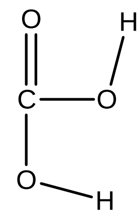
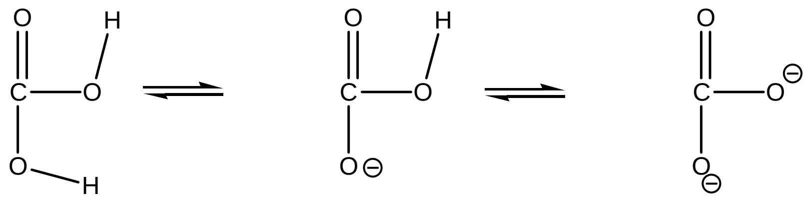
# CH1010 Tutorial 1 Answers

1. Draw a **molecular structure** of **carbonic acid**.
   - What **type of bonding** is present in this molecule.
   - What is the acid/base chemistry of the carbonic acid system important from a biochemical perspective?




Covalent bonding, 3 covalent bonds around C. Each single covalent bond shares 1 electron pair, the double covalent bond shares two electron pairs.
Carbonic acid is a polyprotic acid and can lose up to 2 protons. The conjugate acid-base pair (1 – 2) is a vital part of the bicarbonate buffer system present in the blood. This buffer helps ensure that blood pH remains between 7.35 – 7.45.



**1** **2** **3**

**$HCO_3^-$ bicarbonate** **$CO_3^{2-}$ carbonate**

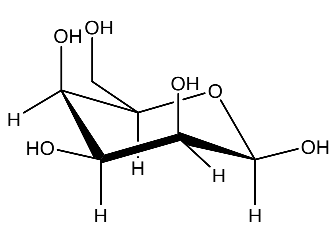
2. Write down the **equilibrium constant** ($K_c$) for the reaction of **methylamine** with water to form the methylammonium ion and $OH^-$

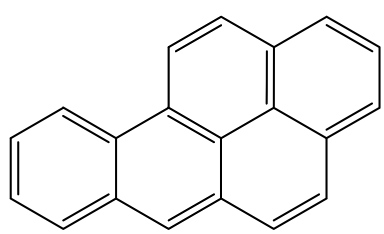
$CH_3NH_2 + H_2O \leftrightarrows CH_3NH_3^+ + OH^-$ $K_c = [CH_3NH_3^+] [OH^-] / [CH_3NH_2] [H_2O]$

Note generally speaking pure liquids and solids are left out of equilibrium constants and in this case the base dissociation constant $K_B$ would leave water out of the above expression for $K_c$.

3. Which of the following molecules would you expect to be **hydrophobic** and which **hydrophilc**? In your answer explain the rationale behind your choice.

A hydrophobic molecule is one that is ‘water hating’ whereas a hydrophilic one is ‘water liking’.
The difference is in the polarities of the molecules. Sugars (such as talose) are polar molecules they have lots of OH groups and each has a +ve end (H) and a –ve end (O). In contrast there is very little difference between C and H in electron sharing and so a simple aromatic hydrocarbon such as benzo(a)-pyrene is very hydrophobic.



Hydrophilic Hydrophobic

4. Calculate the molarity of a **2-deoxyribose sugar** solution prepared from 10g of **2-deoxyribose** and 102cm$^3$ of water. (N.B. 2-deoxyribose = $\beta$-2-deoxy-D-ribose)

**2-deoxyribose** $C_5H_{10}O_4$ M = (5x12) +(10x1) + (4x16) = 134 g mol$^{-1}$

N = m / M = 10 g / 134 g mol$^{-1}$ = 0.07463 mol

c = n/V = 0.07463 mol / 0.102 L = **0.73 mol L$^{-1}$**

5. Does a **catalyst** influence the yield of a chemical/biochemical reaction??

A chemical reaction proceeds when 2 or more reactants collide and (or just 1 reactant) pass over an energy barrier. The activation energy is the height of this energy barrier (kJ mol$^{-1}$). A catalyst functions by providing an alternative pathway for the reaction with a lower activation energy. The result is that the catalysed reaction proceeds much more quickly and yields product in a reduced amount of time, the catalyst though has no influence on the total yield – you do not get more product.

6. Calculate the **pH** of a 0.003M $HNO_3$ solution. Is this acidic, neutral or basic – explain why?

$NaOH \rightarrow Na^+ + OH^-$ a strong base fully dissociates

pOH = $-\log_{10}[OH^-] = -\log_{10}[0.012] = 1.92$

pH = $-\log_{10}[H^+] = -\log_{10}[0.014] = 1.9$

This is a strongly acidic solution as any pH < 7 is acidic.

6. Calculate the **pH** of a 0.0030M $HNO_3$ solution. Is this acidic, neutral or basic – explain why?

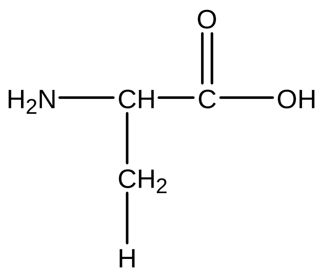
$HNO_3 \rightarrow H^+ + NO_3^-$ a strong acid fully dissociates

pH = $-\log_{10}[H^+] = -\log_{10}[0.003] = 2.5$

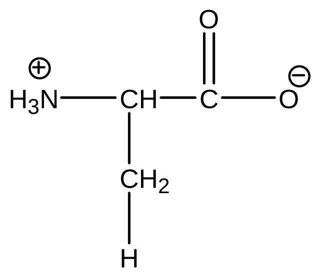
This is a strongly acidic solution as any pH < 7 is acidic.

7. Draw the **un-ionized** and **zwitterionic** forms of alanine. In which form would alanine be present in solution at pH 10.0?

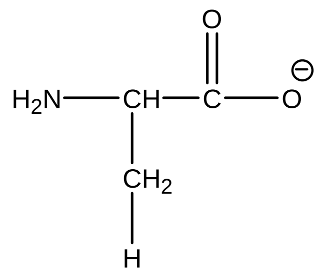
Under basic pH the zwitterion has the ammonium group deprotonated.



un-ionized



zwitterionic



anionic pH 10