1. a. Classify each of the following as molecular, ionic or other.

\[
\text{CF}_2\text{Cl}_2 \quad \text{CO}_2 \quad \text{KF} \quad \text{HNCl}_2 \quad \text{MgSO}_4 \quad \text{Xe} \quad \text{PF}_3 \quad \text{HOCl}
\]

b. Show the Lewis structure of each substance you classified as molecular. For ionic compounds, write charges on the cation and anion.

c. Give the total number of electrons in each compound.

d. Draw and name the VSEPR shape for molecular compounds.

e. Indicate whether the molecule is polar or nonpolar.

f. Name the dominant intermolecular force in each substance.

g. Place the compounds in order of increasing predicted melting point.

2. a. Draw the best Lewis structure for the appropriate substances or indicate the ions (with charges):

\[
\text{CF}_4 \quad \text{SeF}_4 \quad \text{NaBF}_4 \quad \text{H}_2\text{NOH} \quad \text{CaS} \quad \text{Ar} \quad \text{SO}_3 \quad \text{HOOH}
\]

b. Identify all of the intermolecular interactions that occur in the following (pure) compounds. Circle the strongest intermolecular force.

c. Place the compounds in order of decreasing predicted boiling point.

3. Rank the hydrocarbons: pentadecane, pentane, octadecane (all linear structures)

\[
C_{15}H_{32} \quad C_5H_{12} \quad C_{18}H_{38}
\]

in order of increasing:

a. viscosity

b. volatility

4. Classify the following solids as molecular, network (covalent), metallic, ionic or atomic.

a. benzene,

\[
\begin{array}{c}
\text{H} \\
\text{C} \\
\text{H} \\
\text{H} \\
\text{H} \\
\text{H} \\
\text{C} \\
\text{H} \\
\text{H} \\
\end{array}
\]

b. diamond

c. krypton
d. Cd
e. copper(II) chloride

f. ice
g. S\(_8\)
h. Mg\(_3\)(PO\(_4\))\(_2\)
i. quartz (SiO\(_2\))
j. P\(_4\)
5. For the two dimensional arrays shown below, draw a set of lattice points, a single primitive unit cell and a centered unit cell.

a. △ △ △ △ △
   △ △ △ △ △
   △ △ △ △ △
   △ △ △ △ △
   △ △ △ △ △

b. * * * * * * * * * *
   * * * * * * * * * *
   * * * * * * * * * *
   * * * * * * * * * *
   * * * * * * * * * *

6. How many whole atoms are in a primitive cubic unit cell?

7. How many whole atoms are in a body-centered cubic unit cell?

8. How many whole atoms are in a face-centered cubic unit cell?

9. Polonium crystallizes in a sc unit cell with a density of 9.20 g/cm³. Calculate the radius of a Po atom.

10. Copper crystallizes in a fcc unit cell, and has an atomic radius of 128 pm. Calculate the density of copper.

11. The radius of iron is 124 pm, and it crystallizes in a bcc unit cell, what is the volume of the unit cell?

12. For the heating curve below:

   ![Heating Curve Diagram]
13. Calculate the energy released when 12.76 g of CH$_2$FCF$_3$ goes from 0.0 °C to –75.0 °C.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>normal mp CH$_2$FCF$_3$(s)</td>
<td>–101.0 °C</td>
</tr>
<tr>
<td>normal bp CH$_2$FCF$_3$(l)</td>
<td>–26.6 °C</td>
</tr>
<tr>
<td>$\Delta H_{\text{vaporization}}$ CH$_2$FCF$_3$(l)</td>
<td>22.02 kJ/mole</td>
</tr>
<tr>
<td>s CH$_2$FCF$_3$(l)</td>
<td>1.423 J/g°C</td>
</tr>
<tr>
<td>s CH$_2$FCF$_3$(g)</td>
<td>0.875 J/g°C</td>
</tr>
</tbody>
</table>

14. Given the phase diagram of xenon, Xe, answer the following:

a. Estimate the normal boiling point of xenon.
b. Estimate the normal melting point of xenon.
c. Estimate the vapor pressure of Xe(l) at –110 °C.
d. Is Xe(l) or Xe(s) more dense? Explain.

15. Commercial concentrated ammonia is 28.0% NH$_3$ by mass. The density of the solution is 0.899 g/mL. Calculate:

a. the molarity of ammonia
b. the molality of ammonia
c. mole fraction of water
d. the vapor pressure of the solution at 100 °C (assume ammonia is non-volatile).
e. the freezing point of this solution
16. Calculate the difference in solubility of **nitrogen** (mole fraction in air = 0.78) in blood at sea level (P = 1.0 atm) versus 10 m underwater (P = 2.0 atm). Assume that blood is identical to water and $k_{N_2} = 7.0 \times 10^{-4}$ mole/L·atm.

17. Calculate the concentration of oxygen gas in water at sea level and 1.00 atm. The partial pressure of oxygen gas is 0.21 atm and Henry’s constant for oxygen (in water at RT) is $1.3 \times 10^{-2}$ M·atm$^{-1}$.

18. Is solid iodine (I$\text{}_2$), more soluble in benzene, or chloroform, CH$_3$Cl?

19. Name the intermolecular interaction that occurs between:
   a. ammonia and water
   b. cis-dichloroethylene Cl and bromoform (CHBr$_3$)
   c. CH$_3$F and Xe
   d. acetone, CH$_3$COCH$_3$ and water
   e. LiCl and water

20. Classify the following as molecular or ionic. How many **particles** will each form when dissolved in water?
   a. copper(II) chloride
   b. CH$_3$F
   c. Mg$_3$(PO$_4$)$_2$
   d. sucrose, C$_{12}$H$_{22}$O$_{11}$
   e. benzene, C$_6$H$_6$

21. A solution is prepared by dissolving 5.00 g of glucose, C$_6$H$_{12}$O$_6$, in 100.0 g of water. Calculate:
   a. the vapor pressure of water at 90 °C. The vapor pressure of **pure** water at 90 °C is 525.8 torr.
   b. the boiling point of the solution.

22. a. Calculate the freezing point of a solution of 2.00 moles of NaCl in 100.00 mL of water (density of water = 1.00 g/mL).
   b. Calculate the freezing point of a solution of 2.00 moles of CaCl$_2$ in 100.00 mL of water.