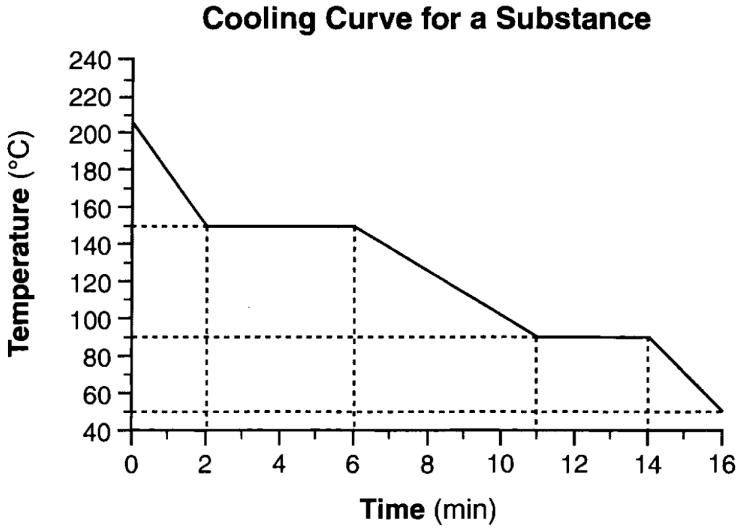
Name_____ May 2, 2012

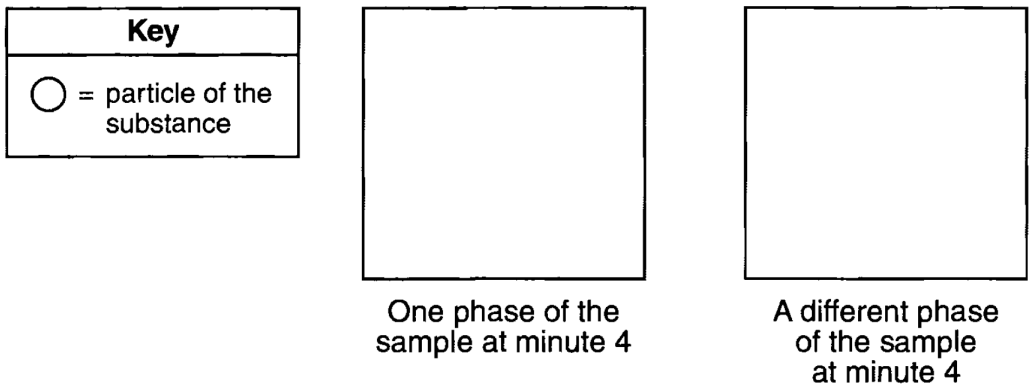
Physical Behavior of Matter and Bonding Review

Base your answers to questions **1** through **3** on the information below.

Starting as a gas at 206°C, a sample of a substance is allowed to cool for 16 minutes. This process is represented by the cooling curve below.



1. Using the key below, draw two particle diagrams to represent the two phases of the sample at minute 4. Your response must include at least six particles for each diagram.



2. At what time do the particles of this sample have the lowest average kinetic energy?

3. What is the melting point of this substance?

Base your answers to questions **4** and **5** on the information below.

A student prepared two mixtures, each in a labeled beaker. Enough water at 20.°C was used to make 100 milliliters of each mixture.

Information about Two Mixtures at 20.°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

4. Describe a procedure to physically remove the water from mixture 1.

5. Classify each mixture using the term "homogeneous" or the term "heterogeneous."

Base your answers to questions **6** and **7** on the information below.

Natural gas is a mixture that includes butane, ethane, methane, and propane. Differences in boiling points can be used to separate the components of natural gas. The boiling points at standard pressure for these components are listed in the table below.

Data Table

Component of Natural Gas	Boiling Point at Standard Pressure (°C)
butane	–0.5
ethane	–88.6
methane	–161.6
propane	–42.1

6. List the four components of natural gas in order of increasing strength of intermolecular forces.

7. Identify a process used to separate the components of natural gas.

Base your answers to questions **8** and **9** on the information below.

Cold packs are used to treat minor injuries. Some cold packs contain $NH_4NO_3(s)$ and a small packet of water at room temperature before activation. To activate this type of cold pack, the small packet must be broken to mix the water and $NH_4NO_3(s)$. The temperature of this mixture decreases to approximately 2°C and remains at this temperature for 10 to 15 minutes.

8. Identify both types of bonds in the $NH_4NO_3(s)$.

9. State the direction of heat flow that occurs when the activated cold pack is applied to the body.

Base your answers to questions **10** and **11** on the information below.

