8.1 What Are Acids and Bases?

Acid : A substance that produces H_3O^+ ions in an aqueous solution.

$$HA(aq) + H_2O(l) = H_3O^+ + A^-$$
$$\Leftrightarrow$$

Base : A substance that produces OH^- ions in an aqueous solution.

$$B(aq) + H_2O \Leftrightarrow BH^+ + OH^-$$
$$X(OH)_n = X^{n+} + n\,OH^-$$

HA : Generic symbol for any acid.
B : Generic symbol for a weak base.
$X(OH)_n$: Generic symbol for a strong base.

8.2 How Do We Define the Strength of Acids and Bases?

Acid :

a) Strong :

$HA(aq) + H_2O(l) = H_3O^+ + A^-$

~100% and only 6
HCl, HBr, HI, HNO_3,
H_2SO_4, $HClO_4$

b) Weak :

$HA(aq) + H_2O(l) \rightleftharpoons H_3O^+ + A^-$

$$K_a = \frac{[H_3O^+][A^-]}{[HA]}$$

Bases :

a) Strong :

$NaOH(aq) = Na^+ + OH^-$

Only 3 others will be considered.
LiOH, KOH and $Ba(OH)_2$

b) Weak :

$B(aq) + H_2O(l) \rightleftharpoons BH^+ + OH^-$

eg. $NH_3(aq) + H_2O(l) \rightleftharpoons NH_4^+ + OH^-$

$$K_b = \frac{[BH^+][OH^-]}{[B]}$$

8.2 How Do We Define the Strength of Acids and Bases?

K_a Values			K_a Values		
Name of Acid	**Acid**	**K_a**	**Name of Acid**	**Acid**	**K_a**
Sulfuric acid	H_2SO_4	large	Hexaaquaaluminum ion	$Al(H_2O)_6^{3+}$	7.9×10^{-6}
Hydrochloric acid	HCl	large	Carbonic acid	H_2CO_3	4.2×10^{-7}
Nitric acid	HNO_3	large	Hydrogen sulfide	H_2S	1×10^{-7}
Hydronium ion	H_3O^+	1.0	Dihydrogen phosphate ion	$H_2PO_4^-$	6.2×10^{-8}
Hydrogen sulfate ion	HSO_4^-	1.2×10^{-2}	Hypochlorous acid	HClO	3.5×10^{-8}
Phosphoric acid	H_3PO_4	7.5×10^{-3}	Ammonium ion	NH_4^+	5.6×10^{-10}
Hexaaquairon(III) ion	$Fe(H_2O)_6^{3+}$	6.3×10^{-3}	Hydrocyanic acid	HCN	4.0×10^{-10}
Hydrofluoric acid	HF	7.4×10^{-4}	Hexaaquairon(II) ion	$Fe(H_2O)_6^{2+}$	3.2×10^{-10}
Formic acid	HCO_2H	1.8×10^{-4}	Hydrogen carbonate ion	HCO_3^-	4.8×10^{-11}
Benzoic acid	$C_6H_5CO_2H$	6.3×10^{-5}	Hydrogen phosphate ion	HPO_4^{2-}	3.6×10^{-13}
Acetic acid	CH_3CO_2H	1.8×10^{-5}	Water	H_2O	1.0×10^{-14}
			Hydrogen sulfide ion	HS^-	1×10^{-19}

For weak acids, the bigger the K_a, the stronger the acid.

8.5 How Do We Use Acid Ionization Constants?

pKa Versus Ka

$$pK_a = -\log_{10} K_a$$

HF: $K_a = 7.4 \times 10^{-4}$ @ 25°C $\qquad pK_a = -\log_{10}(7.4 \times 10^{-4}) = 3.13$

HCN: $K_a = 4.0 \times 10^{-10}$ @ 25°C $\qquad pK_a = -\log_{10}(4.0 \times 10^{-10}) = 9.38$

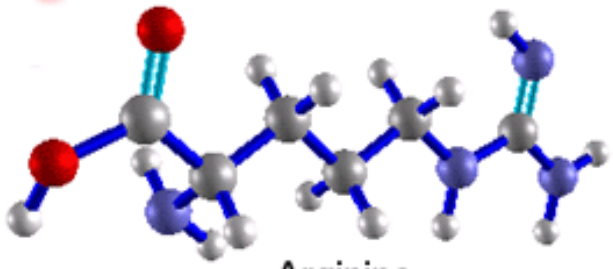
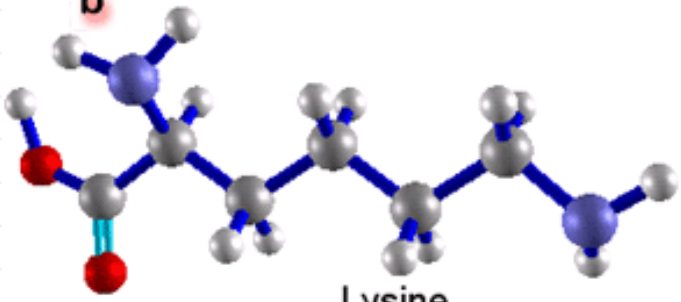
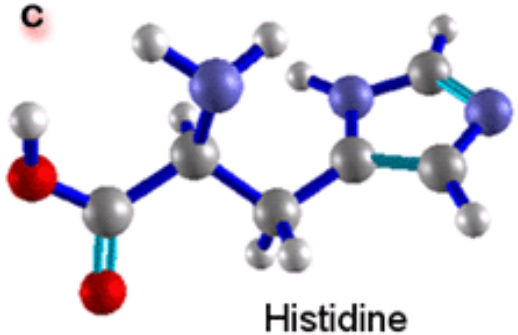
Which is the stronger acid?

