1. Rearrange the Gibbs free energy equation ($\Delta G = \Delta H - T\Delta S$) to solve for the temperature at a phase transition.

a. $T = (\Delta H - \Delta G)/\Delta S$
b. $T = \Delta H/\Delta S$
c. $T = -\Delta G$
d. $T = -\Delta G/\Delta S$

2. What will happen to vapor pressure when non-volatile solute A is added to a pure solution B?

a. Vapor pressure of A increases
b. Vapor pressure of B decreases
c. Vapor pressure doesn't change
d. Boiling point decreases of A inrcreases.
e. Boiling point of B decreases

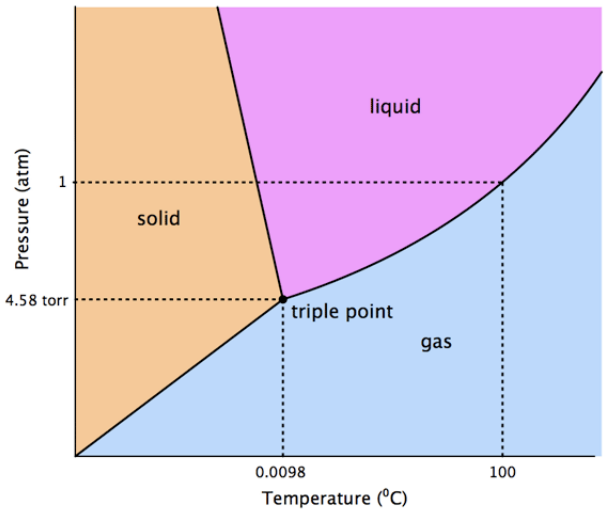
3. Rank the following salts from least to most soluble based on their $\Delta H_{hydration}$: Al^{3+}, 4800 kJ; I^-, 244 kJ; K^+, 350 kJ; Br^-, 284 kJ.

a. $K^+ < I^- <$ Br- < Al3+
b. Al^{3+} < K+ < Br- < I-
c. $I^- < Br^- < K^+ < Al^{3+}$
d. All ions are equally soluble.

4. Which of the following is always true for phase diagrams?

a. The slope of the melting curve is always positive
b. The critical point will have a lower pressure than the triple point
c. Only one phase exists on a phase boundary
d. When going from left to right on the graph, pressure and temperature both increase along the condensation curve
e. The critical point can be reached at 0K

5. At what temperature will water boil on top of a mountain when normal boiling point is 100C at 1 atm. (You should not need to look at this graph to answer the question)



a. Below 100C
b. 100C

c. Above 100C
d. Water will not boil

6. Consider a 27 g sample of ice at 1 atm. Initially, the sample is frozen at -20 °C. How much heat must be added to the sample for it to become a liquid at 78 °C. Heat capacity of ice: 2 J/gK. Heat capacity of water: 4 J/gK. ΔH of melting: 330 J/g

a. 9.5 kJ
b. *18.4 kJ*
c. *5.3 kJ*
d. *10.6 kJ*

7. As the temperature of a solvent (increases/decreases), the solubility of (some/all) gases increases.

a. decreases, all
b. increases, some
c. decreases, some
d. increases, all

8. Rank the following liquids from least to most miscible in H_2O_2: H_2O, C_2H_6, CH_2Cl_2.

a. H_2O, CH_2Cl_2, C_2H_6
b. CH_2Cl_2, C_2H_6, H_2O
c. C_2H_6, H_2O, CH_2Cl_2
d. C_2H_6, CH_2Cl_2, H_2O

9. If a liquid has a vapor pressure of 13.5 atm at 10C what will the temperature be when it has a vapor pressure of 5 atm?

a. Below 10C
b. Above 283K
c. 283K
d. Cannot determine without heat of vaporization

10. Which solution will have a higher boiling point elevation: 2 moles glycerine in 500g water, 16.4g $Ca(NO_3)_2$ in 0.1 kg water, .0746 kg KCl in 1L water.

a. KCl
b. Ca(NO3)2
c. Glycerine
d. All raise BP equally
e. KCl and $Ca(NO_3)_2$ equally raise BP

11. If .5 moles of compound A are added to a liter of gas with 2 moles of compound B how will the total vapor pressure change? The pure vapor pressures for A and B are 100 torr and 50 torr respectively.

a. Increase by 100 torr
b. Decrease by 20 torr
c. Will remain the same
d. Increase by 70 torr
e. Decrease by 100 torr
f. Increase by 20 torr

12. Calculate the molar mass of a mysterious substance if a sample of 10g has an osmotic pressure of 2 atm in 2L of water at room temperature. (RT = 25)

a. 0.1 g/mol
b. 1 g/mol
c. 10 g/mol

d. 100 g/mol

13. Which of the following concerning the boiling point elevation of water mixtures is correct? (K_b = 0.5 K/molal)

a. 1 mole of $CaCl_2$ in 1 kg of water boils at 98.5 °C
b. 2 moles of urea in 400 g of water boils at 101 °C
c. 0.5 moles of sucrose in 2.5 kg of water boils at 99.9 °C
d. 116 g NaCl in 200 mL water boils at 110 °C

14. Determine the correct equilibrium expression for the reaction of hydrogen gas with nitrogen gas to produce ammonia.

a. $K_p = \{P_{(N2)} P^2_{(H2)}\} / P^3_{(NH3)}$
b. $K_p = P^3_{(NH3)} / \{P_{(N2)} P^2_{(H2)}\}$
c. $K_c = [NH_3]^2 / \{[N_2][H_2]^3\}$
d. $K_c = \{[N_2][H_2]^2\} / [NH_3]^3$

