SNC1D CHEMISTRY

ATOMS, ELEMENTS, & COMPOUNDS

- Physical Properties (P.148-151)

Physical Properties

*All life on Earth depends on water. A characteristic of water is that it sticks to itself, a property known as cohesion. A **physical property** describes a characteristic of a substance that can be observed or measured without forming a new substance. Another example of a physical property is the melting point of a substance.*

Physical Properties

PRACTICE

1. Besides the cohesiveness and the melting point of a substance, there are a multitude of other physical properties. List the physical property being described in each case.

Figure 6 This shiny kettle has high lustre.

Physical Properties

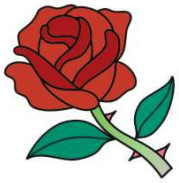
PHYSICAL PROPERTY

- characteristic of a substance that can be observed or measured without forming a new substance
- some examples include:
  - lustre
  - viscosity
  - hardness
  - ductility
  - colour
  - …

Physical Properties

RECALL!

Qualitative *physical properties are those you can observe with your senses, such as physical state, odour, colour, texture, and lustre (shiny appearance).* ***Quantitative*** *physical properties are those that you measure and give a number value, such as an object's mass, volume, and temperature.*



Physical Properties

PRACTICE

2. (a) What are some physical properties of sandpaper?
   (b) Which of these physical properties make sandpaper useful?

Physical Properties

PRACTICE

3. (a) What are some uses of duct tape?
   (b) What physical properties of duct tape make it useful?

Characteristic Physical Properties

If you had to identify a pure liquid, you could perform various chemical tests on it. You could also examine the physical properties of the pure liquid. However, some physical properties are not useful for identifying a sample. Knowing the volume and temperature of a mystery sample is not a great help because these values are not unique to the substance.

Characteristic Physical Properties

Certain physical properties are unique to each pure substance, like fingerprints are unique to each person. These properties are called ***characteristic physical properties,*** *and they can be used with confidence to identify a pure substance. Unlike chemical tests, characteristic physical properties can be determined without changing the composition of the sample, so the test sample is unchanged.*

Characteristic Physical Properties

PRACTICE

4. What are three common characteristic physical properties?

   - density
   - freezing/melting point
   - boiling point

Characteristic Physical Properties

CHARACTERISTIC PHYSICAL PROPERTY

- physical property unique to a substance
- can be used to identify a substance
- most common (3):
  - density
  - freezing/melting point
  - boiling point

Characteristic Physical Properties

PRACTICE

5. Explain why the boiling point of water is a characteristic physical property, but the temperature of water is not.

   the temperature is not unique or characteristic

Characteristic Physical Properties

PRACTICE

6. What characteristic property of steel can be used to separate steel cans from aluminum cans at a recycling depot?

steel is attracted to a magnet but aluminum is not

Characteristic Physical Properties

PRACTICE

7. Megan tested several properties of isopropyl alcohol, sometimes called rubbing alcohol, in a lab investigation. She found that its volume was 50 mL, its freezing point was -89°C, and it was colourless. Which of these is a characteristic property?

freezing point

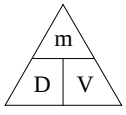
Characteristic Physical Properties – Density

As you may recall, density is the amount of matter per unit volume of that matter. The units of density are usually g/cm³ (solid) and g/mL (liquid).

DENSITY

$$D = \frac{m}{V}$$

where D is the density (g/cm³ or g/mL)
m is the mass (g)
V is the volume (cm³ or mL)



D=m/V m=DV V=m/D

Characteristic Physical Properties – Density

PRACTICE

8. A metal with a mass of 71.68 g occupies a volume of 8.00 cm^3. Calculate the density of the metal. Be sure to show your work!

   D = 8.96 g/cm^3

Characteristic Physical Properties – Density

PRACTICE

9. A sample of pure copper has a volume of 3.75 cm^3. If the density of pure copper is 8.96 g/cm^3, calculate its mass . Be sure to show your work!

   m = 33.6 g

Characteristic Physical Properties – Density

PRACTICE

10. The density of liquid mercury is 13.53 g/cm^3. The density of solid copper is 8.96 g/cm^3. Would you expect a piece of copper to sink or float when placed in a container of liquid mercury? Explain.

    the copper would float when placed in the liquid mercury – this is because the density of copper is less than the density of liquid mercury (i.e. 8.96 < 13.53 g/cm^3)

