chemistry 3rd Kanti study sheet for the test on the 1/10/2012

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ACIDS AND BASES

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INFO

This is a study sheet by Linus Metzler about Acids and Bases, which was mentioned in the 3rd Kanti at Mr. Uetz. There is no claim for completeness. All warranties are disclaimed.

STUDY PART

YOU CAN EXPLAIN HOW THE REACTION EQUATION FOR ACIDS WITH WATER WAS DEDUCED FROM THE RESULTS OF AN EXPERIMENT

We produced HCl which is quite a strong acid. When we let the acid flow into the water, the water conducted, so there had to be ions formed. As it didn't conduct in petrol, it has to be water.

YOU KNOW THE DEFINITION OF AN ACID [AND BASES]

Definition ACIDS give away anH^+, they are H^+ donors. $\rightarrow H_3O^+$

Definition BASES take up anH^+, they are H^+ acceptors. $\rightarrow OH^-$

YOU ARE ABLE TO WRITE THE EQUATIONS FOR THE REACTION OF ANY ACID WITH WATER

Basically, you take an H^+away from the acid molecule and add it to water.

$HNO_3 + H_2O \rightarrow NO_3^- + H_3O^+$
$H_4C_2O_2 + H_2O \rightarrow H_3C_2O_2^- + H_3O^+$

YOU CAN EXPLAIN WHAT AN ACID-BASE-INDICATOR IS

An acid-base-indicator changes its color, when the pH-value changes resp. how strong or weak an acid or a base is.

YOU ARE ABLE TO WRITE THE EQUATIONS FOR THE REACTION OF ANY BASE WITH WATER

Basically you take H^+ away from the water and add it to the basic molecule.

$O^{2-} + H_2O \rightarrow OH^- + OH^-$
$CH_5N + H_2O \rightarrow CH_6N^+ + OH^-$

YOU CAN EXPLAIN WHAT AN AMPHOTERIC PARTICLE IS

Definition An amphoteric particle is a molecule or ion which can react as an acid or as a base. $e.g. H_2O$

YOU CAN EXPLAIN THE EXPRESSION ACID-BASE CONJUGATE PAIR

Definition When an acid HA has given away anH^+, it becomes a baseA^-. This base A^- is called conjugate base of HA

Definition When a base B takes up an H^+, it becomes an acidHB^+. This acid HB^+ is called conjugate acid of B.

Rule The stronger the acid, the weaker its conjugate base.

Rule The stronger the base, the weaker its conjugate acid.

YOU KNOW THE DIFFERENCE BETWEEN AN ACID AND AN ACIDIC SOLUTION

Rule If we disolve an acid in water, we have an ACIDIC SOLUTION. Therein we can find$H_3O^+(aq), A^-, H_2O\ and HA(aq)$, which has not reacted.

YOU KNOW THE DIFFERENCE BETWEEN A BASE AND A BASIC SOLUTION (ALKALINE SOLUTION)

Rule If we disolve a base in water, we have an BASIC (ALKALINE) SOLUTION. Therein we can find $OH^-(aq), HB(aq), H_2O\ and\ B^-(aq)$, which has not reacted.

YOU ARE ABLE TO EXPLAIN WHAT THE IMPLICATIONS OF THE STRENGTH OF AN ACID ARE

- More destructive energy
- Equilibrium lies more to the right → faster reaction
- More H_3O^+ ions
- Food keeps longer (pickles)

YOU KNOW WHAT THE KA-VALUE IS AND YOU KNOW THE IMPORTANCE OF IT

$K_a = \frac{[A^-] * [H_3O^+]}{[HA]}; the\ bigger\ K_a, the\ stronger\ the\ acid\ is$
$pK_a = -\log(K_a)$

- It's the strength of an acid

YOU ARE ABLE TO WORK WITH THE DEFINITION OF THE PH-VALUE

Definition The pH-value is the negative logarithm of the concentration H_3O^+ ions a solution.
$pH = -\log([H_3O^+]) = -\log([HA])$

