

## CHM 101 Sample Exam Questions

1. You are responsible for the information on this page. Please read it carefully.
2. Print and **code** both your name and **10-digit affiliate ID** on the scantron sheet. The affiliate ID is the second sequence of numbers on your University ID card.
3. Use only a #2 pencil.
4. Do all calculations on the exam pages. Do not make any unnecessary marks on the answer sheet.
5. This exam consists of 25 multiple choice questions worth 4 points each and a periodic table. Make sure you have them all.
6. Choose the best answer to each of the questions and answer it on the computer-graded answer sheet. Read all responses before making a selection.
7. When you are finished, turn in your scantron in the stack that corresponds to your version. Your scantron is color-coded in the upper right hand corner. You may keep your exam questions.

Potentially useful information:

1 inch = 2.54 cm  
1 lb = 453.6 g  
1 quart = 0.9464 L  
4 quart = 1 gallon  
32 fluid ounces = 1 quart

$$K = ^\circ C + 273.15$$

Heat energy added	=	Specific heat	×	Mass in grams	×	Change in temperature in C°
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1 cal = 4.184 J  
1000 cal = 1 kcal = 1 Cal

### Solubility Info

All compounds containing any of the following are soluble:

Na<sup>+</sup>, K<sup>+</sup>, NH<sub>4</sub><sup>+</sup>, NO<sub>3</sub><sup>-</sup>

### Activity Series

Li (Most Active)  
K  
Ba  
Ca  
Na  
Mg  
Al  
Zn  
Fe  
Cd  
Ni  
Sn  
Pb  
H  
Cu  
Hg  
Ag  
Au (Least Active)

$$v = \frac{c}{\lambda}$$

$$c = 3.0 \times 10^8 \text{ m/s}$$

$$\frac{P_1 V_1}{n_1 T_1} = \frac{P_2 V_2}{n_2 T_2}$$

$$1 \text{ atm} = 760 \text{ torr} = 760 \text{ mmHg}$$

$$PV = nRT \quad (R = 0.08206 \text{ L} \cdot \text{atm/K} \cdot \text{mol})$$

## Chapter 1

- Which of the following is considered a mixture?  
A.  $\text{Cl}_2$       B.  $\text{CO}_2$       C. Na      D. Copper-zinc alloy      E. Both A and B are mixtures
- Which of the following best describes what happens when water evaporates?  
A. Water molecules undergo a chemical change in which hydrogen and oxygen molecules form.  
B. Water molecules undergo a physical change in which hydrogen and oxygen molecules form.  
C. Water molecules undergo a chemical change in which gaseous water vapor molecules form.  
D. Water molecules undergo a physical change in which gaseous water vapor molecules form.  
E. Water boiling does not involve physical or chemical changes.

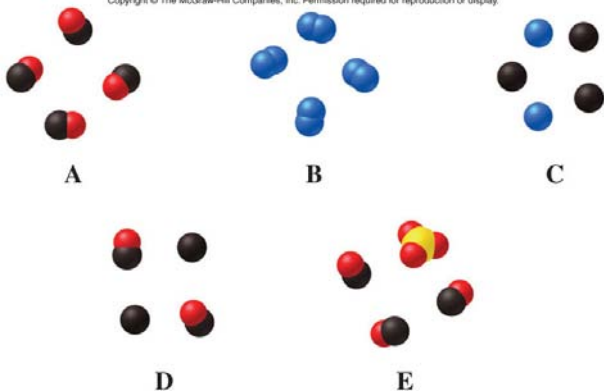
- A pharmaceutical chemist measured the melting point of an unknown compound in four trials. Her data is listed below. Which of the following statements best describes her data?

Melting Point ( $^{\circ}\text{C}$ )
95.29
95.30
95.31
92.99

- Three melting points are accurate and one is not accurate.  
B. Three melting points are precise.  
C. The data is accurate.  
D. All of the data is not accurate.  
E. The average should have only one significant figure.
- Which of the following represents a pure compound?

Problem 1.029

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- If the mass of a dog is 65-lb, what is the mass in units of kilograms? (1 lb = 453 g)  
A. 29,000 kg      D. 0.14 kg  
B. 29 kg      E. 140 kg  
C. 0.290 kg

