

POTIONS

Grades 2,3

Study Guide/Outline_2022

This study guide is intended to help coaches understand the topics the event will cover and the level of comprehension expected for those topics. It is recommended and expected that additional materials, websites and activities be used to help prepare the teams for this event.

Topics for Grades 2,3

- States of Matter (or phases): solid, liquid, gas
- Properties of solids, liquids, gases
- Transitions between phases
- Law of Conservation of matter/mass
- Structure of matter: atoms, elements, molecules, compounds
- Physical and chemical properties, physical vs. chemical changes
- Mixtures
- Periodic table of elements (simplified version)
- Basic elements: Hydrogen, Oxygen

Additional Topics for Grade-3 only:

- Law of Conservation of Matter/Mass
- Basic Elements: Nitrogen, Carbon (besides Hydrogen, Oxygen)

Study Guide/Outline: *Grade-specific concepts are marked accordingly.*

I. What is Chemistry?

The science that studies substances that make up matter and the changes that take place when substances interact. In other words, everything you hear, see, smell, taste, and touch involves chemistry and chemicals (matter). For example, chemistry is involved in cooking and making ice as well as in fireworks, paint, medicine, digestion of food, shape of a snowflake, etc.

People who study chemistry are called chemists. By studying what matter is made of, chemists create new substances. They have made plastics, building materials, new medicines, insecticides, and many other substances that are useful in everyday life.

II. What is Matter?

Everything around us is made up of matter. You are matter, the bed you sleep on is matter and the air you breathe are all types of matter.

- **Matter** is anything that has **mass** and takes up space (and so, it has **volume**).
- **Mass** is the amount of matter in an object. The mass of something is determined by the number of atoms (see below), the type of atoms and the **density** of those atoms. Mass is measured in grams.
- **Volume** is the amount of space something occupies.

- **Density** is the amount of matter in a certain volume.

III. States of matter

Matter can be primarily found in three physical states (also called phases): solid, liquid and gas

- **Solid** - A solid has a definite shape (rigid) and a definite volume.
- **Liquid** - A liquid has a definite volume but no defined shape.
- **Gas** - A gas has no definite shape (takes the shape of its container) or volume.



(Note: Students do not need to know about plasmas and Bose-Einstein condensates. Students need to understand the basic concepts of volume and density.)

IV. Transitions Between States/Phases

- Matter is found in one of those physical states but can change from one state to another. Matter can change from one state to another when a physical force is applied to it. This physical force is often a change in temperature (heat energy). Example: Heat can be applied to change ice to water to steam/vapor



- When matter moves from one state to another, its density changes. **Density** is the amount of matter in a given volume (in other words, how compact a substance is).
- When a material changes state, its smallest units, called molecules, behave differently. However, the material's molecules do not break apart and form into a different material. They remain the same.
- A change in the state of matter is a reversible change. You can turn water into ice and then back into water.
- Terms for the transitions between phases of matter

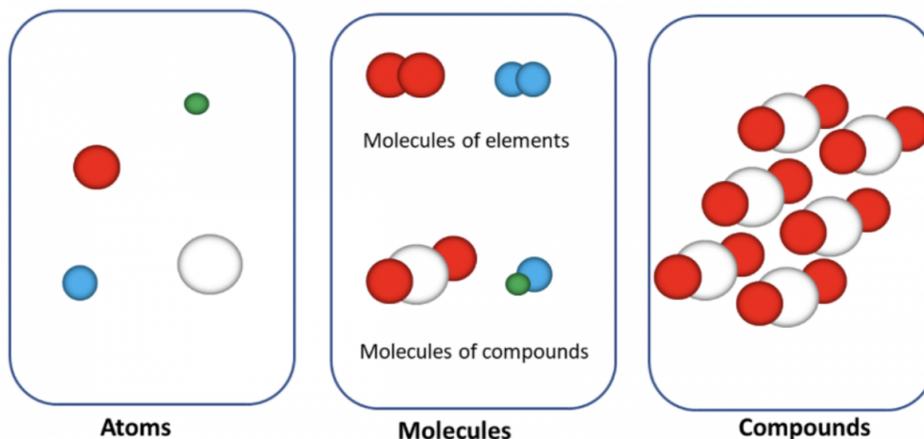
- **Freezing** - a process where a liquid changes to a solid by cooling. The temperature at which this occurs is called the freezing point of the substance.
- **Melting** - a process where a solid changes to a liquid by adding heat. The temperature at which a solid becomes a liquid is called its melting point.
- **Evaporation/Boiling** - a process where a liquid changes to a gas by adding heat. The temperature at which this occurs is called the boiling point of the liquid..
- **Condensation** - a process where a gas changes to a liquid by cooling. The temperature at which this occurs is called the condensation point of the substance. Example: rain, fog, mist, etc.

