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(2) Arrhenius acid: produces H^+ ions
Arrhenius base: produces OH^- ions.
Too restrictive because it isn't obvious why bases such as ammonia, NH_3, should produce OH^- ions (there's no oxygen in NH_3).

(4) In a conjugate A-B pair, the two things (species, "compounds") are (1) on opposite sides of the double arrow and (2) differ by the presence/absence of one H^+.

$$NH_3 + HOH \rightleftharpoons NH_4^+ + OH^-$$

one example of a conj A-B pair: NH_3 (base) & NH_4^+ (acid)

another example: H_2O (acid) & OH^- (base)

(6) H_3O^+; H_3O^+ is the conjugate acid of H_2O

(7) (a) no, they do not constitute a conj A-B pair.
H_2SO_4/HSO_4^-
HSO_4^-/SO_4^{2-}

(7c) No;
$HClO_4/ClO_4^-$
HCl/Cl^-

(8) (a) NH_3 (B) $+ H_2O$ (A) $\rightleftharpoons NH_4^+$ (A) $+ OH^-$ (B)

(9) (a) $HSO_4^- + H^+ \rightarrow H_2SO_4$
(c) $ClO_4^- + H^+ \rightarrow HClO_4$

(10) (a) HCO_3^- minus $H^+ \rightarrow CO_3^{2-}$
(c) HCl minus $H^+ \rightarrow Cl^-$

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(11) (a) $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$ (this shows NH_3 accepting a proton to become NH_4^+)

(c) $O^{2-} + H_2O \rightleftharpoons OH^- + OH^-$ (this shows O^{2-} accepting a proton to become OH^-)

this becomes - - - →

$$O^{2-} + H_2O \rightleftharpoons 2OH^-$$

(12) (a) ~~$HClO_4 + H_2O \rightleftharpoons H_3O^+ + ClO_4^-$~~

acid is proton donor; proton acceptor

$HClO_4$ is a strong acid so the equation should be written like this →

$$HClO_4 + H_2O \rightarrow H_3O^+ + ClO_4^-$$

single arrow!

(c) $HSO_3^- + H_2O \rightleftharpoons SO_3^{2-} + H_3O^+$

HSO_3^- donates a proton to water

(14) weak acid; far less than 100% of acid molecules donate their protons to water.

If the acid doesn't like to give away protons, then the anion must be good at attracting protons.

(15) see #14, same question.

(17) a + c (see #14). Only b is a strong acid, so it would have the <u>weakest</u> conjugate base.

(18) Tough question, depends on what you mean by "relatively"

a comes from a kinda strong acid, HSO_4^-.

b " " " strong acid, HBr

c " " " weak acid, HCN

d " " " weak acid, $HC_2H_3O_2$

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(20) proton transfer

$$H_2O_{(l)} + H_2O_{(l)} \longrightarrow H_3O^+_{(aq)} + OH^-_{(aq)}$$

better: $$2H_2O_{(l)} \longrightarrow H_3O^+_{(aq)} + OH^-_{(aq)}$$

$$K_w = [H_3O^+][OH^-]$$ → Notice that liquids don't go into Keq expressio[n]

(22) (a) $K_w = [H_3O^+][OH^-] = 1.00 \times 10^{-14}$

$[H_3O^+][3.99 \times 10^{-5}] = 1 \times 10^{-14}$

$[H_3O^+] = \frac{10^{-14}}{3.99 \times 10^{-5}} = 2.51 \times 10^{-10}\ M$ — Basic (low conc of $[H_3O^+]$)

(c) $[H_3O^+] = \frac{10^{-14}}{7.23 \times 10^{-2}} = 1.38 \times 10^{-13}\ M$ — Basic (low con of $[H_3O^+]$)

(23) (a) neutral, because $[H_3O^+] = 10^{-7}\ M$

$[OH^-] = \frac{10^{-14}}{10^{-7}} = 10^{-7}\ M = 1.00 \times 10^{-7}\ M$

(c) acidic, because $[H_3O^+]$ is very high.

$[OH^-] = \frac{10^{-14}}{7 \times 10^{-1}} = 1.43 \times 10^{-14}\ M$

(24) $1.2 \times 10^{-3}\ M$ has a higher $[H_3O^+]$; $1.2 \times 10^{-3}\ M$ is more acidic

(25) $1.04 \times 10^{-8}\ M$ is a lower $[H_3O^+]$, so it is more basic.

(27) pick any 5 you want. I guess high pH = bitter and low pH = sour, but I really haven't tasted a lot of NaOH, blood, or stomach acid lately, so.....

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(29) As $[H^+]$ goes up, pH goes down. Explanation: pH looks at ^negative of exponent in the $[H^+]$ concentration.

example: $[H^+] = 0.01M = 10^{-2}M \Rightarrow pH = 2$ (very acidic)

$[H^+] = 0.00001M = 10^{-5}M \Rightarrow pH = 5$ (not as acidic)

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(30) (a) acidic

$pH = -\log[H_3O^+] = -\log(0.00100M) = -(-3) = 3.000$

(c) $pH = -\log[H_3O^+] = -\log[9.18\times10^{-11}] = -(-10.037) = 10.037$ basic

---

(31) (a) $[OH^-][H_3O^+] = 10^{-14}$

$[H_3O^+] = \frac{10^{-14}}{10^{-7}} = 10^{-7}M$ neutral $pH = -\log(10^{-7}M) = 7.000$

