Test of Academic Skills (TEAS)

Chemistry Topics Review

Dr. Ben Tovrog
<table>
<thead>
<tr>
<th>Period</th>
<th>Main-Group Elements</th>
<th>Transition Elements</th>
<th>Inner Transition Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1H (1) 1.008</td>
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<tr>
<td>2</td>
<td>3Li (3) 6.941</td>
<td>4Be (4) 9.012</td>
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<td>3</td>
<td>11Na (11) 22.99</td>
<td>12Mg (12) 24.31</td>
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<td>19K (19) 39.10</td>
<td>20Ca (20) 40.08</td>
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<td>5</td>
<td>37Rb (37) 85.47</td>
<td>38Sr (38) 87.62</td>
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<td>6</td>
<td>55Cs (55) 132.9</td>
<td>56Ba (56) 137.3</td>
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<td>7</td>
<td>87Fr (87) 223</td>
<td>88Ra (88) 226</td>
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**Notes:**
- **Main-Group Elements:** Metals (main-group), Metals (transition), Metals (inner transition), Metalloids, Nonmetals
- **Transition Elements:**
- **Inner Transition Elements:**
- **Lanthanides:**
- **Actinides:**
- **Metals (main-group):**
- **Metals (transition):**
- **Metals (inner transition):**
- **Nonmetals:**
Unit Conversion: 1151 Chap. 1

1. Is a 5 km run or a 5 mile run longer?

2. How many inches are in 12.75 centimeters?

3. How many milligrams are in 5 grams.

4. If 1 kilogram is approximately 2.2 pounds, how many pounds are there in 6 kilograms.

5. 3 pounds = _____ ounces

6. 20 cups = _____ quarts.
Unit Conversion: 1151 Chap. 1

1. Is a 5 km run or a 5 mile run longer? 5 miles is longer
   \[5 \text{ km} \times (0.621 \text{ mile/km}) = 3.11 \text{ mile}.\]

2. How many inches are in 12.75 centimeters?
   \[12.75 \text{ cm} \times (1 \text{ in} / 2.54 \text{ cm}) = 5.02 \text{ in}.\]

3. How many milligrams are in 5 grams.
   \[5 \text{ g} \times (1000 \text{ mg} / \text{ g}) = 5000 \text{ mg}\]

4. If 1 kilogram is approximately 2.2 pounds, how many pounds are there in 6 kilograms.
   \[6 \text{ kg} \times (2.2 \text{ pound} / \text{ kg}) = 13.2 \text{ pounds}\]

5. 3 pounds = 48 ounces (3 pounds * 16 ounce/pound = 48 ounces)

6. 20 cups = 5 quarts. (20 cups * 1 quart / 4 cups) = 5 quart
For a given substance, the gas phase (compared to the liquid phase) is considered to have _______ intermolecular interactions and to exist at _________ temperatures.

a) weaker, higher        b) weaker, lower

b) stronger, higher        d) stronger, lower
For a given substance, the gas phase (compared to the liquid phase) is considered to have \textit{weaker} intermolecular interactions and to exist at \textit{higher} temperatures.

\begin{itemize}
  \item[a)] weaker, higher
  \item[b)] weaker, lower
  \item[c)] stronger, higher
  \item[d)] stronger, lower
\end{itemize}
Suppose a phase transition occurs between a liquid and gas at -196 °C. What is the Kelvin temperature?

Identify whether the following statements are TRUE or FALSE.
A certain amount of a substance is in a solid state but it is then melted to form a liquid, and finally vaporized to form a gas. The solid has a volume of 1.0 cubic centimeter, the liquid occupies 0.75 cubic centimeters, and the gas expanded to 10.0 cubic meters.

1. The liquid is more dense than the gas.
2. The liquid is less dense than the solid.
3. The solid is more dense than the gas.
4. The liquid has the highest density of the three forms.
Suppose a phase transition occurs between a liquid and gas at -196 °C. What is the Kelvin temperature? Degree K = Degree Celsius + 273. For this case, Degree K = -196 + 273 = 77 K

Identify whether the following statements are TRUE or FALSE.

