AP Chem - Unit 10
Review - Key

(1) ANS: D

First, we need to know the $[H^+]$ at equilibrium...bring on the RICE table!

R	HA	⇆	H^+	+	A^-
I	0.50		0		0
C	$-x$		$+x$		$+x$
E	$0.50-x$		x		x

$$K_a = 8\times10^{-4} = \frac{[H^+][A^-]}{[HA]} = \frac{x^2}{0.50} \text{ therefore, } x = \sqrt{4\times10^{-4}} = 2\times10^{-2}$$

$$\text{So, \% dissociation} = \frac{[H^+]}{[HA]}\times 100 = \frac{2\times10^{-2}}{0.50}\times 100 = \frac{2}{0.50} = 4\%$$

DIF: Hard OBJ: 6.16 TOP: Acid-Base KEY: dissociation | equilibrium
NOT: 38% answered correctly

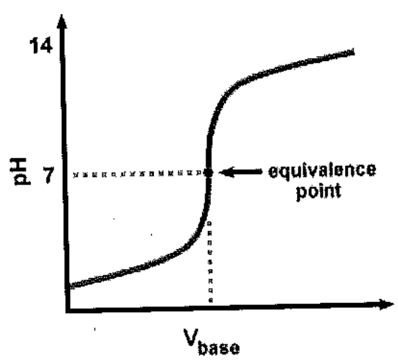
2 ANS: C

Recall that Brönsted acids "donate a proton" and bases "donate accept a proton". Since all of the answer choices have a hydrogen ion or proton they can donate, all fit the definition for acids. Choices (A) and (B) are negative polyatomic ions that can readily accept a hydrogen ion, so they are bases. Answer (D) is not a negative ion, but can readily accept a proton to form hydronium ion. Ammonium ion, however, cannot accept a proton, therefore it cannon act as a base.

DIF: Easy OBJ: 3.7 TOP: Acid-Base KEY: Bronsted
NOT: 63% answered correctly

3 ANS: B

All indicators are weak acids. The end point of a titration is the color change, the equivalence point is when moles acid = moles base. If the indicator has been chosen properly, the two coincide and the eq. pt. can be read from the graph of the titration data as shown below:



Note the drastic change in pH at that volume and note that this curve is for a strong acid-strong base titration! That is the only acid-base combination that has an eq. pt. of pH = 7.0.

DIF: Easy OBJ: 1.20 TOP: Acid-Base KEY: indicator | equivalence point |end point
NOT: 66% answered correctly

4 ANS: B
0.10 *M* H_3PO_4 weak acid which will dissociate into H^+ and $H_2PO_4^-$ in the presence of such a strong base reducing the $[OH^-]$ to 0.10 *M*.

Since so much more strong base is present, $H_2PO_4^-$ will further dissociate into H^+ and HPO_4^{2-}.

Any H^+ formed will be neutralized to water by the abundance of OH^-, so K^+ and HPO_4^{2-} are the most abundant ions once equilibrium is established.

DIF: Hard OBJ: 6.17 TOP: Acid-Base KEY: equilibrium
NOT: 15% answered correctly

5. ANS: C
Expect easy math! But, be careful since $Ba(OH)_2$ releases 2 OH^- ions. You can use the shortcut formula for neutralization and solve for V_a BUT, the amount of base should be doubled since each $Ba(OH)_2$ releases 2** OH^- ions.

$$M_aV_a = M_bV_b$$

$$\therefore V_a = \frac{M_bV_b}{M_a} = \frac{2^{**}(25\times 0.12)}{0.15} = 50\left(\frac{4}{5}\right) = \frac{200}{5} = 40\,\text{mL}$$

DIF: Hard OBJ: 6.13 TOP: Acid-Base KEY: titration | neutralization formula
NOT: 35% answered correctly

6 ANS: B
"Highest pH" indicates most basic. These are all salts, so recall that salts are produced when a acid reacts with a base. So, ask yourself, "Which acid reacted with which base?" If both are strong, the salt is neutral as in the case of $NaHSO_4$, and Na_2SO_4. Na_2CO_3 is a basic salt since NaOH (strong base) reacted with carbonic acid (weak acid), strong wins...the salt is basic with a high pH. NH_4Cl is an acidic salt with a lower pH since a weak base reacted with a strong acid to form the ammonium chloride salt.

DIF: Hard OBJ: 6.16 TOP: Acid-Base KEY: pH of salts | salt hydrolysis
NOT: 21% answered correctly

7. ANS: A
Write out the equilibrium expression and think about that tiny value for K_a.

$K_a = \dfrac{[HCN][C_2H_3O_2^-]}{[HC_2H_3O_2][CN^-]} = 3.7\times 10^{-4}$ which is much less than one, so the denominator is a larger term, therefore reactants are favored, meaning acetic acid is a stronger acid than hydrocyanic acid AND cyanide ion is a stronger base than acetate ion. Answer (D) is only true if the acid base mixture is of equimolar solutions of a strong acid and strong base are mixed.

