Chapter 2 The Nature of Matter — Answers

2.1 Properties of Matter

Warm Up, p. 60

1. For example: cold, white, crystalline, slippery, compressible, cohesive
2. For example: light, heavy, fluffy, wet
3. For example: the air temperature and pressure

Quick Check, p. 62

1. The stuff that materials are composed of
2. A quality of a thing, especially a quality common to a group, type, class, etc.
3. A quality that is or depends upon the amount of the material
4. A property that describes a chemical change. That is one in which a new substance(s) or species is formed, or otherwise describes the tendency of a chemical to react

Quick Check, p. 63

1. The average mechanical energy of the particles that compose a material
2. The total mechanical energy of an object's or a material's particles
3. The energy transferred from one body to another because of a difference in temperature

Quick Check, p. 65

1. The process of changing from a solid to a liquid
2. The vigorous bubbling that occurs within the body of a liquid as it vaporizes internally
3. The amount of heat required to melt a specified amount of a substance at its melting point

Quick Check, p. 67

1. A property of a solution that only depends on the concentration of the dissolved particles, not on their identity
2. For example: boiling point elevation
3. A solution of a metal and another solid or solids

2.1 Activity: The Thickness of Aluminum Foil, p. 69

Results and Discussion

For example:

Length (cm)	Width (cm)	S. Area (cm^2)	Mass (g)	Density (g/cm^3)	Volume (cm^3)	Thickness (cm)
30.0	30.5	**915.0**	**3.872**	2.702	**1.433**	**0.001566**

For example: $\frac{1.566 \times 10^{-5} \text{ m thick}}{2.86 \times 10^{-10} \text{ m/atom}}$ = 54 800 atoms thick

2.1 Review Questions, p. 70

1. a. Vapour is a form of matter; vapour pressure is a property; and vaporizing is a phenomenon.
   b. Solid is a form of matter; freezing point is a property; and freezing is a phenomenon.

2. All matter exerts a force of gravity on other matter and occupies space.

3. Alchemists had it backwards, believing that a material depends on its properties rather that the properties depending on the material.

4. For example: elastic, durable, non-marking, gets good traction without sticking, easily produced

5. For example: how much liquid it can absorb, how quickly it absorbs liquids, how strong it is when wet

6. a. intensive
   b. extensive
   c. extensive
   d. intensive
   e. intensive
   f. extensive

7. a. physical
   b. physical
   c. chemical
   d. physical
   e. physical
   f. chemical

8. a. physical
   b. chemical
   c. chemical
   d. physical
   e. chemical
   f. physical

9. To get a combination of properties not possible in a single material

10. Mass, speed

11. The particles move faster and thereby strike each other harder causing them to bounce farther apart.

12. Solids: fixed shape and volume
    Liquids: fixed volume, adopt the shape of their container
    Gases: adopt the shape and volume of their container

13. No. An individual atom or molecule cannot melt. Melting describes a change in the relationship between atoms or molecules.

14. The particles have spread apart to an extent where they can slip by one another.

15. As a solid melts slowly in its own liquid, the temperature of the liquid does not rise because any added kinetic energy is absorbed by the solid and converted into potential energy through melting.

16. At the liquid's boiling point

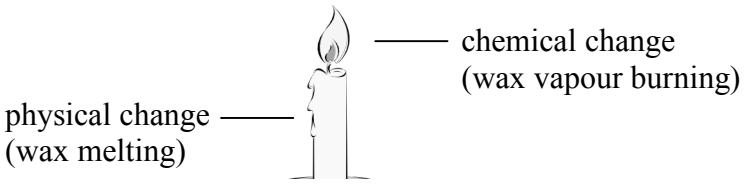
17. Operational: the temperature at which vigorous bubbling occurs
    Conceptual: the temperature at which the substance's vapour pressure equals the pressure of the gas above the liquid

18. Lower the atmospheric pressure above the liquid, for example by putting it in a vacuum chamber or by going to a higher altitude

19. a. Heat of vaporization
    b. Particles in the liquid state are not that much farther apart than they are in the solid state whereas particles in the gas state are much farther apart (on average) than they are in the liquid state. That is, there is a much greater increase in potential energy going from a liquid to a gas than going from a solid to a liquid.

20. a. Heat of combustion
    b. Changing the positions of molecules relative to one another involves less energy than changing the positions of atoms within molecules. Chemical changes generally involve much more energy than physical changes.