V. Law of Conservation of Matter/Mass (Grades 3 only)

- Matter can neither be created nor destroyed (simplified version).
- Students should understand that this applies to both physical and chemical changes. When you have a certain amount (mass) of water and you boil it, you still have the same mass of water. It has just transferred from liquid water to water vapor. See more under physical and chemical changes.

VI. Structure of Matter

All matter is composed of atoms. Therefore, the atom is the basic building block of matter.



- **Atom** - The smallest particle of any element that still retains the characteristics of that element.
- **Elements** - An element is a pure substance made from a single type of atom. Each element has specific properties. For example, gold is a shiny metal but oxygen is an invisible gas.
- **Molecule** - A molecule is formed when two or more atoms bond together. These atoms can either be of the same element (Oxygen, O₂) or of different elements (water, Hydrogen and Oxygen, H₂O).
- **Compound** - When the molecule is made of different elements, it can also be called a compound. When different elements are combined, they form a new

substance with its own properties. Example: Water (H₂O) consists of molecules made up of 2 hydrogen atoms and 1 oxygen atom.

VII. Periodic Table of Elements

- The periodic table contains all the elements organized based on their atomic structure. That means that each element is made of atoms that are slightly different and therefore, behave in a different way. Gold is an element and its atoms are arranged in a way that makes gold a shiny metal. Oxygen is another element but its atoms are arranged so that oxygen is a colorless gas.
- Basic organization of periodic table:
 - Each square represents one element. In the square is the name of the element (or its abbreviation), the atomic number of the element, and often its atomic mass.
 - The elements are organized in the table from left to right in order of increasing atomic number.
 - Groups - The vertical columns. All elements in a group have things in common in their atomic structure.
 - Periods – The horizontal rows. All elements in a period have something in common in regards to their atomic structure.

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period 1	1 H Hydrogen																	2 He
Period 2	3 Li	4 Be											5 B	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F	10 Ne
Period 3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
Period 4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
Period 5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
Period 6	55 Cs	56 Ba	* 71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
Period 7	87 Fr	88 Ra	* 103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
Atomic #			* 57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb		
Element			* 89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No		

Note: This is the periodic table that would be provided to grades 2 and 3 at the event. They do not need to memorize the full names of the elements. That information would be provided if needed. A separate pdf file of this is available on the WESO website.

- Additional information in the above simplified Periodic Table:
 - Atomic number – every element has a unique number assigned to it (Coaches: since we are not including subatomic particles for grades 2 and 3, we are defining atomic number as a unique number for each element just for this event)
 - Symbol – abbreviation for the name of the element.
- **Basic Elements**

Element	Hydrogen (H)	Oxygen (O)	Carbon* (C)	Nitrogen* (N)
Atomic number	1	8	6	7
Physical state at room temperature	gas	gas	solid	gas
Where would you find	mostly in water H ₂ O	In the air	All living things, diamonds, charcoal	air, soil, ammonia
General	lightest atom; 90% of all atoms are hydrogen	We need oxygen to survive; 20% of air is oxygen	All life on earth is carbon based	80% of air is nitrogen
Uses	to make ammonia for fertilizers; in the manufacture of plastics, rocket fuel, etc.	used by animals and plants in respiration; to manufacture steel, plastics, etc.	in almost every industry; for fuel as coal, methane gas and crude oil; to make materials like plastics and alloys, etc.	to make ammonia, fertilizers, explosives. etc.

*** Third grade only**

The following sites are useful:

<http://www.ducksters.com/science/elements.php>

<http://www.chem4kids.com/files/elements/>

VIII. **Physical vs. Chemical Properties**

All matter has both physical and chemical properties.

- Physical properties
 - A physical property can be measured or observed without changing the identity of the substance.

- Examples: mass, volume, length, size, shape, color, odor/smell, state, texture, hardness, density, solubility, boiling point, melting point
- Chemical properties
 - A chemical property is determined by a substance's ability to interact chemically with another substance. Matter has chemical properties that will describe its ability to undergo chemical change or reaction to form new substances.
 - Examples: flammability, acidity, reactivity, combustible.

IX. Physical vs Chemical Changes

- **Physical change** - When a substance undergoes a physical change the substance itself does not change even though it may look different.
 - Examples: When water freezes it is now a hard solid but it is still water.
- **Chemical change** - When a substance undergoes a chemical change, there is a chemical reaction and a new substance is formed. During a chemical change, energy is either given off or absorbed (used).
 - Example: When you mix baking soda and vinegar you will produce a new substance one of which is carbon dioxide which is released as a gas producing bubbles.

