Chemistry H

Exercise 12.3e(H)

Solution Stoichiometry – Answers

Name: _____

Date: _____ Per: _____

Stoichiometry calculations rely on the conversion of chemical measurements into moles. The volume and molarity (mol/L) of a solution may be used to determine the number of moles of a reactant or product in a stoichiometric calculation. Multiplying the volume of the solution in liters by the molarity results in the number of moles of solute.

(given volume of solution expressed in liters)	*(given molarity written as a ratio over 1 mole)*	*(mole ratio step)*	*(final conversion to desired units)*
volume of solution (L)	moles of solute / 1 Liter	moles unknown / moles known	desired unit of known *(or 1 liter)* / 1 mole known *(or moles solute)*

If finding a volume of a particular concentration of solution, the final conversion factor may be written as concentration ratio (L/mol). This provides a final answer in liters of solution.

Example: What volume of 0.100 M Na_3PO_4 is required to precipitate all the lead(II) ions from 150.0 mL of 0.250 M $Pb(NO_3)_2$?

2 Na_3PO_4 + 3 $Pb(NO_3)_2$ → 6 $NaNO_3$ + 1 $Pb_3(PO_4)_2$

$$0.150\ L\ Pb(NO_3)_2 \left|\frac{0.250\ mol\ Pb(NO_3)_2}{1\ liter\ solution}\right.\left|\frac{2\ mol\ Na_3PO_4}{3\ mol\ Pb(NO_3)_2}\right.\left|\frac{1\ liter\ Na_3PO_4\ sol'n}{0.100\ mol\ Na_3PO_4}\right. = \boxed{0.250\ L}$$

DIRECTIONS: Answer the following in the space provided.

1. How many grams of aluminum are required to react with 35 mL of 2.0 *M* hydrochloric acid, HCl?

$6\ HCl + 2\ Al \rightarrow 2\ AlCl_3 + 3\ H_2$

35 mL HCl, 2.0 *M*; ? g Al

$$0.035\ L\ HCl \left|\frac{2.0\ mol\ HCl}{1\ liter\ sol'n}\right.\left|\frac{2\ mol\ Al}{6\ mol\ HCl}\right.\left|\frac{26.982\ g\ Al}{1\ mol\ Al}\right. = 0.62958\ g\ Al$$

= 0.63 g Al

2. How many liters of a 3.0 *M* H_3PO_4 solution are required to react with 4.5 g of zinc?

$2\ H_3PO_4 + 3\ Zn \rightarrow 1\ Zn_3(PO_4)_2 + 3\ H_2$

3.0 *M* H_3PO_4; 4.5 g Zn; ? L

$$4.5\ g\ Zn \left|\frac{1\ mol\ Zn}{65.409\ g\ Zn}\right.\left|\frac{2\ mol\ H_3PO_4}{3\ mol\ Zn}\right.\left|\frac{1\ L\ sol'n}{3.0\ mol\ H_3PO_4}\right. = 0.01528\ L\ sol'n$$

= 0.015 L sol'n

3. How many grams of sodium can be reacted with 750 mL of a 6.0 *M* solution of sulfuric acid, H_2SO_4?

$2\ Na + 1\ H_2SO_4 \rightarrow 1\ Na_2SO_4 + 1\ H_2$

? g Na; 750 mL, 6.0 *M* H_2SO_4

$$0.750\ L\ H_2SO_4 \left|\frac{6.0\ mol\ H_2SO_4}{1\ liter\ sol'n}\right.\left|\frac{2\ mol\ Na}{1\ mol\ H_2SO_4}\right.\left|\frac{22.990\ g\ Na}{1\ mol\ Na}\right. = 206.91\ g\ Na$$

= 210 g Na

4. How many milliliters of 0.10 *M* $Pb(NO_3)_2$ are required to react with 75 mL of 0.20 *M* NaI?

$Pb(NO_3)_2 + 2\ NaI \rightarrow PbI_2 + 2\ NaNO_3$

? mL, 0.10 *M* $Pb(NO_3)_2$; 75 mL, 0.20 *M* NaI

$$0.075\ L\ NaI \left|\frac{0.20\ mol\ NaI}{1\ liter\ sol'n}\right.\left|\frac{1\ mol\ Pb(NO_3)_2}{2\ mol\ NaI}\right.\left|\frac{1\ liter\ sol'n}{0.10\ mol\ Pb(NO_3)_2}\right.\left|\frac{1000\ mL\ sol'n}{1\ liter\ sol'n}\right. = 75\ mL\ sol'n$$

= 75 mL sol'n

Answers: 1) 0.63 g Al 2) 0.015 L 3) 210 g Na 4) 75 mL 5) 9.7 g AgCl 6) 2.9 g $BaSO_4$ 7) 1.9 L $Ca(NO_3)_2$ 8) 0.67 *M* 9) 2.82 g AgBr 10) 0.0667 L HNO_3

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5. If 45 mL of a 1.5 *M* $AgNO_3$ is added to KCl how many grams of AgCl can be formed?

