

- Notes from Progress Check 2:
 - 5000 cesium atoms can form 5000 molecular orbitals, 2500 orbitals of these will be populated by pairs of electrons
 - Explains conduction band (0 C all electrons are below this point but as things warm up they move above Fermi level to move electrons and positive holes)- section 13.3
 - Electrostatic and obey coulombs law; increase with smaller size, getting charges closer together, increasing the charge
 - Radius of ions: example 13.3
 - Thermochemical question (Hess's law)
 - 1 Atomization of sodium: solid to a gas; $\text{Na}_{(s)} \rightarrow \text{Na}_{(g)}$ $\Delta H = 107.3 \text{ kJ/mol}$
 - 2 Ionization energy of Na: $\text{Na}_{(g)} \rightarrow \text{Na}^+_{(g)} + e^-$ $\Delta H = 495.9$
 - 3 Formation of solid Na_2O : $2 \text{Na}_{(g)} + \frac{1}{2} \text{O}_{2(g)} \rightarrow \text{Na}_2\text{O}_{(s)}$ $\Delta H_f = -418$
 - 4 Formation of O (g) from $\text{O}_{2(g)}$: $\frac{1}{2} \text{O}_{2(g)} \rightarrow \text{O}_{(g)}$ $\Delta H_f = 249.1$
 - 5 First e- attachment enthalpy of O: $\text{O}_{(g)} + e^- \rightarrow \text{O}^-_{(g)}$ $\Delta H = -141.0$
 - 6 Lattice energy; $2\text{Na}^+_{(g)} + \text{O}^{2-}_{(g)} \rightarrow \text{Na}_2\text{O}$ $\Delta H_{\text{lat}} = -2481$
 - Want to know: $\text{O}^- + e^- \rightarrow \text{O}^{2-}$ $\Delta H = ?$
- Flip 5: $\Delta H = + 141.0$
 Flip 4: $\Delta H = -249.1$
 Keep 3: $\Delta H = -418$
 Flip 6: $\Delta H = 2481$
 Flip and double 1: $\Delta H = 2(-107.3)$
 Flip and double 2: $\Delta H = 2(-495.9)$
 End up with: $\text{O}^-_{(g)} + e^- \rightarrow \text{O}^{2-}_{(g)}$ $\Delta H =$
- Formation reaction (endo or exo): reaction that produces 1 mol of the product

Making ice cream

- Have to use a lot of salt: lowered freezing point of water below its normal freezing point; super-cooled water & salt solution
 - Same reason we throw salt on roads; ice melts because it has a lower melting point; hopefully it evaporates quickly before it refreezes

Colligative properties:

- Clicker: Physical characteristics of a solution that depend on
 - A the types of particles in the solution
 - B** the concentration of particles in the solution
 - C the types and concentrations of particles in solution
- Colligative properties: physical characteristic of a solution that depend on concentration of particles in solution and not on their identity
 - Slight variability based on what the particles are
 - If replacing to solute-solvent that is much stronger or weaker: little bit of a variability but is very small (usually 0.5%)
 - Can be held as pretty much true
- Colligative properties include:

- o Vapor pressure lowering
- o Boiling point elevation
- o Freezing point depression
- o Osmotic pressure
- Vapor pressure lowering:
 - o Consider a solution where 85% of the molecules are solvent (other 15% are solute)
 - o Vapor pressure occurs of dynamic equilibrium between solvent particles in liquid phase and solvent particles in the gas phase
 - o Solute only exists in liquid phase
 - o Changed the number of particles that can get into the gas phase; actually at surface of liquid that could get into gas phase but they have to have the energy to get there
 - o Decreased rate of liquid going into gas phase which lowers vapor pressure
 - o Clicker: what is the vapor pressure of a solution that is 30.3% w/w ethylene glycol (MW = 62.07 g/mol) in water at 90 C. The vapor pressure of pure water is 525.8 torr at 90 C.
 - $P_{\text{solvent}} = X_{\text{solvent}} P^{\circ}_{\text{solvent}}$
 - Assume 100 g solution \rightarrow 30.3 g ethylene glycol & 69.7 g water
 - $X = \text{mol A} / \text{total mol solution}$; so you have to convert masses to moles
 - 0.488 mol ethylene glycol & 3.87 mol water (total = 4.36 mol)
 - $X_{\text{H}_2\text{O}} = 3.87 \text{ mol} / 4.36 \text{ mol} = 0.888$
 - $P_{\text{H}_2\text{O}} = (0.888)(525.8 \text{ torr}) = 466.7 \text{ torr}$
 - o Assumptions based on what is given:
 - Molar: L of solution
 - % by weight (w/w): 100 g
 - Molal: kg of solvent
 - % weight by volume: 100 mL
 - Need density to convert L of solution to mass of solution

Clicker: Eugenol, a compound found in nutmeg and cloves, has the formula $\text{C}_{10}\text{H}_{12}\text{O}_2$. What is the boiling point of a solution containing 0.144 g of eugenol dissolved in 10.0 g of benzene? The K_{bp} for benzene is $+2.53 \text{ }^{\circ}\text{C}/m$ and the normal boiling point is $80.10 \text{ }^{\circ}\text{C}$.

- o $T_{\text{bp}} = K_{\text{bp}} \times m$
- o $0.00088 \text{ mol}/0.01 \text{ kg} = 0.088 \text{ } m \times 2.53 = 0.22 \text{ }^{\circ}\text{C}$
- o $80.10 \text{ }^{\circ}\text{C} + 0.22 \text{ }^{\circ}\text{C} = 80.32 \text{ }^{\circ}\text{C}$

Clicker: Today's lowest temp in Athens was $12 \text{ }^{\circ}\text{F}$ ($-11 \text{ }^{\circ}\text{C}$). What is the minimum concentration for the radiator fluid in your car so that the solution doesn't freeze? Radiator fluid is ethylene glycol (MW 62.07 g/mol) dissolved in water. The K_{fp} for water is $-1.86 \text{ }^{\circ}\text{C}/m$.

- o $T_{\text{f}} = -11 \text{ }^{\circ}\text{C}$ $\Delta T_{\text{f}} = -11 \text{ }^{\circ}\text{C}$
- o $m = -11 \text{ }^{\circ}\text{C} / (-1.86 \text{ }^{\circ}\text{C}/m) = 5.91 \text{ } m \text{ (mol/L)}$

Osmotic Pressure

- water flows from region of low solute concentration (high water concentration) to region of high solute concentration (low water concentration)
- push down tube to keep water from flowing into the bag
- water flows from low osmotic pressure to high osmotic pressure

- amount of pressure that needs to be applied to stop that flow (can be enough to make flow go the opposite direction)