4 Limiting Reactant

Name: ..Raghad..darwish....................... Section ....

Lab. Instructor .... Date ....

Pre-Laboratory Questions

1. $Na_3PO_4.12H_2O$ and $BaCl_2.2H_2O$ are examples of compounds known as hydrates. Calculate the molar masses of Na_3PO_4 and $BaCl_2$ in the hydrated and anhydrous forms.

...Hydrates: molecules contain water molecules (H_2O)...............

..example : alum $M^IM^{III}(SO_4)_2 \cdot XH_2O$ | (MW) $BaCl_2 \cdot 2H_2O$ $137.3 + 2 \times 35.45 + 2 \times 2 + 2 \times 16$

.....................(KAl(SO₄)₂.XH₂O)... | $= 2.44 \times 10^2$; $BaCl_2 = 2.08 \times 10^2$

(MW) $Na_3PO_4 \cdot 12H_2O = (3 \times 22.99 + 30.97 + 4 \times 16 + 2 \times 12 + 12 \times 16) = 3.8 \times 10^2$

$Na_3PO_4 = 1.64 \times 10^2$

2. A mixture of 0.28 g $BaCl_2.2H_2O$ and 0.72 g $Na_3PO_4.12H_2O$ was dissolved in water. Which of the two reactants is the limiting reactant? Calculate the mass of the precipitate formed, $Ba_3(PO_4)_2$.

$3BaCl_2 \cdot 2H_2O + 2Na_3PO_4 \cdot 12H_2O \rightarrow Ba_3(PO_4)_2 + 6NaCl$

m = .28 g   m = .72 g   m = ?

MW. (=244.2 g/mol   m.w. = 380.2 g/mol   MW = 601.84 g/mol

$n = 1.14 \times 10^{-3}$ $n = 1.89 \times 10^{-3}$

$\frac{n}{3} = 3.82 \times 10^{-4}$ $\frac{n}{2} = 9.4 \times 10^{-4}$

* $BaCl_2 \cdot 2H_2O$ is the limiting reactant *

* 3 mol $BaCl_2 \cdot 2H_2O$ ⟶ 1 mol $Ba_3(PO_4)_2$

1.14×10^{-3} mol ⟶ ? " "

? = 3.8×10^{-4} mol $Ba_3(PO_4)_2$

$n \times m.m. = .230$ g.

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Name: ....Koghna.darwish.................... Section ....4....................

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Results and Calculations

A. Precipitation of $Ba_3(PO_4)_2$:

Unknown Number: 5

Mass of salt mixture (m_1) ± ,01	0,70 g
Mass of filter paper (m_2) ± ,01	0,58 g
Mass of filter paper and $Ba_3(PO_4)_2$ (m_3) ± ,01	0,86 g

B. Determination of the Limiting Reactant:

Limiting reactant in salt mixture is ...PO_4^{-3}...........

Excess reactant in salt mixture is Ba^{+2}..............

Mass of $Ba_3(PO_4)_2$ precipitated (m_3-m_2)	,28 g
Number of moles of $Ba_3(PO_4)_2$ precipitated (n_1)	$\frac{m}{M.M}$: $\frac{,28}{601.93}$ = 4.65 × 10^{-4} mol

(a) If the limiting reactant is $BaCl_2 . 2H_2O$:

Number of moles of $BaCl_2.2H_2O$ reacted (n_2)	mol
Number of moles of $Na_3PO_4 .2H_2O$ reacted (n_3)	mol
Mass of $BaCl_2.2H_2O$ reacted (m_4)	g
Mass of Na_3PO_4 reacted (m_5)	g
Mass of excess Na_3PO_4 [m_1-(m_4+m_5)]	g
Mass percentage of $BaCl_2.2H_2O$	%

(b) If the limiting reactant is $Na_3PO_4.12H_2O$:

Number of mole of $Na_3PO_4.12\ H_2O$ reacted (n_2)	9.3×10^{-4}	mol
Number of moles of $BaCl_2.2H_2O$ reacted (n_3)	1.39×10^{-3}	mol
Mass of $Na_3PO_4.12H_2O$ reacted (m_4)	0.35356	g
Mass of $BaCl_2.2H_2O$ reacted (m_5)	0.3395	g
Mass of excess $BaCl_2.2H_2O$ $[m_1 - (m_4 + m_5)]$	6.94×10^{-3} 0.7 − (0.35356 + 0.3395)	g
Mass percentage of $Na_3PO_4.12H_2O$	0.35356 / 0.7	% 50.51

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mm $Ba(PO_4)_2 = 601.93$.

n $Ba(PO_4)_2$ =

n Ba^{+2} $4.65\times10^{-4}(3) = 1.39\times10^{-3}$.

n PO_4^{-3} $4.65\times10^{-4}(2) = 9.3\times10^{-4}$

mass $BaCl_2\cdot 2H_2O = (1.39\times10^{-3})(244.27) = 0.3395$.

$Na_3PO_4\cdot$ $= (9.3\times10^{-4})(380.18) = 0.3535$.

QUESTIONS

1. Calculate the mass of $Ba_3(PO_4)_2$ produced from the reaction of 0.78 g $Na_3PO_4.12H_2O$ with excess $BaCl_2.2H_2O$. What is the purpose of heating the mixture in step 3 for 20 minutes?

$2Na_3PO_4:12H_2O + 3BaCl_2 \cdot 2H_2O \rightarrow Ba_3(PO_4)_2$

m = 0.78 g (excess) m = ?!

mw = 380.2 mw = mw = 610.84

$n = 2.1 \times 10^{-3}$ mol

2 mol $Na_3PO_4:12H_2O$ → 1 mol $Ba_3(PO_4)_2$

2.1×10^{-3} mol " " → ?! mol $Ba_3(PO_4)_2$

$n = ?! = 1.1 \times 10^{-3}$ mol $n_{Ba_3(PO_4)_2} = \frac{mass}{m.m.} = 0.66$ g

we heat to increase amount of product by complete the reaction

2. What is the purpose of washing the precipitate with hot water in step 4? How would the reported percentage of the excess reactant be affected if the precipitate was not washed in this step?

To remove excess reactant and impurities from the precipitate.

If the precipitate was not washed:

Mass of precipitate will increase so the mass of limiting reactant will increase so the mass of the excess will decrease finally the percentage of the excess will decrease