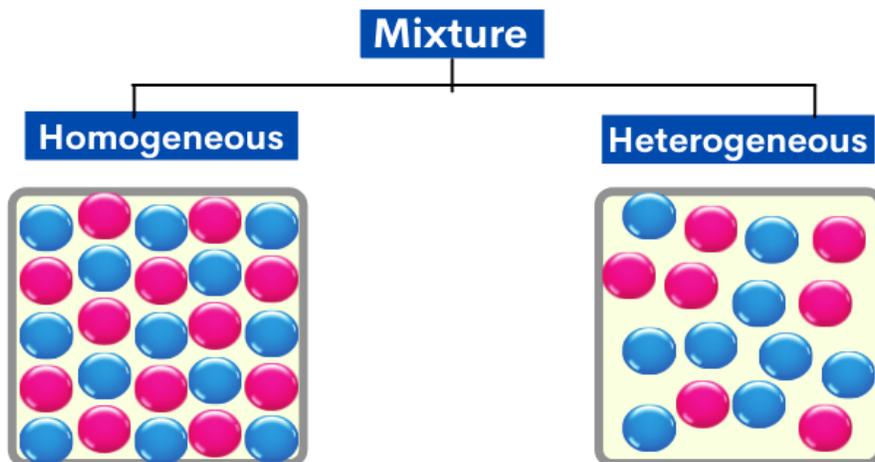


Indicators of Physical Change	Indicators of Chemical Change
change of state/phase: melting, freezing, vaporization, et.	production of light (flames, fire)
	change in temperature
change in shape or form	unexpected color change*
dissolving	odor/smell
absorption	bubbles (gas production)
color change*	precipitate (solid formed when 2 liquids are mixed)
	production of sound

* Color change is tricky. If you mix dark blue paint with white, you get light blue paint. This is a physical change. Color change by itself is not a good indicator of either form of change.

