Youngstown City Schools

Science - - PHYSICAL SCIENCE GRADE 9

Unit 1: MATTER (4.5 WEEKS)

SYNOPSIS: Students investigate matter, its properties, and phases as they relate to everyday life. The key vocabulary terms are incorporated as each concept is introduced. Students will be given information about properties of matter and asked to use that information to solve a problem of importance to Youngstown residents. Students will research and write an informative paper on a topic related to this unit.

STANDARDS

I. THE STUDY OF MATTER

A. Classification of Matter

1. Solutions are homogeneous mixtures of a solute dissolved in solvent [homogeneous vs heterogeneous solution].
   a. solubility increases as the temperature increases since the particles have more kinetic energy to overcome the attractive forces between them, also affected by surface area and stirring
   b. water is a universal solvent since so many substances will dissolve in water
2. Properties of matter are physical and chemical.
   a. physical properties include color, solubility, odor, hardness, density, melting point, boiling point, viscosity, malleability
      (1) physical properties can be used to separate substances of mixtures, including solutions
      (2) physical properties can be altered during chemical change
3. Changes in states of matter involve temperature and the absorption and release of energy.
   a. data for phase change(s) can be graphed as temperature of the sample vs. the time it has been heated; the following are important observations:
      (1) investigations should involve collecting data during heating, cooling and solid-liquid-solid phase changes
      (2) at times, temperature changes steadily - - indicating a change in the motion of the particles and the <u>kinetic</u> energy of the substance
      (3) at times, the temperature of the substance does not change, indicating there is no change in the <u>kinetic</u> energy; students should wonder where the energy goes
      (4) since the substance continues to gain or lose energy during phase changes, these changes in energy are <u>potential</u> and indicate a change in the position of the particles
      (5) when a substance is heated, a phase change will occur when the <u>kinetic</u> energy of the particles is great enough to overcome the attractive forces between the particles; the substance then melts or boils
      (6) when a substance is cooled, a phase change will occur when the <u>kinetic</u> energy of the particles is no longer great enough to overcome the attractive forces between the particles; the substance then condenses or freezes
4. When thermal energy is added to a solid, liquid or gas, most substances increase in volume because the increased kinetic energy of the particles causes and increased distance between the particles.
   a. this results in a change in density of the material; solids have greater density than liquids, which have greater density than gases - - all due to the spacing between the particles
   b. density of a substance can be calculated from the slope of a mass vs. volume graph
   c. differences in densities can be determined by interpreting mass vs. volume graphs of the substances

B. Atoms

1. The atom consists of specific structures and electrical charges surrounding empty space.
   a. the atom is composed of protons, neutrons, and electrons that have measurable properties, including mass; protons and electrons contain a characteristic charge
   b. discovery of p^+ (Au foil experiment): when bombarding thin gold foil with atomic-sized, positively charged, high-speed particles, the following occurs:
      (1) a few of the particles are deflected slightly from their straight-line path; even fewer bounce back toward the source
      (2) most of an atom is empty space with a very small, positively charged nucleus
      (3) the nucleus is composed of protons and neutrons
      (4) electrons move about in the empty space that surrounds the nucleus (e^- location; e^- cloud)

LITERACY STANDARDS: READING (RST) and WRITING (WHST)

RST.1: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

WHST.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

WHST.4: Produce clear and coherent writing in which the development, organization, and style are appropriate to the task, purpose, and audience

WHST.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

WHST.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

WHST.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation

VOCABULARY: Post words in room and leave up for the unit. Create a word wall where students know to look for new words.

Address roots and affixes of new words
Use a diagram to show meaning of new words
Relate the new word to a similar and/or familiar word
In the course of teaching, define the word in the context of where if falls in the unit rather than in isolation
Throughout the teaching of the unit, use the word in conversation/discussion
Require students to use the word(s) in: discussion, investigations, and in 2-and 4-point response questions
Use new words in Rubric for the Authentic Assessments

MATTER UNIT VOCABULARY

Technical Words			Other Words
Matter	States of Matter	Kinetic Energy	Solid
Solubility	Mass	Conductor	Liquid
Solvent	Volume	Insulator	Gas
Physical Properties	Density		Boiling Point
Chemical Properties	Atom		Melting Point
Malleability	Protons		Filtering
Viscosity	Neutrons		Phase Change
Solution	Electrons		Indirect Evidence
Slope of Mass vs Volume Graph			
Compressibility			