Definition The pOH-value is the negative logarithm of the concentration OH^- ions a solution.
$pOH = -\log([OH^-]) = 14 - pH$

	pH-Value		**Uetz-Acid-Value**		
Acidic:	pH0:	½ billion H_2O	**10 million**	H_3O^+	1 mol/l H_3O^+
	pH1:	½ billion H_2O	**1 million**	H_3O^+	10^{-1} mol/l H_3O^+
	pH2:	½ billion H_2O	**100'000**	H_3O^+	10^{-2} mol/l H_3O^+
	pH3:	½ billion H_2O	**10'000**	H_3O^+	10^{-3} mol/l H_3O^+
	pH4:	½ billion H_2O	**1'000**	H_3O^+	10^{-4} mol/l H_3O^+
	pH5:	½ billion H_2O	**100**	H_3O^+	10^{-5} mol/l H_3O^+
	pH6:	½ billion H_2O	**10**	H_3O^+	10^{-6} mol/l H_3O^+
Neutral:	pH7:	½ billion H_2O	**1**	H_3O^+	10^{-7} mol/l H_3O^+
Neutral:	pH7 = pOH7:	½ billion H_2O	**1**	OH^-	10^{-7} mol/l OH^-
	pH8 = pOH6:	½ billion H_2O	**10**	OH^-	10^{-6} mol/l OH^-
	pH9 = pOH5:	½ billion H_2O	**100**	OH^-	10^{-5} mol/l OH^-
	pH10 = pOH4:	½ billion H_2O	**1'000**	OH^-	10^{-4} mol/l OH^-
	pH11 = pOH3:	½ billion H_2O	**10'000**	OH^-	10^{-3} mol/l OH^-
	pH12 = pOH2:	½ billion H_2O	**100'000**	OH^-	10^{-2} mol/l OH^-
	pH13 = pOH1:	½ billion H_2O	**1 million**	OH^-	10^{-1} mol/l OH^-
Alkaline:	pH14 = pOH0:	½ billion H_2O	**10 million**	OH^-	1 mol/l OH^-
	pOH-value		**Uetz-Base-value**		

YOU ARE ABLE TO CALCULATE THE CONCENTRATION OF THE HYDROXIDE IONS IN THE SOLUTION, WHEN YOU KNOW THE PH-VALUE

$[OH^-] = 10^{pH-14} mol/l$

YOU KNOW WHAT A NEUTRAL SOLUTION IS AND YOU KNOW HOW WE FOUND OUT, THAT A NEUTRAL SOLUTION HAS A PH-VALUE OF 7

A neutral solution is neither acidic nor basic and therefore has a pH of 7.

We measured to conductivity (resp. the pH) of pure H_2O.

YOU CAN EXPLAIN WHY THE PH-VALUE GETS CLOSER TO 7 WHEN WE DILUTE A SOLUTION WITH WATER

If you add water, the $H_3O^+ resp. OH^-$ ions decreases (in percentage), therefore it approaches 7.

YOU ARE ABLE TO CALCULATE THE PH-VALUE OF STRONG ACIDS AND STRONG BASES IN WATER, IF YOU KNOW THE CONCENTRATION

Acids $pK_a < 0: pH = -\log([H_3O^+]) = -\log([HA])$

Bases $pH = 14 + \log([OH^-]) = 14 + \log([B^+])$

YOU ARE ABLE TO CALCULATE THE PH-VALUE OF WEAK ACIDS, IF YOU KNOW THE CONCENTRATION

Weak acids $1.5 < pK_a < 14: pH = \frac{pK_a - \log([HA])}{2}; reaction\ grade\ in\ \%: 10^{-\frac{pK_a}{2}} * 100$

Weak bases $pH = \frac{pK_b - \log([B^-])}{2}$

YOU ARE ABLE TO WORK WITH THE DEFINITION FOR NEUTRALISATION

Definition If we add an acidic solution to an alkaline solution until the pH of 7 is reached, we call this reaction neutralization.

Rule If several acids and bases are present in a solution, the strongest acid will react with the strongest base. The reaction between the acid and the base will be on the right hand side, if the value of: $pK_a + pK_b - 14 < 0$.
Or in words: neutralization takes place if the acid lies higher in the list than the base.

