Exam #2 Key

① 167 105 172 195 141 186 165 133 161 179

$s = 27.07$

$\Rightarrow 3s = 81.21$ = signal at detection limit

Signal due to 1.00 μM = 1991 − 48 = 1943 counts

Set up proportionality: $\frac{1.00\ \mu M}{1943\ \text{counts}} = \frac{x\ \mu M}{81.21\ \text{counts}}$

$$\boxed{x = 0.0418\ \mu M}$$

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②

$$Cu(OH)_{2(s)} \rightleftharpoons Cu^{2+}_{(aq)} + 2\,OH^-_{(aq)}$$

$$K_{sp} = [Cu^{2+}][OH^-]^2$$

$$4.8\times10^{-20} = [Cu^{2+}](6.1\times10^{-7})^2 \Rightarrow [Cu^{2+}] = 1.30\times10^{-7}\ M$$

$$Cu^{2+}_{(aq)} + OH^-_{(aq)} \rightleftharpoons Cu(OH)^+$$

$$\beta_1 = [Cu(OH)^+]/[Cu^{2+}][OH^-]$$

$$3.16\times10^{6} = [Cu(OH)^+]/(1.30\times10^{-7})(6.1\times10^{-7}) \Rightarrow [Cu(OH)^+] = 2.419\times10^{-7}\ M$$

$$Cu^{2+}_{(aq)} + 2\,OH^- \rightleftharpoons Cu(OH)_{2(aq)}$$

$$\beta_2 = [Cu(OH)_2]/(Cu^{2+})(OH^-)^2$$

$$6.31\times10^{11} = [Cu(OH)_2]/(1.30\times10^{-7})(6.1\times10^{-7})^2 \Rightarrow [Cu(OH)_2] = 3.05\times10^{-8}\ M$$

$$Cu^{2+}_{(aq)} + 3\,OH^- \rightleftharpoons Cu(OH)_3^-$$

$$\beta_3 = [Cu(OH)_3^-]/[Cu^{2+}][OH^-]^3$$

$$3.16\times10^{14} = [Cu(OH)_3^-]/(1.30\times10^{-7})(6.1\times10^{-7})^3 \Rightarrow [Cu(OH)_3^-] = 9.25\times10^{-12}\ M$$

③ $\frac{(SR)_{unk}}{(SR)_{known}} = \frac{(CR)_{unk}}{(CR)_{known}} \Rightarrow \frac{30.4/7.1}{14.8/11.2} = \frac{(CR)_{unk}}{.500/.800}$

$(CR)_{unk} = 2.025 = \frac{[chloroform]}{[DDT]}$

$[chloroform] = \frac{(10.2\,\mu L)\left(\frac{1\,mL}{1000\,\mu L}\right)\left(\frac{1.484\,g}{mL}\right)\left(\frac{1\,mol}{119.39\,g}\right)}{.1000\,L}$

$= .001268\,M$

$[DDT] = \frac{.001268\,M}{2.025} = 6.261\times10^{-4}\,M\left(\frac{100}{15}\right) = \boxed{0.00417\,M\ DDT}$

dilution factor

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④ $pH = -\log[H^+] \Rightarrow [H^+] = 10^{-pH} = 10^{-6.637} = 2.307\times10^{-7}$

neutral solution $\Rightarrow [H^+] = [OH^-]$

$K_w = [H^+][OH^-] = (2.307\times10^{-7})^2 = \boxed{5.32\times10^{-14}}$

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⑤ $\frac{[X]_i}{[S]_f + [X]_f} = \frac{I_x}{I_{s+x}}$

Let z = ~~water~~ mg Cu^{2+} in 95.0 mL unknown

$\frac{\left(\frac{z}{95.0\,mL}\right)}{\left(\frac{(1.00\,mL)(100.0\,\mu g/mL)}{100.0\,mL}\right) + \left(\frac{z}{100\,mL}\right)} = \frac{0.273}{0.560} = \frac{z/95}{1 + z/100} = .4875$

$z = 86.26\,mg$

$\Rightarrow [Cu^{2+}] = \frac{86.26\,mg}{95.0\,mL} = \boxed{0.908\ ppm}$

⑥ What is $[SO_4^{2-}]$ when 99% of the calcium has precipitated?

$$CaSO_4(s) \rightleftharpoons Ca^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)}$$

$$K_{sp} = [Ca^{2+}][SO_4^{2-}]$$

$.01(.04100) = .000400\,M$ Ca^{2+}

$$2.4 \times 10^{-5} = (.000400)[SO_4^{2-}]$$

$$[SO_4^{2-}] = 0.0600\ M$$

Now, what is the concentration of $[Ag^+]$ that will begin to precipitate when $[SO_4^{2-}] = 0.0600\ M$?