15. Consider the following reaction:

$C_2H_4(g) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 2\ H_2O(l)$

Initial concentrations of C_2H_4, O_2, and CO_2 are 7, 20 and 188 M, respectively. If K = 5 x 10^3, calculate the equilibrium concentrations for the compounds C_2H_4, O_2 and CO_2, respectively.

a. 1, 12, and 192 M
b. 2, 4, and 800 M
c. 1, 2, and 200 M
d. 2, 5, and 198 M

15, Consider the following reaction:

$CH_3OH(l) + O_2(g) \rightarrow CO(g) + 2\ H_2O(g)$

There is excess methanol and the initial partial pressures of O_2, CO, and H_2O are 11, 0, and 0 atm. If K = 4000, calculate the equilibrium pressures for the compounds O_2, CO, and H_2O.

a. 1, 10, and 20 atm
b. 11, 0, 0 atm
c. 5, 6, 12 atm
d. 0, 11, 22 atm
e. 6, 5, 10 atm

17. Consider the following reaction:

$A(aq) + 2\ B(g) \rightarrow 3\ C(aq) + 4\ D(s)$

The equilibrium constant, K, is 50. If the initial concentrations of A, B, C, and D are 10, 10, .1, and 100, respectively, which of the following will occur?

a. The reaction will proceed to the right.
b. The reaction will proceed to the left.
c. Nothing will happen because the reaction is already at equilibrium
d. Not enough information has been give

18. Let's reconsider the combustion of ethene from question 16. ΔH for this reaction is -42 kJ/mol. Which of the following statements is/are true?

I. Increasing the concentration of water will shift the reaction to the left.
II. Increasing the pressure will shift the reaction to the right.
III. Increasing the temperature will shift the reaction to the left.
IV. Increasing the concentration of O2 will shift the reaction to the right.

a. I only

b. II only
c. III only
d. II, III, and IV
e. II and III
f. I and IV

19. Consider the following endothermic reaction:
O2 (aq) --> O2(g)
Choose the best option.
a. Changing the volume of the system will not affect equilibrium.
b. Increasing the pressure will shift the reaction to the left.
c. Increasing the temperature will shift the reaction to the right.
d. a and c
e. b and c

20. For any endothermic reaction, K (increases/decreases) as temperature increases. For any exothermic reaction, K (increases/decreases) as the temperature increases.
a. increases, increases
b. increases, decreases
c. decreases, decreases
d. increases, decreases

21. If ΔG is negative, as the magnitude of ΔG increases, K (increases/decreases) with a (linear/exponential) relationship to ΔG. If ΔG is positive, K will always be (greater/less) than 1.
a. increases, linear, less
b. increases, exponential, less
c. decreases, exponential, greater
d. decreases, linear, greater

22. Which of the following statements is false?
a. Auto-protolysis of water results in the formation of a hydronium ion and a hydroxide ion.
b. Auto-protolysis of water increases as temperature increases
c. The pH of water is 7 only when the temperature is near 25 °C.
d. As the temperature of pure water is increased, the pH of the water increases.

23. At 25 °C, the equilibrium constant, Kw, is about equal to 1.008 x 10^-14. Which of the following values for Kw is plausible at 100 °C?
a. 0.114 x 10^-14
b. .681 x 10^-14
c. 1.008 x 10^-14
d. 51.3 x10^-14

24. Determine the molar solubility of calcium fluoride, CaF_2, if $K_{sp} = 4 \times 10^{-27}$.
a. 10^-9 M
b. 4 x 10^-27 M
c. 10^-15 M
d. 4 x 10^-15 M

25. Consider the following table of salts and their Ksp values at 25 °C.

Salt	K_{sp}
PbS	10^{-28}
$CaCO_3$	10^{-10}

MgF_2 10^{-4}
$Fe(OH)_3$ 10^{-40}

Rank the salts by increasing solubility in water.
a. MgF_2 < CaCO3 < PbS < Fe(OH)3
b. $Fe(OH)_3$ < PbS < CaCO3 < MgF2
c. $Fe(OH)_3$ < CaCO3 < MgF2 < PbS
d. PbS < MgF_2 < CaCO3 < Fe(OH)3

26. Which set of pH and [OH-] values is possible?
a. pH = 6, [OH-] = 10^-6
b. pH = 5, [OH-] = 10^9
c. pH = 4, [OH-] = 10^-10
d. pH = 3, [OH-] = 10^3

27. Consider the following table of bases and their K_a values.

Base	Ka
HCOO-	10^-3
C5H5N	10^-5
NH3	10^-9
CH3COO-	10^-4

Rank the compounds by increasing basicity.
a. CH3COO- < HCOO- < C5H5N < NH3
b. NH3 < C5H5N < CH3COO- < HCOO-
c. NH3 < C5H5N < HCOO- < CH3COO-
d. HCOO- < CH3COO- < C5H5N < NH3

28. You have 109.5 g of HCl. How much water would you dissolve the hydrochloric acid in to make a solution with a pH of 2?
a. 150 L
b. 1.5 L
c. 300 L
d. 100 L

29. At 30 °C, what is the pH of a .5 M solution of ammonia? The Kb of ammonia at 30 °C is 2 x 10^-8.
a. 4
b. 10
c. 5
d. 9

30. At 30 °C, you dissolve 1 mole of acetic acid in 10 L of water. What is the pH of the solution? The pKa of acetic acid at 30 °C is 3.
a. 2
b. 12
c. 1.5
d. 12.5