Characteristic Physical Properties – Density

PRACTICE

11. Aluminum has a density of 2.7 g/cm^3 while copper has a density of 8.96 g/cm^3. Which metal would you choose to build a model airplane? Why?

it would be better to build the model airplane using aluminum because it will be lighter in terms of density

Characteristic Physical Properties – Density

PRACTICE

12. A drinking glass at a crime scene contains a clear colourless liquid that may be water or alcohol. As the investigator, you know that the densities of alcohol, water, and ice are 0.79 g/mL, 1.0 g/mL, and 0.92 g/mL. Design a simple method to determine the identity of the mystery liquid. Explain your design.

place the ice cube in the liquid – if it floats that means the liquid must be water (0.92 < 1.0 g/mL) but if it sinks that means the liquid is alcohol (0.92 > 0.79 g/mL)

Black Holes – DYK?

A black hole is a place in space where gravity pulls so much that even light can not get out. The gravity is so strong because matter has been squeezed into a tiny space (which can happen when a star is dying). But what is the density of a black hole?

Black Holes – DYK?

Black holes are really hard to get a density. Basically, they are so dense that there is no known mechanism for providing sufficient outward force to counterbalance the inward pull of gravity, so they will collapse into an infinitesimally small size. Of course, that doesn't seem likely, it seems likely there is something that will keep the volume from being 0, but it is extremely dense.

Black Holes – DYK?

An alternative method of measuring the density of a black hole is to take the radius beyond which light can't escape (i.e. the Event horizon). Using some sample values for a stellar black hole

$$mass = 2\times10^{31}\ kg \quad \& \quad volume = 3.4\times10^{12}\ m^3$$

the density would then be

$$6\times10^{18}\ kg/m^3 \quad or \quad 6\times10^{15}\ g/cm^3$$

This would be equivalent to ~ 6,000,000,000,000 cars all jammed into a cube measuring 1 cm on each side.

WOW!

Observing Physical Properties

We make direct observations when we are asked to determine the physical properties of a substance. For example, you might describe the substance on the right as white, odourless, and powdery. We make these observations using our five senses. Any property that does not provide numerical information is called a ***qualitative property****.*

Observing Physical Properties

QUALITATIVE PROPERTY

- property that is not measured (i.e. it does not have a value)
- observed using your 5 senses
- colour, odour, texture, …

Observing Physical Properties

Further, we may take some measurements and note that the substance has a mass of 10.0 g and is at a temperature of 25°C. These measured physical properties give us numerical information about the substance. These types of information are ***quantitative properties*** *of the substance.*

Observing Physical Properties

QUANTITATIVE PROPERTY

- property that is measured (i.e. it has a value)
- temperature, height, mass, …

Observing Physical Properties

PRACTICE

13. Uncooked spaghetti noodles are hard, brittle, and have an average length of 26 cm.
    (a) Which of these properties are qualitative?

(a) hard & brittle

Observing Physical Properties

PRACTICE

13. Uncooked spaghetti noodles are hard, brittle, and have an average length of 26 cm.
    (b) Which of these properties are quantitative?

(b) average length of 26 cm

Observing Physical Properties

PRACTICE

14. A student recorded the following observations about a T-shirt. Classify each observation as a qualitative property or a quantitative property, and give reasons for your answers.
    (a) It is red and grey in colour. qualitative
    (b) It is 60 cm long. quantitative
    (c) It is soft and stretchable. qualitative
    (d) It will shrink in 70°C water. quantitative

Activity: Vial Lab (1DCHEM-ASG1)

INSTRUCTIONS

A. Read the activity "1DCHEM - ASG1 (Vial Lab)".
B. Follow the instructions given (i.e. method 1 to 5).
C. Answer the questions given (i.e. analysis 1 to 4).

NOTE!

- If chemistry is your first unit, this will be a "practice" formal lab report. We will write the lab together using the QHMMORCA format so that you have an understanding of what is required for a formal lab. You may find the "Lab Report Scheme" handout very useful.
- Formal lab reports are evaluated on a number of levels including spelling and grammar, form, and content. Simply handing in a table of observations and the answers to the questions is not acceptable when a formal lab report has been requested!

Activity: Vial Lab (1DCHEM-ASG1)

Substance #	State	Colour	Clarity	Texture	Viscosity	Lustre	Identity
	Solid Liquid Gas		Foggy Dense Murky Clear Transparent Cloudy Opaque	Rough Soft Watery Sticky	Thick Thin Smooth Runny Sluggish	Blinding Shiny Dull Matte Wow	