MOTIVATION	TEACHER NOTES
1. Refer to changes in states of matter from last unit with ice cube melting when held and relate temperature and absorption/release of energy; connect to “Energy Saving Guide” from previous unit. 2. Teacher makes a Kool-Aid for class and asks where did the grains go? Students should say that they dissolved and give other examples where something dissolves. Teacher asks a question about Kool-Aid and how it looks and why does it dissolves? **Activities and Questions might include: 1.** Examine and write a description of the particles in the package**. 2.** Are the particles still there after you pour the particles into the water? **3.** How can you find out if the particles are still there? **4.** How do you know? **5.** Can you see the particles? **6.** Where do you think the particles went? 3. Get the students to describe that the drink crystals are still there but in a different form? Drink crystals are a mixture of sugar, flavor particles, and coloring particles. The crystals dissolve in water. What happens to the different particles as the crystals dissolve in water particles? Have students predict and then demo what happens when two substances are combined together? 50 mL sugar + 100mL water. Then ask – what happened to the water + sugar particles when they were mixed? Do demo where you now combine sand which acts like the water + marbles which acts as the sugar. Then ask –how does the sand + marble model help explain what happened to the sugar + water particles? Another demo – add popped corn to a glass of milk one kernel at a time until the milk overflows. Ask students to predict then test how many kernels can be added. Ask why the volume stays almost the same even though you are adding more matter to the glass. 4. Why do states of matter “matter” in our real lives? Share examples in real world ■ The most familiar is water, ice, vapor ■ Elements that can appear in various states of matter: Hydrogen, Helium, Iron (rust?) ■ Hot Soup: has solids (meat, veggies, noodles), liquid (broth), and gas (steam rising) ■ States of matter in outer space behave differently: due to no gravity, water just floats around rather than settling into a container ■ Since sand can be poured, why isn’t it a liquid? ■ “gas” presents itself in everyday living: tire pump; hot air balloon; steam iron; fog; natural wind; wind produced by a fan; air inside a football or basketball; home-building or remodeling (solid materials; various liquids and gases to heat and cool ■ Air pollutants impact lungs and heart 5. Have wall chart on properties of states of matter that is a blank that will be used throughout the unit 6. Students establish both academic and personal goals for this unit Teacher previews the 7. Authentic Assessments for the end of the Unit	

TEACHING-LEARNING	TEACHER NOTES
<u>Changes in states of matter involve temperature and absorption / release of energy (IA3)</u> 1. Teacher reviews **<u>states of matter</u>**: Students take notes as teacher reviews states of matter. Kinetic molecular/particle theory (the idea that particles are constantly in motion and also molecules and how molecules behave) and asks questions as ice cube starts to melt; students describe what is happening as the ice cube **<u>melts</u>**; as it melts, what happens to the ice; what if we put the liquid into a container and placed it on a hot plate and heated the water to **<u>boiling</u>**; focus on states of matter: **<u>solid, liquid, gas</u>**. Teacher then uses **<u>conservation of energy</u>** from last unit and asks where the ice cube went - - to illustrate that it is not gone! Students write down / diagram what happened; record observations and discuss. **(IA3) (WHST.4)** 2. Have samples of solid liquid, gas ready to show students; then have students compare and contrast solids, liquids and gases in terms of the kinetic molecular theory: (do bolded ones first) **volume, shape of molecules**, compressibility, **density, packing and arrangement between particles**, forces of attraction between particles, motion of particles, and energy of particles. See attached chart of properties and how they look for three states of matter; give students a blank of the chart (**attached on page 8 of unit plan**); Discuss chart <u>as it is completed</u> and make comparison among the three states. **(IA3)** 3. **<u>Water is a universal solvent</u> (IA1b)** Teacher presents information on homogeneous and heterogeneous mixtures. Teacher gives notes on **<u>solvent, solubility, and solution</u>**; students take notes. Teacher refers back to the drink crystals/water demonstration and asks if the drink crystals are **still** there. To prove that it is there by **<u>filtering</u>** - - red liquid is still there; cannot separate by **<u>filtering</u>**; must heat drink crystals/water until it **<u>boils</u>** or place several droplets of drink crystals/water and let sit until liquid evaporates; particles remain in the dish and water **<u>evaporates</u>**; then you have drink crystal particles left. Teacher explains that a **<u>Physical Change</u>** occurred when the drink crystals dissolved and explain that one can get the original substances back from a Physical Change. **(IA2a1; IA3a1) (WHST.4)** 4. Have students predict how sugar dissolves in three different liquids and say why they think this is the case: water, rubbing alcohol, and vegetable oil? Teacher do demonstrate this for students (This should help them understand what happens if the particles are not strongly attracted to each other.) **Teacher asks**: (a) Did the sugar dissolve in each of the three liquids? (b) How were you able to tell? (c) Which solute and solvent particles are most strongly attracted to each other? (d) How do you know? (e) Which solute and solvent particles are not very strongly attracted to each other? (f) How do you know? 5. **<u>Effect of temperature on Solubility</u>**: Students are divided into groups, and each group observes three identical containers with100 mL water at different temperatures: room temperature, hot water, ice water; add 5 grams of sugar is poured into each container and then stirred at a consistent rate; record initial temperature for each container. Students use a thermometer to record the temperature in each container at 30 second intervals until the crystals dissolve. Combine data from the groups and graph for hot, cold and warm, using a different color for each container. Students look at **<u>slope of the line</u>** to interpret data to determine **<u>solubility</u>** as it relates to temperature. Ask student questions about the rate of dissolving particles and how this connects to kinetic energy of the molecules- - the higher the temperature, the more **<u>kinetic energy</u>**, the more space between the molecules, the more the substance will dissolve (e.g., boiling water for cooking spaghetti and adding salt)? Look at a graph that shows constant temperature and explain what the graph conveys in terms of kinetic energy **(IA1a) (IA3a3)** 6. Students then examine additional substances that can be pulled off the solubility graph and go over several samples to determine **<u>solubility</u>** for different substances. Teacher asks questions about different substances (e.g., why did more salt dissolve at 80 degrees than at 40 degrees in the same amount of water? [speed of molecules and space between them] **(IA3a, 2)**	

