1&2. Consider the $^{29}\text{Si}$ isotope. An atom of this isotope contains _____ neutrons.

(a) 14  (b) 28  (c) 23  (d) 15  (e) 29

3&4. Which compound cannot exhibit London interaction?

(a) NF$_3$  (b) CO$_2$  (c) CH$_3$OH  (d) Cl$_2$  (e) BaH$_2$

5&6. For the system given below, Bronsted would classify basic species as:

\[ \text{HBrO}_3 + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{BrO}_3^- \]

(a) H$_2$O and BrO$_3^-$  (b) H$_3$O$^+$ and BrO$_3^-$  (c) HBrO$_3$ and H$_3$O$^+$

(d) HBrO$_3$ and H$_2$O  (e) HBrO$_3$ and BrO$_3^-$

7&8. Which one of the following is an insoluble base?

(a) NaOH  (b) NH$_3$  (c) Sr(OH)$_2$  (d) Ba(OH)$_2$  (e) Mg(OH)$_2$
9&10. Which one of the following statements about this phase diagram is FALSE?

(a) At Point 4, the substance is a gas.
(b) Point 5 is called the triple point.
(c) At Point 3, the liquid phase is in equilibrium with gas phase.
(d) When the substance moves from the conditions at Point 2 to the conditions at Point 4, the substance sublimes.
(e) When the conditions change from Point 1 to Point 3, the temperature changes and the pressure stays constant.

11&12. Titanium (Ti) conducts electricity as a solid. It melts at 1675°C to give a liquid that also conducts electricity. Solid Ti can probably be classified as a ______ solid.

(a) ionic  (b) metallic  (c) polar  (d) molecular  (e) covalent

13&14. Which of the following bonds would you expect to be the most polar?

(a) S-F  (b) N-H  (c) O-F  (d) H-Cl  (e) B-Cl

15&16. Which statement is wrong?

(a) The atomic weight of fluorine is about 19.
(b) The most stable magnesium ion is Mg^{2+}.
(c) A sodium cation is larger than a sodium atom.
(d) The atomic radius of sulfur is smaller than the ionic radius of the sulfide anion.
(e) The first ionization energy of fluorine is greater than that of iodine.
17&18. Which of the following statements is FALSE?

(a) Molecules of an ideal gas are assumed to have no volume and have no attractive forces between each other.
(b) Real gases do not always obey the ideal gas laws.
(c) The gas, HF, behaves more ideally at 10 atm than it does at 0.10 atm.
(d) Nitrogen gas behaves more ideally at 400 K than it does at 40 K.
(e) Van der Waal's equation corrects for the non-ideality of real gases.

19&20. Complete and balance the following redox reaction. What is the coefficient of H₂O when the equation is balanced with the set of smallest whole number coefficients.

Fe²⁺ + MnO₄⁻ → Fe³⁺ + Mn²⁺ (in acidic solution)

(a) 3  (b) 4  (c) 5  (d) 8  (e) 10

21&22. The carbonate ion, CO₃²⁻, has _____ resonance structures.

(a) 2  (b) 3  (c) 4  (d) 5  (e) 6

22&24. The compound H-N=N=N, has _____ sigma bonds and _____ pi bonds.

(a) 1,2  (b) 1,4  (c) 3,2  (d) 3,4  (e) another combination

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25&26. Calculate the number of CH$_3$NH$_2$ molecules in 20. g of CH$_3$NH$_2$.

(a) $3.9 \times 10^{23}$  (b) $8.1 \times 10^{22}$  (c) $2.9 \times 10^{23}$  (d) $8.8 \times 10^{22}$  (e) $7.8 \times 10^{23}$

27&28. What is the percentage, by weight of hydrogen in methylamine, CH$_3$NH$_2$?

(a) 3.2%  (b) 16%  (c) 11%  (d) 21%  (e) 25%

29&30. What is the molarity of a HNO$_3$ solution if 23.0 mL of 4.00 M HNO$_3$ solution is diluted to 1000. mL?

(a) 0.23 M  (b) 0.063 M  (c) 0.0058 M  (d) 0.092 M  (e) 0.14 M
31&32. The imaginary element Y (AW = 100.60 amu) has the following isotopic masses:

\[ ^{100}\text{Y} \quad 100.00 \text{ amu} \]
\[ ^{102}\text{Y} \quad 102.00 \text{ amu} \]

What is the percent abundance of \(^{100}\text{Y}\)?

(a) 50.0%  
(b) 70.0%  
(c) 60.0%  
(d) 30.0%  
(e) 40.0%

33&34. An unknown organic compound composed of carbon, hydrogen and oxygen was analyzed and found to be 47.08% carbon, 5.88% hydrogen, and 47.04% oxygen by weight. Which of the following represents the correct empirical formula for the compound?

(a) \(\text{C}_4\text{H}_5\text{O}_2\)  
(b) \(\text{C}_3\text{H}_2\text{O}_2\)  
(c) \(\text{C}_4\text{H}_4\text{O}_3\)  
(d) \(\text{C}_3\text{H}_6\text{O}_2\)  
(e) \(\text{C}_4\text{H}_6\text{O}_3\)

35&36. A sample of \(\text{N}_2\)(g) occupies 10.0 L under a pressure of 790. torr. At what pressure would it occupy 12.0 L if the temperature did not change?