6. If the diameter of a cell is  $9.0 \times 10^{-6}$  meter, its diameter can also be reported as \_\_\_\_\_.
- A. 9.0 mm
  - B.  $9.0 \mu\text{m}$
  - C. 9.0 nm
  - D. 9.0 pm
  - E. 9.0 km
7. What is the **density** of a cubic solid that is 3.00 cm on each side and has a mass of 25.0 grams?
- A.  $0.926 \text{ g/cm}^3$
  - B.  $1.08 \text{ g/cm}^3$
  - C.  $2.78 \text{ g/cm}^3$
  - D.  $8.33 \text{ g/cm}^3$
  - E.  $27.0 \text{ g/cm}^3$
8. Why is the density of gaseous  $\text{CO}_2$  less than that of solid  $\text{CO}_2$ ?
- A. In the gaseous state, the  $\text{CO}_2$  molecules have a lower mass.
  - B. In the gaseous state, the  $\text{CO}_2$  molecules have a greater mass.
  - C. In the gaseous state, there is more space between the  $\text{CO}_2$  molecules.
  - D. In the gaseous state, there is less space between the  $\text{CO}_2$  molecules.
  - E. In the gaseous state, the  $\text{CO}_2$  molecules are bigger.
9. When 222 seconds is converted to minutes, how should the result be properly reported with the correct number of **significant figures**?
- A. 4 min
  - B. 3.7 min
  - C. 3.70 min
  - D. 3.700 min
  - E.  $3.70 \times 10^{-2}$  min
10. The density of gold is  $19.3 \text{ g/mL}$ . What is the **mass** of 0.0100 L of gold, in units of grams?
- A.  $1.93 \times 10^{-6} \text{ g}$
  - B. 0.193 g
  - C. 1.93 g
  - D. 193 g
  - E.  $1.93 \times 10^4 \text{ g}$
11. Which of the following is the lowest possible temperature?
- A.  $-273.15 \text{ }^\circ\text{C}$
  - B.  $-273.15 \text{ K}$
  - C.  $273.15 \text{ K}$
  - D.  $0 \text{ }^\circ\text{C}$
  - E. There is no lowest possible temperature

12. What happens to the potential energy and kinetic energy of a ball as it rolls down a hill?
- A. Potential energy increases and kinetic energy increases.
  - B. Potential energy increases and kinetic energy decreases.
  - C. Potential energy decreases and kinetic energy increases.
  - D. Potential energy decreases and kinetic energy decreases.
  - E. There is no change at all.

## Chapter 2

13. Based in part on his experiments using a cathode ray tube, Thomson developed the “plum pudding” model for the atom. When Rutherford bombarded a thin metal sheet with alpha particles, most passed through but some were deflected or bounced back. Rutherford’s model of the atom included what atomic structure to explain the deflection of alpha particles?
- A. electron
  - B. neutron
  - C. nucleus
  - D. cathode Ray
  - E. plums
14. Which of the following best describes an electron?
- A. same charge as the neutron
  - B. a positively charged particle
  - C. greater in mass than a proton
  - D. located in the nucleus of an atom
  - E. negatively charged particle
15. An atom with 25 protons and 30 neutrons has which of the following symbols?
- A.  ${}^{25}_5\text{B}$     B.  ${}^{30}_{25}\text{Mn}$     C.  ${}^{55}_{25}\text{Mn}$     D.  ${}^{25}_{30}\text{Zn}$     E.  ${}^{55}_{30}\text{Zn}$
16. Calculate the **relative atomic mass** of Kelsium, a fictional element, if it has two *isotopes* with the following abundance and masses:
- |                    |           |        |
|--------------------|-----------|--------|
| ${}^{10}\text{Ke}$ | 10.01 amu | 20.00% |
| ${}^{12}\text{Ke}$ | 12.02 amu | 80.00% |
- A. 5.81 amu
  - B. 5.21 amu
  - C. 10.41 amu
  - D. 11.00 amu
  - E. 11.62 amu
17. Naturally occurring magnesium is comprised of three isotopes:  ${}^{24}\text{Mg}$ ,  ${}^{25}\text{Mg}$ , and  ${}^{26}\text{Mg}$ . Which of the following statements can be said about their relative abundance? (Refer to the periodic table)
- A.  ${}^{24}\text{Mg}$  is present is the largest percent abundance.
  - B.  ${}^{25}\text{Mg}$  is present is the largest percent abundance.
  - C.  ${}^{26}\text{Mg}$  is present is the largest percent abundance.
  - D. Each has a 33.334% abundance
  - E. Each has a 50.000% abundance

18. How many protons and electrons are in a  $S^{2-}$  anion?
- A. 14 protons, 16 electrons
  - B. 16 protons, 18 electrons
  - C. 16 protons, 14 electrons
  - D. 18 protons, 16 electrons
  - E. 32 protons, 30 electrons
19. Which of the following symbols represents an **oxide ion**?
- A.  $O^-$
  - B.  $O^{2-}$
  - C.  $O^{3-}$
  - D.  $O^+$
  - E.  $O^{2+}$
20. About how much more massive is an average argon atom than an average helium atom?
- A. 2 times
  - B. 9 times
  - C. 10 times
  - D. 40 times
  - E. They have the same mass
21. The element calcium can be classified as a(n) \_\_\_\_\_ .
- A. alkali metal
  - B. transition metal
  - C. main-group element
  - D. actinide
  - E. nonmetal
22. Which of these elements is a noble gas?
- A. lanthium
  - B. oxygen
  - C. hydrogen
  - D. neon
  - E. chlorine
23. Which of the following elements occurs naturally as diatomic molecules?
- A. hydrogen
  - B. nitrogen
  - C. fluorine
  - D. iodine
  - E. All of the above

### **Chapter 3**

24. Which of the following is an ionic compound?
- A.  $CaF_2$
  - B.  $N_2$
  - C.  $CF_4$
  - D.  $H_2O$
  - E. all of these
25. What is the formula for a compound composed of  $Cr^{3+}$  ions and  $S^{2-}$  ions?
- A.  $CrS$
  - B.  $Cr_2S_3$
  - C.  $Cr_3S_2$
  - D.  $CrS_2$
  - E.  $CrS_3$