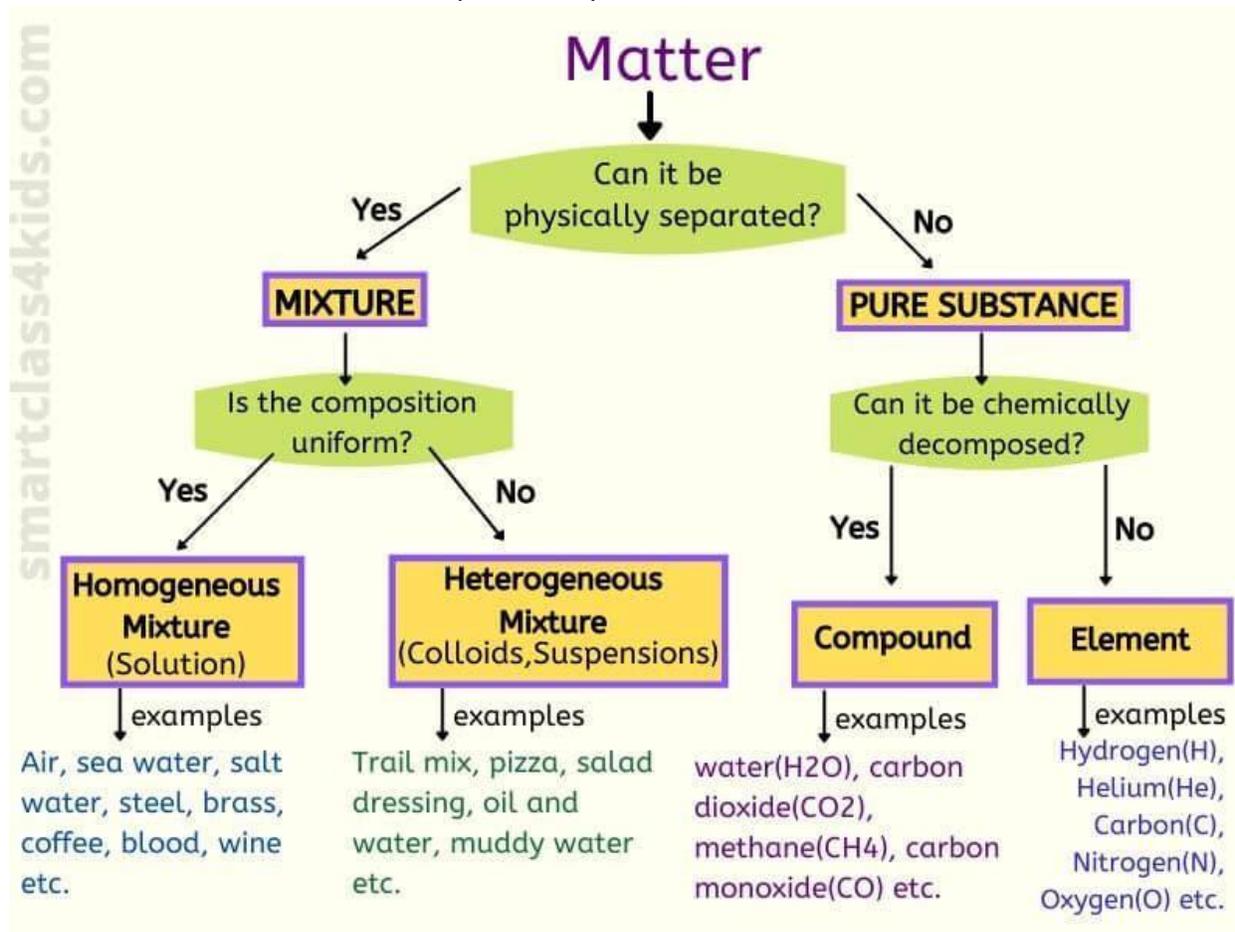
X. Classifying Matter

- **Pure substances** - Any type of matter that is made up of only one type of element or one type of molecule or compound (chemically bonded). Pure substances can not be broken up by their physical properties alone.
- **Mixtures**
A combination of substances whose characteristic properties don't change even though they are mixed together. The substances in a mixture are combined physically not chemically. Because they are not combined chemically, mixtures can be separated based on their physical properties. There are two types of mixtures, homogeneous and heterogeneous.



- A. **Homogeneous mixtures** – the molecules are evenly distributed throughout the mixture (salt water, kool aid, mineral ores, air, etc.)
- **Solution** - A homogeneous mixture where a substance is dissolved in a liquid (usually).
 - **Solvent** – the substance that something is dissolved into (usually a liquid)
 - **Solute** – the substance that is dissolved (solid, gas or liquid)
 - Example: When you make a saltwater solution, the water is the solvent and the salt is the solute.
- B. **Heterogeneous mixtures** - the molecules are not evenly distributed throughout the mixture (milk, wood, peanut butter, sandy water, etc.)

- **Suspensions** - A suspension is a mixture between a liquid and particles of a solid. The particles suspended in the liquid, meaning they do not dissolve and are dispersed throughout the liquid. But the solid particles will settle and separate over time if left alone.
 - Example – sandy water, etc.



XI. Metric System

Teams should understand the correct use of the metric system for the lab skills portion of the event. If asked to record the weight of something, it should be given in grams (g) not lbs or ozs. They must make sure the balance is set accordingly. If asked for the volume of a liquid, it should be given in liters (l) or milliliters (ml). An answer is not correct without the units. No conversions will be asked.

SOME REFERENCE SITES:

- <https://smartclass4kids.com/chemistry/>
- <http://www.ducksters.com/science/>
- <http://www.chem4kids.com>

SAMPLE QUESTIONS:

Which state of matter has no defined shape or volume? Choose the correct answer.

- A. solid
- B. liquid
- C. gas
- D. ice

What type of phase change is occurring in the picture below (picture of ice melting):



Answer: Melting

Match the following to the proper description:

O₂ H₂O H

- Represents a compound H₂O
- Represents an atom H
- Represents a molecule O₂ and H₂O

Choose the correct answer:

Water boils at 100° C.

- A. this is a physical property
- B. this is a chemical property

Choose correct answer:

Iron rusts in a damp environment.

- A. this is a physical change
- B. this is a chemical change

Identify the solution, solvent and solute in the pictures below:



solute

solvent

solution

Grade 3 only:

If you have 10 grams of frozen water, what will be the mass of the water when it melts?

1. it will be more than 10 grams
2. it will be less than 10 grams
3. **it will be 10 grams**

Image Citations:

Solid, Gas, Liquid. Digital Image. <http://clipart-library.com/clipart/1568938.htm>

States of Matter. Digital Image.

<https://cdn.britannica.com/05/92905-050-C1D29DD9/states-matter-liquid-gas.jpg>

Atoms, Molecules, Compounds. *RMIT University, Learning Lab.* (2021)

<https://emedia.rmit.edu.au/learninglab/content/atoms>

Physical Change vs Chemical Change. Digital Image. *Smart Class 4 Kids.* (2022)

<https://smartclass4kids.com/chemical-change-and-physical-change/>

Homogeneous and Heterogeneous Mixtures. Digital Image. *Smart Class 4 Kids.* (2022)

<https://smartclass4kids.com/homogeneous-mixture/>

Matter Flowchart. *Smart Class 4 Kids.* (2022)

<https://smartclass4kids.com/homogeneous-mixture/>