TEACHING-LEARNING	TEACHER NOTES
7. Teacher shows video from website: http: //www.kentchemistry.com/links/kinetics/solubilitycurves.htm (this addresses **compressibility**); complete remaining rows of solid/liquid/gas chart. Students will record temperatures as interactive video work is done and relates to change in particles; graph data and interpret data by writing a summary about changes in **Kinetic Energy** with rising temperatures. (Another interactive website:) **(IA3a, 4, 5, 6)** 8. Teacher gives students article **(attached on page 9-10 of unit plan)** on **physical and chemical properties**: color, **solubility**, odor, hardness, **density**, **melting point**, **boiling point**, **viscosity**, **malleability** ; students read and highlight new terms and record real-world samples for each; **see attached article - - Physical and Chemical Properties**; students record the difference between physical and chemical changes. Students rotate through stations with various objects that can be displayed; students determine / measure objects for each property. Students record their observations on chart and compare with each other. **(IA2a1) (RST.1)** 9. Teacher demonstrates for students to see how physical properties of substances can be used to separate them from other substances in a mixture. Mixtures can be separated into the pure substances making them up by physical or mechanical means because each pure substance retains its own properties. Have students think of real-world examples of several techniques of separation and the property used for the separation: sifting (sieving) - **- (see attached on page 11-13 of unit plan)** visual separation, magnetic attraction, decanting, separating funnel, filtration, evaporation, crystallization, distillation **- -** with real-world examples. **(IA2a1)** 10. Teacher demonstrates **Density**: Use balance and **density** kit to determine density of objects. Measure object, use formula to calculate **volume**; then determine **mass and calculate density**. **Graph mass vs. volume** for several objects and compare **the slope of the lines** to determine relationship between mass and volume. **Density article (attachment: pages 16-17) - -** Teacher asks students what they know about density and students read article and discuss. (**IA4a,b,c)** Students read: Fact or Fiction?: Archimedes Coined the Term "Eureka!" in the Bath, *Scientific American*, December 2006. (**Article attached with reading guide pages 14-15 of unit plan**) **(RST.1)** 11. Teacher demonstrates **Density** of ice and water; tell students that density is .9 and they observe that 90% of an object is under water; ask students to predict what object with a density of .5 would look like when it floats. Objects with density of 1.0 or greater will not float. Relate to people in a swimming pool or bath tub; water rise? Titanic sinking? (**Density article attached pages 16-17 of unit plan) (IA4a,b,c)** 12. Have students calculate density of Hershey Miniatures to see that objects of the same size and volume have different mass and thus, different density. Or, they do Density Lab in which students use mass and volume measurements to understand their relationship to density as the material changes. "Thatsa Pasta" at http://www.adamequipment.com/education/Documents/EdExp1.pdf 13. Teacher demonstrates **chemical changes** - - egg, hardboiled egg, and fried egg; in contrast use Jello to show its reversibility (Jello gelatin, Jello powder, melted Jello); wood burning, rust, etc. Students write down the differences, describing how the physical properties are altered during the chemical change**. (IA2a2)** 14. Teacher introduces **Thermal Energy**; have video of bridges taken on a day where it is hot and sunny to show **expansion and contraction** of metal plates. Students explain why the metal plates are present and how they allow for expansion / contraction. Ball-Ring Apparatus demo. Students talk about the movement of the molecules as it warms. **(IA4)** Blow up a balloon and place in freezer, leave for 15-20 minutes and remove balloon. Have students observe that the balloon is smaller and explain or offer ideas on why it is smaller. **(IA4)**	

