Chemistry pretest 3.1 version 2016 SOLUTIONS

1. a) In photosynthesis, what form of energy causes an electron to pop out of chlorophyll molecules in photosystem I?
light

b) What supplies the second photosystem with the electrons that its chlorophylls have lost?
Water

c) What is the equation of the reaction that shows how water breaks down to oxygen and H^+ ions?
$2\ H_2O \rightarrow 4H^+ + O_2 + 4e^-$

d) Which if the following products from the light reactions are needed by the chloroplasts to produce glucose?

1. NADPH
2. ATP
3. O_2
4. CO_2

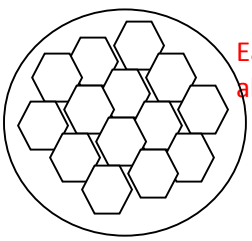
1,2,4

2. a) During what state of inactivity does a chipmunk lowers its heart rate from about 200 to 5 beats per minute?
hibernation
b) What overall body rate is lowered during this state of inactivity?
The metabolic rate. So oxygen and glucose are needed in much lower quantities at the lower temperature.

3. a) In refrigeration why is the spoilage of food slowed down?

At a lower temperature, fungal and bacterial reactions slow down and they cannot reproduce as quickly, therefore breaking down less food in a given time.

b) Draw the cross section of a catalytic converter to reveal how it speeds up the rate of pollution breakdown.



Each honeycomb structure increases surface area and allows more Pt and Rh catalyst to be packed in.

c) What's the difference between detergent and soap? Detergent has soap and enzymes, which can break down stains into smaller molecules, allowing the soap to wash more away.

4. Water is flowing into a sink at a rate of 0.250 L per minute. It is going down the drain at the same rate, so the amount of water in the sink does not change.

Irreversible? Steady state ? Or equilibrium? Explain.

Steady state. The amount of water is not changing, and the system is open. Also we can see the water flowing in and out. In equilibrium, the forward and reverse rates are not observable unless we actually disturb the equilibrium.

5. a) A layer of ice and some water underneath the ice are at equilibrium at 0° C.

No.

b) Is any freezing occurring? Melting?

Yes, and both reactions are occurring at the same rate. Remember: equilibrium does *not* mean you necessarily have equal concentrations of reactants and products. Instead, the *rates are equal*.

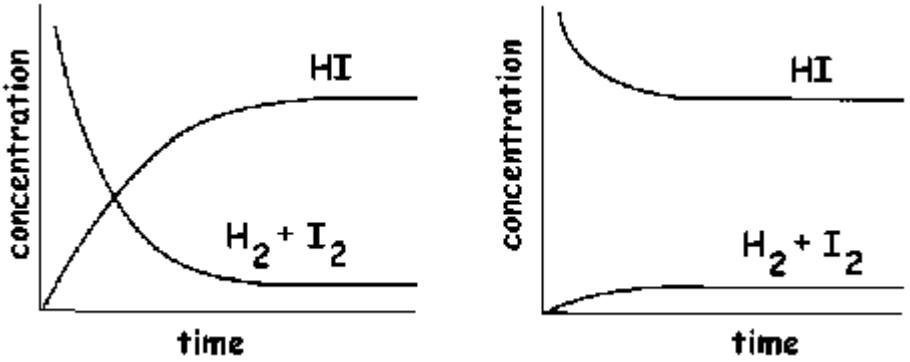
$H_2O_{(s)} = H_2O_{(l)}$

6. Explain what is going on at the molecular level in the following reaction:

$$N_2 + 3\ H_2 \rightleftarrows 2\ NH_3$$

For every molecule of nitrogen that reacts with 3 molecules of hydrogen, there are two molecules of ammonia that decompose at the same rate.

7. In each of the following graphical representations of concentration versus time, show where equilibrium first appears.