Some Properties of Three Compounds at Standard Pressure

Compound	Boiling Point (°C)	Solubility in 100. Grams of H_2O at 20.°C (g)
ammonia	–33.2	56
methane	–161.5	0.002
hydrogen chloride	–84.9	72

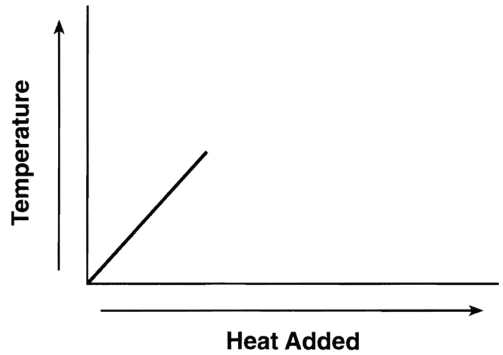
10. Explain, in terms of molecular polarity, why hydrogen chloride is more soluble than methane in water at 20.°C and standard pressure.

11. Convert the boiling point of hydrogen chloride at standard pressure to kelvins.

12. Base your answer to the following question on Heat is added to a sample of liquid water, starting at 80.°C, until the entire sample is a gas at 120.°C. This process, occurring at standard pressure, is represented by the balanced equation below.

$$H_2O(\ell) + \text{heat} \rightarrow H_2O(g)$$

On the diagram below, complete the heating curve for this physical change.



Base your answers to questions **13** through **15** on the information below.

Heat is added to a 200.-gram sample of $H_2O(s)$ to melt the sample at 0°C. Then the resulting $H_2O(\ell)$ is heated to a final temperature of 65°C.

13. Compare the amount of heat required to vaporize a 200.-gram sample of $H_2O(\ell)$ at its boiling point to the amount of heat required to melt a 200.-gram sample of $H_2O(s)$ at its melting point.

14. In the space below, show a numerical setup for calculating the total amount of heat required to raise the temperature of the $H_2O(\ell)$ from 0°C to its final temperature.

15. Determine the total amount of heat required to completely melt the sample.

Base your answers to questions **16** and **17** on the information below.

In 1864, the Solvay process was developed to make soda ash. One step in the process is represented by the balanced equation below.

$$NaCl + NH_3 + CO_2 + H2O \rightarrow NaHCO_3 + NH_4Cl$$

16. In the space draw a Lewis electron-dot diagram for the reactant containing nitrogen in the equation.

17. Explain, in terms of electronegativity difference, why the bond between hydrogen and oxygen in a water molecule is more polar than the bond between hydrogen and nitrogen in an ammonia molecule.

Base your answers to questions **18** and **19** on the information below.

Ozone, $O_3(g)$, is produced from oxygen, $O_2(g)$ by electrical discharge during thunderstorms. The unbalanced equation below represents the reaction that forms ozone.

$$O_2(g) \xrightarrow{\text{electricity}} O_3(g)$$

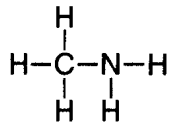
18. Explain, in terms of electron configuration, why an oxygen molecule is more stable than an oxygen atom.

19. Identify the type of bonding between the atoms in an oxygen molecule.

Base your answers to questions **20** through **23** on the information below.

Bond energy is the amount of energy required to break a chemical bond. The table below gives a formula and the carbon-nitrogen bond energy for selected nitrogen compounds.

Selected Nitrogen Compounds

Compound	Formula	Carbon-Nitrogen Bond Energy (kJ/mol)
hydrogen cyanide	H−C≡N	890.
isocyanic acid	H−N=C=O	615
methanamine		293

20. Explain, in terms of charge distribution, why a molecule of hydrogen cyanide is polar.

21. State the relationship between the number of electrons in a carbon-nitrogen bond and carbon-nitrogen bond energy.

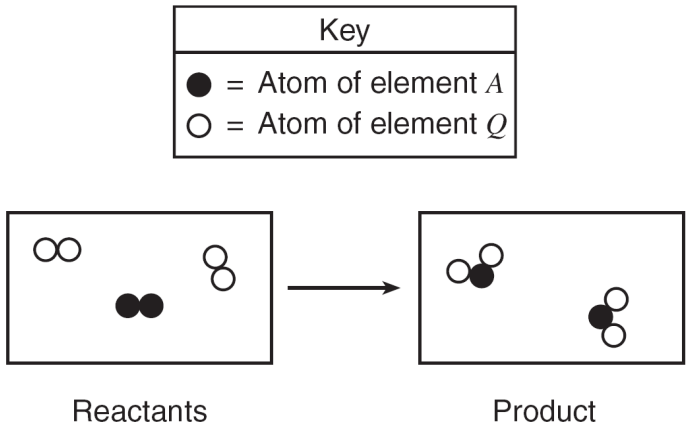
22. Identify the noble gas that has atoms in the ground state with the same electron configuration as the nitrogen in a molecule of isocyanic acid.

