

Unit 1**(Phases)**

1. The particles of a substance are arranged in a definite geometric pattern and are constantly vibrating. This substance can be in

(1) the solid phase, only

(3) either the solid or the liquid phase

(2) the liquid phase, only

(4) neither the liquid nor the solid phase

(Mixtures)

2. When sugar is dissolved in water and mixed well, the resulting solution is classified as a

(1) homogeneous mixture

(3) heterogeneous mixture

(2) homogeneous compound

(4) heterogeneous compound

(Pure Substances-Compound vs Element)

3. Which substance can be decomposed by chemical means?

(1) aluminum

(2) water

(3) silicon

(4) xenon

(Changes- Physical vs Chemical)

4. Which equation represents a physical change?

(1) $\text{H}_2\text{O(s)} + \text{heat} \rightarrow \text{H}_2\text{O(l)}$

(3) $\text{H}_2\text{(g)} + \text{I}_2\text{(g)} + \text{heat} \rightarrow 2\text{HI(g)}$

(2) $2\text{H}_2\text{(g)} + \text{O}_2\text{(g)} \rightarrow 2\text{H}_2\text{O(g)} + \text{heat}$

(4) $\text{N}_2\text{(g)} + 2\text{O}_2\text{(g)} + \text{heat} \rightarrow 2\text{NO}_2\text{(g)}$

(Compound vs Mixture)

5. Every water molecule has two hydrogen atoms bonded to one oxygen atom. This fact supports the concept that elements in a compound are

(1) chemically combined in a fixed proportion

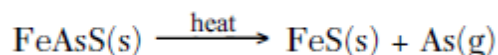
(3) chemically combined in proportions that vary

(2) physically mixed in a fixed proportion

(4) physically mixed in proportions that vary

(Law of Conservation of Mass)

6. Arsenic is often obtained by heating the ore arsenopyrite, FeAsS . The decomposition of FeAsS is represented by the balanced equation below.



When heated, a 125.0-kilogram sample of arsenopyrite yields 67.5 kilograms of FeS. Determine the total mass of arsenic produced in this reaction.

$$125\text{kg} = 67.5\text{ kg} + X$$

$$-67.5\text{kg}$$

$$\underline{57.5} \text{ kg}$$

(Chemical vs Physical Properties)

7. Compare the chemical properties of a 300.-kilogram sample of $\text{Al}_2\text{O}_3(\ell)$ with the chemical properties of a 600.-kilogram sample of $\text{Al}_2\text{O}_3(\ell)$.

The chemical properties are the same.

Unit 2

(Mass Number- Calculating # of Neutrons)

1. What is the total number of neutrons in an atom of an element that has a mass number of 19 and an atomic number of 9?

- (1) 9 (2) 19 **(3) 10** (4) 28

(Calculating # of Protons)

2. A neutral atom contains 12 neutrons and 11 electrons. The number of protons in this atom is

- (1) 1 **(2) 11** (3) 12 (4) 23

(Nuclear Charge)

3. What is the charge of the nucleus in an atom of oxygen-17?

- (1) 0 (2) -2 **(3) +8** (4) +17

(Subatomic Particles)

4. Which statement best describes electrons?

- (1) They are positive subatomic particles and are found in the nucleus.
(2) They are positive subatomic particles and are found surrounding the nucleus.
(3) They are negative subatomic particles and are found in the nucleus.
(4) They are negative subatomic particles and are found surrounding the nucleus.