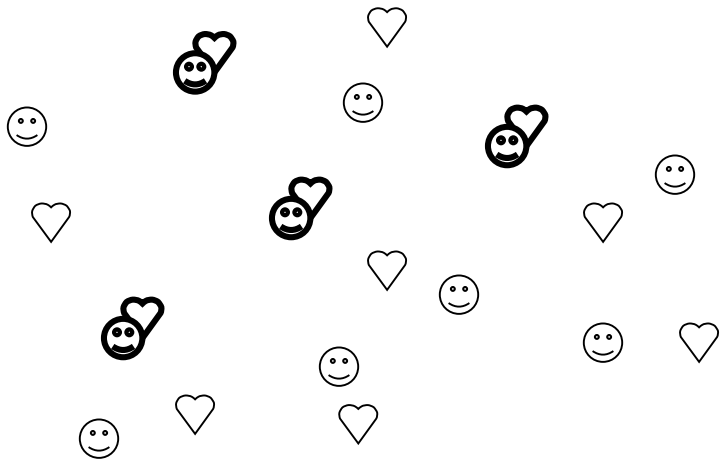


It occurs when both lines flatten out. At this point there is no change in concentration with respect to time. The slope is zero, even though the molecules continue to react. But they cancel each other's work.

8. a) T b) F c)T d)T e)T f)T g)F

9. For every cerebral character (happy face) that befriends a romantic (heart), a cerebral-romantic couple (heart stuck to face) breaks up.

This common situation is illustrated below:



a. In two years, how many couples will there be if this system remains at equilibrium? (see diagram)

Same number as shown now: 4.

b. Write an equation to represent the equilibrium. Place the single people on the left hand side of the equation.

c. How would we disturb equilibrium if we introduced stars into the system? Stars are known to steal hearts away from cerebral types.

(By the way, the reason romance exists in life is so that you can better understand equilibrium!)

The star will drive the reaction to the left by interfering with the forward reaction; the reverse reaction will be favoured.

Another similarity between equilibrium and relationships: Every time one partner saves money (namely, me), my wife will spend it.

10. In which of the following reactions would the equilibrium constant, K, increase by lowering the temperature?

a. $\text{heat} + H_2CO_{3(aq)} \rightleftharpoons H^+_{(aq)} + HCO_3^-{}_{(aq)}$

b. $H_2O_{(g)} \rightleftharpoons H_2O_{(l)}$

Answer : (b) because it is an exothermic process.

11. If we increased the pressure, what would be the effect on K, if any, on the following equilibrium systems?

$\text{heat} + H_2CO_{3(aq)} \rightleftharpoons H^+_{(aq)} + HCO_3^-{}_{(aq)}$

no effect; there are an equal number (ZERO) of gas molecules on each side of the equation.

b. $H_2O_{(g)} \rightleftharpoons H_2O_{(l)}$

Increasing pressure will favour the forward reaction, lowering the amount of reactants (decreasing denominator in the K expression) , hence increasing K.

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12. Write an equilibrium law expression for the following reaction:

$2\ H_2O_{(g)} + 2\ S_{(s)} \rightleftharpoons 2\ H_2S_{(g)} + O_{2(g)}$

K=

$$\frac{[H_2S]^2[O_2]}{[H_2O]^2}$$ (notice: solid sulfur is purposely left out)

13. What chemical equation is represented by the following expression?

Answer:

$C_3H_{8(g)} + 5\ O_{2(g)} = 3\ CO_{2(g)} + 4\ H_2O_{(g)}$

14. answer = $4.0/3.0^2 = 0.44$

15. a. In a 5.0 L flask, 3.0 moles of oxygen are introduced with 8.0 moles of iodine.

At equilibrium we find 1.0 mole of oxygen among the other chemicals. Find K.

$O_{2(g)} + 2\ I_{2(g)} = 2\ OI_{2(g)}$

	$O_{2(g)}$	$I_{2(g)}$	$OI_{2(g)}$
Initial number of moles/L	**3 mol/5 L= 0.6M**	**8 mol/5 L= 1.6M**	**0**
Changing moles/L	**0.6-0.2 = 0.4M**	**0.4(2 I_2/O_2) = 0.8 M**	**Again 2:1 ratio 0.8M**
Equilibrium moles/L	**1/5=0.2M**	**1.6 – 0.8 = 0.8M**	**0.8M**

$$K = \frac{[OI_2]^2}{[O_2][I_2]^2} = \frac{(0.8)^2}{(0.2)(0.8)^2} = 5$$

b. **If temperature is raised and K is found to be a lower value, then is the reaction endothermic?**

No it is exothermic; otherwise, K would have been higher.

16. Given: $4\ HCl_{(g)} + O_{2(g)} = 2H_2O_{(g)} + 2Cl_{2(g)} + 112kJ$

At a certain temperature, the equilibrium constant for the above reaction is 32.