21. Chemical properties

22. 

23. Each student forms new associations with different students

2.2 The Classification of Matter

Warm Up, p. 73

1. For example: tennis
2. For example: racquet sports
3. An example is an individual whereas a class is a subgroup.

Quick Check, p. 74

1. An element is a type of substance.
2. A mixture is composed of more than one substance.
3. For example: copper, sodium chloride (table salt), salt water

Practice Problems, p. 77

1. a. molecular
   b. ionic
   c. molecular
   d. ionic
   e. ionic
   f. ionic

Quick Check, p. 78

1. Ionic
2. Base
3. Salt

Quick Check, p. 81

1. One that appears the same throughout
2. Solute, solvent
3. Dispersed phase, continuous or dispersion medium

2.2 Activity: Classifying Chemical Glassware, p. 82

Results and Discussion

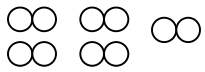
3. Some schemes may be more useful than others but any scheme is as valid as another

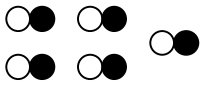
2.2 Review Questions, p. 83

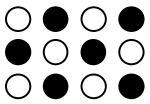
1. For example: copper (in wires), water, milk

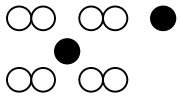
2. A compound. It's easy to demonstrate that you can decompose a substance but difficult to prove that you can't.

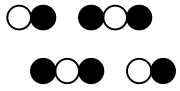
3. a. properties
   b. composition
   c. properties (the particle sizes are only rough guidelines)

4. For example: element 

   molecular compound 

   ionic compound 

   a mixture of elements 

   a mixture of compounds 

5. a. compound
   b. mixture
   c. compound
   d. mixture
   e. element
   f. mixture
   g. element
   h. mixture

6. a. metalloid
   b. metal
   c. non-metal
   d. non-metal

7. conduct heat and electricity, malleable, ductile, lustrous

8.

Compound	**Organic** or **Inorganic**	**Binary** or **Non-Binary**	**Molecular** or **Ionic**	**Acid, Base, Salt** or **None of these**
$CaCl_2$	inorganic	binary	ionic	salt
CH_3CH_2OH	organic	non-binary	molecular	none of these
NH_4ClO_3	inorganic	non-binary	ionic	salt
KOH	inorganic	non-binary	ionic	base
C_3H_8	organic	binary	molecular	none of these
H_3PO_4	inorganic	non-binary	molecular	acid
$Ba(NO_3)_2$	inorganic	non-binary	ionic	salt

CO_2	inorganic	binary	molecular	none of these
$Al(OH)_3$	inorganic	non-binary	ionic	base

9. A mixture of metals (alloy). The same components could be mixed in different proportions. Any material having atoms that are not chemically combined in a fixed ratio is a chemical mixture and would be so even if those atoms were organized in a uniform pattern.

10. Atoms are not homogeneous (the same throughout) and therefore nothing composed of atoms is truly homogeneous.

11. Yes. The different allotropes of an element are different substances. Even though they are composed of the same type of atom, the atoms are grouped or arranged differently resulting in the allotropes having different physical and chemical properties.

12. a. molecule
    b. neutral atom
    c. ion
    d. neutral atom
    e. molecule
    f. ion

13.

	Solution	**Colloid**	**Heterogeneous Mixture**
All particles are less than 1 nm in size	✓		
Gravel			✓
Does not appear the same throughout			✓
Forms a sediment if left undisturbed			✓
Has a solute and a solvent	✓		
Milk	✓	✓	
Exhibits the Tyndall effect		✓	✓
Homogeneous mixture	✓	✓	
Coarse suspension			✓
Orange juice with pulp	✓		✓
May be separated by centrifugation		✓	✓

14. A suspension will settle out if left undisturbed whereas a colloid will not settle out because it's dispersed particles are smaller.

15. Both. Some dust particles settle and some don't.

16. a. Salt water is a denser <u>solution</u> than fresh water.

(Fresh water is not pure water. It also has substances dissolved in it.)

b. The colloid particles were dispersed in water.

2.3 Separating the Substances of a Mixture

Warm Up, p. 86

For example: 1. Filter out the mud particles.
2. Centrifuge to remove the algal cells.
3. Evaporate off the water to leave the solid salts.

