

Review guide:

1) Consider the gravimetric determination of barium. a) In the determination of barium (Ba) in an ore, a 1.701 g sample was dried to a constant weight of 1.677 g and yielded 0.0850 g of the dry precipitate. a) Report the Ba in the sample as both %Ba and %Ba(OH)₂ in the dried sample. b) What is the %water content of the original sample? c) What is the reagent needed to precipitate the barium? What is the precipitate form? Is it the same as the weighing form? (a periodic table will be supplied).

Solution:

a) FW:BaSO₄ = 137.327+32.066+4(15.999)=233.389; FW of Ba(OH)₂ = 137.327+2(15.999+1.0079) = 171.3408.

%Ba = g Ba x 100%/g ore = (.0850 g BaSO₄)(137.327g Ba/233.389g BaSO₄) (100%)/1.677 g dry ore = 2.98%

%Ba(OH)₂=(.0850 g BaSO₄)(171.3408g Ba(OH)₂/233.389g BaSO₄) (100%)/1.677 g dry ore = 3.72 %

b)%water = (1.701-1.677)(100%)/1.701g = 1.41%

c) SO₄ (sulfate) is the reagent needed. Barium is precipitated as BaSO₄ both precipitation and dried forms – this is one of those we discussed in the lecture).

2) Experimental rabbits are fed controlled diets to study the effect of diet on cholesterol blood levels*. Suppose that the cholesterol levels in a group of 12 rabbits fed high cholesterol diets is found to be 104±21 mg/dL while those of a group of 15 control rabbits fed a regular diet is found to be 85±17 mg/dL. Can we be 95% confident that the high cholesterol diet results in significantly different cholesterol blood levels in experimental rabbits? (* blood levels are reported here as mean ± standard deviation)

Solution:

This is a comparison of replicate measurements: we can use the following equations:

$$t_{\text{calc}} = \frac{\bar{X}_1 - \bar{X}_2}{s_{\text{pool}} \sqrt{\frac{n_1 n_2}{n_1 + n_2}}} \quad s_{\text{pool}} = \sqrt{\frac{s_1^2(n_1 - 1) + s_2^2(n_2 - 1)}{(n_1 + n_2 - 2)}}$$

$$s = \{21^2(12-1) + 17^2(15-1)/(12+15-2)\}^{1/2} = 19$$

$$t_{\text{calc}} = ((104-85)/19) \{ (12(15))/(12+15) \}^{1/2} = 2.58 > 2.060 \text{ (95\% confidence)}$$

Conclusion: yes there is a significant difference

4) A 0.5235 g dry powder sample containing only NiCl₂ and NiO is dissolved and the nickel content is selectively precipitated with dimethylglyoxime. If the dried precipitate has a mass of 1.325g, ...

a) what is the %Ni content of the dry powder sample?

b) What is the % NiO content of the dry powder sample?

(nb: Molar W's: Ni = 58.693, NiCl₂=129.599, NiO= 74.693

a) %Ni=(1.325)(58.693/288.91)(100%)/0.5235=**51.42%**

b) We note that this problem has 2 unknowns: let x=g NiCl₂, y=g NiO; 2 equations: (1) x+y=.5235

and x(288.91/129.599)+y(288.91/74.693)=1.325

or, 2nd eqn: (2) 2.229x+3.868y=1.325

Solve for x from eq (1): x = .5235 -y: into (2) : 2.229(.5235-y)+3.868y=1.325

1.1669 - 2.229 y + 3.868 y = 1.325: 1.639 y = .1581; y = 0.09646 grams NiO

so %NiO = .09646x100%/0.5235 = 18.4₃% NiO.

5) MW's: Mg₂P₂O₇ = 222.62g/mol; Mg = 24.31)

$$\% \text{ Mg} = \{20.0 \times 10^{-3} \text{ g Mg}_2\text{P}_2\text{O}_7 (2 (24.31 \text{ g Mg})/222.62 \text{ g}) / 0.0150 \text{ g}\} 100\% = 29.1\%$$

6) at ep: # eq H_3PO_4 = # eq KOH : $3 M_1 V_1 = M_2 V_2 \Rightarrow M_1 = (M_2 V_2) / (3 M_1) = (0.250(22.5)) / (3(20.0)) = 0.0938 \text{ M}$

7) Solve for Q : $Q = \text{gap}/\text{range} = (1.24 - 1.19) / (1.27 - 1.19) = 0.62$. The table shows Q for $n=5$ is 0.64, so $Q_{\text{calc}} < Q_{\text{table}}$ and the data is not rejected. The mean includes all the original data; average = $(1.24 + 1.27 + 1.19 + 1.25 + 1.26) / 5 = 1.24$

8) read Ni expt.

