Directions: (1) Put 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 first (odd) question and the other answer 
down for the second (even) question. If you get the first one correct you'll get 3 pts; if you get the 
second one correct you'll get 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. There is a periodic table on the last page to write on.  
(5) When finished, wait to be excused. You can pick up the multiple choice part with the answers 
outside my office after 2:30pm.  
(6) There are a total of 34 questions (18 actual questions). The last question is extra credit.  

PART 1  

1&2. Which one of the following thermodynamic quantities is NOT a state function?  
(a) ΔE  (b) q  (c) (q+w)  (d) ΔH  (e) T  

3&4. Which of the following is the CORRECT Lewis structure for chlorous acid showing all the valence electrons?  
(a)  
(b)  
(c)  
(d)  
(e)  

5&6. Which of the following is a non-polar covalent bond?  
(a) O-F  (b) H-Cl  (c) C-I  (d) Na-Ca  (e) Te-I  

7&8. Which ground state electronic configuration is NOT correct?  
(a) Mn  [Ar] 3d⁵ 4s²  
(b) Na  1s² 2s² 2p⁶ 3s¹  
(c) Cu  [Ar] 3d¹⁰ 4s¹  
(d) As  [Ar] 3d¹⁰ 4s² 4p³  
(e) Bi  [Xe] 6s² 5d¹⁰ 6p³
9&10. Which statement is FALSE?
(a) In an electron has the quantum number \( l = 1 \), it must be in a \( p \) energy subshell.
(b) If an electron has the quantum number \( n = 2 \), the electron could be in a \( p \) energy subshell.
(c) Two electrons in the same atom CANNOT have quantum numbers of:
\[ 2, 1, -\frac{1}{2} \text{ and } 2, 1, -\frac{1}{2}. \]
(d) An electron that has \( n = 1 \), then it must be in an \( s \) orbital.
(e) A possible set of quantum numbers for an electron in an atom is: \( n = 2, l = -1, m_s = -\frac{1}{2} \).

11&12. Which of the following statements is or are TRUE?
(1) An excited atom can return to a lower energy level by absorbing light energy.
(2) An atom can be excited by emitting light energy.
(3) As the energy of electromagnetic radiation increases, its frequency increases.
(4) The frequency and wavelength of light are inversely proportional.
(a) 1 & 2 (b) 2 only (c) 2 & 3 (d) 1 & 3 (e) 3 & 4

13&14. Which molecule exhibits resonance?
(a) \( \text{CO}_2 \)  (b) \( \text{PF}_3 \)  (c) \( \text{H}_2\text{S} \)  (d) \( \text{SO}_2 \)  (e) \( \text{BeBr}_2 \)

15&16. For which of the following reactions would the \( \Delta H^\circ \) for the reaction be labeled \( \Delta H_f^\circ \)?
(1) \( \text{Mg}(s) + \frac{1}{2} \text{O}_2(g) \rightarrow \text{MgO}(s) \)
(2) \( \text{BaO}(s) + \text{SO}_3(g) \rightarrow \text{BaSO}_4(s) \)
(3) \( \text{CO}(g) + \frac{1}{2} \text{O}_2(g) \rightarrow \text{CO}_2(g) \)
(4) \( \frac{1}{2} \text{H}_2(g) + \frac{1}{2} \text{Br}_2(l) \rightarrow \text{HBr}(g) \)
(5) \( \text{C}_2\text{H}_4(g) \rightarrow 2 \text{C}(s, \text{graphite}) + 2 \text{H}_2(g) \)
(a) 1 only (b) 1 and 2 (c) 1 and 4 (d) 3 and 4 (e) 1 and 5
17&18. Which element is paramagnetic with 1 unpaired electron?

(a) Ca   (b) S   (c) Si   (d) Cl   (e) P

19&20. The following set of 4 quantum numbers: $n = 5$, $\ell = 2$, $m_\ell = +2$, $m_s = +1/2$ could be an appropriate set for the last electron to go into an element of: (Assume that the element is not an exception to the normal filling rule.)

(a) Sr   (b) Kr   (c) Zr   (d) W   (e) Sn

21&22. Which statement is WRONG?

(a) Br$^-$ and Cl$^-$ are isoelectronic with each other.
(b) Oxygen has a more negative electron affinity than carbon.
(c) The most stable ion of calcium is Ca$^{2+}$.
(d) A magnesium cation is smaller than a magnesium atom.
(e) A carbon atom is smaller than a silicon atom.