23. Describe, in terms of electrons, the type of bonding between the carbon atom and the nitrogen atom in a molecule of methanamine.

24. Explain, in terms of electronegativity, why a P–Cl bond in a molecule of PCl_5 is more polar than a P–S bond in a molecule of P_2S_5.

Base your answers to questions **25** and **26** on the information below.

The particle diagrams below represent the reaction between two nonmetals, A_2 and Q_2.



25. Compare the total mass of the reactants to the total mass of the product.

26. Identify the type of chemical bond between an atom of element A and an atom of element Q.

27. a Draw two different compounds, one in each box, using the representations for atoms of element X and element Z given below.

Atom of element X = ○
Atom of element Z = ●

b Draw a mixture of these two compounds.

33. Which statement describes a chemical property of aluminum?

A) Aluminum is malleable.
B) Aluminum reacts with sulfuric acid.
C) Aluminum conducts an electric current.
D) Aluminum has a density of 2.698 g/cm^3 at STP.

28. Draw an electron-dot diagram for each of the following substances:

a calcium oxide (an ionic compound)

b hydrogen bromide

c carbon dioxide

29. Draw a correct Lewis electron-dot structure for each of the following.

a An atom of hydrogen
b An atom of nitrogen
c A molecule of ammonia (NH_3)

30. An unknown solid was tested and showed the properties listed below:

Properties
high melting point
soluble in water
conductor of electricity when dissolved in water
non-conductor of electricity as a solid
hard surface

a State the type of bonding you would expect of this substance.

b Explain why this substance conducts electricity when dissolved in water.

c Explain why it is hard.

31. Which sample of CO_2 has a definite shape and a definite volume?

A) $CO_2(aq)$ B) $CO_2(g)$
C) $CO_2(\ell)$ **D) $CO_2(s)$**

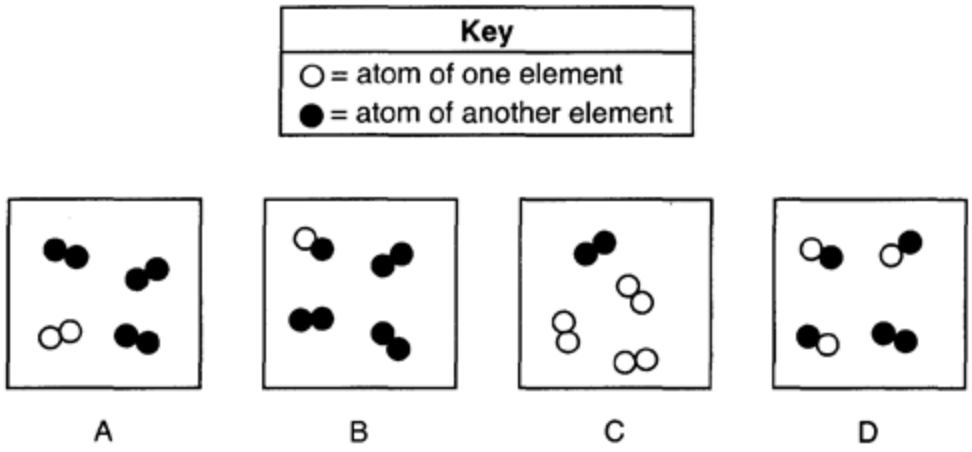
32. Which pair represents two forms of an element in the same phase at STP but with different structures and different properties?