A certain amount of a substance is in a solid state but it is then melted to form a liquid, and finally vaporized to form a gas. The solid has a volume of 1.0 cubic centimeter, the liquid occupies 0.75 cubic centimeters, and the gas expanded to 10.0 cubic meters.

1. The liquid is more dense than the gas. **True**
2. The liquid is less dense than the solid. **False** (Density = mass/volume). The mass stays the same and the volume decreased, so density increased for the liquid relative to the solid.
3. The solid is more dense than the gas. **True**
4. The liquid has the highest density of the three forms. **True**
Evaporation, Vaporization, Condensation. 1151 Chap. 2

Complete the sentence below.
The heat of vaporization (latent heat) refers to the energy necessary (at constant temperature) to _______________________

Suppose a substance A has a mass of M grams and a latent heat of L cal/g. If substance B has a mass three times that of substance A and a latent heat 1/6 of that of substance A, what will be the ratio of the heat of vaporization of A compared to B?
Complete the sentence below.
The heat of vaporization (latent heat) refers to the energy necessary (at constant temperature) to cause a complete phase change from a liquid to a vapor.

Suppose a substance A has a mass of $M$ grams and a latent heat of $L$ cal/g. If substance B has a mass three times that of substance A and a latent heat $1/6$ of that of substance A, what will be the ratio of the heat of vaporization of A compared to B?

Heat = mass x HV.
Mass B = 3*Mass(A).
HV(B) = 1/6 HV(A)
Heat (A) = Mass(A)*HV(A).
Heat (B) = Mass(B) *HV(B) = 3*Mass(A)* 1/6HV(A).
Heat (B) = 0.5 * Heat(A)
Heat (A) = 2 times Heat (B)
1. Describe the construction of the atom. Referring to the periodic table, what is the atomic number of iron?

1. What is the atomic mass of iron?

2. How many protons does iron have?

3. How many neutrons does iron have?
1. Describe the construction of the atom.
The atom is made up of three main subatomic particles, neutrons, protons and electrons. Neutrons and protons are in the nucleus, and electrons are located in orbitals a distance from the nucleus which have different shapes and energies.

Referring to the periodic table, what is the atomic number of iron? Atomic number = 26. (also the number of protons).

1. What is the atomic mass of iron? The value in the periodic table is 55.845 amu (atomic mass units).

2. How many protons does iron have? 26

3. How many neutrons does iron have? The main isotope of iron has mass number 60. Neutrons = mass number – protons = 60-26 = 34.
1. How many protons would a positively charged isotope ion of O-18 have?

2. How many protons would a negatively charged isotope ion of C-14 have?

3. Consider an atom that has 8 protons, 9 neutrons, and 7 electrons. This atom will have an overall charge of ____ and overall mass of ____ AMU.

   a) -1, 17  b) -1, 15  c) +1, 15  d) +1, 17
1. How many protons would a positively charged isotope ion of O-18 have? Oxygen has atomic number 8, which means 8 protons. The charge on the ion does not affect the number of protons. (The charge on an ion results from changes in the number of electrons)

2. How many protons would a negatively charged isotope ion of C-14 have? Carbon has atomic number 6, which means 6 protons. The charge on an ion does not affect the number of protons.

3. Consider an atom that has 8 protons, 9 neutrons, and 7 electrons. This atom will have an overall charge of +1 and overall mass of 17 AMU.

   a) -1, 17      b) -1, 15      c) +1, 15      d) +1, 17
1. A proton should have which of the following characteristics when compared to the charge and mass of an electron
   a) Same mass, same charge    b) same charge, larger mass,
   c) opposite charge, same mass    d) opposite charge, larger mass

2. The electron configuration for a certain neutral atom is
   \[1s^22s^22p^63s^23p^64s^2\]. This atom also has a mass number of 42. Which of the following is correct?
   a) 20 protons, 22 neutrons, b) 20 protons 42 neutrons,
   c) 22 protons, 22 neutrons, b) 22 protons 42 neutrons,
1. A proton should have which of the following characteristics when compared to the charge and mass of an electron
   a) Same mass, same charge    b) same charge, larger mass,
   c) opposite charge, same mass    d) opposite charge, larger mass

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   a) 20 protons, 22 neutrons, b) 20 protons 42 neutrons,
   c) 22 protons, 22 neutrons, b) 22 protons 42 neutrons,
1. Complete the following sentence:

Within a given family (group) in the periodic table, moving from top to bottom, atomic radii _________ while electronegativity _________.