YOU CAN EXPLAIN WHY SOLUTIONS WITH A PH-VALUE BETWEEN 6 AND 8 ARE VERY SENSITIVE TO THE ADDITION OF ACIDS AND BASES

An addition of 1ml of acid/base to a pH of 1 results in a smaller change than if the same amount is added to a pH of 6 resp. 8 (due to the amount (percentage) of $H_3O^+ resp. OH^-$ ions).

YOU CAN DEDUCE THE REACTION EQUATION FOR THE NEUTRALISATION OF ANY PAIR OF ACIDIC AND ALKALINE SOLUTIONS

WARNING: THESE EXAMPLES MIGHT BE TOO IN-DEPTH! IF YOU HAVE QUESTIONS, FEEL FREE TO ASK ME!

Some examples:

- $H_3PO_4\ and\ NaOH; NaOH\ is\ a\ salt \rightarrow Na^+OH^-$

$H_3PO_4 + OH^- \rightarrow H_2PO_4^{-1} + H_2O$
$H_2PO_4^- + OH^- \rightarrow HPO_4^{2-} + H_2O$
$HPO_4^{2-} + OH^- \rightarrow PO_4^{3-} + H_2O$

- $H_2SO_4\ and\ AlOH, AlOH\ is\ a\ salt: Al^{3+} + 3OH^-$
  $3H_2SO_4 + Al^{3+} + 3OH^-$
  $3HSO_4^- + H^+ + Al^{3+} + 3OH^-$
  $3SO_4^{2-} + 2H^+ + Al^{3+} + 3OH^-$
  $\rightarrow 3H_2O + 2Al(SO_4)_3$
- $HCl + Na_2S^{2-}$
  $HCl + S^{2-} \rightarrow Cl^- + HS^-$
  $HCl + HS^- \rightarrow Cl^- + H_2S$
- $HNO_3 + Na_2SO_4$
  $2HNO_3 + 2Na^+ + SO_4^{2-}$
  $2NO_3^- + 2Na^+ + SO_4^{2-} + 2H^+$
  $2NO_3^- + 2Na^+ + H_2SO_4$
  $2NaNO_3 + H_2SO_4$
- $H_2SO_4 + AlO$
  $3H_2SO_4 + 2Al^{3+} + 3O^{2-}$
  $SO_4^{2-} + 6H^+ + 2Al^{3+} + 3O_2^-$
  $Al_2(SO_4)_3 + 3H_2O$
- $H_2CO_3 + NH_3$
  $H_2CO_3 + 2NH_3 + H_2O$
  $CO_3^{2-} + 2H^+ + 2NH_3 + H_2O$
  $H_2O + (NH_4)_2CO_3$

YOU CAN CALCULATE THE PH-VALUES FOR MIXTURES OF ACIDIC AND ALKALINE SOLUTIONS

You calculate the amount of H_3O^+ in the mixture and determine the pH.

YOU CAN EXPLAIN HOW CO_2 OR OTHER GASES CAN BE FORMED IN ACID-BASES REACTIONS

When carbonic acid $H_2CO_3\ (aq)$ decays, $H_2O + CO_2$ is formed.

YOU CAN EXPLAIN HOW WE CAN INFLUENCE THE EQUILIBRIUM OF REACTIONS WITH GASEOUS ACIDS OR BASES, RESPECTIVELY

- Higher pressure prevents gas from coming out from an acid (equilibrium to the right).

YOU CAN EXPLAIN HOW ACIDIC RAIN CAN BE FORMED, WHEN WE BURN COAL OR OIL.

The sulfur reacts with the oxygen and forms sulfur oxide ($S + O_2 \rightarrow SO_2$), which reacts with water to acidic rain (more or less…) ($SO_2 + H_2O \rightarrow H_2SO_3$).

YOU KNOW HOW PHOSPHORIC ACID CAN BE FORMED

Red phosphor is burned in pure oxygen and water is added afterwards.
$P_4 + 5O_2 \rightarrow P_4O_{10}$
$P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$