A) $I_2(s)$ and $I_2(g)$ **B) $O_2(g)$ and $O_3(g)$**
C) $H_2(g)$ and $Hg(g)$ D) $H_2(s)$ and $H_2O(\ell)$

34. Particles are arranged in a crystal structure in a sample of

A) $H_2(g)$ B) $Br_2(l)$ C) Ar(g) **D) Ag(s)**

35. Base your answer to the following question on Which two particle diagrams represent mixtures of diatomic elements?



A) A and B **B) A and C** C) B and C D) B and D

36. Which substance can be decomposed by chemical means?

A) aluminum **B) octane**
C) silicon D) xenon

37. Which equation represents a physical change?

A) $H_2O(s) + 6.01\ kJ \rightarrow H_2O(\ell)$
B) $2H_2(g) + O_2(g) \rightarrow 2H_2O(g) + 483.6\ kJ$
C) $H_2(g) + I_2(g) + 53.0\ kJ \rightarrow 2HI(g)$
D) $N_2(g) + 2O_2(g) + 66.4\ kJ \rightarrow 2NO_2(g)$

38. Which statement best describes the molecules of H_2O in the solid phase?

A) They move slowly in straight lines.
B) They move rapidly in straight lines.
C) They are arranged in a regular geometric pattern.
D) They are arranged in a random pattern.

39. In a laboratory where the air temperature is 22°C, a steel cylinder at 100.°C is submerged in a sample of water at 40.°C. In this system, heat flows from

A) both the air and the water to the cylinder
B) both the cylinder and the air to the water
C) the air to the water and from the water to the cylinder
D) the cylinder to the water and from the water to the air

40. Which unit is used to express the energy absorbed or released during a chemical reaction?

A) kelvin **B) joule** C) volt D) torr

41. The temperature of a sample of matter is a measure of the

A) average kinetic energy of its particles
B) average potential energy of its particles
C) total kinetic energy of its particles
D) total potential energy of its particles

42. Which sample of water contains particles having the highest average kinetic energy?

A) 25 mL of water at 95°C
B) 45 mL of water at 75°C
C) 75 mL of water at 75°C
D) 95 mL of water at 25°C

43. Which temperature is equal to 120. K?

A) –153°C B) –120.°C
C) +293°C D) +393°C

44. The temperature of a sample of a substance changes from 10.°C to 20.°C. How many Kelvin does the temperature change?

A) 10. B) 20. C) 283 D) 293

45. Which Kelvin temperature is equal to –73°C?

A) 100 K B) 173 K **C) 200 K** D) 346 K

46. Which process is exothermic?

A) boiling of water
B) melting of copper
C) condensation of ethanol vapor
D) sublimation of iodine

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

A) The gas particles are relatively far apart and have negligible volume.
B) The gas particles are in constant, nonlinear motion.
C) The gas particles have attractive forces between them.
D) The gas particles have collisions without transferring energy.

48. According to the kinetic molecular theory, which statement describes the particles in a sample of an ideal gas?

A) The force of attraction between the gas particles is strong.
B) The motion of the gas particles is random and straight-line.
C) The collisions between the gas particles cannot result in a transfer of energy between the particles.
D) The separation between the gas particles is smaller than the size of the gas particles themselves.

49. Under which conditions of temperature and pressure would helium behave most like an ideal gas?

A) 50 K and 20 kPa B) 50 K and 600 kPa
C) 750 K and 20 kPa D) 750 K and 600 kPa

50. The concept of an ideal gas is used to explain

A) the mass of a gas sample
B) the behavior of a gas sample
C) why some gases are monatomic
D) why some gases are diatomic

51. A real gas behaves least like an ideal gas under the conditions of

A) low temperature and low pressure
B) low temperature and high pressure
C) high temperature and low pressure
D) high temperature and high pressure

52. Under the same conditions of temperature and pressure, which of the following gases would behave most like an ideal gas?

A) He(g) B) $NH_3(g)$
C) $Cl_2(g)$ D) $CO_2(g)$

53. Which rigid cylinder contains the same number of gas molecules at STP as a 2.0-liter rigid cylinder containing $H_2(g)$ at STP?

A) 1.0-L cylinder of $O_2(g)$
B) 2.0-L cylinder of $CH_4(g)$
C) 1.5-L cylinder of $NH_3(g)$
D) 4.0-L cylinder of He(g)

54. Which two samples of gas at STP contain the same total number of molecules?

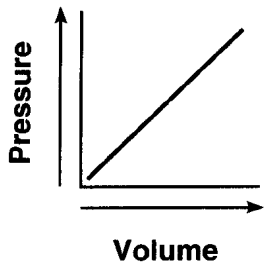
A) 1 L of $CO(g)$ and 0.5 L of $N_2(g)$
B) 2 L of $CO(g)$ and 0.5 L of $NH_3(g)$
C) 1 L of $H_2(g)$ and 2 L of $Cl_2(g)$
D) 2 L of $H_2(g)$ and 2 L of $Cl_2(g)$

55. At 25°C, gas in a rigid cylinder with a movable piston has a volume of 145 mL and a pressure of 125 kPa. Then the gas is compressed to a volume of 80. mL. What is the new pressure of the gas if the temperature is held at 25°C?