26. What is the formula for the compound chromium(III) oxide?
- A.  $\text{Cr}_3\text{O}$
  - B.  $\text{Cr}_2\text{O}_3$
  - C.  $\text{CrO}_3$
  - D.  $\text{CrO}$
  - E.  $\text{Cr}_3\text{O}_2$
27. Which of the following is the correct name for the compound with the formula,  $\text{Na}_2\text{SO}_4$ ?
- A. sodium sulfate
  - B. disodium sulfate
  - C. sodium sulfide
  - D. sodium sulfite
  - E. disodium sulfur tetroxide
28. Which of the following acids is named **incorrectly**?
- A.  $\text{HNO}_3$ , nitric acid
  - B.  $\text{HCl}$ , hydrochloric acid
  - C.  $\text{H}_2\text{CO}_3$ , carbonic acid
  - D.  $\text{H}_3\text{PO}_4$ , hydrophosphoric acid
  - E.  $\text{CH}_3\text{CO}_2\text{H}$ , acetic acid
29. Which of the following substances is classified as a molecular compound?
- A.  $\text{CaCO}_3$
  - B.  $\text{AgCl}$
  - C.  $\text{NH}_3$
  - D.  $\text{NO}_3^-$
  - E. none of the above
30. Solutions containing what type(s) of compounds do NOT conduct electricity?
- A. Acids
  - B. Bases
  - C. Molecular compounds
  - D. Ionic compounds
  - E. All of these

#### **Chapter 4**

31. What is the *molar mass* of  $\text{C}_6\text{H}_{12}\text{O}_6$ ?
- A. 29.02 g/mol
  - B. 30.03 g/mol
  - C. 174.12 g/mol
  - D. 180.16 g/mol
  - E. More information is needed

32. What is the **mass** of 1.50 mole of **ammonia**?
- A. 11.35 g
  - B. 0.0881 g
  - C. 25.5 g
  - D. 17.03 g
  - E. 1.50 g
33. When 1.00 mole of  $\text{Na}_2\text{SO}_4$  is dissolved in water, how many  **$\text{Na}^+$  ions** are in the water?
- A.  $\frac{1}{2} \text{Na}^+$  ion
  - B. 1  $\text{Na}^+$  ion
  - C.  $6.02 \times 10^{23} \text{Na}^+$  ions
  - D.  $1.20 \times 10^{24} \text{Na}^+$  ions
  - E.  $3.32 \times 10^{-24} \text{Na}^+$  ions
34. Which of the following contains the **greatest number of moles** of molecules?
- A. 1.0 gram of  $\text{H}_2$
  - B. 1.0 gram of  $\text{O}_2$
  - C. 1.0 gram of  $\text{Cl}_2$
  - D. 1.0 gram of  $\text{CO}_2$
  - E. All contain the same number of moles
35. Which of the following equations best describes the process of dissolving calcium nitrate in water?
- A.  $\text{Ca}(\text{NO}_3)_2(\text{s}) \rightarrow \text{Ca}(\text{l}) + 2\text{NO}_3(\text{l})$
  - B.  $\text{Ca}(\text{NO}_3)_2(\text{s}) \rightarrow \text{Ca}(\text{aq}) + 2\text{N}(\text{aq}) + 3\text{O}(\text{aq})$
  - C.  $\text{Ca}(\text{NO}_3)_2(\text{s}) \rightarrow \text{Ca}^{2+}(\text{aq}) + 2\text{N}^{3-}(\text{aq}) + 3\text{O}_3^{2-}(\text{aq})$
  - D.  $\text{Ca}(\text{NO}_3)_2(\text{s}) \rightarrow \text{Ca}^{2+}(\text{aq}) + (\text{NO}_3^-)_2(\text{aq})$
  - E.  $\text{Ca}(\text{NO}_3)_2(\text{s}) \rightarrow \text{Ca}^{2+}(\text{aq}) + 2\text{NO}_3^-(\text{aq})$
36. Diamond is a form of pure carbon. How many **moles** of carbon are in a 2.0-gram diamond?
- A. 24 mol
  - B. 12 mol
  - C. 0.50 mol
  - D. 0.083 mol
  - E. 0.17 mol
37. What is the *mass percentage* of **iron** in  $\text{Fe}_2\text{O}_3$ ?
- A. 69.94%
  - B. 66.67%
  - C. 34.97%
  - D. 77.73%
  - E. 40.00%

38. Which of the following is NOT an *empirical formula*?
- A.  $C_3H_9O_3$
  - B.  $C_5H_9N_3$
  - C.  $C_5H_{12}$
  - D.  $CH_4$
  - E.  $CH$
39. Analysis of a compound showed that it contained 21.9% sulfur and 78.1% fluorine by mass. What is the *empirical formula* for the compound?
- A.  $SF_4$
  - B.  $S_2F_7$
  - C.  $SF_6$
  - D.  $S_2F_3$
  - E.  $SF_2$
40. How many moles of HCl are in 35.0 mL of a 0.100 M HCl solution?
- A. 3.50 mol
  - B. 0.350 mol
  - C. 2.86 mol
  - D.  $2.86 \times 10^{-3}$  mol
  - E.  $3.50 \times 10^{-3}$  mol
41. What is the percent by mass concentration of KCl in a solution prepared by adding 25.0 g KCl to 125.0 g of water?
- A. 0.200%      B. 20.0%      C. 0.167%      D. 16.7%      E. 5.00%
42. A solution is prepared by adding enough water to 1.0 mL of a 2.0 M solution so that the total volume is 10.0 mL. What is the concentration of the diluted solution?
- A. 2.0 M
  - B. 1.0 M
  - C. 0.20 M
  - D. 10 M
  - E. 0.22 M

