Directions: (1) Put your name on PART 1 and your name and signature on PART 2 of the exam where indicated. 
(2) Sign the Aggie Code on PART 2 of this exam. 
(3) Each multiple choice question is actually 2 questions on your scanning sheet. If you are sure of an answer, put the same answer down for both questions for 5 pts. If you cannot decide between two answers, put your BEST answer down for the ODD/FIRST question for 3 pts and your SECOND BEST answer down for the EVEN/SECOND question for 2 pts. If there is an ambiguous multiple choice question, use the last page to explain your answer. 
(4) Do NOT write on the envelope. 
(5) When finished, put both parts of the exam in the envelope with the scanning sheet. You can leave during announced times. 
(6) There are a total of 64 questions (34 actual questions with 2 pts extra credit). Total value is 170 + 2 points. 

PART 1

1&2. The species H2O can be described by all of these terms EXCEPT: 
(a) bent molecular geometry  
(b) sp\(^3\) hybridized  
(c) tetrahedral electronic geometry  
(d) contains polar covalent bonds  
(e) nonpolar

3&4. Which of the following is a non-polar covalent bond? 
(a) P-As  
(b) H-Cl  
(c) O-S  
(d) Na-Ca  
(e) Te-I

5&6. Which compound cannot exhibit London forces? 
(a) CH\(_4\)  
(b) HCl  
(c) C\(_2\)H\(_2\)  
(d) CaS  
(e) OF\(_2\)

7&8. The compound CH\(_3\)-C≡C-H, has _____ pi bonds and _____ sigma bonds. 
(a) 3,5  
(b) 2,6  
(c) 2,3  
(d) 3,2  
(e) another combination

9&10. Which ground state electronic configuration is NOT correct? 
(a) Mn [Ar] 3d\(^5\) 4s\(^2\)  
(b) Na 1s\(^2\) 2s\(^2\) 2p\(^6\) 3s\(^1\)  
(c) Cu [Ar] 3d\(^{10}\) 4s\(^1\)  
(d) As [Ar] 3d\(^{10}\) 4s\(^2\) 4p\(^3\)
(e) Bi  \([Xe] \, 6s^2 \, 5d^{10} \, 6p^3\)

11&12. You can find 4 atoms of oxygen in
(a) 1 mole of \(K_2SO_4\)
(b) 4 moles of \(Na_2O\)
(c) 1 formula unit of \(Na_3PO_4\)
(d) 2 molecules of \(H_2O\)
(e) 2 grams of \(Ba(OH)_2\)

13&14. How many electrons can be found in an ion of the isotope \(^{90}Sr^{2+}\)?
(a) 90  (b) 88  (c) 40  (d) 52  (e) 36

15&16. Consider this illustration. Which statement is FALSE?
(a) The substance may be water.
(b) For Step 1: heat = Sp.Ht. x mass x \(\Delta T\)
(c) For Step 2: heat = Ht. of fusion x mass
(d) The substance is being cooled to a solid at its freezing point.
(e) At the intersection where Step 1 and Step 2 meet, the substance is a solid.

17&18. Here is a particle view of a substance in water. Pick the compound that is represented by this particle view.

(a) RbOH  (b) AgOH  (c) \(NH_3\)  (d) HF  (e) FeS

\(\bigcirc\) = cation or H
\(\bullet\) = anion
19&20. For which of the following reactions would the ΔH° for the reaction be labeled ΔH_f°?

(a) \( \frac{1}{2} \text{N}_2\text{O}(g) + \frac{1}{4} \text{O}_2(g) \rightarrow \text{NO}(g) \)
(b) \( \text{PCl}_3(g) + \frac{1}{2} \text{O}_2(g) \rightarrow \text{POCl}_3(g) \)
(c) \( \text{Al}(s) + \frac{3}{2} \text{O}_2(g) + \frac{3}{2} \text{H}_2(g) \rightarrow \text{Al(OH)}_3(s) \)
(d) \( \text{CaO}(s) + \text{SO}_2(g) \rightarrow \text{CaSO}_3(s) \)
(e) The ΔH° for all the reactions would be labeled ΔH_f°.