DIF: Hard OBJ: 6.16 TOP: Acid-Base KEY: Ka | acid and base strength
NOT: 31% answered correctly

8 ANS: B
A solution with a pH of 13 differs from a solution with a pH of 12 by a factor of 10. So, dilute the 100 mL to a total volume that is a power of ten higher...1,000 mL. Place the 100 mL of pH 13 NaOH into a 1-L volumetric flask and fill to the mark with deionized water.

DIF: Hard OBJ: 6.12 | 6.18 TOP: Acid-Base KEY: pH | dilutions
NOT: 22% answered correctly

9. ANS: D
Think about the 2 dissociations since this is a diprotic acid.

$H_2A \rightleftarrows H^+ + HA^-$

$HA^- \rightleftarrows H^+ + A^-$

Some of the diprotic acid dissociates, there is more hydrogen ion (hydronium) present since it is a product of both processes, less of HA^- left since it is formed and then dissociates a bit, which means the A^- concentration in solution is so very small since little of it is ever formed due to the very small value of K_2.

DIF: Hard OBJ: 6.17 TOP: Acid-Base KEY: diprotic acid | equilibrium
NOT: 37% answered correctly

10 ANS: B
Conjugate acid-base pairs simply differ by a proton or H^+. Since the question is asking for the conjugate **acid**, NH_2^- is behaving as the base, thus accepting the H^+ to form NH_3 which may have thrown you off since you have embraced ammonia as the classic weak base.

DIF: Easy OBJ: 3.7 TOP: Acid-Base KEY: ammonia | conjugate acid
NOT: 64% answered correctly

11. ANS: B
Expect easy math!
We're diluting a strong base by cutting its molarity in half to 0.001 which is 1×10^{-3}, thus the $pOH = -\log[10^{-3}] = 3$, therefore the $pH = 14 - 3 = 11$

DIF: Hard OBJ: 6.16 TOP: Acid-Base KEY: pH | pOH
NOT: 24% answered correctly

12 ANS: B
This is a buffer since it is a mixture of a weak acid (acetic) and its conjugate base which is also its salt (sodium acetate). Therefore, $\left[H^+\right] = K_a \frac{[Acid]}{[Base]} = 1.8 \times 10^{-5}\left(\frac{0.5}{1}\right) = 0.09 \times 10^{-5} = 0.9 \times 10^{-5}$ or about 1×10^{-5}. thus, the pH is about 5.0

Answers (A) and (C) both involve a weak acid and a weak base.

DIF: Hard OBJ: 6.18 TOP: Acid-Base
KEY: K expression | Ka calculation | acid strength | buffer NOT: 36% answered correctly

13 ANS: C
The question states that the autoionization of water reaction is endothermic. So, increasing the temperature will cause the reaction to shift right (favor the products), thus MORE H^+ will be present so the pH will decrease. BUT MORE OH^- ions will *also* be present in solution, thus the solution remains neutral.

DIF: Moderate OBJ: 6.14
KEY: chemistry| general chemistry | acids and bases | self-ionization of water and pH | self-ionization of water

14. ANS: A
Remember, acid + base yields salt + water. So, work backwards! Which acid reacted with which base to form the salt in question? AND remember, strong wins!
A) weak base + strong acid forms acidic salt, pH less than 7.00.
B) strong base + weak acid forms basic salt.
C) strong acid + strong base forms neutral salt.
D) weak acid + weak base forms a nonneutral salt, but you need the Ka's & Kb's to determine the pH range.

DIF: easy OBJ: 6.16 TOP: acids and bases | solutions of a weak acid or base
KEY: acid-base properties of salt solutions | prediction of salt solution acid-base properties

15. ANS: B
Beakers 1 & 2 contain the same # of moles of HF which is weak and therefore dissociates less than 1%. Beaker 2 has a much smaller volume, so it's CONCENTRATION (molarity) is higher, thus it dissociates less than Beaker 1. Beakers 3 & 4 contain equal numbers of moles of HCl as beakers 1 & 2 did of HF. HCl is a strong acid and dissociates completely. The concentration of Beaker 3 of HCl is greater than Beaker 4 since it has a much smaller volume of water, but both dissociate 100%.

DIF: moderate OBJ: 6.11 TOP: acids and bases | solutions of a weak acid or base
KEY: acid-ionization equilibria | experimental determination of Ka