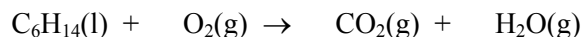
## **Chapter 5**

43. When aqueous solutions of  $H_2SO_4$  and NaOH are mixed, \_\_\_\_\_ will occur.
- A. a combination reaction
  - B. a decomposition reaction
  - C. a single-displacement reaction
  - D. a double-displacement reaction
  - E. no reaction

44. Identify the spectator ions in the following reaction:  $\text{Zn(s)} + 2\text{HNO}_3(\text{aq}) \rightarrow \text{Zn(NO}_3)_2(\text{aq}) + \text{H}_2(\text{g})$

- A.  $\text{Zn}^{2+}$  and  $\text{NO}_3^-$
- B.  $\text{H}^+$  and  $\text{NO}_3^-$
- C.  $\text{NO}_3^-$  only
- D.  $\text{Zn}^{2+}$  only
- E. There are no spectator ions

45. When the equation below is balanced properly, what is the *coefficient* in front of  $\text{O}_2(\text{g})$ ?



- A. 6
- B. 7
- C. 9
- D. 12
- E. 19

46. When aqueous solutions of hydrochloric acid and sodium carbonate are mixed,

- A.  $\text{H}_2$  gas is formed.
- B.  $\text{CO}_2$  gas is produced.
- C. sodium metal is formed.
- D. a precipitate is formed.
- E. no reaction occurs.

47. Which of the metals (Al, Ca, Mg) will react in an aqueous solution of  $\text{KNO}_3$  to produce potassium metal?

- A. Mg
- B. Ca
- C. Al
- D. All of these
- E. None of these

48. When aqueous solutions of  $\text{AgNO}_3$  and  $\text{MgCl}_2$  are mixed, what is the *correct formula* for the **precipitate** that forms?

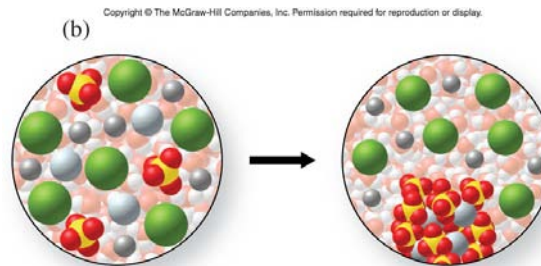
- A.  $\text{K}_2\text{Ag}$
- B.  $\text{AgCl}$
- C.  $\text{AgCl}_2$
- D.  $\text{MgNO}_3$
- E.  $\text{Mg(NO}_3)_2$

49. Which of the following equations best describes the reaction that occurs when potassium metal reacts with oxygen gas in a combination reaction?

- A.  $\text{K(s)} + \text{O(g)} \rightarrow \text{KO(s)}$
- B.  $\text{K(s)} + \text{O}_2(\text{g}) \rightarrow \text{KO}_2(\text{s)}$
- C.  $4\text{K(s)} + \text{O}_2(\text{g}) \rightarrow 2\text{K}_2\text{O(s)}$
- D.  $2\text{K(s)} + \text{O(g)} \rightarrow \text{K}_2\text{O(s)}$
- E.  $\text{K(s)} + \text{O}_2(\text{g}) \rightarrow \text{KO(s)} + \text{O(g)}$

50. Which of the following classifications describes the molecular-level representation?

- A. decomposition
- B. combination
- C. single-displacement
- D. double-displacement
- E. combustion

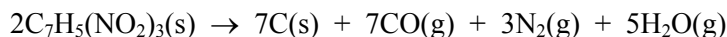


## Chapter 6

51. In any chemical reaction, which of the following is NOT always *conserved*?

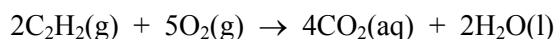
- A. Number of atoms.
- B. Mass
- C. Moles of atoms
- D. Number of molecules

52. The balanced equation for the decomposition of TNT is given. If 4.6 mole of TNT reacts, what is the theoretical yield of  $N_2$  in moles?



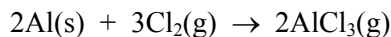
- A. 0.57 mol
- B. 6.9 mol
- C. 14 mol
- D. 3.1 mol
- E. 0.85 mol

53. The balanced equation for the combustion of acetylene,  $C_2H_2$ , is given. If 12 molecules of  $C_2H_2$  reacts, how many molecules of  $O_2$  should react with it?



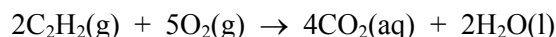
- A. 5
- B. 10
- C. 60
- D. 30
- E. 12

54. What **mass of  $Cl_2$**  will react with 5.00 grams of Al by the reaction represented by the following balanced equation?



