

CHEM 3590 Test 1, 2017

Human Ecology Room 108, 10:30-11:25

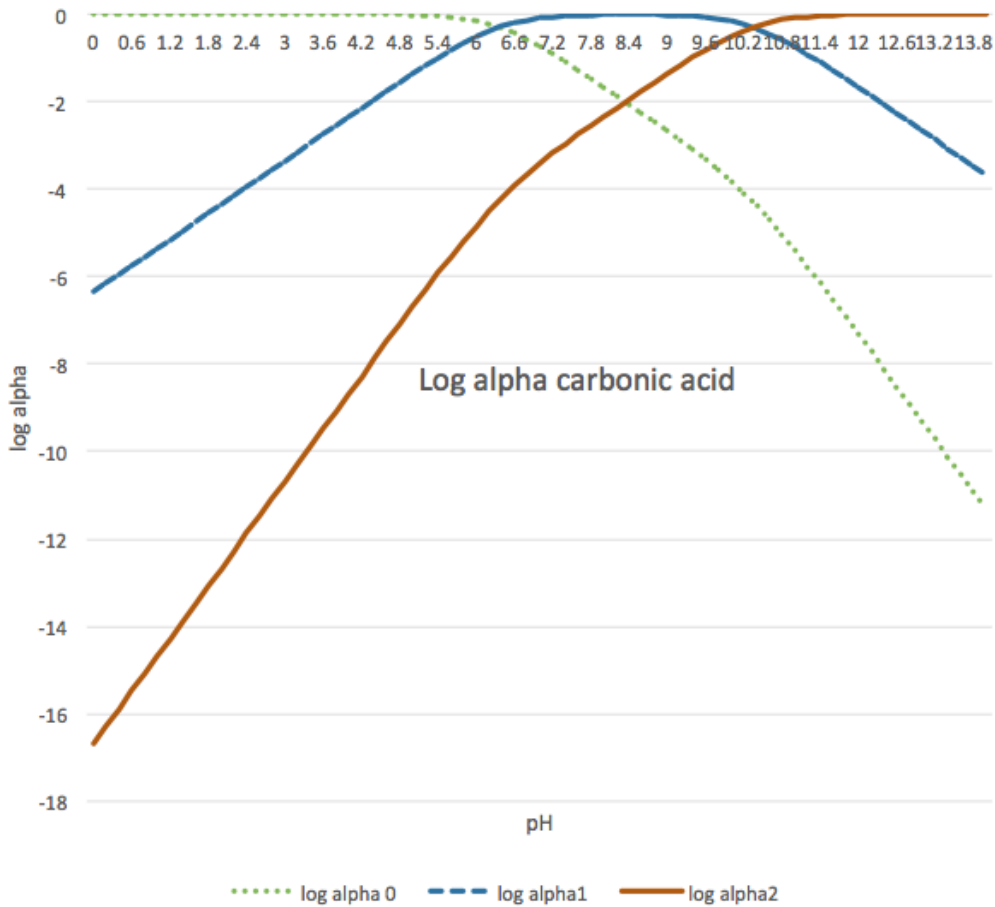
Answer 5 out of 6 questions in the exam book provided. Calculators are allowed.

Question 1

A 100-kg block of CaCO_3 is thrown into a pool containing 12000 L of water at pH 5.6. How much CaCO_3 , in grams or kilograms, will remain solid? Use graph below if needed.

CaCO_3 : 100 g/mole $K_{\text{sp}} = 5.6 \times 10^{-9}$

H_2CO_3 : $K_{\text{a}1} = 4.45 \times 10^{-7}$ $K_{\text{a}2} = 4.69 \times 10^{-11}$