(a) 722 torr  
(b) 846 torr  
(c) 311 torr  
(d) 658 torr  
(e) 943 torr
37&38. When an excess of hydrogen, H\(_2\), reacts with 10.0 g amount of nitrogen, N\(_2\), to give an actual yield of 7.00 g of ammonia, NH\(_3\), what is the percentage yield for this reaction? (Balance the equation first).

(a) 61.1%  (b) 58.6%  (c) 52.3%  (d) 50.7%  (e) 44.4%

39&40. How many milliliters of 0.500 M HNO\(_3\) would be required to react with 1.00 g of Al\(_2\)O\(_3\)?

Al\(_2\)O\(_3\) + HNO\(_3\) → Al(NO\(_3\))\(_3\) + H\(_2\)O  (UNBALANCED)

(a) 118 mL  (b) 19.2 mL  (c) 53.1 mL  (d) 35.2 mL  (e) 93.5 mL
41&42. Consider the **unbalanced** redox reaction:

\[ \text{MnO}_4^- + \text{NO}_2^- \rightarrow \text{MnO}_2 + \text{NO}_3^- \] (in basic solution)

If 0.325 g of NaNO₂ are dissolved in enough water to prepare 200 mL of solution, what is the normality of the NaNO₂ solution used in the above reaction?

(a) 0.0115 N    (b) 0.232 N    (c) 0.0387 N    (d) 0.0471 N    (e) 0.0775 N

43&44. If 5.0 g of each reactant in the following reaction were used, the limiting reactant would be:

\[ 3\text{PbO}_2 + \text{Cr}_2(\text{SO}_4)_3 + \text{K}_2\text{SO}_4 + \text{H}_2\text{O} \rightarrow 3\text{PbSO}_4 + \text{K}_2\text{Cr}_2\text{O}_7 + \text{H}_2\text{SO}_4 \]

(a) K₂SO₄    (b) Cr₂(SO₄)₃    (c) PbSO₄    (d) K₂Cr₂O₇    (e) PbO₂
45&46. What is the density of a sample of CO₂ gas at STP?

(a) 2.0 g/L  
(b) 0.71 g/L  
(c) 2.5 g/L  
(d) 1.4 g/L  
(e) 0.50 g/L

47&48. How many liters (at 300.0°C and 1.50 atm) of oxygen can be produced by the decomposition of 25 g of potassium chlorate?

\[2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2\]

(a) 17.1 L  
(b) 4.11 L  
(c) 9.60 L  
(d) 6.45 L  
(e) 3.21 L
49&50. Which of the following pictures is the best representation of HCN(aq)? Ignore the charges on any ions. What I want is the best illustration of the concept occurring in solution.
Let ○ = hydrogen, ● = carbon and □ = nitrogen.

(a)  (b)  (c)

(d)  (e)

51. Take the on-line questionnaire on our course (5 pts) - see our webpage.
(6 pts) **52.** Describe the meaning of this diagram in your own words. Include in your mini-discussion,

1. the definition of boiling point.
2. the difference between boiling and evaporation,
3. what the approximate normal boiling point of Compound A is.
(5 pts) **53.** Given the following data:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
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<tbody>
<tr>
<td>Freezing point of benzene</td>
<td>5.48°C</td>
</tr>
<tr>
<td>Boiling point of benzene</td>
<td>80.1°C</td>
</tr>
<tr>
<td>Heat of fusion of benzene at 5.48°C</td>
<td>127 J/g</td>
</tr>
<tr>
<td>Specific Heat of liquid benzene</td>
<td>1.74 J/g°C</td>
</tr>
<tr>
<td>Heat of vaporization of liquid benzene</td>
<td>395 J/g</td>
</tr>
<tr>
<td>Specific Heat of gaseous benzene</td>
<td>1.04 J/g°C</td>
</tr>
</tbody>
</table>

Calculate the amount of heat (in kJ) released when 25.0 g of gaseous benzene at 80.1°C is converted to liquid benzene at 40.0°C.

(5 pts) **54.** Determine the correct net ionic equation for the completely neutralized acid-base solution reaction occurring between nitric acid and iron(II) hydroxide.
55. What is the initial boiling point of a solution prepared by dissolving 15.0 g of sodium sulfate in 300.0 g of water. Assume complete ionization. ($K_b$ for water is 0.512 °C/m).

56. Consider the element, selenium, Se.
   
   (a) Write out the full electron configuration for this element. DO NOT USE THE NOBLE GAS SHORTHAND.

   (b) What is an appropriate set of 4 quantum numbers for the last electron assigned to this element?

   (c) Is the element diamagnetic or paramagnetic? Circle the correct response.

OVER ⇒
57. Draw the correct dot structure for the following 2 species showing all valence electrons and fill in the appropriate information.

<table>
<thead>
<tr>
<th></th>
<th>SeF&lt;sub&gt;2&lt;/sub&gt;</th>
<th>SeF&lt;sub&gt;4&lt;/sub&gt;&lt;sup&gt;2-&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Dot structure:</td>
<td>Dot structure:</td>
<td></td>
</tr>
<tr>
<td>(b) molecular (ionic) geometry:</td>
<td>(b) molecular (ionic) geometry:</td>
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<tr>
<td>(c) hybridization of central atom:</td>
<td>(c) hybridization of central atom:</td>
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</tr>
<tr>
<td>(d) has a dipole moment (yes/no):</td>
<td>(d) has a dipole moment (yes/no):</td>
<td></td>
</tr>
</tbody>
</table>