- A. 1.27 grams  $Cl_2$
- B. 7.5 grams  $Cl_2$
- C. 13.1 grams  $Cl_2$
- D. 19.7 grams  $Cl_2$
- E. 8.76 grams  $Cl_2$

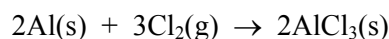
55. When 2.4 mol C<sub>2</sub>H<sub>2</sub> is mixed with 5.0 mol O<sub>2</sub>, the following reaction occurs:



Which of the following best describes this particular reaction?

- A. C<sub>2</sub>H<sub>2</sub> is the limiting reactant and should be used up completely.
- B. O<sub>2</sub> is the limiting reactant and should be used up completely.
- C. C<sub>2</sub>H<sub>2</sub> is the limiting reactant and some should be leftover after the reaction is complete.
- D. O<sub>2</sub> is the limiting reactant and some should be leftover after the reaction is complete.
- E. Both reactants will be used up completely.

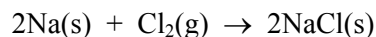
56. When 0.40 mol Al is mixed with 0.80 mol Cl<sub>2</sub>, the following reaction occurs:



Which of the following best describes what remains after the reaction is complete?

- A. 0.40 mol Cl<sub>2</sub> and 0.40 mol AlCl<sub>3</sub>
- B. 0.20 mol Cl<sub>2</sub> and 0.40 mol AlCl<sub>3</sub>
- C. 0.13 mol Al and 0.53 mol AlCl<sub>3</sub>
- D. 0.20 mol Al and 0.20 mol AlCl<sub>3</sub>
- E. 0.60 mol Cl<sub>2</sub> and 0.20 mol AlCl<sub>3</sub>

57. How many moles of NaCl should be produced when 0.50 mol Na is added to 0.50 mol Cl<sub>2</sub>? The balanced equation for the reaction is:



- A. 0.50 mol NaCl
- B. 0.25 mol NaCl
- C. 0.75 mol NaCl
- D. 1.00 mol NaCl
- E. 1.50 mol NaCl

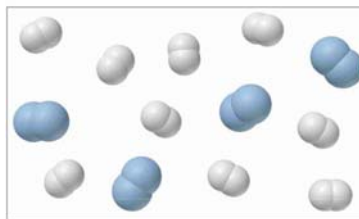
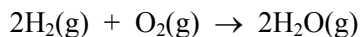
58. A 5.00-gram sample of mercury(II) oxide is decomposed completely to mercury metal and oxygen gas. What is the total mass of the products?

- A. 3.33 g
- B. 1.67 g
- C. 5.39 g
- D. 4.63 g
- E. 5.00 g

59. A student calculated that 20.0 g of product should be obtained in a reaction. However, after doing the reaction, the student obtained only a 65.0% yield. What mass of product did the student actually recover?

- A. 13.0 g
- B. 6.50 g
- C. 65.0 g
- D. 30.8 g
- E. 35.0 g

60. The diagram below shows a mixture of  $O_2$  (larger and darker molecules) and  $H_2$  just at an instantaneous moment just before reaction. Assuming that the reaction goes to completion by the equation shown below, which of the following statements best describes the resulting mixture?



- A.  $H_2$  is the limiting reactant and one  $O_2$  molecule will be leftover.
- B.  $O_2$  is the limiting reactant and one  $H_2$  molecule will be leftover.
- C.  $H_2$  is the limiting reactant and five  $H_2$  molecules will be leftover.
- D.  $O_2$  is the limiting reactant and five  $O_2$  molecules will be leftover.
- E. There is no limiting reactant and no reactant molecules will be left over amounts.

## Chapter 7

61. The wavelength of light that has a frequency of  $1.2 \times 10^{13} \text{ s}^{-1}$  is \_\_\_\_\_ m.

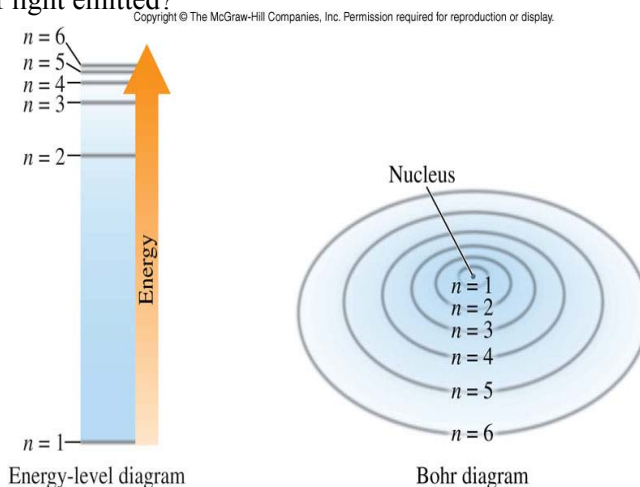
- A. 25
- B.  $2.5 \times 10^{21}$
- C. 0.0400
- D. 12.0
- E.  $2.5 \times 10^{-5}$

62. Which of the following is composed of the **highest frequency** light?

- A. Green light
- B. Violet light
- C. Orange light
- D. Yellow light
- E. Red light