(Isotopes)

5. The total number of protons, electrons, and neutrons in each of four different atoms are shown in the table below.

Subatomic Particles in Four Different Atoms

Atom	Total Number of Protons	Total Number of Electrons	Total Number of Neutrons
A	6	6	7
D	6	6	8
X	7	7	8
Z	8	8	9

5. Which two atoms are isotopes of the same element?

- (1) A and D** (2) A and Z (3) X and D (4) X and Z

(Valence Electrons and the Periodic Table)

6. An atom has seven valence electrons. This atom could be an atom of which element?

- (1) calcium **(2) fluorine** (3) oxygen (4) sodium

(Calculating # of Electrons)

7. What is the total number of electrons in an atom of potassium?

- (1) 18 **(2) 19** (3) 20 (4) 39

(Periodic Table and Properties- Metals vs Metalloids vs Nonmetals)

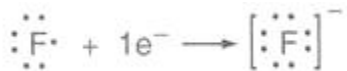
8. Which element has both metallic and nonmetallic properties?

- (1) Rb (2) Rn **(3) Si** (4) Sr

Unit 3

(Atom vs Ion)

1. The following equation represents the formation of a



- (1) fluoride ion, which is smaller in radius than a fluorine atom
- (2) fluorine atom, which is smaller in radius than a fluoride ion
- (3) fluoride ion, which is larger in radius than a fluorine atom**
- (4) fluorine atom, which is larger is radius than a fluoride ion

(Calculating # of Electrons in an Ion)

2. How many electrons are contained in an Au^{3+} ion?

- (1) 76**
- (2) 79
- (3) 82
- (4) 197

(Ionic Compounds-Formula)

3. Which element forms a compound with chlorine with the general formula $M\text{Cl}$?

- (1) Rb**
- (2) Ra
- (3) Re
- (4) Rn

(Naming Ionic Compounds)

4. Which formula represents copper (I) oxide?

- (1) CuO
- (2) CuO_2
- (3) Cu_2O**
- (4) Cu_2O_2

(Drawing Lewis Dot Structures-Covalent)

5. The nitrogen atoms in a molecule of N_2 share a total of

- (1) one pair of electrons
- (2) one pair of protons
- (3) three pairs of electrons**
- (4) three pairs of protons

(Drawing Lewis Dot Structures-Covalent)

6. It is possible for bonds to be single, double or triple covalent. Which molecule contains 3 single covalent bonds?

- (1) H_2
- (2) NH_3**
- (3) I_2
- (4) H_2O

(Polyatomic Ions and Bonding)

7. Which compound has both ionic and covalent bonding?

- (1) CaCO_3**
- (2) CH_2Cl_2
- (3) CH_3OH
- (4) $\text{C}_6\text{H}_{12}\text{O}_6$

(Properties of Covalent and Ionic Substances)

8. Which type of substance can conduct electricity in the liquid phase but *not* in the solid phase?

- (1) ionic compound**
- (3) metallic element
- (2) molecular compound
- (4) nonmetallic element

(Naming Compounds with Polyatomic Ions)

9. Which formula represents barium phosphate?

- (1) BaPO_4
- (2) $\text{Ba}_3(\text{PO}_4)_2$**
- (3) $\text{Ba}_2(\text{PO}_4)_3$
- (4) Ba_3PO_8

(Endothermic vs Endothermic Reactions)

10. In an exothermic reaction

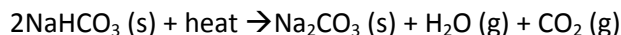
- (1) energy is a product and the surrounding temperature increases**
- (2) energy is a product and the surrounding temperature decreases
- (3) energy is a reactant and the surrounding temperature increases
- (4) energy is a reactant and the surrounding temperature decreases

(Gram Formula Mass/Molar Mass)11. What is the gram-formula mass of $\text{Ca}_3(\text{PO}_4)_2$?

