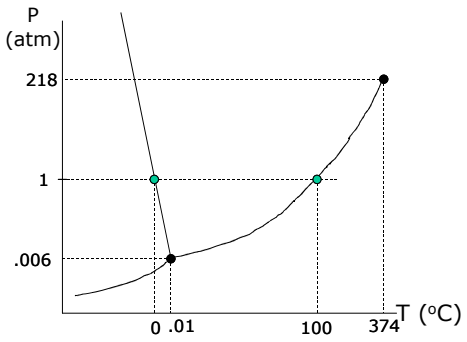
1. C
2. B
3. D
4. C
5. B
6. C
7. B
8. B
9. A
10. B
11. B
12. A
13. C
14. A
15. C
16. A
17. B
18. A

19. a) $K = \frac{[H_2][I_2]}{[HI]^2}$ b) $K = \frac{[Ca^{2+}][HF]^2}{[H^{1+}]^2}$

20. $1.50\,L \times \frac{0.55\,mol}{1\,L} \times \frac{164\,g}{1\,mol}$

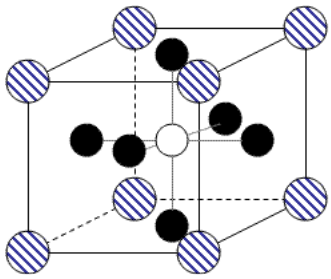
1. Consider the phase diagram for water, shown at the right and select the best statement:



A) starting at 50 °C and 1 atm, as the pressure is decreased, the material will freeze
B) starting at 0 °C and 0.5 atm, as pressure is increased, the material will condense
C) starting at 50 °C and 2 atm, as the temperature is increased, the material will boil
D) all of these will happen
E) none of these will happen

2. Select the best statement regarding cubic unit cells
A) The face centered cubic has the largest coordination number and the least packing efficiency
B) The face centered cubic has the largest coordination number and the greatest packing efficiency
C) The simple cubic has the smallest coordination number and the greatest packing efficiency
D) The simple cubic has the largest coordination number and greatest packing efficiency
E) The body centered cubic has the smallest coordination number and the least packing efficiency

3. The picture at the right shows a unit cell of a compound made up of Na (white spheres), O (black spheres) and W (striped gray spheres). What is the chemical formula of this compound?



A) NaO_8W_6 B) NaO_6W C) NaO_3W_2
D) NaO_3W E) NaO_6W_2

4. Note the following melting points (here, Ge is considered to be a non-metal):
$GeOCl_2$: -56 °C GeO_2 : 1115 °C GeH_4 : -165 °C $GeCl_4$: -49 °C
In their solid state, how many of these materials would be molecular solids?
A) 1 B) 2 C) 3 D) 4 E) 0

5. Select the material with the lowest melting point
A) $COCl_2$ (C is central) B) Ar C) HF D) SO_3 E) SiO_2

6. Consider the following reaction:
$2\ Co_2O_3(s) + 3\ C(s) \rightarrow 4\ Co(s) + 3\ CO_2(g)$
If 6 moles of Co_2O_3 react with 6 moles of C, how many moles of Co can be formed?
A) 4 B) 6 C) 8 D) 12 E) 24

7. If the reaction in the previous question is endothermic, what can you say about the spontaneity?
A) The reaction is spontaneous at both high and low temperature
B) The reaction is spontaneous at high temperature, but non-spontaneous at low temperature
C) The reaction is non-spontaneous at high temperature, but spontaneous at *low* temperature
D) The reaction is non-spontaneous at both high and low temperature

8. A system's energy will increase when the system:
A) absorbs heat and does work
B) absorbs heat and has work done on it
C) releases heat and does work
D) releases heat and has work done on it

9. When water freezes,
   A) the value of ΔH is negative and the value of ΔS is negative
   B) the value of ΔH is negative and the value of ΔS is positive
   C) the value of ΔH is positive and the value of ΔS is negative
   D) the value of ΔH is positive and the value of ΔS is positive

10. During a reaction, a stronger bond breaks and a weaker bond forms. This reaction is most likely:
   A) exothermic
   B) endothermic

11. Which of the following three statements describe a reaction at equilibrium?
   #1) The rates of the forward and reverse reactions are equal
   #2) The amounts of reactants and products are equal
   #3) The amounts of reactants and products are no longer changing

   A) #1 and #2 B) #1 and #3 C) #2 and #3 D) #2 only E) all three

12. Which of the following factors does NOT dictate reaction rates:
   A) ΔH^o
   B) activation energy
   C) orientation of reacting molecules
   D) temperature
   E) concentration of reactants and products

13. What is the difference between ΔG and ΔG^o?
   A) ΔG^o is specifically for 0 ^oC, ΔG is for unspecified temperature
   B) ΔG gives the spontaneity of a reaction, ΔG^o does not
   C) ΔG^o is for specific amounts of reactant and product, ΔG is for unspecified amounts
   D) for a given reaction, they will be of opposite signs
   E) ΔG includes entropy, ΔG^o does not

14. Given this reaction: $A(g) \rightleftarrows B(g)$ Starting with equal amounts of A and B,
   if the rate of the forward reaction is greater than the rate of the reverse, then when the reaction reaches equilibrium:
   A) $K > 1$ B) $K = 1$ C) $K < 1$

15. Given this reaction: $C(g) \rightleftarrows D(g)$ where the reaction is exothermic
   When the reaction reaches equilibrium, then:
   A) $E_a(f)$ will be greater than $E_a(r)$
   B) $E_a(f)$ and $E_a(r)$ will be equal
   C) $E_a(f)$ will be less than $E_a(r)$

16. You are in charge of the following equilibrium:
   $4\ NH_3(g) + 5\ O_2(g) \rightleftarrows 4\ NO(g) + 6\ H_2O(g)$ $\Delta H = -908$ kJ
   If you want to increase the amount of O_2 present, you would
   A) add H_2O and increase the temperature
   B) add H_2O and decrease the temperature
   C) remove H_2O and increase the temperature
   D) remove H_2O and decrease the temperature

17. When one mole of dinitrogen reacts with one mole of dioxygen to produce two moles of nitrogen oxide, the value of ΔH is +200 kJ.
What is ΔH for the following reaction?

$4\ NO \rightarrow 2\ N_2 + 2\ O_2$

A) –200 kJ B) –400 kJ C) +200 kJ D) +400 kJ

18. Which of the following statements is true concerning the solution process?
A) When intermolecular interactions in the solute are broken, energy is absorbed; when solute particles enter solvent cavities, energy is released
B) When intermolecular interactions in the solute are broken, energy is absorbed; when solute particles enter solvent cavities, energy is absorbed
C) When intermolecular interactions in the solute are broken, energy is released; when solute particles enter solvent cavities, energy is released
D) When intermolecular interactions in the solute are broken, energy is released; when solute particles enter solvent cavities, energy is absorbed

PLACE YOUR ANSWERS FOR #19-20 DIRECTLY ON THIS PAPER

19. (5 points each) In the space below each chemical equation, write an expression for K for each of the following equilibria:

a) $2\ HI(g) \rightleftarrows H_2(g) + I_2(g)$

b) $CaF_2(s) + 2\ H^{1+}(aq) \rightleftarrows Ca^{2+}(aq) + 2\ HF(aq)$

20. (10 points) **SET UP this problem,** showing the numbers you would use. You will be graded on your setup, not a final answer. How many grams of $Ca(NO_3)_2$ (M_m = 164 g/mol) are required to make 1500 mL of 0.55 M solution?