63. Which of the following electron transitions in the H atom will result in the longest wavelength of light emitted?

- A.  $n = 6$  to  $n = 2$
- B.  $n = 6$  to  $n = 3$
- C.  $n = 6$  to  $n = 4$
- D.  $n = 6$  to  $n = 5$
- E.  $n = 5$  to  $n = 6$



Questions

64. Which of the following is NOT a type of **electromagnetic radiation**?
- A. X-Rays
  - B. gamma rays
  - C. visible light
  - D. infrared radiation
  - E. sound waves
65. Which of the following best describes a ***p* orbital**?
- A. spherical
  - B. an orbit
  - C. two lobes, 2-dimensional
  - D. two lobes, 3-dimensional
  - E. four lobes, 3-dimensional
66. Which type(s) of **orbitals** are allowed in the  $n = 2$  principle energy level?
- A. *s* orbitals only
  - B. *s* and *p* orbitals only
  - C. *p* orbitals only
  - D. *s*, *p*, and *d* orbitals only
  - E. *s*, *p*, *d* and *f* orbitals only
67. How many **orbitals** are in the  $4d$  sublevel?
- A. 2                      B. 4                      C. 5                      D. 8                      E. 10
68. How many **unpaired** electrons are in the ground state electron configuration of a nitrogen atom?
- A. 1                      B. 2                      C. 3                      D. 5                      E. 6
69. Which of the following is the **abbreviated electron configuration** for a titanium atom, Ti?
- A.  $[\text{Ar}] 3d^2$
  - B.  $[\text{Ar}] 4s^2 3d^2$
  - C.  $[\text{Ar}] 4d^2$
  - D.  $[\text{Ar}] 4s^2 4d^2$
  - E.  $[\text{Ar}] 4s^2 3d^4$
70. Which of the following has the electron configuration,  $1s^2 2s^2 2p^6 3s^2 3p^6$ ?
- A.  $\text{S}^{2-}$
  - B.  $\text{Cl}^-$
  - C. Ar
  - D.  $\text{K}^+$
  - E. All of the above

71. A lead atom has \_\_\_\_ **valence electrons**.
- A. 28      B. 2              C. 4              D. 14              E. 84
72. Which of the following atoms has the largest **radius**?
- A. Li              B. C              C. O              D. F              E. Ne
73. Which of the following atoms has the largest **first ionization energy,  $I_1$** ?
- A. Li  
B. Be  
C. B  
D. C  
E. N
74. Why is the second ionization energy for potassium significantly greater than its first ionization energy?
- A. The second electron is a nonvalence (core) electron, therefore easier to remove.  
B. The second electron is a nonvalence (core) electron, and therefore harder to remove.  
C. The second proton is held more tightly, and therefore harder to remove.  
D. The second proton is held more tightly, and easier to remove.  
E. Formation of an anion requires more energy
75. Which of the following has the largest radius?
- A.  $S^{2-}$   
B.  $Cl^-$   
C. Ar  
D.  $K^+$   
E. All have the equal radii.

## **Chapter 8**

76. Which of the following substances has both **ionic** and **covalent bonding**?
- A. NaCl  
B.  $Cl_2$   
C. MgO  
D.  $MgCO_3$   
E. Ne
77. Which of the following elements is the most **electronegative**?
- A. H  
B. Li  
C. N  
D. O  
E. S

78. In which of the following molecules does **oxygen** have a **partial positive charge ( $\delta^+$ )**?

- A.  $O_2$
- B.  $OF_2$
- C.  $H_2O$
- D.  $MgO$
- E. None of the above

79. Which of the following contains a **triple bond**?

- A.  $C_2H_6$
- B.  $HCN$
- C.  $NO_3^-$
- D.  $NH_3$
- E.  $O_2$

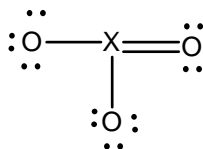
80. Which of the following is best represented by **two equivalent resonance structures**?

- A.  $CO_2$
- B.  $NO_2^-$
- C.  $NO_3^-$
- D.  $N_2$
- E. None of these

81. In which of the following does the central atom disobey the **octet rule**?

- A.  $BH_3$
- B.  $NH_3$
- C.  $PH_3$
- D.  $H_2S$
- E. None of the these

82. An unknown molecular compound has the following Lewis structure. Which of the following elements could be the identity of **X**?



