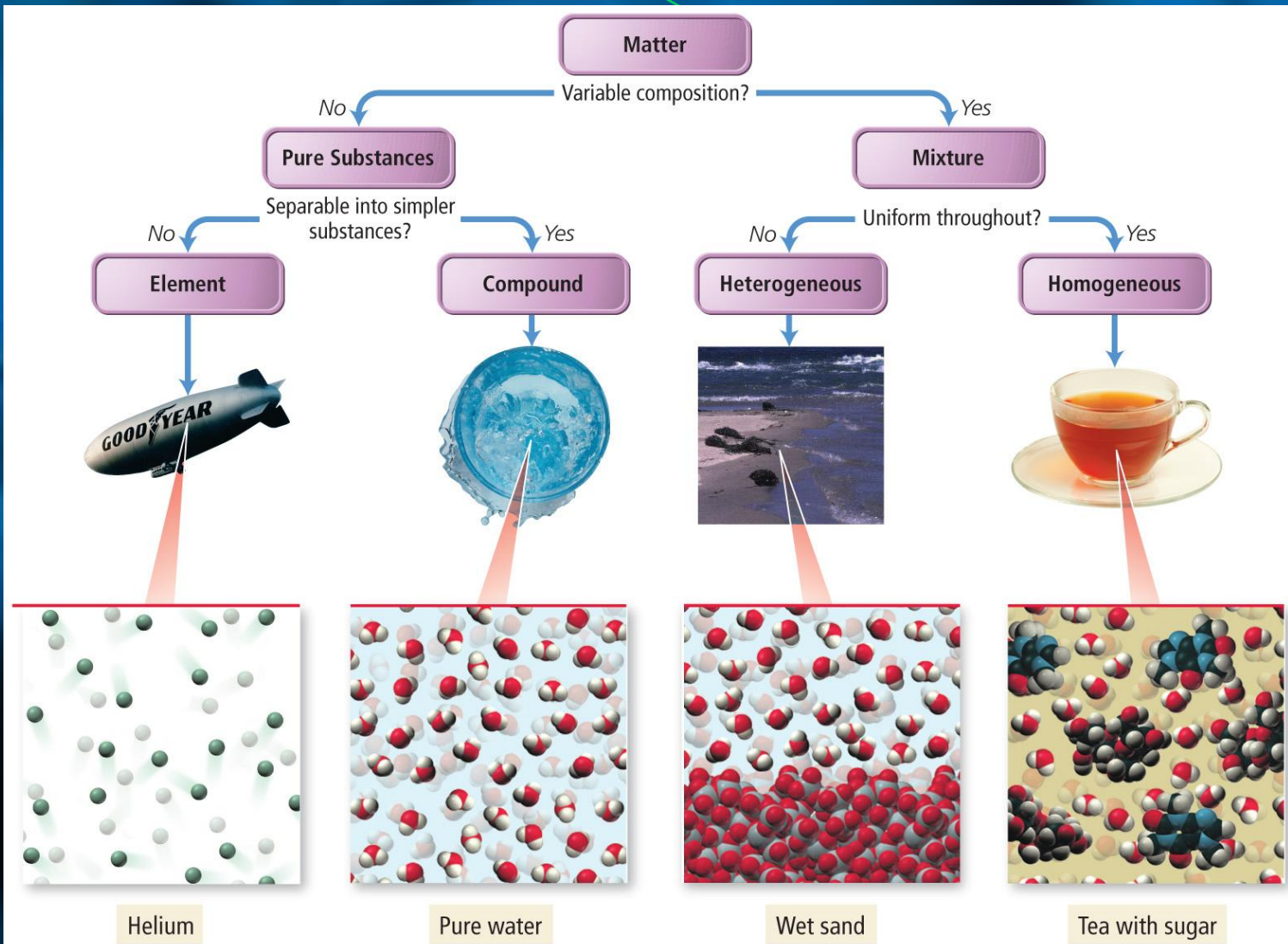


•COMPOUND

- Sodium chloride: salt, unreactive, harmless

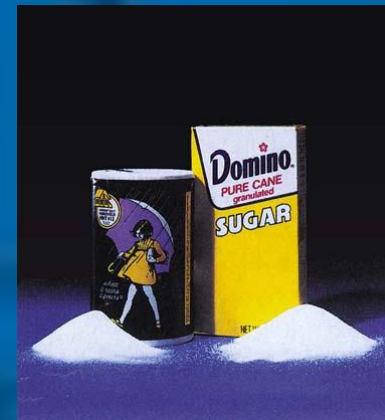
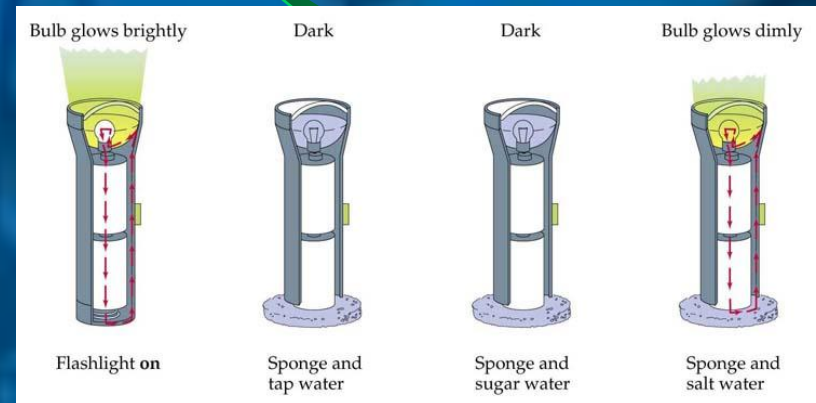


