1. The face centered cubic cell of copper has an edge length of 0.362 nm. Calculate the density of copper (g/cm³).

2. Consider the following ionic substances and arrange them in order of increasing melting point. NaI, KI, LiCl. Explain your answer.

3. Which of the following has the highest normal boiling point? Why?
   a. CH₃ - N - CH₃
   b. CH₃ - CH₂ – OH
   c. CH₃ - CH₂ – F

4. Use the structure below to determine the number of Zinc and oxide ions in the unit cell. What type of unit cell do the oxide ions adopt?

5. Use the structure below to determine the number of cesium and chloride ions in the unit cell. What type of unit cell does this resemble?

6. List all types of IMFs that would occur in each of the following:
   a. CH₃CF₃
   b. CCl₄
   c. SO₂
   d. BrF
   e. (CH₃)₃N
   f. PCl₅

7. Of the major types of solids, which would you expect each of the following to form and what is the predominant force holding it together.
   A. graphite
   B. Na
   C. Si
   D. NaCl
   E. diamond
   F. Sn
   G. KCl
   H. F₂

8. Circle the substance that will best dissolve in the solvent indicated, and determine the Dominant IMF between the solvent and solute.

<table>
<thead>
<tr>
<th>Solvent</th>
<th>Substances</th>
<th>Dominant IMF between solvent and solute</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Water H₂O</td>
<td>CO₂ or CO</td>
<td></td>
</tr>
<tr>
<td>b. Benzene C₆H₆</td>
<td>NH₃ or CH₄</td>
<td></td>
</tr>
</tbody>
</table>

9. For each solid below, list the type of solid and the forces holding the solid together.
   a. BaO
   b. IBr
   c. Mg
   d. LiBr
10. Examine the following phase diagram and identify the feature represented by point A and point B.

11. Examine the following phase diagram and determine what phase exists at point F.

12. Select the pair of substances in which the one with the higher vapor pressure at a given temperature is listed first.
   A. C_7H_{16}, C_5H_{12}
   B. CCl_4, CBr_4
   C. H_2O, H_2S
   D. CH_3CH_2OH, CH_3-O-CH_3
   E. Xe, Kr

13. Consider the following phase diagram and identify the process occurring as one goes from point C to point D.

14. Strontium metal crystallizes in a cubic unit cell which has an edge length of 612 pm. If the density of Sr metal is 2.54 g/cm^3, calculate the number of atoms per unit cell. What type of unit cell is this?

15. Dichloromethane, CH_2Cl_2, is an organic solvent used for removing caffeine from coffee beans. The graph below shows the non-linear relationship between vapor pressure and temperature. Draw curves on the graph that represents methane (CH_4) and water.
16. Given the phase diagram below, answer the following questions.

![Phase Diagram](image)

(a) What phases exist at each point (A, B, C, D, and E) on the phase diagram above?

(b) Which point is the triple point?

(c) Which point is the critical point?

(d) If the current conditions are 25°C and 2000 torr, to what temperature would a sample have to be heated to produce liquid at 2000 torr?

(e) If the current conditions are 45°C and 500 torr, to what pressure would a sample have to be compressed to produce liquid at 45°C?

17. The heating curve of iron is shown below. How much heat (in kilojoules) is absorbed when 1.50 g of iron is heated from 1000.0°C to 2500.0°C?

Iron has the following enthalpy values: \( \Delta H_{\text{vap}} = 340 \text{ kJ/mol} \) \( \Delta H_{\text{fus}} = 13.81 \text{ kJ/mol} \).

Assume the specific heat for iron is the same for the solid, liquid, and gaseous states (0.448 J/g°C).

![Heating Curve](image)

21. If the two substances listed below in each case were interacting, what IMF would dominate the interaction?

- NH₃ and H₂O
- SO₂ and SO₂
- N₂ and H₂
22. Hydrochloric acid is sold as a concentrated aqueous solution. The molarity of commercial HCl (MM = 36.45 g/mol) is 12.0 mol/L, and its density is 1.18 g/mL. Fill out the table and then answer the question below.

<table>
<thead>
<tr>
<th>Solute</th>
<th>Relative Mass (g)</th>
<th># Moles</th>
<th>Volume (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solute</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solvent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solution (total)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Determine the Molarity, Normality, and Mass Percent of HCl in this solution.

23. Hydrogen peroxide is a powerful oxidizing agent that is used in concentrated solution in rocket fuel systems and in dilute solution as hair bleach. An aqueous solution of H\textsubscript{2}O\textsubscript{2} (MM = 34 g/mol) is 30.0% by mass and has a density of 1.11 g/mL. Determine the Solution Molarity (M).

24. Dimethylglyoxime, DMG, is an organic compound used to test for aqueous nickel(II) ions. A solution prepared by dissolving 65.0 g of DMG in 375 g of ethanol boils at 80.3°C. What is the molar mass of DMG? 

\[ K_b = 1.22°C/m, \text{ boiling point of pure ethanol = 78.5°C} \]

25. Benzaldehyde (MM = 106.1 g/mol), also known as oil of almonds, is used in the manufacture of dyes and perfumes and in flavorings. What would be the freezing point of a solution prepared by dissolving 75.00 g of benzaldehyde in 850.0 g of ethanol? 

\[ K_f = 1.99°C/m, \text{ freezing point of pure ethanol = -117.3°C} \]

26. Octane and nonane are liquids which are components of gasoline. Their vapor pressures at 25°C are 13.9 torr and 4.7 torr, respectively. What is the vapor pressure of a mixture consisting of 1.0 mole of each of these compounds?