TEACHING-LEARNING	TEACHER NOTES
15. Research and validate information on a specific aspect of atomic structure. Write an informational paper in cooperation with English/Language Arts. Gather relevant information from multiple authoritative print and digital sources using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate the information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. Take advantage of technology's capacity to link to other information. Produce clear and coherent writing in which the development, organization, and style are appropriate to the task, purpose, and audience. (**WHST.2,4,5,6,8)** 16. **Atoms**: Teacher gives students a variety of objects (paper, salt, clay, etc.) and asks them to make the smallest piece possible, discuss how far it can be broken down. Ask what the smallest particle is that we can break it into. Teacher lectures on **atom, protons (+), neutrons (0) and electrons (-)**; and they have measurable properties where they live in the atom. Use the concept of a "model" to illustrate atoms and where protons, electrons, and neutrons go**.** Students take notes and draw atom structure. Teacher shows video of Rutherford's Gold Foil experiment and uses 3-D model of atom; use Bill Nye video of atoms (go to: video atoms Bill Nye) **(IB1a)** 17**.** Use indirect evidence to examine events in which the particles cannot be directly observed. There are several activities to do this; you might offer to students: (1) An object is hidden in clay and students insert toothpicks (4 at a time) into the clay until it touches something inside/or not. They sketch results and continue until they can make a determination of what the shape is. (2) Blocks of different shapes are attached in different positions under a large piece of plywood. Students roll marbles under the elevated plywood from one side and watch where the marbles exit. They construct a map of the scatterings and determine the shapes underneath which are changing the direction of motion of the marble**. (IB1)**	

TRADITIONAL ASSESSMENT	TEACHER NOTES
Unit Test	

TEACHER CLASSROOM ASSESSMENT	TEACHER NOTES
Quizzes	

AUTHENTIC ASSESSMENT	TEACHER NOTES
1. Students evaluate progress on their goals 2. Students will determine the best material for a certain construction project by considering various materials and the properties of each. The Youngstown area has a serious problem each spring with potholes in the county's roads. Recently, new information has been discovered about pothole patching that may help solve the problem. Listed below are three patches and their properties. The cost is not an issue. Your job is to select the best material to be used for the county to patch holes in the roads next spring. Be sure to explain your reasons for making the selection. Use the chart on page 7 to address this scenario. (**RUBRIC attached on page 7)**	

LEVELS OF QUESTIONS		
CONVERGENT		**DIVERGENT**
LEVEL 1 (Explicit)	**LEVEL 2 (Inferential)**	**LEVEL 3 (Hypothetical)**
What are the states of matter? (IA3)	Why is color a physical property? (IA2a1) Why is odor a physical property? (IA2a1)	If you could shrink in size to allow you to walk inside a piece of gold, what would it look like? Consider what you know about the kinetic-molecular theory to help you formulate your drawing.

