

VERSION 01 - GREY

1. In the reaction $\overset{B}{N_2H_4(aq)} + \overset{A}{H_2O(l)} \rightleftharpoons \overset{A}{N_2H_5^+(aq)} + \overset{B}{OH^-(aq)}$, which species are acids?

A) $N_2H_4(aq)$ and $N_2H_5^+(aq)$

B) $H_2O(l)$ and $N_2H_5^+(aq)$

C) $N_2H_5^+(aq)$ and $OH^-(aq)$

D) only $OH^-(aq)$

E) only $N_2H_5^+(aq)$

2. At a given temperature, $K = 0.020$ for the equilibrium: $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

What is K for $2Cl_2(g) + 2PCl_3(g) \rightleftharpoons 2PCl_5(g)$

A) 0.020

B) 50

C) 100

D) 500

E) 2500

↑ eqn is reversed so $K \rightarrow \frac{1}{K}$

eqn is multiplied by 2 so $K \rightarrow K^2$

$$\therefore \left(\frac{1}{K}\right)^2 = \frac{1}{(0.020)^2} = 2500$$

3. What volume of 0.500 M strontium nitrate solution is needed to prepare 250.0 mL of a solution that is 0.200 M in nitrate?

A) 25.0 mL

B) 50.0 mL

C) 75.0 mL

D) 100. mL

E) 125 mL

$$0.200 \frac{\text{moles}}{L} \times 0.2500 L = 0.0500 \text{ moles } NO_3^-$$

$$0.0500 \text{ moles } NO_3^- \times \frac{1 \text{ mole } Sr(NO_3)_2}{2 \text{ moles } NO_3^-} = 0.0250 \text{ moles } Sr(NO_3)_2$$

$$0.0250 \text{ moles } Sr(NO_3)_2 \times \frac{1 L}{0.500 \text{ moles } Sr(NO_3)_2} = 0.0500 L \text{ or } 50.0 \text{ mL}$$

4. How many hydrogen atoms are present in 6.0 g of water?

A) 2.0×10^{23}

B) 4.0×10^{23}

C) 7.2×10^{24}

D) 1.1×10^{24}

E) 0.66

$$6.0 \text{ g } H_2O \times \frac{1 \text{ mole } H_2O}{18.02 \text{ g } H_2O} \times \frac{2 \text{ moles } H}{1 \text{ mole } H_2O} \times \frac{6.02 \times 10^{23} \text{ H atoms}}{1 \text{ mole } H}$$

$$= 4.0 \times 10^{23} \text{ H atoms}$$

5. Which of the following indicates the most acidic solution?

A) $[OH^-] = 0.5 \text{ M} \rightarrow pOH = 0.3 \therefore pH = 14.00 \rightarrow \text{high } [H^+], \text{ low } pH$

B) $pH = 1.2$ acidic

C) $[H^+] = 0.3 \text{ M} \rightarrow pH = 0.5$ lowest

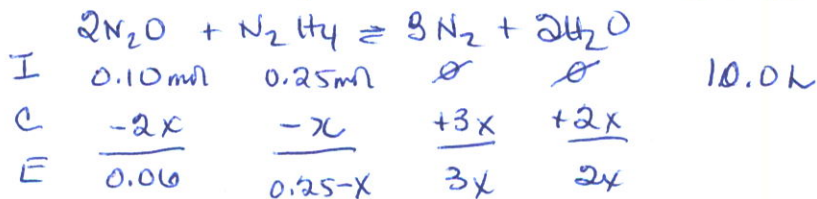
D) $pOH = 5.9 \rightarrow pH = 14 - pOH = 8.1$ (basic) X

E) $[H^+] = 1.0 \times 10^{-4} \text{ M}$

$$\hookrightarrow pH = -\log[H^+] = 4.00$$

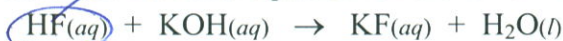
6. Consider the following: $2\text{N}_2\text{O}(\text{g}) + \text{N}_2\text{H}_4(\text{g}) \rightleftharpoons 3\text{N}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$
Initially there are 0.10 moles of N_2O and 0.25 moles of N_2H_4 in a 10.0 L container. If there are 0.06 moles of N_2O at equilibrium, how many moles of N_2 are present at equilibrium?

- A) 0.9
B) 0.04
C) 0.06
D) 0.02
E) none of these



$0.10 - 2x = 0.06$
 $2x = 0.04$
 $x = 0.02$
moles $\text{N}_2 = 3x$
 $= 3(0.02)$
 $= 0.06$

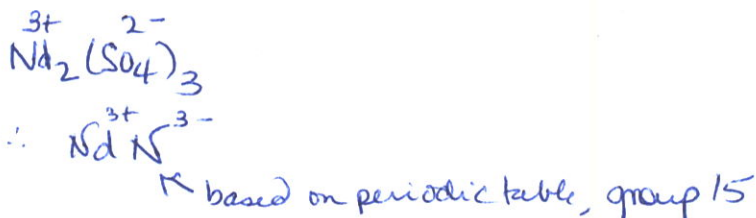
7. Write a balanced net ionic equation for the following reaction:
weak acid / weak electrolyte ∴ doesn't dissociate