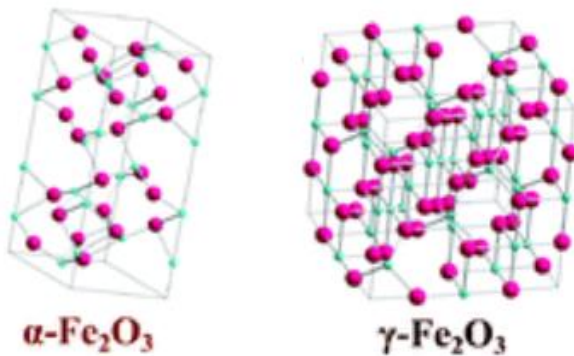


Question 2

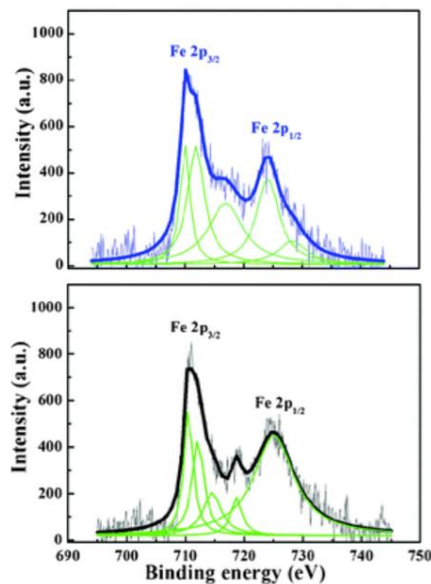
- a) In a SIMS instrument equipped with a magnetic sector analyzer, Ca^{2+} ions travel on a 0.45 m radius trajectory. Which element's $3+$ ions follow a 0.3 m radius path in this same instrument?
- b) Why do most SIMS instruments have both Cs^+ and dual plasmatron gun attachments?

Question 3

Iron oxide species comprise FeO , Fe_3O_4 and, in larger proportions, Fe_2O_3 . In turn, Fe_2O_3 has two crystalline forms, $\alpha\text{Fe}_2\text{O}_3$ (hematite) and $\gamma\text{Fe}_2\text{O}_3$ (maghemite). Structures are shown below. The smaller dots represent iron ions and the larger spheres, oxygen.



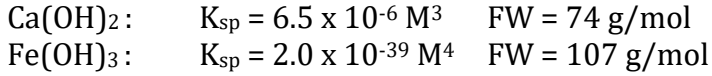
- a) Assign the following XPS spectra to each crystalline form and justify.



- b) How are the kinetic energies of photoelectrons measured in XPS?

Question 4

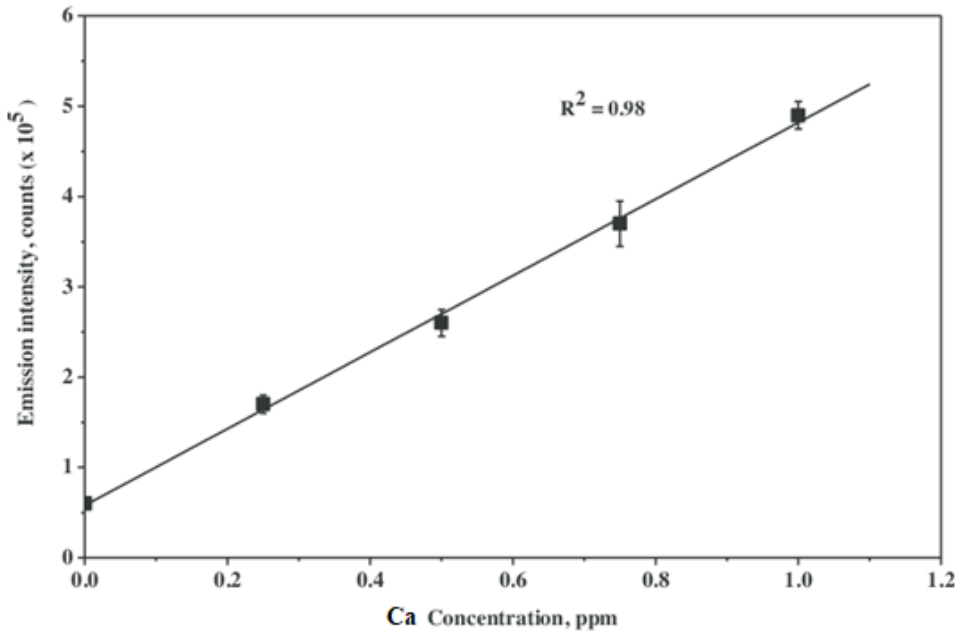
You decide to use EDTA to analyze the metals contained in a solid mixture of $\text{Ca}(\text{OH})_2$ (2 g) and $\text{Fe}(\text{OH})_3$ (3 g). HCl is used to dissolve the sample in a 2L-volume.



- What is the pH necessary to dissolve all the mixture? Comment on the possibility of using EDTA at this pH.
- Write the charge balance equation of the solution when everything is dissolved.

