1. Which of the following changes are *chemical*, as distinct from physical?
   a. Water evaporating to vapor
   b. Rusting Iron
   c. Heating aluminum until it melts
   d. Mixing oil and water at room temperature
   e. Tearing a sheet of paper

2. Which represents the balanced chemical equation for the heating of sodium chlorite to form sodium chloride and oxygen gas.
   a. \( \text{NaClO}_3 (s) \rightarrow \text{NaCl (s)} + \text{O}_2 (g) \)
   b. \( \text{Na}_2(\text{ClO})_2 (s) \rightarrow 2 \text{NaCl (s)} + \text{O}_2 (g) \)
   c. \( \text{NaClO}_2 (s) \rightarrow \text{NaCl (s)} + \text{O}_2 (g) \)
   d. \( \text{NaClO (s)} \rightarrow \text{NaCl (s)} + \text{O (g)} \)
   e. \( \text{Na}_2(\text{ClO})_2 (s) \rightarrow 2 \text{NaCl (s)} + 2\text{O (g)} \)

Questions 3-9 refer to the neurotransmitter serotonin (molecular formula: \( \text{C}_{10}\text{H}_{12}\text{N}_2\text{O} \))

3. What is the molar mass of serotonin?
   a. 54 g/mol
   b. 77 g/mol
   c. 145 g/mol
   d. 176 g/mol
   e. 201 g/mol

\[
10(12) + 12(1) + 2(14) + 1(16) = 176 \text{ g/mol}
\]

4. What is the percentage by weight of nitrogen in serotonin?
   a. 11.3%
   b. 15.9%
   c. 23.5%
   d. 37.0%
   e. 41.2%

\[
2*14/176 * 100\% = 15.9\%
\]
5. What is the mass of $7.31 \times 10^{-3}$ mol of serotonin?
   a. 1.34 g
   b. 5.43 g
   c. 12.9 g
   d. 15.7 g
   e. 23.4 g

   \[
   7.31 \times 10^{-4} \text{ mol} \times 176 \text{ g/1 mol} = 0.128656 \text{ g}
   \]

6. How many moles of serotonin are in a sample weighing 0.781 g?
   a. $4.43 \times 10^{-3}$ moles
   b. $1.09 \times 10^{-3}$ moles
   c. $5.40 \times 10^{-4}$ moles
   d. $9.87 \times 10^{-2}$ moles
   e. $3.99 \times 10^{-3}$ moles

   \[
   0.781 \text{ g} \times 1 \text{ mol/176 g} = 0.0044375 \text{ mol}
   \]

7. How many moles of carbon are in a sample of serotonin weighing 0.781 g?
   a. $4.43 \times 10^{-2}$ moles
   b. $3.35 \times 10^{-2}$ moles
   c. $4.21 \times 10^{-3}$ moles
   d. $8.23 \times 10^{-1}$ moles
   e. $3.99 \times 10^{-2}$ moles

   \[
   4.43 \times 10^{-3} \text{ moles serotonin} \times \frac{10 \text{ moles carbon}}{1 \text{ mol serotonin}} = 4.43 \times 10^{-2} \text{ moles carbon}
   \]

8. How many molecules are in a sample of serotonin weighing 0.781 g?
   a. $5.67 \times 10^{21}$ molecules
   b. $1.43 \times 10^{23}$ molecules
   c. $7.87 \times 10^{21}$ molecules
   d. $2.67 \times 10^{21}$ molecules
   e. $9.24 \times 10^{22}$ molecules

   \[
   0.781 \text{ g} \times 1 \text{ mol/176 g} \times 6.022 \times 10^{23} \text{ molecules/mol} = 2.67226 \times 10^{21} \text{ molecules}
   \]
9. How many atoms of Hydrogen are in a sample of 0.547 g of serotonin?
   a. $6.87 \times 10^{21}$ atoms
   b. $1.19 \times 10^{24}$ atoms
   c. $3.21 \times 10^{22}$ atoms
   d. $2.16 \times 10^{22}$ atoms
   e. $9.24 \times 10^{22}$ atoms

   

9. $2.67226 \times 12$ atoms H = $3.20672E+22$ atoms H

Questions 10 and 11 refer to: An unidentified compound, unknown A, with a molecular weight of 92 g/mol, was found to be 52% carbon by mass, 13% hydrogen by mass, and 35% oxygen by mass.

