Chemistry 141 Name

Dr. Cary Willard

Quiz 3a (20 points) February 15, 2011

All work must be shown to receive credit.

1. (8 points) Complete the following double displacement reactions and write complete and net ionic reactions for them. Be sure to include all state labels.
	1. CrBr2 *(aq)* + Na2CO3 *(aq)* 🡪

Conventional equation

 CrBr2 *(aq)* + Na2CO3*(aq)* 🡪 CrCO3(s) + 2 NaBr*(aq)*

Total ionic equation

 Cr+2*(aq)* + 2 Br-1*(aq)* + 2 Na+1*(aq)* + CO3-2*(aq)* 🡪 CrCO3(s) + 2 Na+1*(aq)* + 2 Br-1*(aq)*

Net ionic equation

 Cr+2*(aq)* + CO3-2*(aq)* 🡪 CrCO3(s)

* 1. NH4I*(aq)* + NaOH*(aq)* 🡪

Conventional equation

 NH4I*(aq)* + NaOH*(aq)* 🡪 NaI*(aq)* + NH4OH*(aq)* 🡪 NaI*(aq)* + H2O*(l)* + NH3*(g)*

Total ionic equation

 NH4+1*(aq)* + I-1*(aq)* + Na+1*(aq)* + OH-1*(aq)* 🡪 Na+1*(aq)* +I-1*(aq)* + H2O*(l)* + NH3*(g)*

Net ionic equation

 NH4+1*(aq)* + OH-1*(aq)* 🡪 H2O*(l)* + NH3*(g)*

1. (12 points) Urea (CH4N2O) is a common fertilizer that can be synthesized by the reaction of ammonia (NH3) with carbon dioxide as shown in the reaction below. In an industrial synthesis of urea, a chemist combines 163.4 kg of ammonia with 337.6 kg of carbon dioxide and obtains 193.4 kg of urea. Determine the limiting reactant, theoretical yield of urea, mass of each reagent remaining, and percent yield for the reaction. Use the IE method.

2 NH3(aq) + CO2(aq) 🡪 CH4N2O(aq) + H2O(l)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **x=4.798 kmol** | x=7.671 kmol |  |  |
| I | 9.595 kmol | 7.671 kmol | 0 kmol | 0 kmol |
|  | -2x | -x | +x | +x |
| E | 9.595-2x kmol=9.595-2(4.798)=0 kmol | 7.671-x kmol=7.671-4.798=2.874 kmol | x kmol=4.798 kmol | x kmol=4.798 kmol |

$$?kmol NH\_{3}=163.4 kg NH\_{3}×\frac{1 kmol NH\_{3}}{17.03 kg NH\_{3}}=9.595 kmol NH\_{3}$$

$$?kmol CO\_{2}=337.6 kg CO\_{2}×\frac{1 kmol CO\_{2}}{44.01 kg CO\_{2}}=7.671 kmol CO\_{2}$$

$$?mass urea=4.798 kmol CH\_{4}N\_{2}O×\frac{60.02 kg CH\_{4}N\_{2}O}{1 kmol CH\_{4}N\_{2}O}=288.0 kg CH\_{4}N\_{2}O$$

$$?mass NH\_{3} remaining=0 kmol NH\_{3}×\frac{17.03 kg NH\_{3}}{1 kmol NH\_{3}}=0 kg NH\_{3} $$

$$?mass CO\_{2} remaining=2.874 kmol CO\_{2}×\frac{44.01 kg CO\_{2}}{1 kmol CO\_{2}}=126.5 kg CO\_{2}$$

$$?percent yield=\left(\frac{193.4 kg CO\_{2}}{288.0 kg CO\_{2}}\right)×100\%=67.15\% yield$$

Mass NH3 remaining 0 kg mass CO2 remaining 126.5 kg

Mass urea 288.0 kg % yield 67.15%

Chemistry 141 Name

Dr. Cary Willard

Quiz 3b (20 points) February 15, 2011

All work must be shown to receive credit.

1. (8 points) Complete the following double displacement reactions and write complete and net ionic reactions for them. Be sure to include all state labels.
	1. NiBr2 *(aq)* + (NH4)2S *(aq)* 🡪

Conventional equation

 NiBr2 *(aq)* + (NH4)2S*(aq)* 🡪 NiS(s) + 2 NH4Br*(aq)*

Total ionic equation

 Ni+2*(aq)* + 2 Br-1*(aq)* + 2 NH4+1*(aq)* + S-2*(aq)* 🡪 NiS(s) + 2 NH4+1*(aq)* + 2 Br-1*(aq)*

Net ionic equation

 Ni+2*(aq)* + CO3-2*(aq)* 🡪 NiS(s)

* 1. HCl *(aq)* + Li2CO3*(aq)* 🡪

Conventional equation

 2 HCl*(aq)* + Li2CO3 *(aq)* 🡪LiCl*(aq)* + H2CO3*(aq)* 🡪 LiCl*(aq)* + H2O*(l)* + CO2*(g)*

Total ionic equation

 2 H+1*(aq)* + 2 Cl-1*(aq)* + 2 Li+1*(aq)* + CO3-1*(aq)* 🡪 Li+1*(aq)* +Cl-1*(aq)* + H2O*(l)* + CO2*(g)*

Net ionic equation

 2 H+1*(aq)* + CO3-1*(aq)* 🡪 H2O*(l)* + CO2*(g)*

1. (12 points) Urea (CH4N2O) is a common fertilizer that can be synthesized by the reaction of ammonia (NH3) with carbon dioxide as shown in the reaction below. In an industrial synthesis of urea, a chemist combines 256.4 kg of ammonia with 285.6 kg of carbon dioxide and obtains 275.9 kg of urea. Determine the limiting reactant, theoretical yield of urea, mass of each reagent remaining, and percent yield for the reaction. Use the IE method.

2 NH3(aq) + CO2(aq) 🡪 CH4N2O(aq) + H2O(l)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | x=7.528 kmol | **x=6.489 kmol** |  |  |
| I | 15.06 kmol | 6.489 kmol | 0 kmol | 0 kmol |
|  | -2x | -x | +x | +x |
| E | 15.06-2x kmol=15.06-2(6.498)=2.064 kmol | 6.489-x kmol=6.489-6.498=0 kmol | x kmol=6.498 kmol | x kmol=6.498 kmol |

$$?kmol NH\_{3}=256.4 kg NH\_{3}×\frac{1 kmol NH\_{3}}{17.03 kg NH\_{3}}=15.06 kmol NH\_{3}$$

$$?kmol CO\_{2}=285.6 kg CO\_{2}×\frac{1 kmol CO\_{2}}{44.01 kg CO\_{2}}=6.489 kmol CO\_{2}$$

$$?mass urea=6.498 kmol CH\_{4}N\_{2}O×\frac{60.02 kg CH\_{4}N\_{2}O}{1 kmol CH\_{4}N\_{2}O}=390.0 kg CH\_{4}N\_{2}O$$

$$?mass NH\_{3} remaining=2.064 kmol NH\_{3}×\frac{17.03 kg NH\_{3}}{1 kmol NH\_{3}}=35.15 kg NH\_{3} $$

$$?mass CO\_{2} remaining=0 kmol CO\_{2}×\frac{44.01 kg CO\_{2}}{1 kmol CO\_{2}}=0 kg CO\_{2}$$

$$?percent yield=\left(\frac{274.9 kg CO\_{2}}{390.0 kg CO\_{2}}\right)×100\%=70.49\% yield$$

Mass NH3 remaining 35.15 kg mass CO2 remaining 0 kg

Mass urea 390.0 kg % yield 70.49%