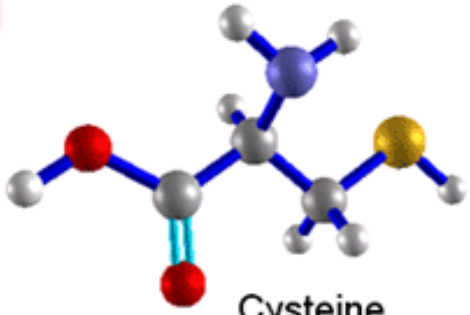
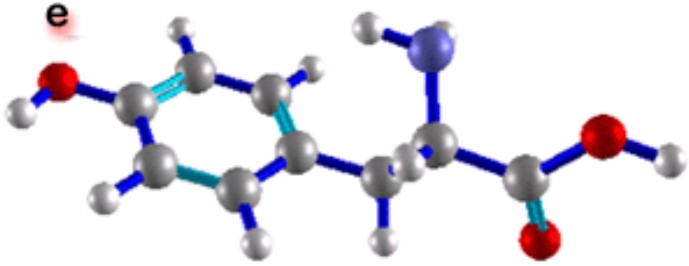
a) The one with the larger K_a: HF

b) The one with the smallest pK_a: HF

8.5 How Do We Use Acid Ionization Constants?

pKa Versus Ka

	pKa
a  Arginine	12.0
b  Lysine	9.0
c  Histidine	6.1

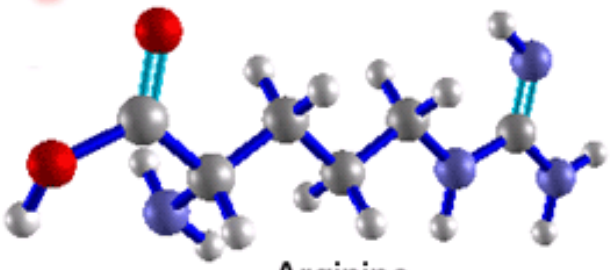
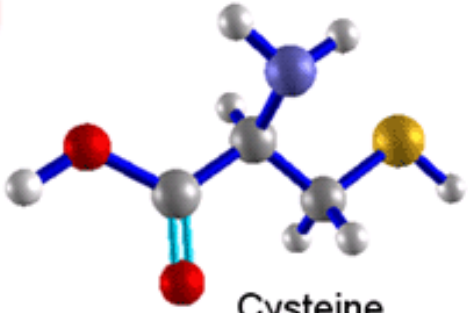
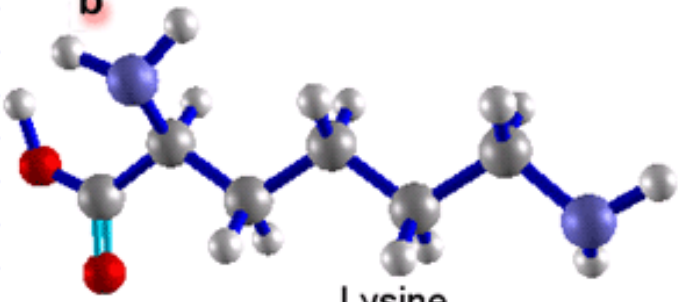
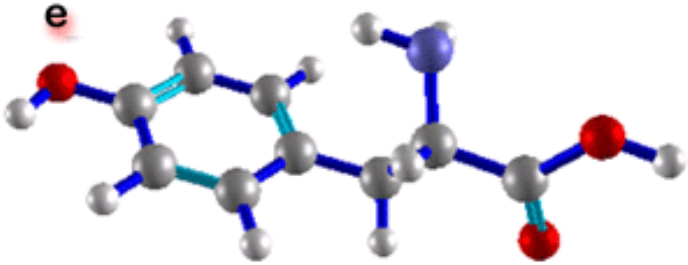
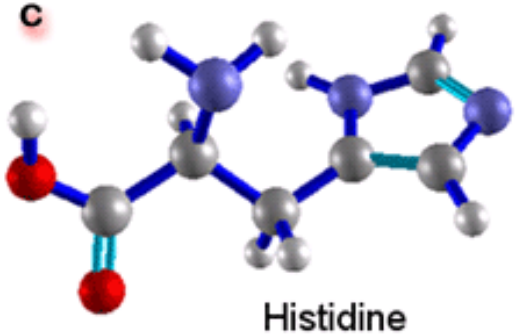
	pKa
d  Cysteine	8.3
e  Tyrosine	9.8

The strongest acid depicted?

Smallest pKa

8.5 How Do We Use Acid Ionization Constants?

pKa Versus Ka

	pKa		pKa
a  Arginine	12.0	d  Cysteine	8.3
b  Lysine	9.0	e  Tyrosine	9.8
c  Histidine	6.1		

The one with an acid strength closest to that of NH_4^+, $K_a = 5.6 \times 10^{-10}$ @ 25°C?

$pK_a = -\log_{10}(5.6 \times 10^{-10}) = 9.25$