10. What is the empirical formula of unknown A?
   a. C$_2$H$_6$O
   b. CH$_3$O
   c. C$_2$H$_6$CH$_2$OH
   d. CH$_2$(OH)$_2$
   e. CH$_4$OH

<table>
<thead>
<tr>
<th></th>
<th>Grams if 100 g total</th>
<th>Moles</th>
<th>Divide by Smallest</th>
<th>Round</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>52</td>
<td>4.3333333333</td>
<td>1.98095238</td>
<td>2</td>
</tr>
<tr>
<td>H</td>
<td>13</td>
<td>13</td>
<td>5.94285714</td>
<td>6</td>
</tr>
<tr>
<td>O</td>
<td>35</td>
<td>2.1875</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

11. What is the molecular formula of unknown A?
   a. C$_2$H$_6$O
   b. CH$_2$(OH)$_2$
   c. C$_4$H$_{12}$C$_2$H$_4$(OH)$_2$
   d. C$_2$H$_4$(OH)$_4$
   e. C$_4$H$_{12}$O$_2$

92/46 (molecular mass of 1 mol) = 2 therefore multiple coefficients by 2
Questions 12-15 consider the element Carbon, Os (Z=6). The average atomic weight of Osmium is 12.011 g/mol. Carbon has three possible isotopes: C-12, C-13, and C-14.

12. Which Carbon isotope is the most abundant in nature?
   a. C-12
   b. C-13
   c. C-14
   d. All are equal
   e. Cannot be determined from the given information

   **Average atomic weight is 12.011 – so C-12 must be the overwhelming abundant in nature**

13. How many total electrons does a carbocation, carbon ion with a positive 1 charge, have?
   a. 6
   b. 7
   c. 5
   d. 4
   e. Cannot be determined from the given information

   **Normal C – 6 electrons, +1 ion, loss of one electron → 5 electrons remaining**

14. How many neutrons does a C-14 atom have?
   a. 0
   b. 6
   c. 7
   d. 8
   e. 9

   **14 (p + n) – 6 (p) = 8 n**

15. How many protons does a C-13 atom have?
   a. 4
   b. 5
   c. 6
   d. 7
   e. 8

   **All carbon isotopes will have 6 protons!!!
Questions 16-20 will refer to the following categories:

I. Element – **ONLY ONE ELEMENT**
II. Molecular compound – **COVALENT BONDS**
III. Ionic compound – **IONIC BONDS**
IV. Homogenous mixture – **EVENLY DISSOLVED SOLUTION, i.e. FULLY SOLUBLE**
V. Heterogenous mixture – **UNEVENLY DISSOLVED SOLUTION, i.e. INSOLUBLE**
VI. Pure substance – **DEFINED STRUCTURE**
VII. Acid – **PROTON DONOR**
VIII. Base – **PROTON ACCEPTOR**

16. Neon can be classified as...
   a. I only
   b. I and VI
   c. I and II
   d. I, II, and VI
   e. I and VII

17. A phosphoric acid solution can be classified as...
   a. IV and VII
   b. VII only
   c. V only
   d. II and VII
   e. III and VII

18. Dinitrogen tetroxide can be classified as...
   a. V and III
   b. V and VI
   c. II, V, and VI
   d. II only
   e. II and VI

19. Sodium perchlorate can be classified as...
   a. VI only
   b. II and VI
   c. II and VIII
   d. III and VI
   e. II, VI, and VII

20. Sodium hydride can be classified as...
   a. III and VI
   b. II, III, and VI
   c. II only
   d. III only
   e. VI and VIII