(1) 248 g/mol

(2) 263 g/mol

(3) 279 g/mol

(4) 310. g/mol**(Moles Calculations)**12. Some dry chemicals can be used to put out forest fires. One of these chemicals is NaHCO_3 . When $\text{NaHCO}_3(\text{s})$ is heated, one of the products is $\text{CO}_2(\text{g})$, as shown in the balanced equation below.Determine the total number of moles of $\text{CO}_2(\text{g})$ produced when 7.0 moles of $\text{NaHCO}_3(\text{s})$ is completely reacted.

$$\frac{7 \text{ mol NaHCO}_3}{2 \text{ mol NaHCO}_3} \times \frac{1 \text{ mol CO}_2}{2 \text{ mol NaHCO}_3} = \underline{\underline{3.5 \text{ mol CO}_2}}$$

(Moles Calculations)13. Determine the mass of 5.20 moles of C_6H_{12} (gram-formula mass = 84.2 grams/mole)

$$5.20 \text{ mol C}_6\text{H}_{12} \times \frac{84.2 \text{ g C}_6\text{H}_{12}}{1 \text{ mol C}_6\text{H}_{12}} = \underline{\underline{437.84 \text{ g C}_6\text{H}_{12}}}$$

Unit 4**(States of Matter)**1. Which 5.0-milliliter sample of NH_3 will take the shape of and completely fill a closed 100.0-milliliter container?(1) $\text{NH}_3(\text{s})$ (2) $\text{NH}_3(\text{l})$ **(3) $\text{NH}_3(\text{g})$** (4) $\text{NH}_3(\text{aq})$ **(States of Matter)**

2. Which statement correctly describes a sample of gas confined in a sealed container?

(1) It always has a definite volume, and it takes the shape of the container.

(2) It takes the shape and the volume of any container in which it is confined.

(3) It has a crystalline structure.

(4) It consists of particles arranged in a regular geometric pattern

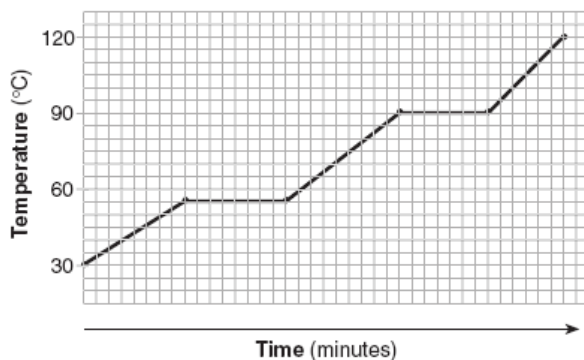
(Phase Changes)

3. Which equation represents sublimation?

(1) $\text{I}_2(\text{s}) \rightarrow \text{I}_2(\text{g})$ (2) $\text{I}_2(\text{s}) \rightarrow \text{I}_2(\text{l})$ (3) $\text{I}_2(\text{l}) \rightarrow \text{I}_2(\text{g})$ (4) $\text{I}_2(\text{l}) \rightarrow \text{I}_2(\text{s})$ **(Heating Curve)**

4. The graph below represents the heating curve of a substance that starts as a solid below its freezing point.

4. What is the melting point of this substance?



(1) 30°C

(2) 55°C

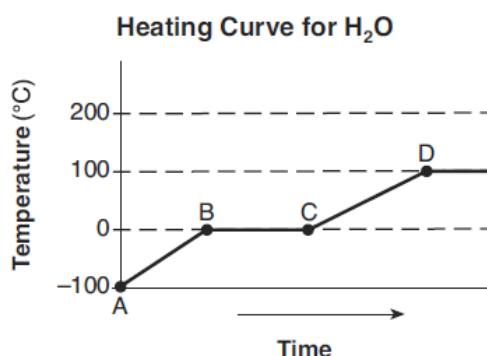
(3) 90°C

(4) 120°C

(PE vs KE)

5. The graph represents the relationship between temperature and time as heat is added to a sample of H_2O . Which statement correctly describes the energy of the particles of the sample during interval BC?

- (1) Potential energy decreases and average kinetic energy increases.
- (2) Potential energy increases and average kinetic energy increases.
- (3) Potential energy increases and average kinetic energy remains the same.**
- (4) Potential energy remains the same and average kinetic energy increases.