- A. Si
- B. P
- C. S
- D. Cl
- E. Ne

83. Which of the following has bond angles closest to  $120^\circ$ ?

- A.  $CO_2$
- B.  $H_2O$
- C.  $SO_2$
- D.  $CH_4$
- E.  $NH_3$

84. Draw the Lewis structure for  $H_2S$  and determine its approximate **bond angles** and **molecular shape**.

- A. 90 degrees, tetrahedral
- B. 120 degrees, linear
- C. 120 degrees, bent
- D. 109.5 degrees, trigonal planar
- E. 109.5 degrees, bent

85. Which of the following molecules is a **nonpolar molecule** with **polar bonds**?

- A.  $\text{NF}_3$
- B.  $\text{CH}_2\text{Cl}_2$
- C.  $\text{CF}_4$
- D.  $\text{O}_3$
- E.  $\text{CO}$

### Chapter 9

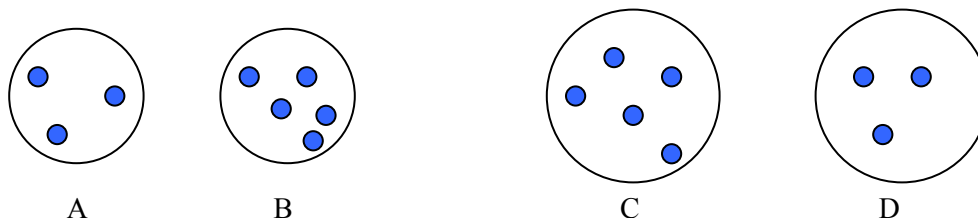
86. Which of the following best explains what happens to a balloon that rises to a higher altitude at constant temperature? (Note: Atmospheric pressure decreases as altitude increases)

- A. The volume of the balloon increases because the pressure inside and outside the balloon decreases.
- B. The volume of the balloon increases because the number of gas molecules in the balloon increases.
- C. The volume of the balloon decreases because the pressure inside and outside the balloon decreases.
- D. The volume of the balloon decreases because the number of gas molecules in the balloon decreases.
- E. The volume of the balloon will remain constant because temperature is held constant.

87. Which of the following should be most soluble in benzene,  $\text{C}_6\text{H}_6$ ?

- A.  $\text{CH}_3\text{OH}$       B.  $\text{H}_2\text{O}$       C.  $\text{Br}_2$       D.  $\text{H}_2\text{C}=\text{O}$       E.  $\text{CH}_3\text{-O-CH}_3$

88. Consider the following diagrams representing the same gas under different conditions of temperature and pressure. Which has the lowest density?



- A. A
- B. B
- C. C
- D. D
- E. Both B and C

89. A 2.00-L sample of gas at 1.00 atm pressure is cooled from  $30.00^\circ\text{C}$  to  $-100.00^\circ\text{C}$  in an elastic container such as a balloon. What is the **final volume** of the gas? Because the container is elastic, the pressure remains constant.

- A. 3.50 L
- B. 6.67 L
- C. 1.14 L
- D.  $-6.67$  L
- E. 0.030 L

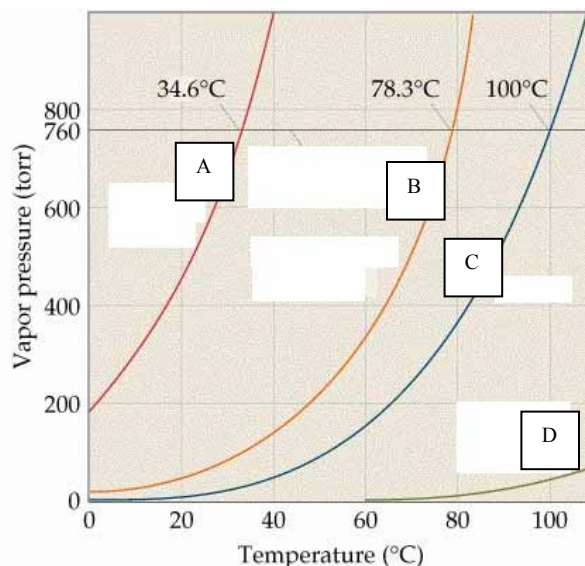
90. Which of the following occurs when an ideal gas sample is **increased in temperature**? (volume and moles are held constant.)
- A. Pressure increases
  - B. Average kinetic energy increases
  - C. Average molecular speed increases
  - D. All of the above
  - E. None of the above
91. What is the mass of argon (Ar) gas in a 20.0-liter container given that the pressure in the container is 815 mmHg and the temperature is 298 K?
- A. 35.0 g
  - B. 667 g
  - C. 45.6 g
  - D. 40.0
  - E. 0.0247 g
92. A mixture of gases contains helium, neon, nitrogen, and carbon dioxide at 298 K. Which gas has the greatest average velocity?
- A. N<sub>2</sub>
  - B. CO<sub>2</sub>
  - C. He
  - D. Ne
  - E. All have the same average velocity.

### **Chapter 10**

93. In which of the following liquids is **London-dispersion forces** present?
- A. CH<sub>3</sub>OH
  - B. CH<sub>3</sub>NH<sub>2</sub>
  - C. H<sub>2</sub>O
  - D. CCl<sub>4</sub>
  - E. All of the above
94. Which of the following liquids is expected to have the **highest boiling point**? (Note types of intermolecular forces in each substance.)
- A. CH<sub>4</sub>
  - B. CH<sub>3</sub>OH
  - C. CH<sub>3</sub>Cl
  - D. CH<sub>3</sub>CH<sub>3</sub>
  - E. CH<sub>3</sub>CH<sub>2</sub>CH<sub>3</sub>

95. The graph below shows the vapor pressure of each liquid as a function of temperature. Which liquid has the **strongest** intermolecular forces?

