

AP Chemistry Chapter 14 Practice Exam

A 1. For the equilibrium that exists in an aqueous solution of nitrous acid ( $\text{HNO}_2$ , a weak acid), the equilibrium constant expression is: 6.12

A)  $K = \frac{[\text{H}^+][\text{NO}_2^-]}{[\text{HNO}_2]}$

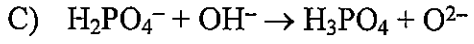
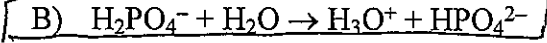
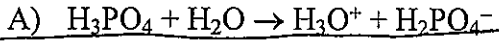
B)  $K = \frac{[\text{H}^+][\text{N}^{2+}][\text{O}^{2-}]^2}{[\text{HNO}_2]}$

C)  $K = [\text{H}^+][\text{NO}_2^-]$

D)  $K = \frac{[\text{H}^+]^2[\text{NO}_2^-]}{[\text{HNO}_2]}$

E) none of these

B 2. In which of the following reactions does the  $\text{H}_2\text{PO}_4^-$  ion act as an acid? 3.7



D) The ion cannot act as an acid.

E) Two of these.

C 3. The equilibrium constants ( $K_a$ ) for HCN and HF in  $\text{H}_2\text{O}$  at  $25^\circ\text{C}$  are  $6.2 \times 10^{-10}$  and  $7.2 \times 10^{-4}$ , respectively. The relative order of base strengths is: 6.16  $1.6 \times 10^{-5}$   $1.39 \times 10^{-11}$   $1 \times 10^{-6}$

A)  $\text{F}^- > \text{H}_2\text{O} > \text{CN}^-$

B)  $\text{H}_2\text{O} > \text{F}^- > \text{CN}^-$

C)  $\text{CN}^- > \text{F}^- > \text{H}_2\text{O}$

D)  $\text{F}^- > \text{CN}^- > \text{H}_2\text{O}$

E) none of these

E 4. Given the following acids and  $K_a$  values: 6.16

$\text{HClO}_4$	$\text{HOAc}$	$\text{HCN}$	$\text{HF}$
$1 \times 10^7$	$1.76 \times 10^{-5}$	$4.93 \times 10^{-10}$	$3.53 \times 10^{-4}$
$1 \times 10^7$	$1.76 \times 10^{-5}$	$4.93 \times 10^{-10}$	$3.53 \times 10^{-4}$

What is the order of increasing base strength?

A)  $\text{CN}^-$ ,  $\text{F}^-$ ,  $\text{OAc}^-$ ,  $\text{ClO}_4^-$

B)  $\text{CN}^-$ ,  $\text{OAc}^-$ ,  $\text{F}^-$ ,  $\text{ClO}_4^-$

C)  $\text{CN}^-$ ,  $\text{ClO}_4^-$ ,  $\text{F}^-$ ,  $\text{OAc}^-$

D)  $\text{ClO}_4^-$ ,  $\text{OAc}^-$ ,  $\text{CN}^-$ ,  $\text{F}^-$

E)  $\text{ClO}_4^-$ ,  $\text{F}^-$ ,  $\text{OAc}^-$ ,  $\text{CN}^-$

Name: \_\_\_\_\_



ID: A

B 5. HA and HB are both weak acids in water, and HA is a stronger acid than HB. Which of the following statements is correct? 6.16

A)  $A^-$  is a stronger base than  $B^-$ , which is a stronger base than  $H_2O$ , which is a stronger base than  $Cl^-$ .

B)  $B^-$  is a stronger base than  $A^-$ , which is a stronger base than  $H_2O$ , which is a stronger base than  $Cl^-$ .

C)  $B^-$  is a stronger base than  $A^-$ , which is a stronger base than  $Cl^-$ , which is a stronger base than  $H_2O$ .

D)  $Cl^-$  is a stronger base than  $A^-$ , which is a stronger base than  $B^-$ , which is a stronger base than  $H_2O$ .

E) None of these (A-D) is correct.

C 6. Calculate the  $[H^+]$  in a solution that has a pH of 2.73.

A) 2.7 M

B) 11.3 M

C)  $1.9 \times 10^{-3} M$

D)  $5.4 \times 10^{-12} M$

E) none of these

$$10^{-2.73}$$

C 7. The pH of a solution at  $25^\circ C$  in which  $[OH^-] = 3.9 \times 10^{-5} M$  is:

A) 4.41

B) 3.90

C) 9.59

D) 4.80

E) none of these

$$pOH = 4.41$$

$$9.59$$

C 8. Solid calcium hydroxide is dissolved in water until the pH of the solution is 11.44. The hydroxide ion concentration  $[OH^-]$  of the solution is:

A)  $3.6 \times 10^{-12} M$

B)  $5.5 \times 10^{-3} M$

C)  $2.8 \times 10^{-3} M$

D)  $1.4 \times 10^{-3} M$

E) none of these

$$10^{-11.44} = [H^+]$$

$$14 - pOH = 2.56 \quad 10^{-2.56}$$

A 9. Calculate the pH of 0.203 M  $HNO_3(aq)$ .

