

Exam #1 Key

① $1.6 \text{ ppm} - 0.2 \text{ ppm} = 1.4 \text{ ppm needed}$

$1.4 \text{ ppm} = 1.4 \text{ } \mu\text{g/mL}$

$\text{NaF} = 41.99 \text{ g/mol}$

$$\left(\frac{1.4 \text{ } \mu\text{g F}^-}{\text{mL}} \right) \left(\frac{1000 \text{ mL}}{\text{L}} \right) \left(\frac{.946 \text{ L}}{\text{ft}^3} \right) \left(\frac{4 \text{ ft}^3}{\text{gal}} \right) \left(\frac{10^{-3} \text{ mg F}^-}{1 \text{ } \mu\text{g F}^-} \right) \left(\frac{41.99 \text{ mg NaF}}{19.00 \text{ mg F}^-} \right)$$

$$= 11.7 \text{ mg NaF/gal}$$

② a) .638 .638 .639 .639 .639 .640 .640 .645

Range
 Gap

$$Q_{\text{calc}} = \frac{\text{Gap}}{\text{Range}} = \frac{.645 - .640}{.645 - .638} = \frac{.005}{.007} = 0.7$$

$Q_{\text{tab}}(8) = 0.47$

$Q_{\text{calc}} > Q_{\text{tab}} \Rightarrow \text{throw out } 0.645$

b) .638 .638 .639 .639 .639 .640 .640

$S = 8.16 \times 10^{-4} \quad \bar{x} = 0.639$

$t_{99\%, 6df} = 3.707$

Confidence Interval =

$$\mu = \bar{x} \pm \frac{tS}{\sqrt{n}}$$

$$= 0.639 \pm \frac{(3.707)(.000816)}{\sqrt{7}}$$

$$= 0.639 \pm .00114$$

includes 0.640

\Rightarrow no significant difference

or:

$$t_{\text{calc}} = \frac{|\mu - \bar{x}|}{S} \sqrt{n}$$

$$= \frac{|.640 - .639|}{.000816} \sqrt{7}$$

$$= 3.24$$

$t_{\text{tab}} = 3.707$

$t_{\text{tab}} > t_{\text{calc}} \Rightarrow$ no difference

$$\textcircled{3} \quad \frac{(12.18 \pm .08) + (23.04 \pm .07)}{(3.247 \pm .004)} - (9.91 \pm .08)$$

$$12.18 + 23.04 = 35.22 \quad e = \sqrt{(.08)^2 + (.07)^2} = .1063$$

$$\frac{(35.22 \pm .1063)}{(3.247 \pm .006)} - (9.91 \pm .08)$$

$$\frac{35.22}{3.247} = 10.8469 \Rightarrow \frac{e}{10.8469} = \sqrt{\left(\frac{.1063}{35.22}\right)^2 + \left(\frac{.006}{3.247}\right)^2} \Rightarrow e = .03839$$

$$(10.8469 \pm .03839) - (9.91 \pm .08)$$

$$= .9369 \quad e = \sqrt{(.03839)^2 + (.08)^2} = .0887$$

$$\Rightarrow 0.937 (\pm 0.089) = 0.94 (\pm .09)$$

$$\textcircled{4} \quad M_1 V_1 = M_2 V_2$$

$$M_1 (15.00 \text{ mL}) = (0.2216 \text{ M}) (75.00 \text{ mL})$$

$$M_1 = 1.108 \text{ M}$$

$$\left(\frac{1.108 \text{ mol NiCl}_2}{\text{L solution}} \right) \left(\frac{129.61 \text{ g NiCl}_2}{\text{mol NiCl}_2} \right) \left(\frac{1 \text{ L solution}}{1000 \text{ mL solution}} \right) \left(\frac{100 \text{ g solution}}{12.50 \text{ g NiCl}_2} \right)$$

$$= 1.149 \text{ g/mL}$$

$$\textcircled{5} \quad \left. \begin{array}{l} \text{Method 1: } \bar{x} = 1.5884 \quad s = .0080 \quad n = 9 \\ \text{Method 2: } \bar{x} = 1.5982 \quad s = .0082 \quad n = 6 \end{array} \right\} t_{\text{table}} (95\%, 9+6-2 = 13 \text{ df})$$

$$s_p = \sqrt{\frac{(.0080)^2(9-1) + (.0082)^2(6-1)}{9+6-2}} = .0080775 \quad \begin{array}{l} 2.131 < t < 2.228 \text{ (actually 2.160)} \\ 10 \text{ df} \quad 15 \text{ df} \end{array}$$

$$t_{\text{calc}} = \frac{|\bar{x}_1 - \bar{x}_2|}{s_p} \sqrt{\frac{n_1 n_2}{n_1 + n_2}} = \frac{|1.5884 - 1.5982|}{.0080775} \sqrt{\frac{9 \cdot 6}{9+6}} = 2.302$$