21&22. Which of the following is the CORRECT Lewis structure for bromous acid showing all the valence electrons?

(a) \( \begin{array}{c}
\cdot\text{O}\cdot\text{O}\cdot\text{Br}\cdot\text{H}
\end{array} \)
(b) \( \begin{array}{c}
\text{H}\cdot\text{O}\cdot\text{O}\cdot\text{Br}
\end{array} \)
(c) \( \begin{array}{c}
\text{H}\cdot\text{O}\cdot\text{Br}\cdot\text{O}
\end{array} \)
(d) \( \begin{array}{c}
\cdot\text{O}\cdot\text{Br}\cdot\text{O}
\end{array} \)
(e) \( \begin{array}{c}
\text{H}\cdot\text{O}\cdot\text{Br}\cdot\text{O}
\end{array} \)

23&24. Which statement is WRONG?

(a) Br⁻ and Cl⁻ are isoelectronic with each other.
(b) Oxygen has a more negative electron affinity than carbon.
(c) A total of 6 electrons can have quantum numbers, \( n=3 \) and \( \ell=1 \).
(d) A magnesium cation is smaller than a magnesium atom.
(e) A carbon atom is smaller than a silicon atom.

25&26. If you have 3 moles of calcium, how many moles of oxygen atoms are also present in your sample of \( \text{Ca(NO}_3)_2 \cdot 6\text{H}_2\text{O} \)?

(a) 12  (b) 36  (c) 15  (d) 21  (e) 33

27&28. The correct ranking of these substances: \( \text{CaBr}_2 \), \( \text{CO}_2 \), \( \text{CH}_3\text{COOH} \), \( \text{SeF}_4 \) according to their boiling points from lowest boiling point to highest boiling point is:

(a) \( \text{CO}_2 < \text{SeF}_4 < \text{CH}_3\text{COOH} < \text{CaBr}_2 \)
(b) \( \text{CO}_2 < \text{CH}_3\text{COOH} < \text{CaBr}_2 < \text{SeF}_4 \)
(c) \( \text{CH}_3\text{COOH} < \text{SeF}_4 < \text{CO}_2 < \text{CaBr}_2 \)
(d) \( \text{CaBr}_2 < \text{CO}_2 < \text{SeF}_4 < \text{CH}_3\text{COOH} \)
(e) \( \text{CH}_3\text{COOH} < \text{CaBr}_2 < \text{SeF}_4 < \text{CO}_2 \)

29&30. The correct formula for sodium sulfite is:

(a) \( \text{NaSO}_4 \)  (b) \( \text{Na}_2\text{SO}_4 \)  (c) \( \text{NaSO}_3 \)  (d) \( \text{Na}_2\text{SO}_3 \)  (e) \( \text{Na}_2\text{S} \)
31&32. Assign oxidation numbers to each element in this reaction. The reducing agent is:

\[ 16 \text{H}^+ + 2 \text{MnO}_4^- + 10 \text{SO}_4^{2-} \rightarrow 2 \text{Mn}^{2+} + 5 \text{S}_2\text{O}_8^{2-} + 8 \text{H}_2\text{O} \]

(a) \text{H}^+  \hspace{1cm} (b) \text{MnO}_4^-  \hspace{1cm} (c) \text{SO}_4^{2-}  \hspace{1cm} (d) \text{Mn}^{2+}  \hspace{1cm} (e) \text{S}_2\text{O}_8^{2-}

33&34. Consider this acid-base net ionic equation: \[ 2\text{H}^+(\text{aq}) + \text{Cu(OH)}_2(\text{s}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2\text{H}_2\text{O}(\ell) \]

Which of the following statements is TRUE?

