Colligative Properties Homework

Explain what happens when a substance dissolves in water. Be sure to mention the forces involved as the substance goes into solution.

When a substance dissolves in water, the water molecules are strongly attracted (not bonded) to the solute particles by intermolecular forces. These IMF's cause the water molecules to surround the solute particles and carry them off into solution.

Why does oil not dissolve in water?

Oil does not dissolve in water because the polar water molecules are not attracted strongly enough to the nonpolar oil molecules to allow the water to dissolve the oil

What do you know to be true about a substance that does dissolve in water?

If a substance dissolves in water we know that the substance is polar.

How can we be sure that a substance that dissolves in water will decrease its freezing point and increase its boiling point?

If order for a substance to dissolve in water it must form strong intermolecular attractions with the water molecules. These strong intermolecular attractions then cause the boiling point to increase and the freezing point to decrease.

Why does a solute cause the boiling point of water to increase?

A solute cause the boiling point of water to increase because the water is strongly attracted to the solute particles. These strong attractions are more difficult to break, making it harder for the water to boil. As a result, the water must be heated to a higher temperature to get the water to boil.

Why does a solute cause the freezing point of water to decrease?

A solute cause the freezing point of water to decrease because the water is strongly attracted to the solute particles. These strong attractions are more difficult to break, making it harder for the water to join together and freeze. As a result, the water must be cooled to a lower temperature to get the water to freeze.

Why do we spread salt on our icy roads in the winter time? At a molecular level, why does this work?

We spread salt on our icy roads to melt the ice. At molecular level, the salt ions are strongly attracted to the water molecules in the ice crystals, disrupting the crystal and causing it to melt.

The radiator in your car is filled with a solution of water and ethylene glycol (anti-freeze). Explain why adding the antifreeze provides advantages over filling your radiator with pure water.

Pure water freezes at 0˚C and boils at 100˚C, both temperatures which occur frequently in the normal operation of a car. In either case, ice or steam is not able to cool the engine of the car, causing problems. Adding a solute (anti-freeze) to the water makes the freezing point go down and the boiling point go up, which makes the solution in your cooling system more likely to remain a liquid a broader range of temperatures.

Given the chart at right (from the back of an antifreeze container) how much antifreeze must be added to a 16 quart cooling system to protect the radiator down to -19˚F?

From the chart below, to protect a 16 quart cooling system down to -19˚F, 7 quarts of antifreeze must be added.

Given the chart at right, does antifreeze (along with the 15psi pressure cap mentioned) provide greater protection from freezing or boiling?

Given the data at the bottom of the chart, regardless of how much antifreeze you add (50%, 60%, 70%) the freezing point goes down more from 32˚F than the boiling point goes up from 212˚F, meaning antifreeze provides great freezing protection than boiling protection.

PEAK® ANTIFREEZE & COOLANT MEANS MAXIMUM SEVERE CONDITIONS PROTECTION

Cooling System Capacity in Quarts	Quarts of Antifreeze Required for Protection to Temperatures (˚F) Shown								
	3	4	5	6	7	8	9	10	11
8	-7	-34	-69						
9	0	-21	-50	-70					
10	4	-12	-34	-62					
11	8	-6	-23	-47	-65				
12	10	0	-15	-34	-57				
13		3	-9	-25	-45	-64			
14		6	-5	-18	-34	-54	-68		
15		8	0	-12	-26	-43	-62		
16		10	2	-8	-19	-34	-52	-64	
17			5	-4	-14	-27	-42	-58	-69
18			7	0	-10	-21	-34	-50	-62
19			9	2	-7	-16	-28	-42	-56
20			10	4	-3	-12	-22	-34	-48

For best overall protection, solution strengths within the yellow color band are recommended.

FREEZE/BOIL PROTECTION CHART *Using a 15 PSI Pressure Cap	% of Cooling System Capacity	PROTECTS FROM	
		Freezing Down to	Boiling Up to*
	50	-34˚F	265˚F
	60	-62˚F	270˚F
	70	-84˚F	276˚F

What roles does the 15psi pressure cap play in your car's cooling system?

The pressure cap on the radiator traps the solution in the cooling system, causing the pressure on the solution. This increase in pressure causes the boiling point to increase, allowing the solution to better cool the engine.