(c) $[OH^-][H_3O^+] = 10^{-14}$

$[H_3O^+] = \frac{10^{-14}}{1.04\times10^{-4}} = 9.62\times10^{-11}$ basic $pH = -\log(9.62\times10^{-11}) = 10.017$

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(32) (a) $pH + pOH = 14$

$pH = 14 - 4.32 = 9.68$ basic

(32) (c) $pH + pOH = 14$

$pH + 1.81 = 14$

$pH = 12.19$ basic

---

(33) (a) $[H^+][OH^-] = 10^{-14}$

$[OH^-] = \frac{10^{-14}}{10^{-7}} = 1.00\times10^{-7}$

$pH = -\log(10^{-7}) = 7$

$pOH = -\log(10^{-7}) = 7$

(33) (c) $[H^+][OH^-] = 10^{-14}$

$(4.29\times10^{-11})([OH^-]) = 10^{-14}$

$[OH^-] = 2.33\times10^{-4}$

$pH = -\log(4.29\times10^{-11}) = 10.37$

$pOH = -\log(2.33\times10^{-4}) = 3.63$

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34 (a)

$pH = -\log[H_3O^+]$

$1.04 = -\log[H_3O^+]$

$-1.04 = \log[H_3O^+]$

$\log^{-1}(-1.04) = [H_3O^+]$

antilog or 10^x button

$0.0912\,M = [H_3O^+]$

$0.091\,M = [H_3O^+]$

34 (c) $pH = 5.99 = -\log[H_3O^+]$

$-5.99 = \log[H_3O^+]$

$\log^{-1}(-5.99) = [H_3O^+]$

$1.02 \times 10^{-6} = [H_3O^+]$

~~[illegible]~~

$1.0 \times 10^{-6}\,M = [H_3O^+]$

35 (a) $pOH = 3.91$

$14 - 3.91 = pH = 10.09$

$pH = 10.09 = -\log[H_3O^+]$

$-10.09 = \log[H_3O^+]$

$\log^{-1}(-10.09) = [H_3O^+]$

~~$8.13 \times 10^{-11} = [H_3O^+]$~~

$8.1 \times 10^{-11}\,M = [H_3O^+]$

(c) $pOH = 1.15$

$pH + pOH = 14$

$pH = 14 - 1.15$

$pH = 12.85$

$pH = -\log[H_3O^+]$

$12.85 = -\log[H_3O^+]$

$-12.85 = \log[H_3O^+]$

$\log^{-1} -12.85 = [H_3O^+]$

$1.4 \times 10^{-13}\,M = [H_3O^+]$

36 (a) ~~$pH + pOH = 14$~~

~~$5.12 + pOH = 14$~~

$pH = 5.12 = -\log[H_3O^+]$

$-5.12 = \log[H_3O^+]$

$7.59 \times 10^{-6}\,M = [H_3O^+]$

$7.6 \times 10^{-6}\,M = [H_3O^+]$

$\frac{10^{-14}}{7.6 \times 10^{-6}} = 1.3 \times 10^{-9}\,M = [OH^-]$

36 (c) $pH = 7$

$pOH = 7$

$pH = 1.0 \times 10^{-7}\,M$

$pOH = 1.0 \times 10^{-7}\,M$

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(37) pH paper is an indicator, it's just soaked into paper. pH meters are more accurate but expensive, a pain to maintain, and need to be calibrated.

(40) HNO_3 is a strong acid. Thus, a solution of HNO_3 doesn't actually contain any (measurable amounts of) HNO_3 molecules. It has completely dissociated into H^+ and NO_3^- ions. The H^+ ions jump onto water molecules to make H_3O^+ ions. The ions actually present are H_3O^+ and NO_3^-.

(42) (a) [strong acid] = $[H_3O^+]$

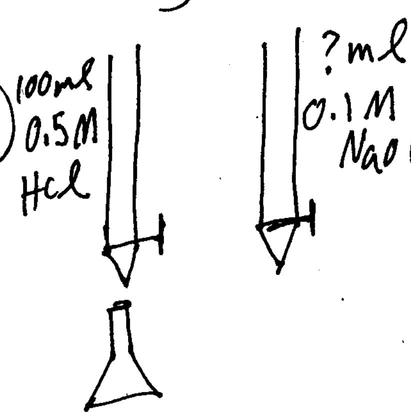
thus $[HCl] = [H_3O^+] = 0.00010M = 1.0 \times 10^{-4} M$

$pH = -\log 10^{-4} = 4.00$

(c) $4.21 \times 10^{-5} M\ HClO_4 \longrightarrow [H_3O^+] = 4.21 \times 10^{-5} M$

$pH = -\log(4.21 \times 10^{-5} M) = 4.376$

(43)



$HCl + NaOH \longrightarrow NaCl + H_2O$

HCl		NaOH
0.5 mol/L	M	0.1 mol/L
0.100 L	V	(c) 500 ml
(a) 0.05 mol	n	(b) 0.05 mol

(a) $M = \frac{n}{V}$ $n = MV$

$n = (.5)(.1)$

$= 0.05$ mol

(b) $0.05 \text{ mol HCl} \times \frac{1 \text{ mol NaOH}}{1 \text{ mol HCl}} = 0.05 \text{ mol NaOH}$

(c) $M = \frac{n}{V}$

$0.10 \frac{mol}{L} = \frac{0.05 \text{ mol}}{x\ L}$

$x\ L = \frac{0.05 \text{ mol}}{0.10 \frac{mol}{L}} = 0.5\ L = 500.\ ml$

↑ this answer is OK, too

Note: $M_A V_A = M_B V_B$ "shortcut" will work here but will screw you up in future chemistry courses.