All of this is intended to be done without the aid of a calculator. All of the calculations are designed such that approximating should be straight-forward and produce a correct result.

1. Based on the physical constants involved, which colligative property has the greatest magnitude for a solution of a given concentration? Which can't be compared in this way? Why?

2. Which colligative properties have a linear concentration dependence? Write their equations.

3. Rank the following aqueous solutions in terms of increasing boiling point: 3 *m* sugar, 2 *m* NaCl, 0.5 *m* $Mg(OH)_2$, 5 *m* AlN, 1 *m* urea.

4. Assuming a cell wall can withstand an osmotic pressure of 1 atmosphere and the concentration of Na^+ in a cell is 50 mM, approximate the $[Na^+]$ outside the cell that would cause lysis.

5. If you dissolved 28 grams of NaCl in 90 grams of pure H_20 hot enough to have a vapor pressure of 30 torr, what will the new vapor pressure be?

6. Assuming standard conditions and a $K_f = 0.2\ K{\cdot}m^{-1}$ and a $K_b = 0.5\ K{\cdot}m^{-1}$ for water, what would be the freezing point of a solution that boiled at 375.5 K? Express your answer in both K and °C.

7. Based on the question above and assuming 1 kg of water, how many moles of NaCl would be needed to produce this effect? What about sugar?

8. Based on you understanding of boiling point elevation, why **doesn't** salting water help food to cook faster?

9. Vapor pressure is often described as a "surface phenomenon." Define this term in your own words to the best of your ability.

10. Raoult's can be used to calculate the decrease in vapor pressure when a non-volatile substance (like salt) is dissolved in a volatile substance (like water). Explain this phenomenon.

11. Write a mass action quotient (aka mass action expression) for the general equation below:
aA + bB -> cC + dD

12. What sort of mathematical relationship exists between ΔG and K? Which of these terms should have a wider range of possible values?

13. What is the difference between Q and K?

14. What can you for certain about ΔG when K is less than 1, equal to 1 or greater than 1?

15. Based on your answer to question 14, what does the value of K tell you about the spontaneity of a reaction?

16. If a given reaction has K = 10, and presently has a Q = 5, what must happen in order for the reaction to reach equilibrium?

17. Based on your understanding of reaction stoichiometry, complete the RICE diagram below by filling in the blank regions.

Reaction	$CH_4(g)$ +	2 $O_2(g)$ ---->	$CO_2(g)$ +	2 $H_2O(g)$
Initial	10 moles	19 moles		
Change				
Equilibrium	1 mol		10 moles	25 moles

18. Write a mass action quotient and determine K for the reaction in question 17.
$K = [CO2]\cdot[H2O]^2 / [CH4]\cdot[O2]^2 = 10\cdot25^2 / 1\cdot1^2 = 6{,}250$

19. If the equilibrium established in question 17 were disturbed by the addition of 90 moles of CO_2, what would the value of Q then be? Fill in a new RICE diagram, using X for unknown values.

Reaction	$CH_4(g)$ +	2 $O_2(g)$ ---->	$CO_2(g)$ +	2 $H_2O(g)$
Initial				
Change				
Equilibrium				

20. How will the system respond to the stress in question 19 in order to re-establish equilibrium?