(a) The acid is a weak acid.
(b) The spectator ion could have been a \text{NO}_3^-\text{ion}.
(c) The base is a weak electrolyte.
(d) The salt is insoluble.
(e) The reaction is called a precipitation reaction.

35&36. A sample of \text{SO}_3 \text{gas begins to exhibit non-ideal behavior near which temperature?}

(a) 0 K  \hspace{1cm} (b) 273 K  \hspace{1cm} (c) melting point  
(d) boiling point  \hspace{1cm} (e) 22.4 \degree \text{C}

37&38. An unknown organic compound composed of carbon, hydrogen and oxygen was analyzed and found to be 46.15% C, 7.74% H with the rest being oxygen. Which of the following represents the correct empirical formula for the compound?

(a) \text{CH}_3\text{O}  \hspace{1cm} (b) \text{C}_2\text{H}_3\text{O}  \hspace{1cm} (c) \text{C}_4\text{H}_8\text{O}_3  \hspace{1cm} (d) \text{CH}_2\text{O}  \hspace{1cm} (e) \text{C}_2\text{H}_5\text{O}_2
39 & 40. You are given the data for all the isotopes of the newly discovered element, Aggiedaddium:

<table>
<thead>
<tr>
<th>Abundance (%)</th>
<th>Isotopic Mass (amu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>122.00</td>
</tr>
<tr>
<td>50</td>
<td>125.00</td>
</tr>
<tr>
<td>40</td>
<td>128.00</td>
</tr>
</tbody>
</table>

The atomic weight of Aggiedaddium (in amu) is:

(a) 125.9  (b) 125.0  (c) 125.6  (d) 124.7  (e) 126.3

41 & 42. What is the density of the gas XeF₆ (MW = 245.3 g/mol) at STP?

(a) 22.4 g/L  (b) 0.091 g/L  (c) 1.00 g/L  (d) 11.0 g/L  (e) 2.55 g/L

43 & 44. Given the heats of reaction below, calculate \( \Delta H^\circ \) for the reaction: \( 2\text{NO}(g) + \frac{1}{2}\text{O}_2(g) \rightarrow \text{N}_2\text{O}_3(g) \)

\[
\begin{align*}
\text{N}_2(g) + \text{O}_2(g) & \rightarrow 2\text{NO}(g) \quad \Delta H^\circ = +180.5 \text{ kJ} \\
2\text{N}_2(g) + 3\text{O}_2(g) & \rightarrow 2\text{N}_2\text{O}_3(g) \quad \Delta H^\circ = +167.4 \text{ kJ}
\end{align*}
\]

(a) +91.8 kJ  (b) −264.2 kJ  (c) +264.2 kJ  (d) −6.55 kJ  (e) −96.8 kJ
45&46. Using bond energies, calculate $\Delta H_{\text{rxn}}$ for the reaction: $2 \text{IF}_3(g) \rightarrow 3 \text{F}_2(g) + \text{I}_2(g)$

where $D_{\text{I-F}} = +278 \text{ kJ/mol}$
$D_{\text{F-F}} = +158 \text{ kJ/mol}$
$D_{\text{I-I}} = +151 \text{ kJ/mol}$

(a) +845 kJ  (b) +1043 kJ  (c) +410 kJ  (d) +665 kJ  (e) +721 kJ

47&48. What mass of $\text{SiF}_4$ (FW=104.1 g/mol) could be produced by the reaction of 15 g of HF (FW=20.0 g/mol) with an excess of $\text{SiO}_2$? The unbalanced equation for the reaction is:

$\text{SiO}_2 + \text{HF} \rightarrow \text{SiF}_4 + \text{H}_2\text{O}$ (UNBALANCED)

(a) 19.5 g  (b) 1.21 g  (c) 3.02 g  (d) 10.4 g  (e) 15.0 g
49&50. If the pH of an HClO₄ solution is 2.94, what is the concentration of HClO₄?
   (a) 0.47 M  (b) 0.0011 M  (c) 1.08 M  (d) 0.053 M  (e) 0.34 M