There were no products initially and the following equilibrium concentrations were measured. [HCl] = 2.0 moles/L [O_2] = 2.0 moles/L (By the way 2.0 M means 2.0 moles/L)

What are the equilibrium concentrations of steam and chlorine?

Let x = [H_2O] = [Cl_2], since there were no products initially.

	4HCl	O_2	$2H_2O$	$2Cl_2$
Initial number of moles/L	doesn't matter		0	0
Changing moles/L	doesn't matter		x(ratio steam to chlorine is 2:2 or 1:1)	x
Equilibrium moles/L	2	2	x	x

$$Kc = \frac{[H_2O]^2[Cl_2]^2}{[HCl\ \ ]^4\,[O_2]}$$

$x^2x^2 /(2^4*2)= 32$

$x^4 = 1024$

$x = (1024)^{1/4}$

x = 5.7 moles/L

17. Use the K_{sp} for calcium fluoride to calculate its solubility in grams per liter. (CaF_2: $K_{sp} = 4.0 \times 10^{-11}$)

	$CaF_{2(s)}$	$Ca^{+2}_{(aq)}$	$2F^{-}_{(aq)}$
I		0	0
C	x = solubility	x	2x
E		x	2x

$K_{sp} = [x][2x]^2 = 4x^3 = 4.0 \times 10^{-1}$

$x = \sqrt[3]{(1.0 \times 10^{-1})} = 0.000215\ldots mol/L$

multiply by molar mass:

x = 0.017 g/L

18. a) What is the solubility in moles/L of $AlPO_4$ in 0.050 M Na_3PO_4?
Ksp of $AlPO_4$ = **9.84×10^{-21}**

	$AlPO_{4\,(s)}$	$Al^{+3}_{(aq)}$	$PO_4^{-3}{}_{(aq)}$
I		0	0.050M (note that it's 0.050 because every 1mole of Na_3PO_4 produces just one mole of phosphate when it dissolves: $Na_3PO_4 \rightarrow 3Na^+ + PO_4^{3-}$
C	x = solubility	x	x
E		x	x + 0.050

$K_{sp} = [x]\,[x + 0.050] =$ **9.84×10^{-21} ; bring all terms to one side and use the quadratic formula to solve for x**

$x = 1.97 \times 10^{-19}$ mol/L

b) If it wasn't for the 0.050M Na_3PO_4 how would the solubility have compared?

It would have been higher. The equilibrium is being shifted to the left(creating more solid) by increasing the amount of phosphate.

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FLASHBACKS:

19. Knowing that the rate of a reaction = $k[A]^2[B]$, what must be done to the concentration of solute B, if the rate is to triple by using only 0.6th of the original concentration of A?

$$\frac{new\ rate}{old\ rate} = \frac{3}{1} = \frac{k\left[[0.6A]^2[xB]\right]}{k[A]^2[B]}$$

3 = 0.36 x
x = 3/0.36 = 8.3
So we have to increase the concentration of B by about a factor of 8(sig figs)

20. In organic chemistry, an SN_1 reaction occurs in several steps, of which only one is rate-determining, and the reaction is considered to be *1st order* because the rate depends on just one reactant's concentration.

The overall reaction is:

$(CH_3)_3CCl_{(aq)} + NH_{3(aq)} \rightarrow (CH_3)_3CNH_{2(aq)} + HCl_{(aq)}$

The mechanism of the following:

Step (1) $(CH_3)_3CCl_{(aq)} \rightarrow (CH_3)_3C^+_{(aq)} + Cl^-_{(aq)}$ *slow*

Step (2) $(CH_3)_3C^+_{(aq)} + NH_{3(aq)} \rightarrow (CH_3)_3CNH_3^+_{(aq)}$ *fast*

Step (3) $(CH_3)_3CNH_3^+_{(aq)} + Cl^-_{(aq)} \rightarrow (CH_3)_3CNH_{2(aq)} + HCl_{(aq)}$ *fast*

a) What is the **rate expression** for the formation of $(CH_3)_3CNH_{2(aq)} + HCl_{(aq)}$

Based on the slow step:
Rate = $k[(CH_3)_3CCl_{(aq)}]^1$; it's a power of 1 because of the coefficient in front of the involved reactant in the slow step.

b) Why is the reaction labeled *1st order*?
The rate is dependent on the concentration of only 1 reactant. (the answer is in the question!)