- A) $\text{F}(\text{aq}) + \text{K}^+(\text{aq}) \rightarrow \text{KF}(\text{aq})$
B) $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$
C) $\text{K}^+(\text{aq}) + \text{KOH}(\text{aq}) \rightarrow \text{K}^+(\text{aq}) + \text{H}_2\text{O}(\text{l})$
D) $\text{HF}(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{F}^-(\text{aq}) + \text{H}_2\text{O}(\text{l})$
E) $\text{HF}(\text{aq}) + \text{K}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{K}^+(\text{aq}) + \text{F}^-(\text{aq}) + \text{H}_2\text{O}(\text{l})$

8. The formula for neodymium sulfate is $\text{Nd}_2(\text{SO}_4)_3$. On the basis of this information, the formula for the nitride of neodymium would be expected to be

- A) $\text{Nd}_2(\text{NO}_2)_3$
B) Nd_3N_2
C) $\text{Nd}(\text{NO}_3)_3$
D) $\text{Nd}(\text{NO}_2)_3$
E) NdN



9. For the reaction system: $2\text{HI}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + \text{I}_2(\text{g})$; $K_c = 0.020$ at 720 K.

If the initial concentrations of HI, H_2 and I_2 are all 1.50×10^{-3} M at 720 K, which one of the following statements is correct?

- A) The system is at equilibrium. X
B) The $[\text{H}_2]$ and $[\text{HI}]$ will decrease as the system is approaching equilibrium. X
C) The $[\text{HI}]$ will increase as the system is approaching equilibrium.
D) The $[\text{HI}]$ and $[\text{I}_2]$ will increase as the system is approaching equilibrium. X
E) The $[\text{H}_2]$ and $[\text{I}_2]$ will increase as the system is approaching equilibrium.

$Q = \frac{(\text{H}_2)(\text{I}_2)}{(\text{HI})^2}$
 $Q = \frac{(1.5 \times 10^{-3})(1.5 \times 10^{-3})}{(1.5 \times 10^{-3})^2}$
 $Q = 1 > K$

∴ too many products
Rxn moves L ← R

10. At 25°C and 1.00 atm pressure, it is found that 2.24 L of gas weighs 3.11 g.

Its relative molecular mass is

- A) 34.0 g.
B) 3.11 g.
C) 37.1 g.
D) 28.5 g.
E) 31.1 g.

$add\ 273.15 = 298.15\text{K}$
 $PV = nRT$
 $n = \frac{PV}{RT} = \frac{1.00\text{atm} \times 2.24\text{L}}{0.0821\text{atm}\cdot\text{K} \times 298.15\text{K}}$
 $n = 0.0915\text{ moles}$
 $MM = \frac{3.11\text{g}}{0.0915\text{ moles}}$
 $= 33.985$
 $= 34.0\text{g/mol}$

11. In the reaction $2A + B \rightarrow 3C + D$, 3.0 moles of A and 2.0 moles of B react to form 4.0 moles of C. What is the percent yield for this reaction?

- A) 50%
- B) 67%
- C) 75%
- D) 89%
- E) 100%

$$3.0 \text{ moles } A \times \frac{3 \text{ moles } C}{2 \text{ moles } A} = \frac{9}{2} \text{ OR } 4.5 \text{ moles } C \quad \text{(LR)}$$

$$2.0 \text{ moles } B \times \frac{3 \text{ moles } C}{1 \text{ mole } B} = 6.0 \text{ moles } C \quad \text{Excess}$$

$$\% \text{ yield} = \frac{\text{actual}}{\text{theoretical}} \times 100\% = \frac{4.0}{4.5} \times 100\% = 88.88\% \approx 89\%$$

12. What is the percentage of nitrogen in ammonium phosphate, $(\text{NH}_4)_3\text{PO}_4$?

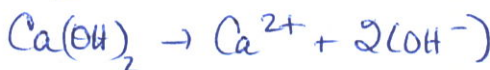
- A) 11.6%
- B) 16.0%
- C) 28.2%
- D) 31.9%
- E) 34.3%

$$M_{(\text{NH}_4)_3\text{PO}_4} = 3(14.01) + 12(1.01) + 30.97 + 4(16.00) = 149.12 \text{ g/mole}$$

$$\% N = \frac{3(14.01)}{149.12} \times 100\% = 28.19\% \approx 28.2\%$$

13. The pH of a 0.0025 M aqueous solution of calcium hydroxide is

- A) 11.70
- B) 11.40
- C) 12.00
- D) 2.60
- E) 2.30



$$\text{pOH} = -\log(\text{OH}^-) = 2.30$$

I	0.0025	0	0
C	-0.0025	+0.0025	+2 x 0.0025
E	<u>0</u>	0.0025	0.0050 M

$$\text{pH} = 14.00 - 2.30 = 11.70$$

14. Four identical 1.0 L flasks contain the gases He, Cl_2 , CH_4 and NH_3 each at 0°C and 1 atm pressure. Which gas sample has the greatest number of molecules?