**(Phase Changes- Exothermic vs Endothermic)**

6. Which phase change happens as a result of the release of energy?

- (1) $\text{H}_2\text{O}(s) \rightarrow \text{H}_2\text{O}(l)$
- (2) $\text{H}_2\text{O}(s) \rightarrow \text{H}_2\text{O}(g)$
- (3) $\text{H}_2\text{O}(l) \rightarrow \text{H}_2\text{O}(g)$
- (4) $\text{H}_2\text{O}(g) \rightarrow \text{H}_2\text{O}(l)$**

(Temperature)

7. Which sample of ethanol has particles with the highest average kinetic energy?

- (1) 10.0 mL of ethanol at 25°C
- (2) **10.0 mL of ethanol at 55°C**
- (3) 100.0 mL of ethanol at 35°C
- (4) 100.0 mL of ethanol at 45°C

(Heat Flow)

8. A person with a body temperature of 37°C holds an ice cube with a temperature of 0°C in a room where the air temperature is 20°C . The direction of heat flow is

- (1) from the person to the ice, only
- (2) from the person to the ice and air, and from the air to the ice**
- (3) from the ice to the person, only
- (4) from the ice to the person and air, and from the air to the person

(Table H-Vapor Pressure)

9. Using your knowledge of chemistry and the information in Reference Table H, which statement concerning propanone and water at 50°C is true?

- (1) Propanone has a higher vapor pressure and stronger intermolecular forces than water.
- (2) Propanone has a higher vapor pressure and weaker intermolecular forces than water.**
- (3) Propanone has a lower vapor pressure and stronger intermolecular forces than water.
- (4) Propanone has a lower vapor pressure and weaker intermolecular forces than water.

(Kinetic Molecular Theory)

10. Which statement describes the particles of an ideal gas based on the kinetic molecular theory?

- (1) The gas particles are relatively far apart and have negligible volume.**
- (2) The gas particles are in constant, nonlinear motion.
- (3) The gas particles have attractive forces between them.
- (4) The gas particles have collisions without transferring energy.

(Ideal vs Real gas Conditions)

11. Under which conditions of temperature and pressure would a real gas behave most like an ideal gas?

- (1) 200. K and 50.0 kPa
- (2) 200. K and 200.0 kPa
- (3) 600. K and 50.0 kPa**
- (4) 600. K and 200.0 kPa

(Comparing Samples of Gas)

12. Which gas sample at STP has the same total number of molecules as 2.0 liters of $\text{CO}_2(g)$ at STP?

- (1) 5.0 L of $\text{CO}_2(g)$
- (2) 2.0 L of $\text{Cl}_2(g)$**
- (3) 3.0 L of $\text{H}_2\text{S}(g)$
- (4) 6.0 L of $\text{He}(g)$

(Gas Law Calculations)

14. A rigid cylinder contains a sample of gas at STP. What is the pressure of this gas after the sample is heated to 410K?

(1) 1.0 atm

(2) 0.50 atm

(3) 0.67 atm

(4) 1.5 atm

Unit 5

(Exothermic vs Endothermic)

1. For which compound is the process of dissolving in water exothermic?

(1) NaCl

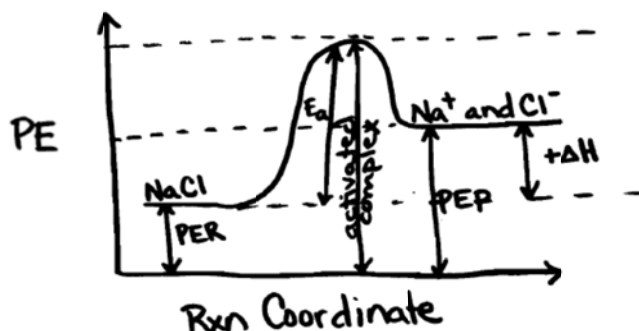
(2) NaOH

(3) NH_4Cl

(4) NH_4NO_3

(PE Diagrams)

2. Draw a potential energy diagram for the reaction of sodium chloride as it dissolves in water.



(PE Diagrams)