2. Which groups on the periodic table contain the most metalloids?

3. A student has two material samples. One is a metal (A) and the other is a nonmetal (B). The student is trying to determine which one is the metal. Which of the following could the student observe”? (Select all that apply)

   a. Sample A cools rapidly when refrigerated, but sample B does not.
   b. Sample B heats very slowly when heat is applied, but sample A heats very quickly.
1. Complete the following sentence:

Within a given family (group) in the periodic table, moving from top to bottom, **atomic radii increases** while **electronegativity decreases**.

2. Which groups on the periodic table contain the most metalloids? (3A, 4A, 5A, 6A. Shown also as group 13, 14, 15, 16.

3. A student has two material samples. One is a metal (A) and the other is a nonmetal (B). The student is trying to determine which one is the metal. Which of the following could the student observe”? (Select all that apply)

   a. Sample A cools rapidly when refrigerated, but sample B does not.
   c. Sample B heats very slowly when heat is applied, but sample A heats very quickly.

   **Metals have low values of specific heat. This means they cool and heat quickly. Nonmetals cool and heat slowly. Answers a, and b apply.**
1. When examining electronegativity values, which of the following atoms will form the least polar bond with hydrogen?
   a) H   b) F   c) Cl   d) Br

2. Which of the following elements is the best electrical conductor?
   a) Br   b) As   c) C   d) K
1. When examining electronegativity values, which of the following atoms will form the least polar bond with hydrogen?
   a) H    b) F    c) Cl    d) Br

2. Which of the following elements is the best electrical conductor?
   a) Br    b) As    c) C    d) K
1. Why does hydrogen gas exist as \( \text{H}_2 \) and never just as \( \text{H} \)?

2. Regarding the Lewis structure for sulfur (S), how many unshared pairs of electrons will sulfur have in neutral covalent compounds.
1. Why does hydrogen gas exist as H\textsubscript{2} and never just as H?

A Stable H atom will contain 2 electrons to fill its 1s orbital. Joining 2 H atoms with a single bond satisfies that need.

1. Regarding the Lewis structure for sulfur (S), how many unshared pairs of electrons will sulfur have in neutral covalent compounds.

Neutral sulfur atoms in dot structures will have two lone pairs of electrons and two bonds to other atoms. (Such as H\textsubscript{2}S, SCl\textsubscript{2})
1. What type of reaction is the following? Balance the reaction.

\[ \text{Ca(OH)}_2 + \text{HCl} \rightarrow \text{H}_2\text{O} + \text{CaCl}_2 \]

Identify whether the following statements are TRUE or FALSE.

2. pH neutralization is an important oxidation-reduction reaction.

3. Metabolism is an important oxidation reduction reaction.

4. Combustion is an important acid-base reaction.

5. Photosynthesis is an important acid-base reaction.
1. What type of reaction is the following? Balance the reaction.
Acid-base reaction

\[ \text{Ca(OH)}_2 + 2 \text{HCl} \rightarrow 2 \text{H}_2\text{O} + \text{CaCl}_2 \]

Identify whether the following statements are TRUE or FALSE.

2. pH neutralization is an important oxidation-reduction reaction.
False, it is an acid base reaction

2. Metabolism is an important oxidation reduction reaction. True

3. Combustion is an important acid-base reaction.
False – It is an oxidation-reduction reaction.

2. Photosynthesis is an important acid-base reaction.
False – It is an important oxidation-reduction reaction.
Identify whether the following statements are TRUE or FALSE.