- A) He
- B) Cl_2
- C) CH_4
- D) NH_3
- E) All gases have the same.

↳ Same V, T, P ∴ Same # moles = # molecules

15. Acid rain is produced by the following sequence of reactions:



How many moles of H_2SO_4 will be produced from 5.00 moles of $\text{FeS}_2(\text{s})$?

- A) 10.0 moles
- B) 20.0 moles
- C) 5.00 moles
- D) 12.2 moles
- E) 6.11 moles

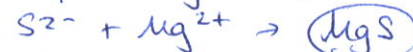
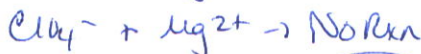
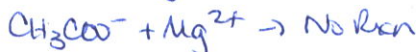
$$5.00 \text{ mol FeS}_2 \times \frac{8 \text{ moles SO}_2}{4 \text{ moles FeS}_2} \times \frac{2 \text{ moles SO}_3}{2 \text{ moles SO}_2} \times \frac{1 \text{ mole H}_2\text{SO}_4}{1 \text{ mole SO}_3} = 10.0 \text{ moles H}_2\text{SO}_4$$

16. A student is given a sample in the lab which contains one of the ions listed below.

After adding $\text{AgNO}_3(aq)$ to part of the unknown sample, the student got a greyish precipitate.

After adding $\text{Mg}(\text{NO}_3)_2(aq)$ to another part of the unknown sample, the student got a black precipitate.

Based on these observations, the only possible ion to be in the sample is:



17. At 0°C , the ion-product constant of water, K_w is 1.2×10^{-15} . What is the pH of pure water at 0°C ?

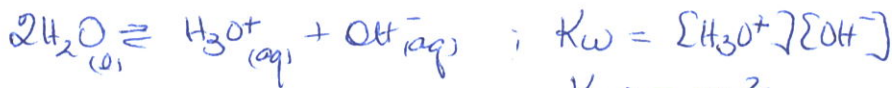
A) 7.00

B) 6.88

C) 7.56

D) 14.92

E) 7.46



$K_w = x^2$

$x = \sqrt{K_w}$

$\therefore [\text{H}_3\text{O}^+] = \sqrt{K_w} = 3.46 \times 10^{-8}$

$\text{pH} = -\log[\text{H}_3\text{O}^+]$
 $\therefore \text{pH} = 7.46$

18. For the reaction, $\text{PCl}_5(g) + \text{heat} \rightleftharpoons \text{PCl}_3(g) + \text{Cl}_2(g)$, which of the following is FALSE?

A) Adding PCl_3 to the container shifts the equilibrium to form more PCl_5 . \checkmark $L \leftarrow R$

B) Increase the temperature shifts the equilibrium to form more PCl_3 . \checkmark $h \rightarrow R$

C) Decreasing the volume of the container shifts the equilibrium to form more PCl_5 . \checkmark $L \leftarrow R$ takes up less room

D) Removing PCl_5 from the container shifts the equilibrium to form more PCl_3 . \times $L \leftarrow R$ to make more PCl_5

E) Changing the internal pressure has no effect on the system. \checkmark

19. Consider the reaction between 50.0 mL of 0.200 M sodium hydroxide and 75.0 mL of 0.100 M HCl. Which of the following statements is correct?

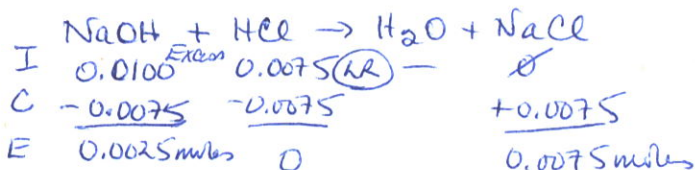
A) NaOH is the limiting reagent. \times

B) After the reaction, $[\text{Na}^+]$ is greater than $[\text{OH}^-]$. \checkmark

C) After the reaction, $[\text{Na}^+] = [\text{Cl}^-]$. \times

D) After the reaction, $[\text{Na}^+] = 0.200 \text{ M}$ because Na^+ is a spectator ion. \times

E) None of these are correct. \times



not equal $\left(\begin{array}{l} \text{Na}^+ = 0.0100 \text{ moles} \\ \text{Cl}^- = 0.0075 \text{ moles} \\ \text{OH}^- = 0.0025 \text{ moles} \end{array} \right)$

20. What volume of 0.350 M H_3PO_4 is required to react completely with 0.156 moles KOH?

A) 149 mL

B) 446 mL

C) 748 mL

D) 1340 mL

E) 2240 mL



0.350 M 0.156 moles

$0.156 \text{ moles KOH} \times \frac{1 \text{ mole H}_3\text{PO}_4}{3 \text{ moles KOH}} \times \frac{1 \text{ L}}{0.350 \text{ moles H}_3\text{PO}_4} = 0.1486 \text{ L OR } 148.6 \text{ mL OR } 149 \text{ mL}$