Table M Acid Base Indicator Handout name: ____

Acid Base indicators are (mostly) weak acids. A weak acid is an acid that does not dissociate well in water. When you put a million molecules of $HC_2H_3O_2$ into water, it forms acetic acid. But only about 50,000 molecules ionize, while the vast majority (nearly 95%) just dissolve because they are polar. With so few ions in solution, the strength of the acid is weak. One mole of these molecules does NOT produce 6.02.x 10^{23} H^{+1} molecules (not by a long shot). Weak acids are weak because these molecules shouldn't ionize in the first place (ionic compounds ionize, and so do the acids). When they do ionize, they form a dynamic equilibrium, they ionize, then they recombine back into polar molecules. So do acid base indicators.

What's so cool about these molecules is that as molecules they are ONE COLOR, but the ions form a DIFFERENT COLOR. We can literally see with our eyes how far the solution you put the indicators can shift forward or reverse, towards ONE COLOR or a DIFFERENT COLOR.

A simple example from our notes is how phenolphthalein works. The molecule is colorless in solution, the more of that molecule that is present, the clearer the solution appears. $HC_{20}H_{13}O_4$ is the formula for this weak acid called phenolphthalein. In water it forms a dynamic equilibrium with most of it remaining whole (and colorless). The few ions that do form, which the hot pink ion color, are so few that they are invisible to the eye.

Putting phenolphthalein into an acid or base will be the same as adding H^{+1} ions, or adding OH^{-1} ions. That will cause a shift forward to more ions (more pink) or shift reverse to more molecules (less pink). At pH between 8-9 there is a near "balance" between the acid and base level, the numbers of pink ions and colorless molecules is almost even, giving the solution a light pink color. Shifts will change the color to HOT pink, or ALL clear. In symbols:

$$HC_{20}H_{13}O_4 \overset{\text{water}}{\rightleftharpoons} H^{+1} + C_{20}H_{13}O_4^{-1}$$

Colorless Pink

← ADD ACID H^{+1} causes a reverse shift, less pink, more colorless

ADD BASE OH^{-1} →

Adding base ions is the same as removing the H^{+1} ions (the OH^{-1} combine with the H^{+1} ions to form water, effectively removing the H^{+1} ions from solution) causing a forward shift, and more pink color to present

All acid base indicators work this same way: the molecule of the weak acid is one color, the ion formed when it ionizes into an acid is a different color. The solutions that the indicator is placed into has either excess H^{+1} ions (it's an acid) or it has excess OH^{-1} ions (it's a base). The acid or base will cause a LeChatelier Shift towards the molecule or the ion (one color or the other).

On the other side are the six indicators from Table M. Each shifts at a different pH, or a different level of acid or base present. The colors are all different too as the specific molecules have a color, and their ions have a different color. (If the molecule and the ion had the same color, they wouldn't indicate anything to us and so we wouldn't use them like this).

Using COLOR pencils, show where on each mini-graph where the pH changes for each indicator. Use the correct colors for each indicator. Write the pH "zone" where this change occurs as well. All pH lower than the "zone" are ONE COLOR and all pH above the "zone" are the other color. INSIDE the ZONE is where the colors change and sometimes mix (yellow and blue make green) (red and blue make purple) (colorless and pink make light pink)

Indicators can indicate a pH range, but are not necessarily able to tell THE pH of the solution. If a solution is PINK with phenolphthalein YOU know that the pH is above 9. It could be 9, or 10, 12.74, or even 14! Pink indicates something true but it does not always tell the exact truth. All solutions that turn red with litmus are acids, some have pH 0 through pH 4.5. An acid of pH 4.6, or even 6.9 will NOT be red with litmus, but it's still an acid. The indicators indicate, but are not always decisive for us.

indicator	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
methyl orange															

indicator	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
bromthymol blue															

indicator	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
phenolphthalein															

indicator	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
litmus															

indicator	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
bromcresol green															

indicator	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
thymol blue															