1. Water serves as the standard for pH and has a value of 6.

2. Water has the standard electronegative value on the periodic table.

3. Water undergoes relatively minor temperature and phase changes compared to other substances due to its:
   a) Low specific heat and low heat of vaporization
   b) Low specific heat and high heat of vaporization
   a) High specific heat and low heat of vaporization
   a) High specific heat and high heat of vaporization

Water’s ___ bonding results in a ________ ratio of hydrogen to oxygen
a) ionic, 1:2    b) ionic 2:1    c) covalent 1:2    d) covalent 2:1
Properties of Water 1151 Chap. 8,10.

Identify whether the following statements are TRUE or FALSE.

1. Water serves as the standard for pH and has a value of 6. **FALSE**
   Water is the standard solvent for pH and has a value of 7.0.

2. Water has the standard electronegative value on the periodic table. **FALSE**. Electronegativity values are given for elements, not compounds. Water is a compound so doesn’t have an electronegativity value.

3. Water undergoes relatively minor temperature and phase changes compared to other substances due to its:
   a) Low specific heat and low heat of vaporization
   b) Low specific heat and high heat of vaporization
   a) High specific heat and low heat of vaporization
   a) **High specific heat and high heat of vaporization**

Water’s **covalent** bonding results in a **2:1** ratio of hydrogen to oxygen
a) ionic, 1:2  b) ionic 2:1  c) covalent 1:2  d) **covalent 2:1**
1. Given reactants X and Y, a catalyst C and product Z, order the following steps in the general catalytic reaction process.

\[
\begin{align*}
\text{XYC} & \rightarrow \text{CZ} \\
\text{CZ} & \rightarrow \text{C} + \text{Z} \\
\text{X} + \text{C} & \rightarrow \text{XC} \\
\text{Y} + \text{XC} & \rightarrow \text{XYC}
\end{align*}
\]

2. How does a catalyst increase the rate of a chemical reaction?
1. Given reactants X and Y, a catalyst C and product Z, order the following steps in the general catalytic reaction process.

\[ \begin{align*}
X + C & \rightarrow XC \\
Y + XC & \rightarrow XYC \\
XYC & \rightarrow CZ \\
CZ & \rightarrow C + Z
\end{align*} \]

2. How does a catalyst increase the rate of a chemical reaction. Catalysts lower the activation energy of a reaction which has the result of increasing the reaction rate.
1. Suppose the activity (concentration) of hydrogen ions in a solution is 1 part per ten thousand. Find the pH value of the solution.

2. Complete the following sentence:

Regarding bases, a ______ number of hydrogen ions is associated with a basic solution (as opposed to an acidic solution) and red litmus paper will turn ______ in the presence of a base.

3. What does a difference of one unit on the pH scale represent in terms of H+ concentration?
1. Suppose the activity (concentration) of hydrogen ions in a solution is 1 part per ten thousand. Find the pH value of the solution. Is this a basic or acidic solution? The H+ concentration is 0.0001M, which is $1 \times 10^{-4}$. pH = $-\log (H^+) = -\log 1 \times 10^{-4} = 4.0$. The solution is acidic. (pH below 7 is acidic)

2. Complete the following sentence:

Regarding bases, a **smaller** number of hydrogen ions is associated with a basic solution (as opposed to an acidic solution) and red litmus paper will turn **blue** in the presence of a base.

3. What does a difference of one unit on the pH scale represent in terms of H+ concentration? Since pH = $-\log H^+$, one unit on the pH scale equals a factor of 10 in concentration.
1. Which of the following describes a substance that is completely ionized in solution and has a pH = 2.
   a. Strong acid       b) strong base       c) weak acid       d) weak base

2. A difference of 2 units on the pH scale represents a concentration difference of H+ of ____
   a) 2            b) 20           c) 100         d) 1000

3. A substance with pH = 7.0 when dissolved in water is:
   a) A strong acid       b) a weak base
   c) a weak acid       d) a neutral substance

4. Which of the following is a property of bases?
   a) Tastes sour       b) dissolves metal       c) turns blue litmus paper red
   d) Liberates OH⁻ in solution.
pH and H⁺ Concentration 1151 Chap. 10