$t_{\text{calc}} > t_{\text{table}} \Rightarrow$ difference IS significant & samples ARE different

7) a) Volumetric:

$$\mu = \bar{x} \pm \frac{t_s}{\sqrt{n}}$$

$$95\%: \mu = 35.8073 \pm \frac{2.04523(.71944)}{\sqrt{30}}$$

$$= 35.8073 \pm .2686$$

$$\Rightarrow 35.54 \text{ to } 36.07 \text{ } \left. \vphantom{\Rightarrow} \right\} \text{contains } 35.55$$

$$\begin{aligned} \text{OR: } t_{\text{calc}} &= \frac{(\mu - x) \sqrt{n}}{s} \\ &= \frac{|35.8073 - 35.55|}{.71944} \sqrt{30} \\ &= 1.96 < 2.05 \end{aligned}$$

$$99\%: \mu = 35.8073 \pm \frac{(2.756)(.71944)}{\sqrt{30}}$$

$$= 35.8073 \pm .362$$

$$\Rightarrow 35.44 \text{ to } 36.17 \text{ } \left. \vphantom{\Rightarrow} \right\} \text{contains } 35.55$$

$$\begin{aligned} \text{OR } t_{\text{calc}} &= 1.96 < 2.76 \\ &= 1.96 < 2.76 \end{aligned}$$

Gravimetric:

$$95\%: \mu = 35.794 \pm \frac{2.04523(.367083)}{\sqrt{30}}$$

$$= 35.794 \pm .137$$

$$\Rightarrow 35.66 \text{ to } 35.93$$

(DOES NOT contain 35.55)

$$t_{\text{calc}} = \frac{35.794 - 35.55}{.367083} \sqrt{30}$$

$$= 3.64 > 2.05$$

$$99\%: 35.794 \pm \frac{2.756(.367083)}{\sqrt{30}}$$

$$= 35.794 \pm .185$$

$$\Rightarrow 35.61 \text{ to } 35.98$$

(DOES NOT contain 35.55)

b)

$$\left. \begin{aligned} S_{\text{VOL}} &= .71944 & S_{\text{VOL}}^2 &= .5176 \\ S_{\text{GRAV}} &= .367083 & S_{\text{GRAV}}^2 &= .1347 \end{aligned} \right\} F_{\text{calc}} = \frac{.5176}{.1347} = 3.84$$

$$F_{\text{TAB}} = 1.86$$

\Rightarrow difference IS significant

c) use t-test assuming unequal variances

$$t_{\text{calc}} = .09 \quad t_{\text{tab}} = 2.01 \quad \Rightarrow \text{they are the same}$$

d) Volumetric:

Standard: ~~0.1047~~ $0.10447 (\pm .00236)$ mol/L

Unknown: $0.059605 (\pm .00114)$ g/mL

~~0.059605 (± .00114)~~

$$\left(\frac{0.10447 \text{ mol NaOH}}{1 \text{ L NaOH}} \right) \left(\frac{1 \text{ L NaOH}}{1000 \text{ mL NaOH}} \right) \left(\frac{1 \text{ mL NaOH}}{0.059605 \text{ g solid}} \right) \left(\frac{1 \text{ mL KHP}}{1 \text{ mL NaOH}} \right) \left(\frac{204.221 \text{ g KHP}}{1 \text{ mL KHP}} \right) = .35793 \frac{\text{g KHP}}{\text{g solid}}$$

$$\frac{e}{.35793} = \sqrt{\left(\frac{.00236}{.10447} \right)^2 + \left(\frac{.00114}{.059605} \right)^2} \Rightarrow e = .01059$$

$$\Rightarrow .35793 (\pm .01059) \Rightarrow \boxed{35.8 (\pm 1.1) \%}$$

Gravimetric:

Standard: $0.104897 (\pm .000952)$ mol NaOH/kg NaOH

Unknown: 0.059855 ~~550~~ $(\pm .000634)$ g solid/g NaOH

$$\left(\frac{0.104897 \text{ mol NaOH}}{\text{kg NaOH}} \right) \left(\frac{1 \text{ kg NaOH}}{1000 \text{ g NaOH}} \right) \left(\frac{1 \text{ g NaOH}}{0.059855 \text{ g solid}} \right) \left(\frac{1 \text{ mL KHP}}{1 \text{ mL NaOH}} \right) \left(\frac{204.221 \text{ g KHP}}{1 \text{ mL KHP}} \right) = .357901$$

$$\frac{e}{.357901} = \sqrt{\left(\frac{.000952}{.104897} \right)^2 + \left(\frac{.000634}{.059855} \right)^2} \Rightarrow e = .004992$$

$$\Rightarrow .357901 (\pm .00499) \Rightarrow \boxed{35.79 (\pm .50) \%}$$