3. The activation energy of a chemical reaction can be *decreased* by the addition of

(1) a catalyst

(2) an indicator

(3) electrical energy

(4) thermal energy

(Entropy)

4. The entropy of a sample of H_2O increases as the sample changes from a

(1) gas to a liquid

(2) liquid to a gas

(3) gas to a solid

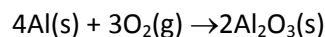
(4) liquid to a solid

(Types of Chemical Reactions)

5. Which type of chemical reaction is represented by this equation?

(1) double replacement

(2) single replacement



(3) substitution

(4) synthesis

Unit 6

(Soluble vs Insoluble)

1. Which ion, when combined with chloride ions, Cl^- , forms an insoluble substance in water?

(1) Fe^{2+}

(2) Mg^{2+}

(3) Pb^{2+}

(4) Zn^{2+}

(Molarity)

2. Which sample of HCl(aq) contains the greatest number of moles of solute particles?

(1) 1.0 L of 2.0 M HCl(aq)

(2) 2.0 L of 2.0 M HCl(aq)

(3) 3.0 L of 0.50 M HCl(aq)

(4) 4.0 L of 0.50 M HCl(aq)

(Molarity)

Base your answers to questions 3 and 4 on the information below.

A 2000 mL aqueous solution contains a total of 3.0 moles of dissolved NH_4Cl at 25°C at standard pressure.

3. Determine the molarity of the solution.

$$\text{Molarity} = \frac{\text{moles of solute}}{\text{Liters of solution}} = \frac{3.0 \text{ moles}}{2 \text{ L}} = 1.5 \text{ moles/Liter}$$

1.5 M

4. Identify the two ions present in the solute.

NH_4^+ and Cl^-

(Electrolytes)

5. A substance is classified as an electrolyte because

- (1) it has a high melting point
- (2) it contains covalent bonds

(3) its aqueous solution conducts an electric current

(4) its aqueous solution has a pH value of 7

(Identifying Electrolytes)

6. Which pair of formulas represents two compounds that are electrolytes?

- (1) HCl and CH₃OH
- (2) **HCl and NaOH**
- (3) C₅H₁₂ and CH₃OH
- (4) C₅H₁₂ and NaOH

(Acid vs Base)

7. The compound HNO₃ can be described as an

- (1) **Arrhenius acid and an electrolyte**
- (2) Arrhenius acid and a nonelectrolyte
- (3) Arrhenius base and an electrolyte
- (4) Arrhenius base and a nonelectrolyte

(Identifying an Acid or Base)

8. Which substance is an Arrhenius base?

- (1) CH₃OH
- (2) CH₃Cl
- (3) **LiOH**
- (4) LiCl

(Acid vs Base)

9. The only positive ion found in H₂SO₄(aq) is the

- (1) ammonium ion
- (2) **hydronium ion**
- (3) hydroxide ion
- (4) sulfate ion

(pH of Acidic and Basic solutions)

10. Which pH indicates a basic solution?

- (1) 1
- (2) 5
- (3) 7
- (4) **12**

(Comparing pH and Acid-Base Indicators)

11. Which statement correctly describes a solution with a pH of 2?

- (1) It has a higher concentration of H₃O⁺ than OH⁻ and causes litmus to turn blue.
- (2) It has a higher concentration of OH⁻ than H₃O⁺ and causes litmus to turn blue.
- (3) **It has a higher concentration of H₃O⁺ than OH⁻ and causes methyl orange to turn red.**
- (4) It has a higher concentration of OH⁻ than H₃O⁺ and causes methyl orange to turn red.

