

Answer all questions in the blue books

- Write the electron configuration ($1s^2 2s^2 2p^6 \dots$) for Se^{2-} , ${}_{29}\text{Cu}^+$, and ${}_{24}\text{Cr}$?
 - Use the notation ($\uparrow \downarrow$) with labels under each orbital i.e. $1s, 2p_x \dots$, and write the electron configurations for ${}_{16}\text{S}$ and ${}_{26}\text{Fe}$? (10)
- Define each of the following using a statement or an equation: ionization energy, electron affinity, and atomic (covalent) radius. Draw a box that illustrates the arrangement of the representative elements in the periodic table with F at the top right and Cs at the bottom left. Use an arrow in each box that illustrates the trend in magnitude of each of the properties you have just defined?
 - Explain the anomalies that break the general trend in ionization energy for the second period representative elements Li through Ne? (10)
- Draw dot formulas including all important resonance forms for (a) BCl_3 , (b) NO_3^- , (c) XeO_3 , and (d) SnCl_2 ? (8)
- Predict the structure of the following molecules using VSEPR theory and identify the point group of each? (a) PCl_4F , (b) XeOF_4 , and (c) XeO_2F_2 ? (12)
- The nuclear decay process for ${}_{92}^{238}\text{U}$ includes the following unbalanced equations. Complete each equation.

$${}_{92}^{238}\text{U} \rightarrow ? + {}_2^4\alpha$$

$${}_{91}^{234}\text{Pa} \rightarrow {}_{92}^{234}\text{U} + ?$$
 - Briefly describe the preparation of deuterium? (8)
- What will be the predicted infrared absorption energy (cm^{-1}) of ${}^{13}\text{CO}$ if ${}^{12}\text{CO}$ has an absorption of $2,170 \text{ cm}^{-1}$?
 - Which is the stronger bond C-H or C-D? (10)
- Given that both ${}^{31}\text{P}$ and ${}^{19}\text{F}$ have 100% natural abundance and $I = \frac{1}{2}$, how would you expect the ${}^{31}\text{P}$ NMR spectrum of PF_5 to appear? How would the ${}^{19}\text{F}$ spectrum of the same compound appear?
 - ${}^{129}\text{Xe}$ has 26.4 % natural abundance with $I = \frac{1}{2}$ and the remaining isotopes are NMR silent. Draw an approximate spectrum for the ${}^{19}\text{F}$ NMR of XeF_2 (${}^{19}\text{F}$ has $I = \frac{1}{2}$ and $J_{\text{Xe-F}} = 3400 \text{ Hz}$)? (12)
- Using symmetry methods derive the MO scheme for BF_3 and identify the LUMO? The VSIE for B are $2s, -14 \text{ eV}$, and $2p, -8 \text{ eV}$. For the $1s$ electron of H the VSIE is -13.6 eV . (10)
- The compound $\text{Mn}(\text{CO})_5\text{I}$ has ligands CO and I located at the vertices of an octahedron (hint not O_h symmetry). Predict the number of infrared and raman bands that one might expect to observe in the carbonyl stretching region of the spectra? *I will correct your reducible representation during the exam so that you can proceed correctly if you have made an error at this point.* (11)
- Write the MO schemes $(\sigma_{2s})^2(\sigma_{2s}^*)^2 \dots$, and predict both the bond order and magnetic type for B_2 , N_2 , and O_2^{2-} ? (9)