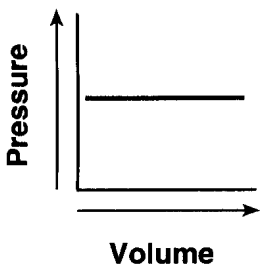
A) 69 kPa B) 93 kPa
C) 160 kPa **D) 230 kPa**

56. Which graph represents the relationship between pressure and volume for a sample of an ideal gas at constant temperature?

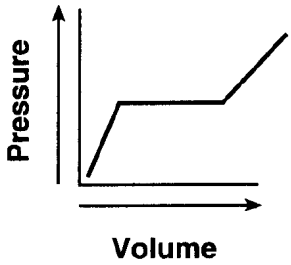
A)



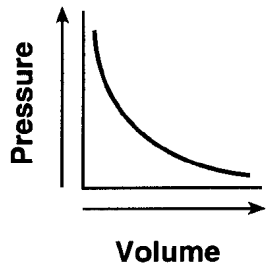
B)



C)



D)



57. A sample of gas occupies a volume of 50.0 milliliters in a cylinder with a movable piston. The pressure of the sample is 0.90 atmosphere and the temperature is 298 K. What is the volume of the sample at STP?

A) 41 mL B) 49 mL
C) 51 mL D) 55 mL

58. Given the balanced equation representing a reaction:
$Cl_2 \rightarrow Cl + Cl$

What occurs during this reaction?

A) A bond is broken as energy is absorbed.
B) A bond is broken as energy is released.
C) A bond is formed as energy is absorbed.
D) A bond is formed as energy is released.

59. Which of these elements has an atom with the most stable outer electron configuration?

A) Ne B) Cl C) Ca D) Na

60. Which element has an atom with the greatest tendency to attract electrons in a chemical bond?

A) carbon **B) chlorine**
C) silicon D) sulfur

61. Which bond is least polar?

A) As–Cl B) Bi–Cl C) P–Cl **D) N–Cl**

62. The bonds in BaO are best described as

A) covalent, because valence electrons are shared
B) covalent, because valence electrons are transferred
C) ionic, because valence electrons are shared
D) ionic, because valence electrons are transferred

63. Which formula represents an ionic compound?

A) H_2 B) CH_4
C) CH_3OH **D) NH_4Cl**

64. A substance that does not conduct electricity as a solid but does conduct electricity when melted is most likely classified as

A) an ionic compound
B) a molecular compound
C) a metal
D) a nonmetal

65. A molecular compound is formed when a chemical reaction occurs between atoms of

A) chlorine and sodium
B) chlorine and yttrium
C) oxygen and hydrogen
D) oxygen and magnesium

66. What is the total number of electron pairs shared between the two atoms in an O_2 molecule?

A) 1 **B) 2** C) 6 D) 4

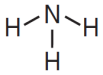
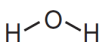
67. Which type of substance is soft, has a low melting point, and is a poor conductor of heat and electricity?

A) network solid **B) molecular solid**
C) metallic solid D) ionic solid

68. A solid substance is an excellent conductor of electricity. The chemical bonds in this substance are most likely

A) ionic, because the valence electrons are shared between atoms
B) ionic, because the valence electrons are mobile
C) metallic, because the valence electrons are stationary
D) metallic, because the valence electrons are mobile

69. Which molecule has a nonpolar covalent bond?

A) H—H
B) 
C) 
D) H—Cl

70. Which formula represents a nonpolar molecule?

A) CH_4 B) HCl C) H_2O D) NH_3

71. Which of the following compounds has the highest boiling point?

A) H_2O B) H_2S C) H_2Se D) H_2Te

72. Given the formula representing a molecule:

$$H - C \equiv C - H$$

The molecule is

A) symmetrical and polar
B) symmetrical and nonpolar
C) asymmetrical and polar
D) asymmetrical and nonpolar

73. Which formula represents a nonpolar molecule?

A) HCl B) H_2O C) NH_3 **D) CH_4**

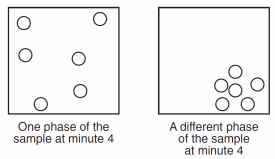
74. Which formula represents a polar molecule?