RUBRIC FOR AUTHENTIC ASSESSMENT						
PRODUCT	**RESISTANCE TO SALT**	**BONDING WITH CONCRETE**	**EXPANSION**	**DURABILITY**	**DRYING / MOLD**	**COLOR**
Product A	Resistant to salt	Does not bond easily with concrete	Expands slightly with heat	Extremely durable in high traffic areas	Hard to mold and dries quickly	Can be made in any color to match road
Product B	Somewhat resistant to salt	Bonds well with concrete	Does not expand in heat	Least durable in high traffic	Easy to mold but dries slowly	Comes only in black
Product C	Reacts with salt	Bonds slightly with concrete	Expands and contracts greatly with heat	Somewhat durable in high traffic	Hard to mold and dries slowly	Comes in black or brown

Teaching-Learning Activity #2

Kinetic-Particle Theory of Matter

Property	Solid	Liquid	Gas
Volume	Fixed	Fixed	Not Fixed
Shape	Fixed	Takes shape of container	Takes shape of container
Compressibility	Not Compressible	Not Compressible	Compressible
Density	Very Dense	Dense	Not Dense
Packing and Arrangement between Particles	Closely packed in an orderly arrangement	Closely packed in a disorderly arrangement	Far apart in random arrangement
Forces of Attraction between Particles	Very strong forces of attraction between particles	Strong forces of attraction between particles	Negligible forces of attraction between particles
Motion of Particles	Vibrate about a fixed position	Slide and roll past each other	Move about randomly at high speed
Energy of Particles	Least energy	→	Most energy
Diagrammatic Representation			

Teaching –Learning Activity #8

Physical and Chemical Properties

I. Physical Properties

A physical property of a pure substance is anything that can be observed without changing the identity of the substance. The observations usually consist of some type of numerical measurement, although sometimes there is a more qualitative (non-numerical) description of the property. There are many physical properties and each textbook will have a different list of examples. Here are some of the more common ones:

melting point	electrical conductivity	color	density
boiling point	thermal conductivity	odor	hardness

There are others which are not mentioned as often. Examples include:

refractive index	atomic radius	ductility
ionization energy	allotropes	malleability

There are more which have not be mentioned. There is no single, definitive list of physical properties. A few example properties are cited, there is some discussion and the author moves on.

Groups of similar elements or compounds can be characterized by commonality in their physical properties. Metals have a whole bunch of physical properties that are similar. For example, metals are very ductile and very malleable. All easily conduct electricity and heat and all have a bright luster. These all reflect a commonality of structure.

However, the similarities in a group do not extend to every property. Both tantalum and sodium are metals. Tantalum's melting and boiling points are 2996 °C and 5425 °C. Sodium? 98 °C and 883 °C. However, they are both considered metals and no one in the scientific world disputes this. The reason is that both exhibit the characteristic arrangement of atoms and electrons all metals have. (This arrangement will be taught later in the course.) The wide disparity in the melting and boiling points between tantalum and sodium simply highlight the wide range that exists within the common structure all metals have.

II. Chemical Properties

This one is more difficult. Here is one way to define "chemical property:" characteristics which are exhibited as one substance is chemically transformed into another.

Here are some examples.

(1) Iron rusting. When iron (an element, symbol = Fe) rusts, it combines in a complex fashion with oxygen to form a reddish-colored compound called ferric oxide (formula = Fe_2O_3). Not all substances rust.

(2) Glucose mixed with yeast, ferments to make alcohol. Glucose ($C_6H_{12}O_6$) is a chemical compound which enzymes in yeast can use to make ethyl alcohol (C_2H_5OH). Not all substances ferment.

(3) Trinitrotoluene (TNT) reacts very, very fast when it is ignited. Among other products, it makes LOTS of nitrogen gas and LOTS of heat. Inside the proper container, it can cause an explosion. Not all substances can make an explosion.

There really isn't a set of chemical properties in the same way there is, more or less, a set of physical properties. That's because the chemical properties are tied to the change, whereas a given substance has a property (such as melting point) all to itself.

Another textbook I consulted defined "chemical property" this way: chemical properties describe the way a substance may change or react to form other substances.

One example was given: flammability - the ability of a substance to burn in the presence of oxygen. Some substances (wood, alcohol) are very flammable, others are not. Iron (see above) reacts with oxygen, but so slowly we do not say the iron burns, but that it rusts.