23&24. If a system gains 10 J of heat and has 40 J of work done on it by the surroundings, the change in internal energy is

(a) $-10$ J   (b) $+10$ J   (c) $-50$ J   (d) $+50$ J   (e) 0 J
25&26. Which is the correct order of bond length?

(a) double bond > single bond > triple bond
(b) single bond > double bond > triple bond
(c) triple bond > double bond > single bond
(d) triple bond > single bond > double bond
(e) single bond > triple bond > double bond

27&28. 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
29&30. A 1.800 g sample of isopentane, C₅H₁₂, was completely burned in a bomb calorimeter that was surrounded by 5100. g of water. The temperature of the water rose from 24.200°C to 28.126°C. The heat capacity of the calorimeter was 840. J/°C. The specific heat of water is 4.184 J/°C. Calculate ΔE for the reaction in kJ/mol.

(a) +3840 kJ/mol (b) −6280 kJ/mol (c) −3490 kJ/mol (d) −48.5 kJ/mol (e) −2210 kJ/mol

31&32. In 1947 a ship loaded with ammonium nitrate exploded in the harbor of Texas City. Calculate the standard enthalpy change associated with the reaction of 240. grams of NH₄NO₃, according to the equation:

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

<table>
<thead>
<tr>
<th>Compound</th>
<th>ΔH°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) −354 kJ     (b) −262 kJ     (c) −5104 kJ     (d) −717 kJ     (e) +372 kJ
(16 pts) 33. For each of species, draw the Lewis dot structure (3 pts and don't forget all the electrons). For the central atom, give the electronic geometry (2 pts), the molecular (or ionic) geometry (2 pts), and say if the species has a dipole moment (is polar) or not (1pt).

(a) BBr₃  
(b) BrF₄⁻

<table>
<thead>
<tr>
<th></th>
<th>BBr₃</th>
<th>BrF₄⁻</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronic Geometry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molecular/ Ionic Geometry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has dipole moment (yes/no)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(is polar)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(4 pts) Draw a 3-dimensional representation of these 2 species using wedges and dotted lines. Show ALL lone pairs of electrons. Show and state the bond angles.
EXTRA CREDIT:

(2 pts) 34. Sketch the pictures of the following orbitals:

(a) $p_y$  
(b) $d_{x^2-y^2}$
# Periodic Table of Elements

<table>
<thead>
<tr>
<th>Period</th>
<th>Group IA (1)</th>
<th>Group II A (2)</th>
<th>Group IIIA (13)</th>
<th>Group IVA (14)</th>
<th>Group VA (15)</th>
<th>Group VIA (16)</th>
<th>Group VIIA (17)</th>
<th>Group 0 (18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H</td>
<td>He</td>
<td>Li</td>
<td>Be</td>
<td>B</td>
<td>C</td>
<td>N</td>
<td>O</td>
</tr>
<tr>
<td>2</td>
<td><strong>Ne</strong></td>
<td><strong>Ar</strong></td>
<td><strong>Kr</strong></td>
<td><strong>Xe</strong></td>
<td><strong>Kr</strong></td>
<td><strong>Xe</strong></td>
<td><strong>Br</strong></td>
<td><strong>Kr</strong></td>
</tr>
<tr>
<td>3</td>
<td><strong>Rn</strong></td>
<td><strong>Cd</strong></td>
<td><strong>In</strong></td>
<td><strong>Sn</strong></td>
<td><strong>Sb</strong></td>
<td><strong>Te</strong></td>
<td><strong>I</strong></td>
<td><strong>Xe</strong></td>
</tr>
<tr>
<td>4</td>
<td><strong>Po</strong></td>
<td><strong>Pb</strong></td>
<td><strong>Bi</strong></td>
<td><strong>Po</strong></td>
<td><strong>At</strong></td>
<td><strong>Rn</strong></td>
<td><strong>Fr</strong></td>
<td><strong>Ra</strong></td>
</tr>
<tr>
<td>5</td>
<td><strong>Rf</strong></td>
<td><strong>Db</strong></td>
<td><strong>Sg</strong></td>
<td><strong>Bh</strong></td>
<td><strong>Hs</strong></td>
<td><strong>Mt</strong></td>
<td><strong>Uun</strong></td>
<td><strong>Uuu</strong></td>
</tr>
<tr>
<td>6</td>
<td><strong>Uub</strong></td>
<td><strong>Uuq</strong></td>
<td><strong>Lanthanides</strong></td>
<td><strong>Actinides</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Lanthanide Series
** Actinide Series

© Keeney-Kennicutt, 2010