Quick Check, p. 88

1. Buoyancy
2. Decanting is carefully pouring off the liquid and leaving the sediment in the bottom of the original container.
3. Particles are separated by spinning the liquid in tubes.

Quick Check, p. 92

1. Chromatography is a technique that separates the substances in a solution by having a flowing liquid or gas carry them at different rates through a stationary phase.
2. Distillation is any process that separates a mixture of substances by using their different vapour pressures or boiling points.
3. Mining, wastewater treatment, and paper recycling

2.3 Activity: Separating Stuff, p. 93

For example:

Procedure		Items Separated from Mixture
1.	Place a magnet in the mixture	Paper clips
2.	Pour water into the mixture	Wooden discs
3.	Pour off the water and marbles.	Marbles

2.3 Review Questions, p. 94

1. Decomposing compounds is a chemical change (new substances are produced) OR Decomposition disassembles substances whereas separation sorts substances.

2. To allow the substances to be identified or to obtain the substances for their useful properties, their intrinsic values or more commonly to use the substances to produce useful mixtures of our own design

3. viscosity

4. Forces such as buoyancy and fluid friction become meaningless when the size of the particle approaches the size of the supporting medium's particles.

5. a. A resistance to change in motion
   b. As the tube changes its direction, the suspended particles initially maintain their linear motion.

6. of their greater inertia

7. For example:
i. Use a magnet to remove the iron filings.
ii. Add water to dissolve the sugar and then filter out the sand or decant the liquid.
iii. Evaporate the water to recover the solid sugar.

8. To filter particulate matter such as dust particles out of the air

9. Each substance travels through the stationary phase at its own characteristic rate, according to its relative affinities for the two phases.

10. Spraying chemicals on a chromatogram that form coloured complexes with the separated substances to reveal their location

11. The process of rinsing the separated substances off the chromatogram. Their recovery is usually necessary so that they can be identified through further analysis.

12. The ink itself might run through the stationary phase and become mixed with the sample substances whereas the graphite in pencils is insoluble in most solvents.

13. $$R_f = \frac{4.9 \text{ cm}}{5.4 \text{ cm}} = 0.91$$

14. Liquids can evaporate long before their boiling point; thus the distillate still contains some of each liquid, although it is now richer in the liquid with the lower boiling point.

15. How far apart their boiling points are and the length of the fractionating column

16. Cool the air until the oxygen condenses out at –183°C. Continued cooling would condense the nitrogen at –196°C if you wished to collect it as a liquid.

17. Distillation because of the heating or cooling required

18. Froth flotations require adding chemicals to the mixture that float the target substance to the surface. In density separations, the substance floats to the surface of its own accord.

2.4 A Review of Chemical Nomenclature

Warm Up, p. 96

	Br^-	O^{2-}	N^{3-}	OH^-	SO_4^{2-}	PO_4^{3-}
Na^+	NaBr	**Na_2O**	Na_3N	**NaOH**	**Na_2SO_4**	**Na_3PO_4**
Ca^{2+}	**$CaBr_2$**	**CaO**	**Ca_3N_2**	**$Ca(OH)_2$**	**$CaSO_4$**	$Ca_3(PO_4)_2$
Al^{3+}	**$AlBr_3$**	**Al_2O_3**	**AlN**	$Al(OH)_3$	**$Al_2(SO_4)_3$**	**$AlPO_4$**
NH_4^+	**NH_4Br**	$(NH_4)_2O$	**$(NH_4)_3N$**	**NH_4OH**	**$(NH_4)_2SO_4$**	**$(NH_4)_3PO_4$**
Sn^{4+}	**$SnBr_4$**	**SnO_2**	**Sn_3N_4**	**$Sn(OH)_4$**	$Sn(SO_4)_2$	**$Sn_3(PO_4)_4$**

Practice Problems, p. 98

1. a. Li_2S
   b. CrO
   c. $AlCl_3$
   d. PbS
   e. SnI_2
   f. $ZnBr_2$

2. a. zinc oxide
   b. lead(IV) chloride
   c. copper(II) chloride
   d. sodium iodide
   e. potassium sulphide
   f. chromium(II) oxide

Practice Problems, p. 99

1. a. $BaSO_4$
   b. $AgNO_3$
   c. $HgBr_2$
   d. $Sn(C_2O_4)_2$
   e. $Al_2(Cr_2O_7)_3$
   f. KF