1. Which of the following describes a substance that is completely ionized in solution and has a pH = 2.
   a. Strong acid       b) strong base       c) weak acid       d) weak base

2. A difference of 2 units on the pH scale represents a concentration difference of H⁺ of
   a) 2      b) 20       c) 100       d) 1000

3. A substance with pH = 7.0 when dissolved in water is:
   a) A strong acid      b) a weak base
   c) a weak acid       d) a neutral substance

4. Which of the following is a property of bases?
   a) Tastes sour       b) dissolves metal       c) turns blue litmus paper red
   d) Liberates OH⁻ in solution.
Enzymes as Catalysts - 1152

Identify whether the following are TRUE or FALSE.

1. Enzymes participate in a limited number of chemical reactions throughout the human body.

2. Enzymes act to lower the activation energy of chemical reactions.

3. An enzyme can reshape itself when placed in contact with a substrate.

4. The amino-acid structure of an enzyme is important to its function.
Enzymes as Catalysts - 1152

Identify whether the following are TRUE or FALSE.

1. Enzymes participate in a limited number of chemical reactions throughout the human body. **False**

2. Enzymes act to lower the activation energy of chemical reactions. **True**

3. An enzyme can reshape itself when placed in contact with a substrate. **True**

4. The amino-acid structure of an enzyme is important to its function. **True**
Hydrocarbons 1152

1. What is the name and formula of the common saturated hydrocarbon that has four carbons.

2. What is the name and formula of the common saturated hydrocarbon that has five carbons.

3. Which of the following is the chemical formula for octyne
   a) \( \text{C}_8\text{H}_{12} \)  b) \( \text{C}_8\text{H}_{14} \)  c) \( \text{C}_8\text{H}_{16} \)  d) \( \text{C}_8\text{H}_{18} \)

4. Which of the following is an example of hydrocarbons containing double bonds.
   a) \( \text{C}_2\text{H}_6 \)  b) \( \text{C}_4\text{H}_8 \)  c) \( \text{C}_6\text{H}_{10} \)  d) \( \text{C}_8\text{H}_{12} \)
1. What is the name and formula of the common saturated hydrocarbon that has four carbons.

Butane \( \text{C}_4\text{H}_{10} \)

2. What is the name and formula of the common saturated hydrocarbon that has five carbons.

Pentane. \( \text{C}_5\text{H}_{12} \)

Which of the following is the chemical formula for octyne

a) \( \text{C}_8\text{H}_{12} \)  b) \( \text{C}_8\text{H}_{14} \)  c) \( \text{C}_8\text{H}_{16} \)  d) \( \text{C}_8\text{H}_{18} \)

Which of the following is an example of hydrocarbons containing double bonds.

a) \( \text{C}_2\text{H}_6 \)  b) \( \text{C}_4\text{H}_8 \)  c) \( \text{C}_6\text{H}_{10} \)  d) \( \text{C}_8\text{H}_{12} \)
<table>
<thead>
<tr>
<th>Number of C atoms</th>
<th>Molecular formula</th>
<th>Name (n-alkane)</th>
<th>Number of constitutional isomers</th>
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<tr>
<td>1</td>
<td>CH₄</td>
<td>methane</td>
<td>—</td>
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<tr>
<td>2</td>
<td>C₂H₆</td>
<td>ethane</td>
<td>—</td>
</tr>
<tr>
<td>3</td>
<td>C₃H₈</td>
<td>propane</td>
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<td>4</td>
<td>C₄H₁₀</td>
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<td>5</td>
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<td>75</td>
</tr>
<tr>
<td>20</td>
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<td>eicosane</td>
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Alkenes

- C=C double bond
- C\textsubscript{n} H\textsubscript{2n} - general formula
- unsaturated
  - not "saturated" with maximum hydrogens
  - unsaturated fats have some double bonds (easier to digest)
- note that cycloalkanes also are C\textsubscript{n} H\textsubscript{2n}
Alkynes

- Carbon-carbon triple bond
- Sp hybridization (linear)
- No cis-trans possibilities
- The two pi bonds are perpendicular
- High electron density
- (Usually more reactive than alkenes)