Generally speaking, information about physical properties is clearly laid out and chemical properties are harder to pin down. That's just the way it is sometimes.

http://www.chemteam.info/Matter/PhysicalChemProperties.html

Teaching Learning Activity #9

Some methods for separating the components of a mixture include:

separation technique	property used for separation	example
Sifting (sieving)	particle size	alluvial gold is separating from smaller soil particles using a sieve
Visual Sorting	color, shape or size	gold nuggets can be separated from crushed rock on the basis of color
Magnetic Attraction	magnetism	magnetic iron can be separated from non-magnetic sulfur using a magnet
Decanting	density or solubility	liquid water can be poured off (decanted) insoluble sand sediment less dense oil can be poured off (decanted) more dense water
Separating Funnel	density of liquids	in a separating funnel, less dense oil floats on top of more dense water, when the valve is open the water can be poured out from under the oil
Filtration	solubility	insoluble calcium carbonate can be separated from soluble sodium chloride in water by filtration
Evaporation	solubility and boiling point	soluble sodium chloride can be separated from water by evaporation
Crystallization	solubility	slightly soluble copper sulfate can be separated from water by crystallization
Distillation	boiling point	ethanol (ethyl alcohol) can be separated from water by distillation because ethanol has a lower boiling point than water

Teaching –Learning Activity #9 (additional Teacher info)

Separation Process

In chemistry and chemical engineering, a **separation process**, or simply a **separation**, is any mass transfer process used to convert a mixture of substances into two or more distinct product mixtures, at least one of which is enriched in one or more of the mixture's constituents. In some cases, a separation may fully divide the mixture into its pure constituents. Separations are carried out based on differences in chemical properties such as size, shape, mass, or chemical affinity between the constituents of a mixture, and are often classified according to the particular differences they use to achieve separation. In the case that no single difference can be used to accomplish a desired separation, multiple processes will often be performed in combination to achieve the desired end.

Barring a few exceptions, almost every element or compound is naturally found in an impure state. Often these impure raw materials must be separated into their purified components before they can be put to productive use, making separation processes essential for the modern industrial economy. In some cases these separations require total purification, as in the electrolysis refining of bauxite ore for aluminum metal, but a good example of an incomplete separation process is oil refining. Crude oil occurs naturally as a mixture of various hydrocarbons and impurities. The refining process splits this mixture into other, more valuable mixtures such as natural gas, gasoline and chemical feedstocks, none of which are pure substances, but each of which must be separated from the raw crude. In both these cases a series of separations is necessary to obtain the desired end products. In the case of aluminum refining, bauxite ore is first converted to alumina, a compound of aluminum and oxygen, and then further refined into pure aluminum metal. In the case of oil refining, crude is subjected to a long series of individual distillation steps, each of which produces a different product or intermediate.

Various types of separation processes

- Adsorption, adhesion of atoms, ions or molecules of gas, liquid, or dissolved solids to a surface.
- Centrifugation and cyclonic separation, separates based on density differences.
- Chromatography separates dissolved substances by different interaction with (i.e., travel through) a material.
- Crystallization.
- Decantation.
- Demister (vapor), removes liquid droplets from gas streams.
- Distillation, used for mixtures of liquids with different boiling points.
- Drying, removes liquid from a solid by vaporization.
- Electrophoresis, separates organic molecules based on their different interaction with a gel under an electric potential (i.e., different travel).
- Elutriation.
- Evaporation.
- Extraction.
    - Leaching.
    - Liquid-liquid extraction.
    - Solid phase extraction.
- Flotation.
    - Dissolved air flotation, removes suspended solids non-selectively from slurry by bubbles that are generated by air coming out of solution.
    - Froth flotation, recovers valuable, hydrophobic solids by attachment to air bubbles generated by mechanical agitation of an air-slurry mixture, which float, and are recovered.
    - Deinking, separating hydrophobic ink particles from hydrophilic paper pulp in paper recycling.

- Flocculation, separates a solid from a liquid in a colloid, by use of a flocculant, which promotes the solid clumping into flocs.
- Filtration, Mesh, bag and paper filters are used to remove large particulates suspended in fluids (e.g., fly ash) while membrane processes including microfiltration, ultrafiltration, nanofiltration, reverse osmosis, dialysis (biochemistry) utilizing synthetic membranes, separates micrometre-sized or smaller species.
- Fractional distillation
- Fractional freezing
- Oil-water separation, gravimetrically separates suspended oil droplets from waste water in oil refineries, petrochemical and chemical plants, natural gas processing plants and similar industries.
- Magnetic separation.
- Precipitation.
- Recrystallization.
- Sedimentation, separates using density differences.
  - Gravity separation.
- Sieving.
- Stripping.
- Sublimation.
- Vapor-liquid separation, separates by gravity, based on the Souders-Brown equation.
- Winnowing.
- Zone refining.