9) This is similar to Case I in the textbook:

and we note also that $x_{\text{ave}} = 3.26$ and $s = 0.04$

$$t_{\text{calc}} = (\mu - x_{\text{ave}}) n / s = |(3.19 - 3.26)| 4 / 0.04 = 3.4 ;$$

$t_{\text{calc}} > t_{\text{table}} = 3.182$ (@ 95% conf, and $n-1=3$) so this means that there is a 95% confidence of a significant difference between the true value and the spectrophotometric method determination.

10) Note: MW's

$$\% \text{ Fe} = 0.170 \text{ g Fe}_2\text{O}_3 (2 * 55.85 \text{ g Fe} / 160 \text{ g Fe}_2\text{O}_3) \times 100\% / 0.550 \text{ g} = 21.6\%$$

for % Cl need to calculate actual grams of FeCl_2 present. We have 2 unknowns:

Let $x = \text{g Fe}(\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$, $y = \text{g FeCl}_2 \cdot 6\text{H}_2\text{O}$

$$x + y = 0.550 \text{ g}$$

Since $\text{g Fe}(\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O} + \text{g FeCl}_2 \cdot 6\text{H}_2\text{O} = 0.550 \text{ g}$, we can write:

$$(1) x + y = 0.550 \text{ g}$$

Next, the precipitates are equal to 0.170 g:

$$\text{g Fe}_2\text{O}_3 (\text{from Fe}(\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}) + \text{g Fe}_2\text{O}_3 (\text{from FeCl}_2 \cdot 6\text{H}_2\text{O}) = 0.170 \text{ g}$$

$$x(160 \text{ g Fe}_2\text{O}_3) / 2(392 \text{ g Fe}(\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}) + y(160 \text{ g Fe}_2\text{O}_3) / 2(235 \text{ g FeCl}_2 \cdot 6\text{H}_2\text{O}) = 0.170 , \text{ or:}$$

$$(2) 0.204 x + 0.681 y = 0.170; \text{ from (1) } x = 0.550 - y; \text{ substitute in (2):}$$

$$0.204 (0.550 - y) + y(0.681) = 0.170$$

$$\text{solve for } y : y = 0.0578(100\%) / 0.477 = 12.1\%$$

11) Solution:

First, you need V_e : at ep: $\text{mol Ag}^+ = \text{mol I}^-$; $M_1 V_1 = M_2 V_2$

$$\Leftrightarrow V_e = M_{Ag} V_{Ag} / M_I = (20.0 \text{ mL})(0.100 \text{ M}) / (0.0800 \text{ M}) = 25.0 \text{ mL}$$

(i) At $V_I = 10.0 \text{ mLs}$:

$$M_{Ag} = \text{mol Ag} / V_{\text{total}} = \text{mol Ag}_{\text{total}} - \text{mol Ag}_{\text{reacted}} / V_{\text{total}}$$

$$= (M_{Ag} V_{Ag}^{\circ} - M_I V_I) / (V_{Ag} + V_I) = \{(20.0(0.100 \text{ M}) - 10.0(0.0800 \text{ M})\} / (20.0 + 10.0)$$

$$= 0.00400 \text{ M}; \quad \text{pAg}^+ = -\log(0.00400) = 2.40$$

(ii) At $V_I = V_e$: use K_{sp} equilibrium: $\text{AgI} \rightleftharpoons \underset{x}{\text{Ag}^+} + \underset{x}{\text{I}^-}$

$$\text{so } K_{sp} = 8.3 \times 10^{-17} = [\text{Ag}^+][\text{I}^-] = x^2 \Rightarrow x = 9.1 \times 10^{-9} = [\text{Ag}^+];$$

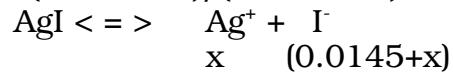
$$\text{pAg}^+ = -\log(9.1 \times 10^{-9}) = 8.04$$

iii) At $V_I = 35.0 \text{ mL}$: use K_{sp} equilibrium: $\text{AgI} \rightleftharpoons \text{Ag}^+ + \text{I}^-$

But we need $[\text{I}^-]$:

$$[\text{I}^-] = M_I(V_I - V_e) / (V_I + V_{Ag}) = 0.0800(35.0 - 25.0) / (35.0 + 20.0) = 0.0145 \text{ M}$$

so we have:



$$\text{so } K_{sp} = 8.3 \times 10^{-17} = [\text{Ag}^+][\text{I}^-] = x(0.0145 + x) \quad 0.0145 x \quad (\text{ie } 5\% \text{ rule})$$

$$\Rightarrow x = 5.72 \times 10^{-15}$$

$$\text{pAg}^+ = -\log(5.72 \times 10^{-15}) = 14.24$$