A) 0.693

B) 2.030

C) -1.140

D) 13.797

E) 1.595

$$-\log 0.203$$

C 10. Calculate the pOH of a 4.9 M solution of HCl.

A) -0.69

B) 13.31

C) 14.69

D) 0.69

E) -0.96

$$-\log 4.9$$

$$14 - -0.69$$

A

11. Calculate the pH of a 0.13 M solution of HOCl,
- $K_a = 3.5 \times 10^{-8}$
- .

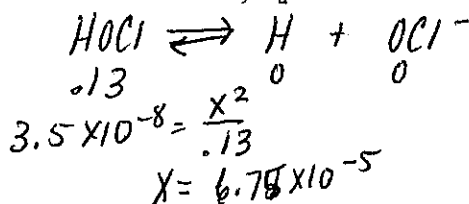
A) 4.17

B) 8.34

C) 9.83

D) 1.00

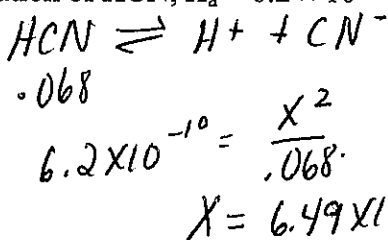
E) 3.76

B

12. Calculate the
- $[\text{H}^+]$
- in a 0.068 M solution of HCN,
- $K_a = 6.2 \times 10^{-10}$
- .

A)  $1.0 \times 10^{-7} \text{ M}$ B)  $6.5 \times 10^{-6} \text{ M}$ C)  $4.2 \times 10^{-11} \text{ M}$ D)  $1.3 \times 10^{-5} \text{ M}$ 

E) none of these

B

13. A
- $8.5 \times 10^{-3} \text{ M}$
- solution of a weak acid is 4.6% dissociated at 25°C. In a
- $8.5 \times 10^{-4} \text{ M}$
- solution, the percentage of dissociation would be

A) the same

B) &gt; 4.6%

C) &lt; 4.6%

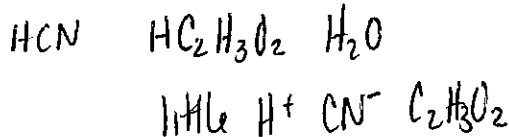
D) zero

E) need to know the  $K_a$  of the acid to answer this

↓ [ ] ↑ % ioniz.

E

14. Consider a solution made by mixing HCN (
- $K_a = 6.2 \times 10^{-10}$
- ) with
- $\text{HC}_2\text{H}_3\text{O}_2$
- (
- $K_a = 1.8 \times 10^{-5}$
- ) in aqueous solution. What are the
- major species
- in solution?

A)  $\text{H}^+$ ,  $\text{CN}^-$ ,  $\text{H}^+$ ,  $\text{C}_2\text{H}_3\text{O}_2^-$ ,  $\text{H}_2\text{O}$ B) HCN,  $\text{H}^+$ ,  $\text{C}_2\text{H}_3\text{O}_2^-$ ,  $\text{H}_2\text{O}$ C)  $\text{H}^+$ ,  $\text{CN}^-$ ,  $\text{HC}_2\text{H}_3\text{O}_2$ ,  $\text{H}_2\text{O}$ D)  $\text{H}^+$ ,  $\text{CN}^-$ ,  $\text{H}^+$ ,  $\text{C}_2\text{H}_3\text{O}_2^-$ ,  $\text{OH}^-$ ,  $\text{H}_2\text{O}$ E) HCN,  $\text{HC}_2\text{H}_3\text{O}_2$ ,  $\text{H}_2\text{O}$ A

15. Calculate the pH of a 0.059 M solution of
- $\text{Ca}(\text{OH})_2$
- .

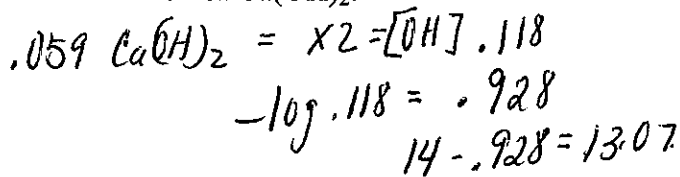
A) 13.07

B) 12.77

C) 0.93

D) 1.23

E) none of these

C

16. Calculate the pH of a 0.69 M solution of pyridine (
- $\text{C}_5\text{H}_5\text{N}$
- ;
- $K_b = 1.7 \times 10^{-9}$
- ):