(pH Scale)

12. As the pH of a solution is changed from 3 to 6, the concentration of hydronium ions

- (1) increases by a factor of 3
- (2) increases by a factor of 1000
- (3) decreases by a factor of 3
- (4) **decreases by a factor of 1000**

(Acid- Base Indicators)

13. In which 0.01 M solution is phenolphthalein pink?

- (1) CH₃OH(aq)
- (2) **Ca(OH)₂(aq)**
- (3) CH₃COOH(aq)
- (4) HNO₃(aq)

(Neutralization Reaction)

14. Which compound could serve as a reactant in a neutralization reaction?

- (1) NaCl
- (2) **KOH**
- (3) CH₃OH
- (4) CH₃CHO

(Identifying Neutralization Reaction)

15. Which chemical equation represents the reaction of an Arrhenius acid and an Arrhenius base?

- (1) **HC₂H₃O₂(aq) + NaOH(aq) → NaC₂H₃O₂(aq) + H₂O(l)**
- (2) C₃H₈(g) + 5 O₂(g) → 3 CO₂(g) + 4 H₂O(l)
- (3) Zn(s) + 2 HCl(aq) → ZnCl₂(aq) + H₂(g)
- (4) BaCl₂(aq) + Na₂SO₄(aq) → BaSO₄(s) + 2 NaCl(aq)

(Titration)

16. Which volume of 2.0 M NaOH(aq) is needed to completely neutralize 24 milliliters of 1.0 M HCl(aq)?

(1) 6.0 mL

(2) 12 mL

(3) 24 mL

(4) 48 mL

Calculations- Equations Table T

1. Which kelvin temperature is equivalent to -24°C ?

→ Which equation do you need to use? $K = ^{\circ}\text{C} + 273$

(1) 226 K

(2) 273 K

(3) 249 K

(4) 297 K

2. If 0.025 gram of $\text{Pb}(\text{NO}_3)_2$ is dissolved in 100. grams of H_2O , what is the concentration of the resulting solution, in parts per million?

→ Which equation do you need to use? $\text{parts per million} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 1\,000\,000$

(1) 2.5×10^{-4} ppm

(2) 2.5 ppm

(3) 250 ppm

(4) 4.0×10^3 ppm

3. Based on data collected during a laboratory investigation, a student determined an experimental value of 322 joules per gram for the heat of fusion of H_2O . Calculate the student's percent error. Your response must include a correct numerical setup and the calculated result.

→ Which equation do you need to use? $\% \text{ error} = \frac{\text{measured value} - \text{accepted value}}{\text{accepted value}} \times 100$

$$\% = \frac{322-334}{334} \times 100$$

-3.59 (-3.6) %

4. A student prepared two mixtures, each in a labeled beaker. Enough water at $20.^{\circ}\text{C}$ was used to make 100 milliliters of each mixture.

Information about Two Mixtures at $20.^{\circ}\text{C}$

	Mixture 1	Mixture 2
Composition	NaCl in H_2O	Fe filings in H_2O
Student Observations	• colorless liquid • no visible solid on bottom of beaker	• colorless liquid • black solid on bottom of beaker
Other Data	• mass of NaCl(s) dissolved = 2.9 g	• mass of Fe(s) = 15.9 g • density of Fe(s) = 7.87 g/cm^3

Determine the volume of the Fe filings used to produce mixture 2.

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

→ Which equation do you need to use?

$$7.87\text{g/cm}^3 = \frac{15.9\text{g}}{X}$$

$$\underline{2.02\text{ cm}^3}$$

5. In a titration, a few drops of an indicator are added to a flask containing 35.0 milliliters of $\text{HNO}_3(\text{aq})$ of unknown concentration. After 30.0 milliliters of 0.15 M $\text{NaOH}(\text{aq})$ solution is slowly added to the flask, the indicator changes color, showing the acid is neutralized.

a) The volume of the $\text{NaOH}(\text{aq})$ solution is expressed to what number of significant figures? 3

b) Show a numerical setup below for calculating the concentration of the $\text{HNO}_3(\text{aq})$ solution.