27. 1.00 L of an aqueous solution contains 1.52 g of a covalent compound used in antifreeze. If the osmotic pressure of this solution at 20.0°C is 448 torr, calculate the molar mass of the antifreeze compound.

28. Calculate the vapor pressure of a solution prepared by dissolving 0.500 mol of a non-volatile solute in 275 g of hexane (MM = 86.18 g/mol) at 49.6°C. 

\[ P^o_{\text{hexane}} = 400.0 \text{ torr at 49.6°C} \]

29. The vapor pressure of acetone (CH\textsubscript{3}COCH\textsubscript{3}) at 25 °C is 271 torr and that of methanol is 143 torr. What is the vapor pressure of a solution that is 27.5 % methanol by mass in acetone as the solvent?

30. Iron (radius of 124 pm) may crystallize in either the body-centered cubic or face-centered cubic structures. You have a cube of iron that has a mass of 25.0 g and has a length of 1.47 cm. What type of unit cell does the iron in your sample adopt? (HINT: determine the density of iron if it is FCC and if it is BCC and compare to the actual density that you can calculate from the given data).

31. Describe how to make 100.0 mL of a 0.125M solution of potassium chromate from a 0.872 M potassium chromate.

32. Rank the following metals from highest to lowest melting points. Explain your answer. Rb, Sr, and Cs
Exam 3 Practice Problems Answers

1. 8.90 g/cm³
2. KI < NaI < LiCl Since all 3 of these solids are ionic solids, we must look at the charges and the distance between the ions. The charges are the same in all cases. Thus, we must look at the sizes of the ions. The smaller the ions, the smaller the distance between them, the stronger the bond, and the higher the melting point. Li⁺ and Cl⁻ are the smallest ions and K⁺ and I⁻ are the biggest.

3. B because it forms the strongest IMFs (H-bonds) while A and C just form the weaker dipole-dipole attractions.

4. 4 Zn²⁺ and 4 O²⁻; FCC
5. 1 Cs⁺ and 1 Cl⁻; BCC
6. a. dispersion, dipole-dipole b. dispersion c. dispersion, dipole-dipole d. dispersion, dipole-dipole e. dispersion, dipole-dipole f. dispersion

7.
A. Network; covalent bonds
B. Metallic; metallic bonds
C. Network; covalent bonds
D. Ionic; ionic bonds
E. Network; covalent bonds
F. Metallic; metallic bonds
G. Ionic; ionic bonds
H. Nonpolar molecular; LDFs

8.
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<td>NH₃ or CH₄</td>
<td>Dispersion</td>
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9. a. Ionic Solid; Ionic Bonds b. Polar Molecular; DDAs c. Metallic; Metallic Bonds
d. Ionic; Ionic Bonds
10. A – triple point and B – critical point
11. gas
12. B
13. Sublimation
14. 4 atoms; FCC
15. Since CH₄ is nonpolar, it has weaker IMFs and will have a higher vapor pressure at a given temperature (top line). Since water has H-bonds, it will have a lower vapor pressure at a given temperature (bottom line).
16. (a) What phases exist at each point (A, B, C, D, and E) on the phase diagram above?  
   A = solid + gas; B = solid + liquid + gas; C = liquid + gas; D = liquid + gas; E = solid + liquid  
(b) Which point is the triple point? B  
(c) Which point is the critical point? D  
(d) If the current conditions are 25°C and 2000 torr, to what temperature would a sample have to be  
   heated to produce liquid at 2000 torr? around 30°C  
(e) If the current conditions are 45°C and 500 torr, to what pressure would a sample have to be  
   compressed to produce liquid at 45°C? ~1700 torr  

17. 1.38kJ  

18. HF and CH₃OH  
   For H-bonding to occur, you must have a H bound to a very electronegative atom (H, F, or N). This is  
   not the case for HCl or CH₃CH₂OCH₂CH₃.  

19. F₂ < Cl₂ < HCl < HF  
   F₂ and Cl₂ have only dispersion forces present and they are ranked from smallest to largest size since  
   molecules with the more electrons are more polarizable. HCl, has stronger DDA forces, and HF has H-  
   bonding and hence has the strongest IMFs.  

20. Highest melting point. will be H₂Po, then H₂Te, then H₂Se, then H₂S. All have DDAs and LDFs. So,  
   they are ranked from largest to smallest size since the largest atoms with the most electrons are the  
   most polarizable and will have stronger LDFs  

21.  

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>NH₃ and H₂O</td>
</tr>
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</tr>
<tr>
<td>N₂ and H₂</td>
</tr>
</tbody>
</table>

22. 12.0 M, 12.0 N, 37.1%  
23. 9.79 M  
24. 117 g/mol  
25. -119.0°C  
26. 9.3 torr  
27. 62.1 g/mol  
28. 346 torr  
29. 219 torr  
30. BCC  

31. Use 14.3 mL 0.872 M potassium chromate and add water to get a total solution volume of 100.0 mL.  
32. Sr>Rb>Cs. Sr is the highest because it has the most number of bonding electrons. Rb and Cs have  
   the same number of bonding electrons, so we must look at the size. Since Rb is smaller, it has stronger  
   bonds and hence a higher melting point.