$1\ AgNO_3 + 1\ KCl \rightarrow 1\ AgCl + 1\ KNO_3$
45 mL ? g
1.5 *M*

$$\frac{0.045\ L\ AgNO_3}{} \left| \frac{1.5\ mol\ AgNO_3}{1\ liter\ sol'n} \right| \frac{1\ mol\ AgCl}{1\ mol\ AgNO_3} \left| \frac{143.323\ g\ AgCl}{1\ mol\ AgCl} \right. = 9.674\ g\ AgCl$$

= 9.7 g AgCl

6. How many grams of solid $BaSO_4$ will form when Na_2SO_4 reacts with 25 mL of 0.50 *M* $Ba(NO_3)_2$?

$1\ Ba(NO_3)_2 + 1\ Na_2SO_4 \rightarrow 1\ BaSO_4 + 2\ NaNO_3$
25 mL ? g
0.50 *M*

$$\frac{0.025\ L\ Ba(NO_3)_2}{} \left| \frac{0.50\ mol\ Ba(NO_3)_2}{1\ liter\ sol'n} \right| \frac{1\ mol\ BaSO_4}{1\ mol\ Ba(NO_3)_2} \left| \frac{233.391\ g\ BaSO_4}{1\ mol\ BaSO_4} \right. = 2.917\ g\ BaSO_4$$

= 2.9 g $BaSO_4$

7. How many liters of a 0.75 *M* solution of $Ca(NO_3)_2$ will be required to react with 148 g of Na_2CO_3?

$1\ Ca(NO_3)_2 + 1\ Na_2CO_3 \rightarrow 1\ CaCO_3 + 2\ NaNO_3$
? L 148 g
0.75 *M*

$$\frac{148\ g\ Na_2CO_3}{105.988\ g\ Na_2CO_3} \left| \frac{1\ mol\ Na_2CO_3}{1\ mol\ Na_2CO_3} \right| \frac{1\ mol\ Ca(NO_3)_2}{0.75\ mol\ Ca(NO_3)_2} \left| \frac{1\ liter\ sol'n}{} \right. = 1.86\ L\ sol'n$$

= 1.9 mL sol'n

8. If 525 mL of 0.80 *M* HCl solution is neutralized with 315 mL of $Sr(OH)_2$ solution what is the molarity of the $Sr(OH)_2$?

$2\ HCl + Sr(OH)_2 \rightarrow SrCl_2 + 2\ H_2O$
525 mL 315 mL
0.80 *M* ? *M*

$$\frac{0.525\ L\ HCl}{} \left| \frac{0.80\ mol\ HCl}{1\ liter\ sol'n} \right| \frac{1\ mol\ Sr(OH)_2}{2\ mol\ HCl} \left| \frac{}{0.315\ L\ Sr(OH)_2} \right. = 0.6666\ M\ Sr(OH)_2$$

= 0.67 M $Sr(OH)_2$

9. What mass of solid AgBr is produced when 100.0 mL of a 0.150 M $AgNO_3$ is added to 20.0 mL of 1.00 M NaBr?

Limiting Reactant Problem

$1\ AgNO_3 + 1\ NaBr \rightarrow 1\ AgBr + 1\ NaNO_3$
100.0 mL 20.0 mL ?g
0.150 *M* 1.00 *M*

$$\frac{0.1000\ L\ AgNO_3}{} \left| \frac{0.150\ mol\ AgNO_3}{1\ liter\ sol'n} \right| \frac{1\ mol\ AgBr}{1\ mol\ AgNO_3} \left| \frac{187.774\ g\ AgBr}{1\ mol\ AgBr} \right. = 2.8166\ g\ AgBr$$

= 2.82 g AgBr

$$\frac{0.0200\ L\ NaBr}{} \left| \frac{1.00\ mol\ NaBr}{1\ liter\ sol'n} \right| \frac{1\ mol\ AgBr}{1\ mol\ NaBr} \left| \frac{187.774\ g\ AgBr}{1\ mol\ AgBr} \right. = 3.7554\ g\ AgBr$$

10. What volume of 0.150 M HNO_3 will react completely with 50.00 mL of 0.200 M NaOH?

$HNO_3 + NaOH \rightarrow H_2O + NaNO_3$
? mL 50.00 mL
0.150 *M* 0.200 *M*

$$\frac{0.05000\ L\ NaOH}{} \left| \frac{0.200\ mol\ NaOH}{1\ liter\ sol'n} \right| \frac{1\ mol\ HNO_3}{1\ mol\ NaOH} \left| \frac{1\ liter\ sol'n}{0.150\ mol\ HNO_3} \right. = 0.06666\ L\ sol'n$$

= 0.667 L sol'n

Answers: 1) 0.63 g Al 2) 0.015 L 3) 210 g Na 4) 75 mL 5) 9.7 g AgCl 6) 2.9 g $BaSO_4$ 7) 1.9 L $Ca(NO_3)_2$ 8) 0.67 *M* 9) 2.82 g AgBr 10) 0.0667 L HNO_3