2. a. zinc hydroxide
   b. tin(II) oxide
   c. copper(II) hypochlorite
   d. sodium ethanoate or sodium acetate
   e. magnesium iodide
   f. iron(II) dichromate

Practice Problems, p. 101

1. a. NO
   b. NO_2
   c. N_2O_4
   d. N_2O_3

2. a. phosphorus pentachloride
   b. sulphur dioxide
   c. carbon monoxide
   d. diphosphorus pentoxide

Practice Problems, p. 102

1. a. $BaCl_2$, $2H_2O$
   b. Na_2CO_3, H_2O
   c. $Fe(NO_3)_3$, $9H_2O$
   d. $Ba(OH)_2$, $8H_2O$

2. a. cobalt chloride hexahydrate
   b. iron(III) chloride tetrahydrate
   c. sodium dichromate dihydrate
   d. magnesium sulphate heptahydrate

Practice Problems, p. 103

1. a. HF
   b. HClO
   c. H_3PO_4
   d. H_2S

2. a. ethanoic or acetic acid
   b. sulphurous acid
   c. carbonic acid
   d. hydriodic acid

2.4 Activity: The Ionic Compound Card Game, p. 104

Students' answers will vary depending on their experience with the game and their ideas for new games.

2.4 Review Questions, p. 105

1. a. $Na^+ + F^- \longrightarrow NaF$
   b. $Fe^{2+} + 2Br^- \longrightarrow FeBr_2$
   c. $Sn^{4+} + 4Cl^- \longrightarrow SnCl_4$
   d. $2Cr^{3+} + 3S^{2-} \longrightarrow Cr_2S_3$

2. a. $CrCl_2$
   b. AlF_3
   c. MgI_2
   d. SnO_2

3. a. potassium oxide
   b. zinc bromide
   c. lead(IV) oxide
   d. mercury(I) chloride

4. a. potassium chloride KCl
   b. manganese(IV) oxide MnO_2
   c. iron(III) sulphide Fe_2S_3
   d. copper(II) iodide CuI_2

5. a. $Na^+ + NO_2^- \longrightarrow NaNO_2$
   b. $3Ag^+ + PO_4^{3-} \longrightarrow Ag_3PO_4$
   c. $Li^+ + CH_3COO^- \longrightarrow LiCH_3COO$
   d. $2Cr^{3+} + 3C_2O_4^{2-} \longrightarrow Cr_2(C_2O_4)_3$

6. a. $CuClO_4$
   b. $Ca(HS)_2$
   c. $Al_2(HPO_4)_3$
   d. $Mg(OH)_2$

7. a. barium phosphate
   b. iron(II) bisulphite
   c. lead(IV) binoxalate
   d. copper(I) dihydrogen phosphate

8. a. For example: $FeNa(CrO_4)_2$ or $FeNa_3(CrO_4)_3$
   b. For example: $Zn_2(SO_4)(NO_3)_2$ or $Zn_3(SO_4)_2(NO_3)_2$

9. a. ClO
   b. P_4O_6
   c. AsF_5
   d. NI_3

10. a. Triphosphorus pentabromide
    b. Diboron hexahydride
    c. sulphur tri-oxide
    d. carbon tetrafluoride

11. a. $Na_2SO_4, 10H_2O$
    b. $CaCl_2, 2H_2O$
    c. $Cu(CH_3COO)_2, H_2O$
    d. $CrCl_3, 6H_2O$

12. a. cadmium nitrate, tetrahydrate
    b. sodium monohydrogen phosphate, heptahydrate
    c. copper(II) sulphate, pentahydrate
    d. iron(III) nitrate, nonahydrate

13. Because water is combined in a fixed ratio with the salt ions

14. Bracketing the H_2O might suggest that it is a polyatomic ion.

15. a. HBr
    b. H_2CrO_4
    c. $HClO_3$
    d. $HClO$

16. a. hydrosulphuric acid
    b. perchloric acid
    c. nitrous acid
    d. thiocyanic acid

17. a. K_2O
    b. $HMnO_4$
    c. SO_2
    d. $(NH_4)_2CO_3$
    e. $FeSO_4, 7H_2O$
    f. HCN
    g. SF_6
    h. $Ca(CH_3COO)_2, H_2O$
    i. $Cr(HSO_3)_2$
    j. $Mg(OH)_2$