$$Ag_2SO_4(s) \rightleftharpoons 2Ag^+_{(aq)} + SO_4^{2-}{}_{(aq)}$$

$$K_{sp} = [Ag^+]^2[SO_4^{2-}]$$

$$1.5 \times 10^{-5} = [Ag^+]^2(.0600)$$

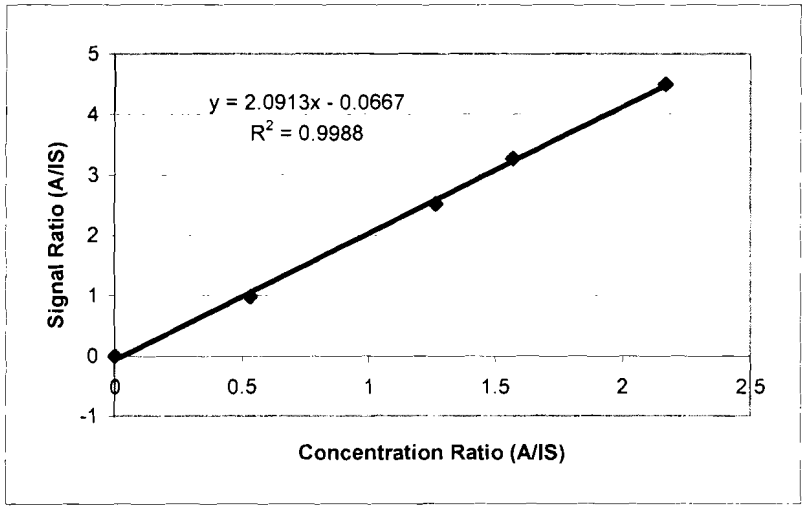
$$[Ag^+] = 0.0158\ M$$

$\Rightarrow [Ag^+]$ must be less than $0.0158\ M$.

7)

Solution	mg A	mg IS	final V	Sig (A)	Sig (IS)
0	0	0	50	0	0
1	186	147	50	0.475	0.189
2	249	468	50	0.589	0.601
3	319	203	50	0.681	0.209
4	193	89	50	0.472	0.105
Unk	*??*	*125*	*50*	*0.289*	*0.115*

Solution	mg/mL A	mg/mL IS	Con Ratio	Sig Ratio
0	0	0	0	0
1	3.72	2.94	1.27	2.513
2	4.98	9.36	0.53	0.980
3	6.38	4.06	1.57	3.258
4	3.86	1.78	2.17	4.495
Unk	*??*	*2.50*	*??*	*2.513*



Slope = 2.0913
Intercept = -0.0667

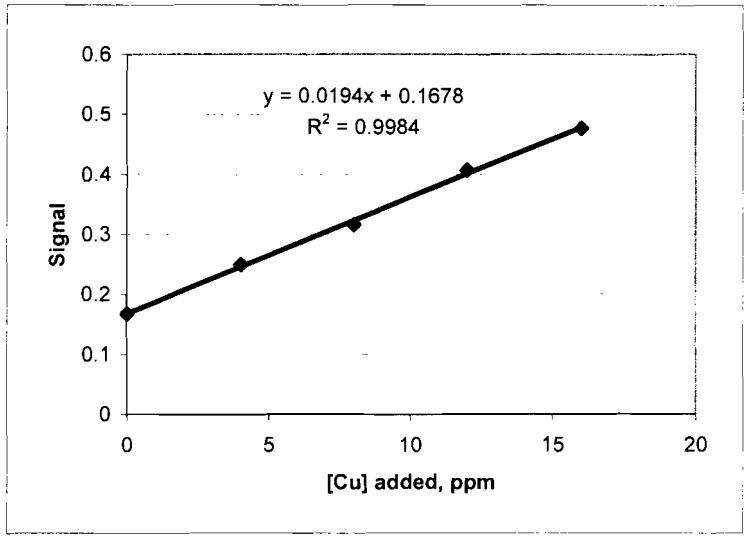
Sig Ratio = 2.0913 (Con Ratio) - .0667
2.513 = 2.0913 (Con Ratio) - .0667

Con Ratio = 1.2335 = [A] / [IS]
[IS] = 2.50 mg/mL
Con Ratio = 1.2335 = [A] / 2.50
[A] = 3.08 mg/mL

Consider dilution: x 50/20
$[A]_{init}$ = 7.71 mg/mL
$[A]_{init}$ = 7710 ppm

8)

Flask	mL added	ug added	final vol	ppm added	signal
1	0	0	50	0	0.167
2	2	200	50	4	0.249
3	4	400	50	8	0.316
4	6	600	50	12	0.406
5	8	800	50	16	0.476



slope =	0.019375		
y-intercept =	0.1678		
|x-intercept| =	8.66		
[Cu] in flask 1 =	8.66	ppm	
ug Cu in flask 1 =	433.0322581	ug	(x 50)
[Cu] in first dilution flask =	86.60645161	ppm	(÷ 5)
ug Cu in first dilution flask =	4330.322581	ug	(x 50)
[Cu] in original flask =	433.0322581	ppm	(÷ 10)
ug Cu in original flask =	216516.129	ug	(x 500)
g Cu in original flask =	0.216516129	g	(x 1E-6)
mass of original sample =	0.2316	g	
% Cu in original sample =	**93.49**	**%**	