TEACHING-LEARNING #10

Legend says that Archimedes discovered the principle of displacement while stepping into a full bath. He realized that the water that ran over equaled in volume the submerged part of his body. Through further experiments, he deduced the above mentioned Archimedes' principle.

The legends goes further and tells that Archimedes was so excited with his discovery that he hopped out of the bath, and rushed naked into the street yelling triumphantly, "Eureka!" "Eureka!" (Greek word for 'I have found it!).

Another legend describes how Archimedes uncovered a fraud against King Hieron II of Syracuse using his principle of buoyancy. The king suspected that a solid gold crown he ordered was partly made of silver. Archimedes took two pieces of pure gold and of pure silver that had weights identical to the weight of the crown. He then successively immerses the gold, the silver, and the crown in a container filled to the brim with water and measured the volume of water that overflowed with each material. He found that the crown displaced more water than the gold but less than the silver, thereby proving that the crown contained some other metal which was less dense than gold.

Text Analysis Guide for RST 1

Student Name: ____________________ **Teacher:** _____________ **Date:** __/__/__

Name of the Article:

____

Source: ___________________________________ **Date of Publication:**

____

Central Idea:

e.g.,

"Buoyancy" is when a solid object is lowered into a tub of liquid, the liquid rises by the volume of the solid which is called displacement. The weight of the water displaced by the object equals the amount of the buoyant force pushing up on the object.

Summary of Events / Ideas as Developed Through the Piece:

e.g.,

"Archimedes discovered "buoyancy" while taking a bath. But he then used it to determine if a king's crown was pure gold. Two objects made of the same thing (gold, silver, lead, wood, etc.) should displace the same amount of liquid. He took pieces of gold and pieces of silver that each weighed the same amount as the crown. When the crown displaced more water than the gold but less than the silver, he knew the crown was not pure gold.

Everyday Application

e.g., Boats in the water; submarines; hot air balloons eHow

Print Article

Discover the expert in you.

Importance of Density

By Laurel Brown, eHow Contributor

Density is an important physical characteristic of matter. All objects have density and that density can increase or decrease as the result of actions taken on the object. The effects of density are important for the workings of the universe and for our daily lives. It is simple to find the density of an object and see the effect of density.

Identification

Density is defined as the ratio of an object's mass to its volume. You can express this mathematically as density (abbreviated with the Greek symbol rho) is equal to mass (m) divided by volume (V).

Size

Density increases either with increasing mass or with decreasing volume. For example, if you have two balls of the same mass and you compress one of the balls to a smaller size, the compressed ball will have a higher density than the other. Similarly, if you have two balls of equal volume but different masses, the ball with the higher mass has a higher density. It is for this reason that a bowling ball has a higher density than a volleyball, even though both are similar in volume.

Features

Objects with higher density are invariably heavier than low-density objects of similar appearance. This increased weight has some benefits: you would not want to bowl with a low-density volleyball. Density is most noticeable in the case of buoyancy. If you want something to float, it needs to have a lower density than the liquid. This is why a canon ball will sink in water but a metal ship floats. The density of the ship is less, because it is filled with air and cargo, while the canon ball is pure, high-density metal.

Considerations

You can change the density of a complex object (an object made of more than one substance) by increasing the mass or by decreasing the volume. In practice, you increase the mass by adding to the object. Filling a bowl with water or adding people to a boat are examples of increasing mass while keeping volume constant. To decrease the volume, you need to compact the object. Crushing an empty soft dri can or shrinking the open space of a bag decrease the volume and increase the density.

Gravity Effects

Gravity is dependent on both the mass and the volume of an object, so density is important. A high density body, like a neutron star or a black hole, has a much higher density than a normal, high volume star. A neutron star, with a diameter o only about 20 kilometers (12.4 miles), has 100,000,000,000 times the gravity of t Earth.

Buoyancy Effects

When water freezes, the molecules crystallize, with the space between each molecule increasing. If the mass of water does not change, this has the effect of decreasing the density of frozen water. It is for this reason that ice floats on top o water, as seen in the frozen surfaces of lakes and in icebergs. When the ice melts the density increases again. This is an important effect for roof stability: when ic and snow collect on a roof and melt, the increased density of the resulting water c be enough to collapse the roof.

Resources

Read this Article in Spanish
Density Calculator
Density Experiments