- A. A
- B. B
- C. C
- D. D



### Chapter 11

96. Many ionic compounds dissolve in water because

- A. there are attractive forces between ions and water molecules
- B. there are no attractive forces between ions and water molecules.
- C. the entropy of the solution is greater than the entropy of pure NaCl and pure H<sub>2</sub>O.
- D. the entropy of the solution is less than the entropy of pure NaCl and pure H<sub>2</sub>O.
- E. Both A and C

97. Which of the following increases the **solubility** of a gas in solution?

- A. Increasing gas pressure and increasing temperature
- B. Increasing gas pressure and decreasing temperature
- C. Decreasing gas pressure and increasing temperature
- D. Decreasing gas pressure and decreasing temperature
- E. Adding more water

98. If the solubility of a solid substance is 18.2 g/100 g water, which of the following best describes what is eventually formed after 10.0 grams of the substance is mixed with 50.0 grams of water?

- A. Saturated solution with some undissolved solid
- B. Unsaturated solution with some undissolved solid
- C. Saturated solution with no undissolved solid
- D. Unsaturated solution with no undissolved solid
- E. Supersaturated solution

99. What **volume** of a 0.500 M HCl solution contains 2.00 mol HCl?

- A. 1.00 L
- B. 2.00 L
- C. 4.00 L
- D. 0.250 L
- E. None of these

## Chapter 12

100. Consider the following system at equilibrium:  $\text{FeO}(s) + \text{H}_2(g) \rightleftharpoons \text{Fe}(s) + \text{H}_2\text{O}(g)$

Given that the reaction in the forward direction is endothermic, which of the following will cause an increase in the moles of iron metal at equilibrium?

- A. Removing  $\text{H}_2\text{O}$  vapor
- B. Removing Fe solid
- C. Removing  $\text{H}_2$  gas
- D. Decreasing the reaction temperature
- E. None of these

101. Which of the following is always true when a system is in a state of equilibrium?

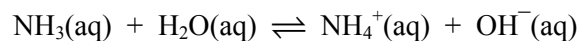
- A. The moles of reactants is equal to the moles of products.
- B. The mass of reactants is equal to the mass of products.
- C. The rate of the forward process is equal to the rate of the reverse process.
- D. The forward process and the reverse process both stop (rates of both are zero).
- E. The pH is equal to 7.

## Chapter 13

102. Which of the following is the conjugate acid of  $\text{HSO}_4^-$ ?

- A.  $\text{H}_2\text{SO}_4$
- B.  $\text{SO}_4^{2-}$
- C.  $\text{H}_2\text{SO}_4^-$
- D.  $\text{H}_3\text{O}^+$
- E.  $\text{HSO}_3^-$

103. Identify the acid reactant in the following reaction.



- A.  $\text{NH}_3(\text{aq})$
- B.  $\text{H}_2\text{O}(\text{l})$
- C.  $\text{NH}_4^+(\text{aq})$
- D.  $\text{OH}^-(\text{aq})$
- E.  $\text{H}_3\text{O}^+(\text{aq})$

104. Which one of the following is an **acid that will ionize completely** when dissolved in water?
- A. NaOH
  - B. HBr
  - C. HF
  - D. NaCl
  - E. NH<sub>3</sub>
105. Which of the following is considered a *basic* solution?
- A. A solution with a pH of 5
  - B. A 0.10 *M* solution of HCl
  - C. A solution with  $[\text{H}_3\text{O}^+] = 1.0 \times 10^{-4} \text{ M}$
  - D. A solution with  $[\text{H}_3\text{O}^+] = 1.0 \times 10^{-7} \text{ M}$
  - E. A solution with  $[\text{H}_3\text{O}^+] = 1.0 \times 10^{-10} \text{ M}$
106. What is the pH of a 0.010 *M* NaOH solution?
- A. 1.00            B. 2.00            C. 7.00            D. 12.00            E. 13.00
107. When extra water is added to 10.0 mL of an unknown solution, the pH increases by 1.00 pH unit. Does the solution contain an acid or a base, and how much water was added to the solution?
- A. Acid; 10.0 mL water added
  - B. Acid; 90.0 mL water added
  - C. Base; 10.0 mL water added
  - D. Base; 90.0 mL water added

Answer Key

1. D	27. A	53. D	79. B
2. D	28. D	54. D	80. B
3. B	29. C	55. B	81. A
4. A	30. C	56. B	82. C
5. B	31. D	57. A	83. C
6. B	32. C	58. E	84. E
7. A	33. D	59. A	85. C
8. C	34. A	60. B	86. A
9. C	35. E	61. E	87. C
10. D	36. E	62. B	88. D
11. A	37. A	63. D	89. C
12. C	38. A	64. E	90. D
13. C	39. C	65. D	91. A
14. E	40. E	66. B	92. C
15. C	41. D	67. C	93. E
16. E	42. C	68. C	94. B
17. A	43. D	69. B	95. D
18. B	44. C	70. E	96. E
19. B	45. E	71. C	97. B
20. C	46. B	72. A	98. A
21. C	47. E	73. E	99. C
22. D	48. B	74. B	100. A
23. E	49. C	75. A	101. C
24. A	50. D	76. D	102. A
25. B	51. D	77. D	103. B
26. B	52. B	78. B	104. B
			105. E
			106. D
			107. B