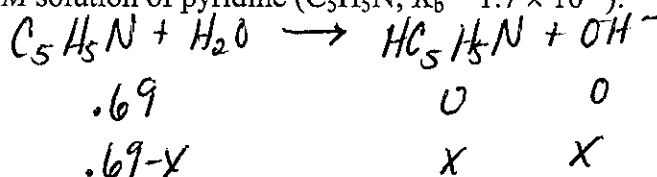
A) 4.47

B) 5.07

C) 9.53

D) 8.93

E) none of these



$$1.7 \times 10^{-9} = \frac{x^2}{.69 - x}$$

$$x = 3.42 \times 10^{-5} = [\text{OH}^-]$$

$$\text{pOH} = 4.465$$

$$\text{pH} = 9.53$$

- D 17. For the stepwise dissociation of aqueous  $\text{H}_3\text{PO}_4$ , which of the following is not a conjugate acid-base pair?
- A)  $\text{HPO}_4^{2-}$  and  $\text{PO}_4^{3-}$  ✓  
 B)  $\text{H}_3\text{PO}_4$  and  $\text{H}_2\text{PO}_4^-$  ✓  
 C)  $\text{H}_2\text{PO}_4^-$  and  $\text{HPO}_4^{2-}$  ✓  
 D)  $\text{H}_2\text{PO}_4^-$  and  $\text{PO}_4^{3-}$  ✗  
 E)  $\text{H}_3\text{O}^+$  and  $\text{H}_2\text{O}$
- Handwritten: differ by 1 H+*

- D 18. The pH of a solution of 1.9 M  $\text{H}_2\text{A}$  ( $K_{a1} = 1.0 \times 10^{-6}$  and  $K_{a2}$  is  $1.0 \times 10^{-10}$ ) is:
- A) 10.00  
 B) 5.72  
 C) 11.14  
 D) 2.86  
 E) none of these
- Handwritten:*  
 $\text{H}_2\text{A} \rightleftharpoons \text{H}^+ + \text{HA}^-$   
 $1.9 \quad \quad \quad 0 \quad \quad \quad 0$   
 $1.0 \times 10^{-6} = \frac{x^2}{1.9-x} \quad x = .001378$   
 $\text{HA}^- \rightleftharpoons \text{H}^+ + \text{A}^{2-}$   
 $.001378-y \quad .001378+y \quad y$   
 $1.0 \times 10^{-10} = \frac{(.001378)(y)}{.01378}$   
 $y = 1 \times 10^{-10}$

- B 19. The dihydrogenphosphate ion,  $\text{H}_2\text{PO}_4^-$ , has both a conjugate acid and a conjugate base. These are, respectively:
- A)  $\text{H}_3\text{PO}_4, \text{PO}_4^{3-}$   
 B)  $\text{H}_3\text{PO}_4, \text{HPO}_4^{2-}$   
 C)  $\text{H}_2\text{PO}_4^-, \text{HPO}_4^{2-}$   
 D)  $\text{HPO}_4^{2-}, \text{PO}_4^{3-}$   
 E)  $\text{HPO}_4^{2-}, \text{H}_3\text{PO}_4$
- Handwritten:*  $\text{H}_3\text{PO}_4 \quad \text{HPO}_4^{2-} \quad 3.7$

Select the answer that best describes an aqueous solution made from each of the following substances:

- B 20. solid sodium carbonate ( $\text{Na}_2\text{CO}_3$ )
- A) acidic  
 B) basic  
 C) neutral  
 D) cannot tell  
 E) none of these (A-D)
- A 21. solid ammonium perchlorate ( $\text{NH}_4\text{ClO}_4$ ) For  $\text{NH}_4^+$ ,  $K_a = 5.6 \times 10^{-10}$ ; for  $\text{ClO}_4^-$ ,  $K_b \approx 10^{-21}$ .
- A) acidic  
 B) basic  
 C) neutral  
 D) cannot tell  
 E) none of these (A-D)
- A 22. Which is the strongest acid of the following?
- A)  $\text{HClO}_2$   
 B)  $\text{HClO}$   
 C)  $\text{HBrO}$   
 D)  $\text{HIO}$   
 E)  $\text{HOAt}$

Name: \_\_\_\_\_

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E

23. For each group of compounds listed, which is the strongest acid?

I.  $\text{HIO}_2$ ,  $\text{HIO}_3$ ,  $\text{HIO}_4$

II.  $\text{H}_2\text{Se}$ ,  $\text{H}_2\text{S}$ ,  $\text{H}_3\text{As}$

III.  $\text{HPO}_2$ ,  $\text{HClO}_2$ ,  $\text{HBrO}_2$

A) I.  $\text{HIO}_2$ ,  $\text{H}_2\text{Se}$ ,  $\text{HBrO}_2$

B) I.  $\text{HIO}_4$ ,  $\text{H}_2\text{Se}$ ,  $\text{HBrO}_2$

C) I.  $\text{HIO}_2$ ,  $\text{H}_3\text{As}$ ,  $\text{HPO}_2$

D) I.  $\text{HIO}_3$ ,  $\text{H}_3\text{As}$ ,  $\text{HClO}_2$

E) I.  $\text{HIO}_4$ ,  $\text{H}_2\text{Se}$ ,  $\text{HClO}_2$