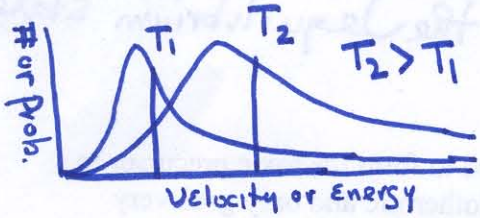
EXAM 3 (Chemistry 1211) KEY

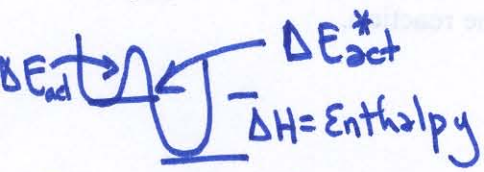
NAME: Print _____ Sign _____

1) Temperature is the result of the Boltzmann distribution of the velocities or energies of molecules/atoms. What does this distribution look like; and how does it change when the temperature goes up or down. *Be specific here! (10 points)*



The distribution widens and shifts to right (higher energy) as Temperature increases More and more molecules that are in bi have "high" energy as T increases

2) The enthalpy of a reaction influences the likelihood (direction) of a reaction. What **added** factor most directly influences the RATE of a reaction? *Describe in words in graphically. (10 points)*



$\Delta E_{act} \equiv$ Barrier

For Reverse reaction the barrier ΔE^*_{act} is the sum of ΔE_{act} (forward) plus the ΔH. For exothermic reaction this sum is greater (larger barrier) – slower rate

3) How is this factor also influenced by Enthalpy ΔH **when** we are look at the **backwards** reaction. *Describe in words in graphically. (10 points)*

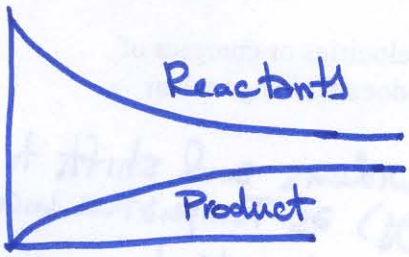
(See above)

ΔE^*_{act} (reverse) is the sum of ΔE_{act} (forward) + ΔH

4) Reactions go both forward and backwards to the extent of their reaction rates. Why are strongly EXOTHERMIC reactions most likely NOT to reach equilibrium in a long long time. (10 points)

The backward reaction is very slow since the barrier and subsequent # of molecules able to overcome this barrier is small.

5) What does EQUILIBRIUM mean? If we begin with only reactants and no products. Draw a plot that would demonstrate what would happen when as one achieves equilibrium. (10 points)



← reaches a steady level which defines the equilibrium state

6) Consider the reaction of Laughing Gas (N_2O) oxidized to form the toxic precursor to nitric acid, nitrogen dioxide. Luckily this reaction is endothermic and only goes very slightly to the right in the absence heat. (20 points)

Q + $2N_2O + 3O_2 \rightleftharpoons 4NO_2$

a) Balance this reaction and then show the equation for K_{eq} for the reaction.

$$K_{eq} = \frac{[NO_2]^4}{[N_2O]^2[O_2]^3}$$

b) If after many many hours it was found that the concentration a vessel equilibrated in which there was 0.1M in both N_2O and O_2 and a concentration of 10^{-10} M NO_2; what would be the Equilibrium Concentration K_{eq} *Be careful here*

$$\frac{[10^{-10}]^4}{[.1]^2[.1]^3} = \frac{10^{-40}}{10^{-5}} = 10^{-35} = K_{eq}$$

c) Show diagrammatically why the fact that this reaction is ENDOTHERMIC favors having a very small K_{eq} HINT: What does having a small number mean?

When Endothermic the barrier for reverse reaction is smaller than forward reaction – thus rate of backward reaction is larger and somewhat comparable with forward reaction thus ratio of reactants to products is similar. Small # means few product molecules since they went back to reactants.

d) If I heated this reaction what would you expected to happen here?

LeChatelier principle tells us that heating reaction will shift it to the right. (more product)

7) What happens when one introduces a CATALYSIS or ENZYME to a reaction system? Explain in words and graphically. (10 points)

Both Catalysis & Enzymes lower the ΔE_{act} allowing both forward and backward reactions to go more quickly.

11) A 2.0 L containing Argon gas is heated from 300K to 450K. If the initial pressure where 2.4 atmospheres, what would be the final pressure. (10 points)

$$\frac{P_1V_1}{\cancel{n_1}T_1} = \frac{P_2V_2}{\cancel{n_1}T_2} \qquad \frac{(2.4)(\cancel{2.0})}{300} = \frac{(P_2)(\cancel{2.0})}{450}$$

$$P_2 = \frac{(2.4)(450)}{300} = 3.6 \text{ atm}$$

12) When a Helium balloon is filled in a warm environment and then taken outside into the cold, (20 points)

a) What will happen to the balloon? Illustrate using the Ideal gas law.

$PV = nRT$ The ballon will decrease in size Smaller V since at same n and P; decreasing T will decrease V

b) When taken back into a warm environment, what will then happen?

As we return to higher temperature Increase in T will result in an increase in V Balloon will expand.

c & d) If the balloon where released into the atmosphere and it rose, why would it rise and what would happen to the balloon as it rose.

(a) Helium has a lower density than air thus will rise

(b) The balloon will rise and at lower pressures the balloon will expand. UNTIL it will burst!

8) What volume would ANY ONE MOLE of gas occupy at standard temperature (0 C) and pressure (1 atm) (10 points)

22.4 liters

$$V = \frac{nRT}{P} = \frac{(1)(.0821)(273)}{1}$$

9) What would be the **Pressure** (in torr) of 24.0 grams of N_2 gas contained in a 300 ml container at 35°C? (10 points)

$$P = \frac{nRT}{V} = \frac{\left(\frac{24}{28}\right)(.0821)(273+35)}{0.3L}$$

$$= 72.32 \text{ atm} = 54,910 \text{ torr}$$

10) Pressure: (20 points)

a) Describe what pressure really is and how it is influenced by the air around us.

Is the force per unit area exerted by all of the AIR above us. If we were under water it would be the sum of both the air + water above us.

b) If suddenly the concentration of CO_2 gas were increased to equivalently replace all the O_2 in the air what would happen in general to the pressure on earth. NOT A REASONABLE SENERIO!!!!

Because CO_2 has a higher MW that O_2, the weight of air above would increase and thus would the pressure.

c) Describe how a barometer works and why we use Hg rather than water to measure atmospheric pressure. What does 760 mm of Hg mean?

The pressure of the air pushes the liquid (either Hg or H_2O) up a column in which there is no resistance (no counter pressure). Thus there is a vaccum above the liquid the height of the liquid is equal to the force or weight of air pushing down. Hg much denser than air thus is practical to use. 760 mm of Hg ≡ 1 typical atm. pressure

d) The atmospheric pressure on Mars is much much lower. Give a number of reasons why this is so.

Mars is smaller - less/reduced gravity. Thus the weight of atmosphere less. But also the amount or density of atmosphere is less on Mars.