Multiple Choice: (4 points each. Put answers in left margin as capital letters.)

1. Which of the following sets of conditions possesses the least amount of kinetic energy? (FYI: All speeds are approximately correct for the sport.)
   A) a 2 kg bowling ball traveling at $10^3$ m/hr   D) a 400 g football traveling at $10^5$ m/hr
   B) a 10 kg shot put traveling at $10^4$ m/hr   E) a 500 g basketball traveling at $10^3$ m/hr
   C) a 150 g baseball traveling at $10^5$ m/hr

2. Which of the following is false about the enthalpies of the following pairs?
   A) 1 mol CO$_2$ (g) $>$ 1 mol CO$_2$ (l) @ 25 ºC
   B) 2 mol H$_2$ $>$ 1 mol H$_2$ @ 25 ºC
   C) 1 mol H$_2$ + $\frac{1}{2}$ mol O$_2$ $>$ 1 mol H$_2$O (l) @ 25 ºC
   D) 1 mol N$_2$ @ 300º $>$ 1 mol N$_2$ @ 100º
   E) All are true

3. The first 3 quantum numbers for the last electron in bromine (Br) could be: (n, ℓ, m$_\ell$)
   A) 3, 0, 0   C) 3, 2, 1   E) 4, 1, -1
   B) 3, 1, 0   D) 4, 0, 0

4. The electrons in which orbital shield best?
   A) s   B) p   C) d   D) f

5. Which of the following is isoelectronic to calcium ion?
   A) Cl$^-$   B) Ne   C) O$^{2-}$   D) Rb$^+$
   E) All are isoelectronic to calcium ion.

6. Which of the following salts is likely to have the highest (most exothermic) lattice energy? (see discussion 2)
   A) Al$_2$O$_3$   B) KBr   C) CaF$_2$   D) MnO$_2$   E) Na$_2$S

7. Which of the following is a polar covalent molecule?
   A) KCl   B) MgCl$_2$   C) SCl$_2$   D) SrO   E) TlF

8. Place the bonds: C-S, B-F, N-O in order of decreasing bond polarity.
   A) C-S $>$ B-F $>$ N-O   D) N-O $>$ C-S $>$ B-F
   B) C-S $>$ N-O $>$ B-F   E) N-O $>$ B-F $>$ C-S
   C) B-F $>$ C-S $>$ N-O
Discussion Questions: (You must show your work to receive credit.)

1. Write out the electron configurations for each of the following and provide the number of unpaired electrons on each. (10 points)
   S: \[ \text{In}^+:\]

2. Explain your answer to multiple choice question 6. (6 points)

3. Predict which of the species in each pairing is larger and provide the physical rationale for your choices. (10 points)
   a) \[ \text{O, O}^2-\]
   b) \[ \text{O, S}^-\]

4. (6 points)
   a) Which element would be more metallic arsenic (As) or bromine (Br)? ______
   b) An element's second ionization energy is 1450 kJ/mol.
      It's third IE = 13,628 kJ/mol? Which 3rd row element is it likely to be? ______

5. The reaction of sodium and chlorine yields sodium chloride according to the following reaction:
   \[2 \text{Na(s)} + \text{Cl}_2(\text{g}) \rightarrow 2 \text{NaCl(s)}\]
   Explain why you might expect NaCl\(_2\) to form, then why it does not. (10 points)

6. Why are ionic compounds (salts) hard, while molecular compounds are soft? (6 points)
7. For the reaction: (20 points)

\[
\begin{align*}
2 \text{H}_\text{C} & \text{C} \text{H} + 13 \text{O}=\text{O} \rightarrow 8 \text{O}=\text{C}=\text{O} + 10 \text{H}_\text{O} \text{H} \\
2 \text{CH}_3 & \text{CH}_2 \text{CH}_3 + 13 \text{O}2 \rightarrow 8 \text{CO}_2 + 10 \text{H}_2 \text{O}
\end{align*}
\]

a) Calculate $\Delta H^\circ$ of reaction for the burning of butane using the heats of formation table

b) Calculate $\Delta H^\circ$ of reaction for the burning of butane using the bond energy table.