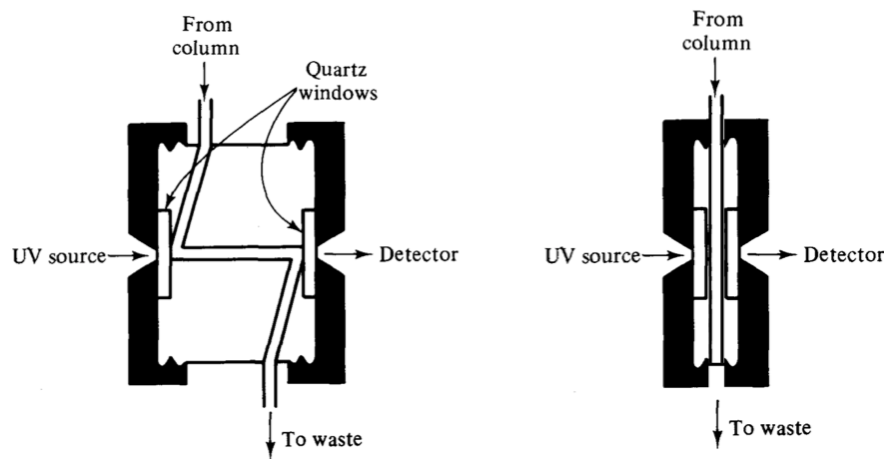
Question 5

- The ICP-OES calibration curve shown here was obtained for Ca with standard CaCl_2 solutions. Determine the emission measured for a $4 \times 10^{-6} \text{ M}$ $\text{Ca}(\text{NO}_3)_2$ solution.
- Give a possible reason why the y-intercept is not zero.



Question 6

- a) Comment on the advantages of using a diode array detector over a single photo multiplier tube for spectrophotometry
- b) The xenon lamp emits over a range of 200-1000 nm. How is this light generated?
- c) Sample cuvettes made of quartz offer higher quality UV-vis measurements than those made of regular glass. Why?
- d) Which sample cuvette of the two below is better for dynamic flow UV-vis measurements, and why?



Don't hesitate to ask if you have any questions during the exam, and have a great Thanksgiving break!

Periodic Table of the Elements

1 H Hydrogen 1.01																	2 He Helium 4.00																														
3 Li Lithium 6.94	4 Be Beryllium 9.01											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18																														
11 Na Sodium 22.99	12 Mg Magnesium 24.31											13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.95																														
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.88	23 V Vanadium 50.94	24 Cr Chromium 51.99	25 Mn Manganese 54.94	26 Fe Iron 55.93	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.73	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.09	35 Br Bromine 79.90	36 Kr Krypton 84.80																														
37 Rb Rubidium 84.49	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium 98.91	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.6	53 I Iodine 126.90	54 Xe Xenon 131.29																														
55 Cs Cesium 132.91	56 Ba Barium 137.33	57-71 Lanthanides	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.85	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.20	83 Bi Bismuth 208.98	84 Po Polonium [208.98]	85 At Astatine 209.98	86 Rn Radon 222.02																														
87 Fr Francium 223.02	88 Ra Radium 226.03	89-103 Actinides	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [293]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown																														
<table border="1"> <tr> <td>57 La Lanthanum 138.91</td> <td>58 Ce Cerium 140.12</td> <td>59 Pr Praseodymium 140.91</td> <td>60 Nd Neodymium 144.24</td> <td>61 Pm Promethium 144.91</td> <td>62 Sm Samarium 150.36</td> <td>63 Eu Europium 151.97</td> <td>64 Gd Gadolinium 157.25</td> <td>65 Tb Terbium 158.93</td> <td>66 Dy Dysprosium 162.50</td> <td>67 Ho Holmium 164.93</td> <td>68 Er Erbium 167.26</td> <td>69 Tm Thulium 168.93</td> <td>70 Yb Ytterbium 173.04</td> <td>71 Lu Lutetium 174.97</td> </tr> <tr> <td>89 Ac Actinium 227.03</td> <td>90 Th Thorium 232.04</td> <td>91 Pa Protactinium 231.04</td> <td>92 U Uranium 238.03</td> <td>93 Np Neptunium 237.05</td> <td>94 Pu Plutonium 244.06</td> <td>95 Am Americium 243.06</td> <td>96 Cm Curium 247.07</td> <td>97 Bk Berkelium 247.07</td> <td>98 Cf Californium 251.08</td> <td>99 Es Einsteinium [254]</td> <td>100 Fm Fermium 257.10</td> <td>101 Md Mendelevium 258.10</td> <td>102 No Nobelium 259.10</td> <td>103 Lr Lawrencium [262]</td> </tr> </table>																		57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium 144.91	62 Sm Samarium 150.36	63 Eu Europium 151.97	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.97	89 Ac Actinium 227.03	90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium 237.05	94 Pu Plutonium 244.06	95 Am Americium 243.06	96 Cm Curium 247.07	97 Bk Berkelium 247.07	98 Cf Californium 251.08	99 Es Einsteinium [254]	100 Fm Fermium 257.10	101 Md Mendelevium 258.10	102 No Nobelium 259.10	103 Lr Lawrencium [262]
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- Alkali Metal
- Alkaline Earth
- Transition Metal
- Basic Metal
- Semimetal
- Nonmetal
- Halogen
- Noble Gas
- Lanthanide
- Actinide