A) H_2 **B) H_2O** C) CO_2 D) CCL_4

75. Which formulas represent two polar molecules?

A) CO_2 and HCl B) CO_2 and CH_4
C) H_2O and HCl D) H_2O and CH_4

Answer Key
Physical Behavior of Matter and Bonding Review

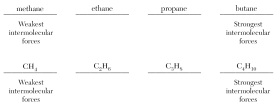
1. 

2. minute 16 or at 16 minutes

3. 90°C ± 2°C

4. – Heat mixture 1 until all the water evaporates. – Allow the water to evaporate.

5. – Mixture 1: homogeneous – Mixture 2: heterogeneous

6. 

7. – fractional distillation – distillation

8. Acceptable responses include, but are not limited to: • ionic and polar covalent • covalent and ionic

9. Acceptable responses include, but are not limited to: • Heat flows from the body to the cold pack from the area of higher temperature to the area of lower temperature.

10. –Molecules of CH_4 are nonpolar, but molecules of HCl and H_2O are both polar. –Hydrogen chloride and water are both polar.

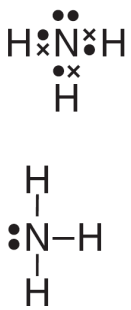
11. 188 K.

12. a line is drawn horizontally to represent the phase change and extending the line with a positive slope to represent the gas phase, only.

13. –The heat necessary to vaporize 200 grams of water is about seven times larger than the heat necessary to melt 200 grams of ice. –It takes more heat to vaporize the same amount of $H_2O(\ell)$

14. q = (200. g)(4.18 J/g•°C)(65°C) *or* (200)(4.18)(65)

15. 66800 J *or* 6.68×10^4 J

16. 

17. – The electronegativity difference is 1.4 for H and O, which is higher than the 0.9 for H and N. – The difference in electronegativity between hydrogen and oxygen is greater than that for hydrogen and nitrogen.

18. – Both atoms in an O2 molecule have achieved a noble gas electron configuration. – An oxygen atom does not have a stable octet of valence electrons.

19. – nonpolar covalent – covalent – double covalent

20. Examples: The molecule has an asymmetrical charge distribution.; The molecule has an unequal distribution of charge.

21. Examples:As the number of shared electrons in a carbon-nitrogen bond increases, the bond energy increases; Less energy is required to break a single carbon-nitrogen bond than to break a triple carbon-nitrogen bond.

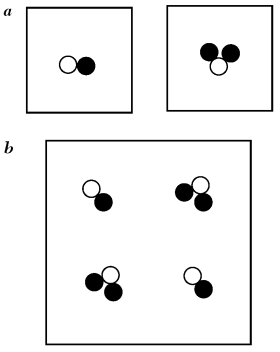
22. Examples: Ne; neon; element 10

23. Examples: The structural formula for methanamine shows electrons being shared, so the bond is covalent; Electrons are shared in the bond; covalent bonding due to shared electrons

24. A P–Cl bond is more polar than a P–S bond because the electronegativity difference for P–Cl is 1.0 and the electronegativity difference for P–S is 0.4.

25. *Examples:* —The total mass of reactants equals the total mass of product. —Mass of reactants equals mass of product.—Mass is conserved.

26. *Examples:* — polar covalent — covalent

27. 

Answer Key

Physical Behavior of Matter and Bonding Review

28. *a.* $Ca^{2+}\ [:\ddot{O}:]^{2-}$

$Ca \rightrightarrows :\ddot{O}:$

$Ca \quad :\overset{\times}{\underset{\times}{O}}:$

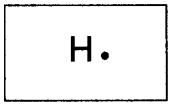
b. $H:\ddot{Br}:$

$H-\ddot{Br}:$

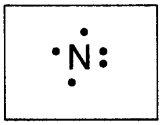
c. $:\ddot{O}=C=\ddot{O}:$

$:\ddot{O}::C::\ddot{O}:$

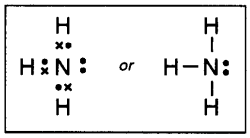
29. *a*



b



c



30. a) Ionic b) When ionic substances dissolve in water the substance breaks down into ions. Ions, being charged particles, can cause a current to flow. c) Ionic substances attract each other strongly because of their opposite charge

31. D
32. B
33. B
34. D
35. B
36. B
37. A
38. C
39. D
40. B
41. A
42. A
43. A
44. A
45. C
46. C
47. A
48. B
49. C
50. B
51. B
52. A
53. B
54. D
55. D
56. D
57. A
58. A
59. A
60. B
61. D
62. D
63. D
64. A
65. C
66. B
67. B
68. D
69. A
70. A
71. A
72. B
73. D
74. B
75. C