Summary



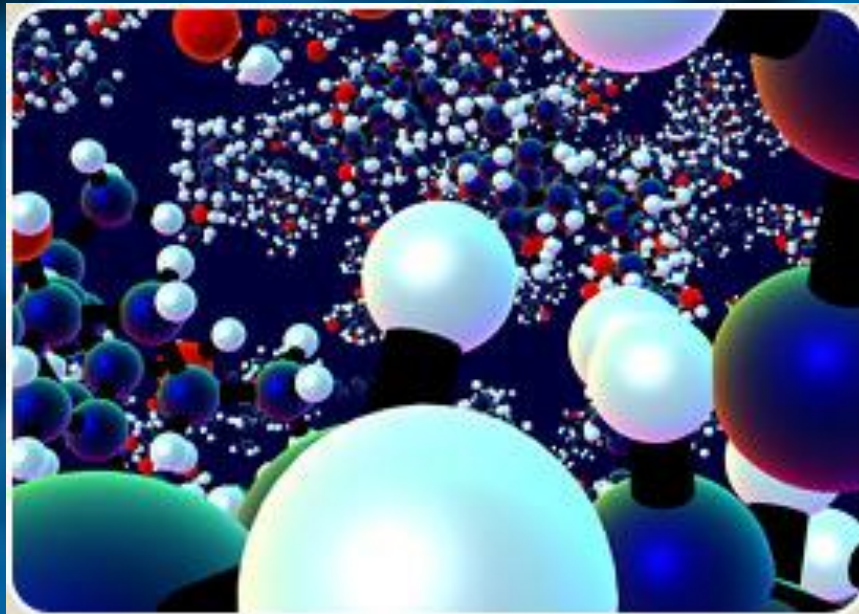
Matter reveals itself through properties

- Salt and sugar are both white crystalline powders
- Both dissolve in water
- Solution of salt conducts electricity
- Solution of sugar does not



Properties depend on the “mollycules”

- Salt is an electrolyte – contains ions
- Sugar is made up of neutral molecules
- Molecules are not the smallest thing but are composed of atoms



Flann O'Brien's Mollycular Theory: an Artist's view

“Did you ever study the Mollycule Theory when you were a lad?” he asked.

Mick said no, not in any detail.

“That is a very serious defalcation and an abstruse exacerbation, he said severely, but I'll tell you the size of it. Everything is composed of small mollycules of itself and they are flying around in concentric circles and arcs and segments and innumerable other various routes too numerous to mention collectively, never standing still or resting but spinning away and darting hither and thither and back again, all the time on the go. Do you follow me intelligently? Mollycules?”

- *From The Dalkey Archive by Flann O'Brien*

Chemical and Physical Properties

- Physical properties: things that we can measure about a substance (always the same for a pure substance)
 - Melting point
 - Boiling point
 - Density
 - Electrical conductivity
 - Thermal conductivity
 - Colour
- Chemical properties: how substances behave in chemical reactions (always involves change in composition)

Intensive and Extensive properties

- Intensive properties do *not* depend on the size of the sample
 - Temperature, density, melting point
- Extensive properties do depend on sample size
 - Mass, length, heat
- How to decide?
 - Looking at units can help: per unit mass or per unit volume will be intensive
 - Perform thought experiment – imagine effect of size change on the property under consideration

Chemical and Physical Change

- Physical change: changes where ultimately no change in the chemical composition occurs – easily reversible
 - Change of state (melting, boiling etc.)
 - Dissolving
- Chemical change: a change where a chemical reaction occurs

Decide for yourself: Chemical or physical?

- Grape juice turns to wine
- Wood burns to ashes
- Water boils
- Leaves turn yellow in Fall
- Rock is crushed to powder
- Salt dissolves in water

A glimpse into the future: the periodic table

There are 90-odd naturally occurring elements: 2 liquids, 11 gases, 23-25 nonmetals

Periodic Table of Elements

Representative elements

Alkali metals
↓
Group 1A

Alkaline earth metals
↓
Group 2A

Halogens
↓
Group 7A

Noble gases
↓
Group 8A

Period number

	1	2											13	14	15	16	17	18
	Group 1A	Group 2A											Group 3A	Group 4A	Group 5A	Group 6A	Group 7A	Group 8A

1	1	2											5	6	7	8	9	10	
	H	Li	Be											B	C	N	O	F	Ne
2	3	4											13	14	15	16	17	18	
	Na	Mg	3	4	5	6	7	8	9	10	11	12	Al	Si	P	S	Cl	Ar	
3	11	12	3B	4B	5B	6B	7B	8B		11B	12B	13	14	15	16	17	18		
	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	
	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
6	55	56	57*	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	
	Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	—	—	—	—	—	—	—		
7	87	88	89†	104	105	106	107	108	109	110	111	112	113	114	115				

*Lanthanides

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu

†Actinides

90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

Metals

Metalloids

Nonmetals

Copyright © 2005 Pearson Education, Inc., publishing as Benjamin Cummings

[illegible]

Groups are columns of elements

Periods are rows of elements

Atoms or molecules?

- Stuff is ultimately made from atoms
- Ninety naturally occurring elements (only a fraction of those important)
- Atoms in *combination* make molecules
- Millions of different substances
- Molecules determine properties and behaviour