→ Which equation do you need to use? $M_A V_A = M_B V_B$

$$M_A (35.0) = 0.15\text{M} (30.0)$$

6. One sample of a green vegetable contains 0.0035 gram of boron. Determine the total number of moles of boron in this sample.

→ Which equation do you need to use? $\text{number of moles} = \frac{\text{given mass}}{\text{gram-formula mass}}$

$$\# \text{ moles} = \frac{0.0035\text{ g}}{10.81\text{g/mole}}$$

$$\underline{0.000324 (3.24 \times 10^{-4}) \text{ moles}}$$

7. What is the amount of heat energy released when 50.0 grams of water is cooled from 20.0°C to 10.0°C ?

→ Which equation do you need to use? $q = mC\Delta T$

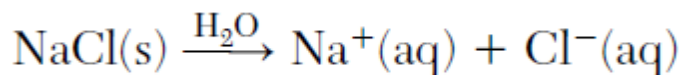
(1) $5.00 \times 10^2 \text{ J}$

(2) $2.09 \times 10^3 \text{ J}$

(3) $1.67 \times 10^5 \text{ J}$

(4) $1.13 \times 10^6 \text{ J}$

8. A 2.50-liter aqueous solution contains 1.25 moles of dissolved sodium chloride. The dissolving of $\text{NaCl}(\text{s})$ in water is represented by the equation below.



a) Determine the molarity of this solution.

→ Which equation do you need to use? $\text{molarity} = \frac{\text{moles of solute}}{\text{liter of solution}}$

$$M = \frac{1.25 \text{ moles}}{2.50\text{L}}$$

$$\underline{0.5 \text{ M}}$$

b) Compare the freezing point of this solution to the freezing point of a solution containing 0.75 mole NaCl per 2.50 liters of solution.

The solution that contains 1.25 moles of NaCl has a lower freezing point.

9. When the air bag inflates, the nitrogen gas is at a pressure of 1.30 atmospheres, a temperature of 301 K, and has a volume of 40.0 liters. In the below, calculate the volume of the nitrogen gas at STP. Your response must include both a correct numerical setup and the calculated volume.

→ Which equation do you need to use? $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

$$\frac{(1.3 \text{ atm})(40.0\text{L})}{301\text{K}} = \frac{(1 \text{ atm})V_2}{273\text{K}} \quad \underline{\underline{47.16 \text{ L}}}$$

10. Gypsum is a mineral that is used in the construction industry to make drywall (sheetrock). The chemical formula for this hydrated compound is $\text{CaSO}_4 \cdot 2 \text{H}_2\text{O}$. A hydrated compound contains water molecules within its crystalline structure. Gypsum contains 2 moles of water for each 1 mole of calcium sulfate.

a) What is the gram formula mass of $\text{CaSO}_4 \cdot 2 \text{H}_2\text{O}$?

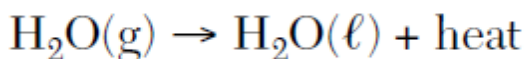
$$\begin{array}{ll} 1 \text{ Ca} = 1 (40) & = 40 \\ 1 \text{ S} = 1 (32) & = 32 \\ 4 \text{ O} = 4 (16) & = 64 \\ 4 \text{ H} = 4 (1) & = 4 \\ 2 \text{ O} = 2 (16) & = 32 \\ \hline & 172 \text{ g/mol} \end{array}$$

b) In the space provided, show a correct numerical setup and calculate the percent composition by mass of water in this compound.

→ Which equation do you need to use? $\% \text{ composition by mass} = \frac{\text{mass of part}}{\text{mass of whole}} \times 100$

$$\frac{36 \text{ g}}{172 \text{ g}} \times 100 \quad \underline{\underline{20.9 (21) \%}}$$

11. Determine the total amount of heat released by 5.00 grams of water vapor during the phase change shown below.



→ Which equation do you need to use? $q = mH_v$

$$q = 5.00\text{g} (2260 \text{ J/g}) \quad \underline{\underline{11,300 \text{ J}}}$$