51&52. A 13.8 g chunk of zinc is heated to 98.8°C. It is then immersed in 45.0 g water originally at 25.0°C.
   The final temperature of both the iron and the water is 27.1°C. Calculate the specific heat of iron. The
   specific heat of water is 4.18 J/g°C.
   (a) 0.31 J/g°C  (b) 0.40 J/g°C  (c) 0.15 J/g°C  (d) 0.21 J/g°C  (e) 0.67 J/g°C
53&54. Consider this reaction: $\text{N}_2 + \text{O}_2 \rightarrow \text{NO}_2$ (UNBALANCED).

If you had 4 moles of $\text{N}_2$ and 4 moles of $\text{O}_2$, how many moles of $\text{NO}_2$ can you make?

Let $\bigcirc = \text{N}$ and $\bigcirc = \text{O}$

(a) 1 mol (b) 2 mol (c) 4 mol (d) 6 mol (e) 8 mol

55&56. What is the percentage yield of elemental sulfur if 7.54 grams of sulfur are obtained from the reaction of 6.00 grams of SO$_2$ with an excess of H$_2$S?

$\text{2 H}_2\text{S} + \text{SO}_2 \rightarrow \text{2 H}_2\text{O} + 3 \text{ S}$

(a) 76.1% (b) 79.4% (c) 83.8% (d) 88.4% (e) 91.4%
57&58. Calculate the standard enthalpy change associated with the reaction below as written:

$$2 \text{NH}_4\text{NO}_3(\text{s}) \rightarrow 2\text{N}_2(\text{g}) + \text{O}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g})$$

<table>
<thead>
<tr>
<th>Compound</th>
<th>$\Delta H^\circ_1$ (kJ/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium nitrate (s)</td>
<td>$-366$</td>
</tr>
<tr>
<td>Water (g)</td>
<td>$-242$</td>
</tr>
</tbody>
</table>

(a) $+124$ kJ       (b) $-608$ kJ   (c) $+236$ kJ   (d) $-236$ kJ   (e) $-124$ kJ

59&60. You have 7.50 g of liquid cyclohexanol (C₆H₁₁OH – FW=100.1 g/mol). How many atoms of hydrogen atoms do you have?

(a) $5.4 \times 10^{23}$       (b) $3.2 \times 10^{23}$   (c) $2.9 \times 10^{22}$   (d) $4.3 \times 10^{22}$   (e) $6.0 \times 10^{23}$
(4 pts) 61. (a) How much faster will helium gas effuse through a tiny hole than sulfur trioxide gas?

(b) Why? Does the reason involve the size of the hole?

(5 pts) 62. Gold can be dissolved from gold-bearing ore by treating the rock with sodium cyanide in the presence of oxygen gas, according to:

\[ 4 \text{Au} + 8 \text{NaCN} + \text{O}_2 + 2 \text{H}_2\text{O} \rightarrow 4 \text{NaAu(CN)}_2 + 4 \text{NaOH} \]

If 20.0 mL of 0.0750 M NaCN are required to react with all the gold in 1550 g of rock, what is the percentage of gold in the ore sample?
63. What total gas pressure measured at 600°C in a 43.0 L container, would result from the complete combustion of 2.20 g of hexene, $\text{C}_6\text{H}_{12}$ (MW = 84.2 g/mol) with a stoichiometric amount of oxygen gas according to:

$$\text{C}_6\text{H}_{12}(g) + 9\text{O}_2(g) \rightarrow 6\text{CO}_2(g) + 6\text{H}_2\text{O}(g)$$

64. Draw a typical phase diagram.
   (a) Label the axes and the areas where solids, liquids and gases can be found.
   (b) Label the triple point and the melting curve.

Extra credit:
(1 pt) Cr forms a __________________ solid.
(1 pt) NaCl forms a ______________________ solid.