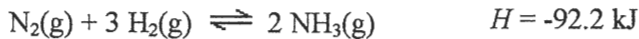


SHOW ALL WORK TO RECEIVE CREDIT.

- e 1. (3Pts) The formation of ammonia from elemental nitrogen and hydrogen is an exothermic process.



Which of the following would drive the equilibrium system to the left?

- a. addition of hydrogen    b. removal of ammonia    c. increasing the pressure  
 d. decreasing the temperature    **e. removal of nitrogen**

- d 2. (3Pts) In the following reaction:  $H_2S(aq) + H_2O(l) \rightleftharpoons HS^-(aq) + H_3O^+(aq)$

- a.  $H_2O$  is an acid and  $H_2S$  is its conjugate base.  
 b.  $H_2S$  is an acid and  $H_2O$  is its conjugate base.  
 c.  $H_2O$  is an acid and  $H_3O^+$  is its conjugate base.  
**d.  $H_2S$  is an acid and  $HS^-$  is its conjugate base.**  
 e.  $H_3O^+$  is an acid and  $HS^-$  is its conjugate base.

3. (3Pts) What is the conjugate acid of  $HPO_4^{2-}(aq)$ ? *Add one more proton*  $H_2PO_4^{1-}$

4. (3Pts) What is the pH of 0.094 M HCl at 25°C?  
*Strong Acid*  $HCl + H_2O \rightarrow H_3O^+ + Cl^-$   $pH = -\log[0.094] = 1.027$

5. (3Pts) What is the pH of  $1.3 \times 10^{-5}$  M NaOH at 25°C?  
*Strong Base*  $NaOH \xrightarrow{H_2O} Na^+ + OH^-$   $pOH = -\log(1.3 \times 10^{-5}) = 4.89$   $pH = 9.11$

6. (5Pts) Benzoic acid ( $HC_6H_5COO$ ) has a  $pK_a$  value of 4.20. Determine the pH of a 0.12 M benzoic acid solution.  
 $HC_6H_5COO + H_2O \rightleftharpoons H_3O^+ + C_6H_5COO^-$   $K_a = 10^{-pK_a} = 6.31 \times 10^{-5}$   

I	0.12	NA	0	0
C	-x		+x	+x
E	0.12-x		x	x

 $K_a = \frac{x^2}{0.12-x} \leftarrow \text{try 5\% rule}$   
 $x = 0.00275 = [H_3O^+]$   
 $pH = -\log[H_3O^+] = 2.56$

7. (5Pts) The pH of 0.010 M trimethylamine,  $(CH_3)_3N$  is 10.88. What is the value of  $K_b$  for this base? (hint: pOH)  
 $(CH_3)_3N + H_2O \rightleftharpoons (CH_3)_3NH^+ + OH^-$   

I	0.010	NA	0	0
C	-x		+x	+x
E	0.010-x		x	x

 $pOH = 14 - 10.88 = 3.12$   
 $x = [OH^-] = 10^{-pOH} = 7.59 \times 10^{-4}$   
 $K_b = \frac{x^2}{0.010-x} = \frac{7.59 \times 10^{-4}}{0.010 - 7.59 \times 10^{-4}} = 6.2 \times 10^{-5}$