CHEM 3590

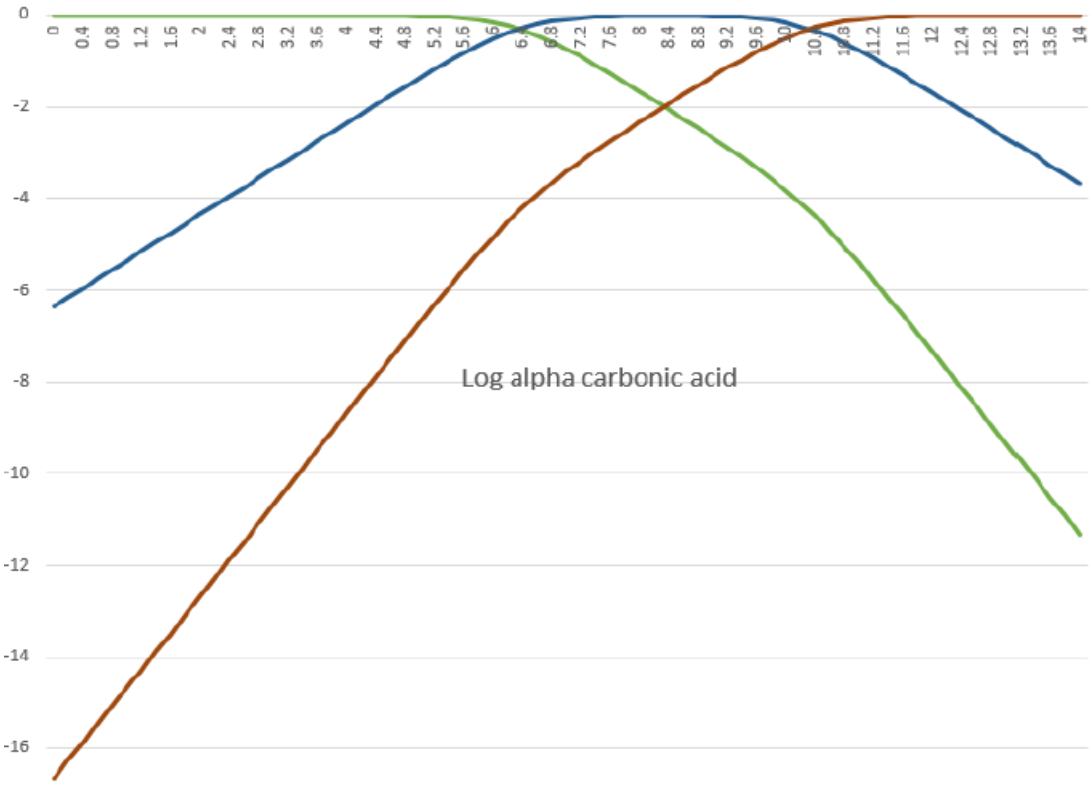
Midterm Test 1 Version A Wednesday October 5 2016 Parker 539

One (1) point per question. Please answer on the bubble sheet.

Question 1:

Calculate the solubility of $CaCO_3$ at pH 6.5 and 25°C. Use the graph below if needed.

(for $CaCO_3$ at 25°C $K_{sp} = 5.6 \times 10^{-9}$, and for carbonic acid $k_{a1} = 4.45 \times 10^{-7}$; $k_{a2} = 4.69 \times 10^{-11}$)



a) 1.01×10^{-4} M b) 4.10 M c) 3.16×10^{-7} M d) 7.10×10^{-3} M e) 8.10×10^{-5} M

Question 2:

If phosphoric acid (H_3PO_4) is used to dissolve a cube of $CaCO_3$ in water, write the solution's mass (Ca) and charge balance equations. Assume no precipitation of calcium phosphate.

a) MB $[Ca^{2+}] = [H_3PO_4] + [H_3PO_4^-] + [HCO_3^-] + [H_2CO_3] + [H_2PO_4^{2-}] + [CO_3^{2-}] + [HPO_4^{3-}]$
CB $[Ca^{2+}] + [H_30^+] = [HCO_3^-] + [CO_3^{2-}] + [OH^-] + [H_3PO_4^-] + [H_2PO_4^{2-}] + [HPO_4^{3-}]$

b) MB $2[Ca^{2+}] = [H_2CO_3] + [HCO_3^-] + 2[CO_3^{2-}]$
CB $[Ca^{2+}] + [H_30^+] = [HCO_3^-] + [CO_3^{2-}] + [OH^-] + [PO_4^{3-}]$

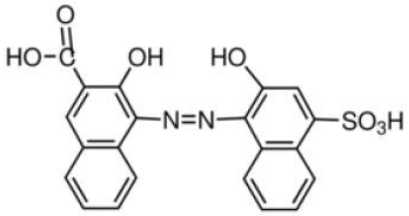
c) MB $[Ca^{2+}] + [H_3PO_4] = [H_2CO_3] + [HCO_3^-] + [CO_3^{2-}] + [PO_4^{3-}]$
CB $2[Ca^{2+}] + [H_2CO_3] = [HCO_3^-] + [CO_3^{2-}] + [OH^-] + 3[H_3PO_4^-] + 2[H_2PO_4^{2-}] + [HPO_4^{3-}]$

d) MB $[Ca^{2+}] = [H_2CO_3] + [HCO_3^-] + [CO_3^{2-}]$
CB $2[Ca^{2+}] + [H_30^+] = [HCO_3^-] + 2[CO_3^{2-}] + [OH^-] + 3[PO_4^{3-}] + [H_2PO_4^-] + 2[HPO_4^{2-}]$

e) None of these answers

Question 3:

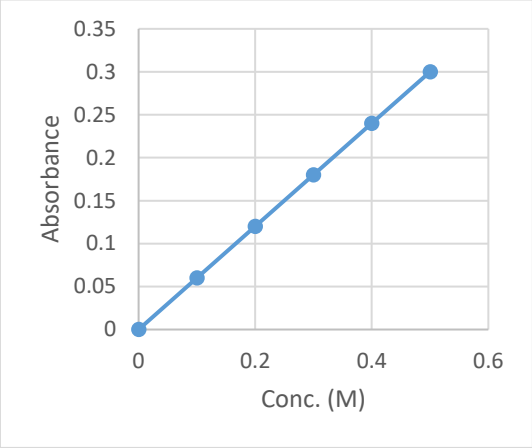
In a direct Ca^{2+} titration with EDTA using Patton and Reeder's indicator (see figure), why does the indicator change colours?



a) When all Ca^{2+} has been captured by EDTA, the indicator is precipitated, changing the colour of the solution.
b) The A^{2-} form of the indicator takes H^+ ions from H_4Y and becomes H_2A.
c) The H_2A form of the indicator gives two H^+ ions to Y^{4-} and becomes A^{2-}.
d) This indicator cannot be used alone and this method requires a back titration.
e) It gets displaced from Ca^{2+} by EDTA

Question 4:

From the generic absorbance calibration curve shown below, determine the % transmittance of a solution of concentration 0.35 M, assuming that T_0 = 100% (blank).



a) 59.6% b) 0.225 % c) 0.017 % d) 25.1% e) none of these answers

Question 5:

How effective would pH 10 be for precipitation of only Mg^{2+} ions as $Mg(OH)_2$ for a solution containing 600 ppm of soluble $CaCl_2$ and 10 ppm of soluble $MgCl_2$?

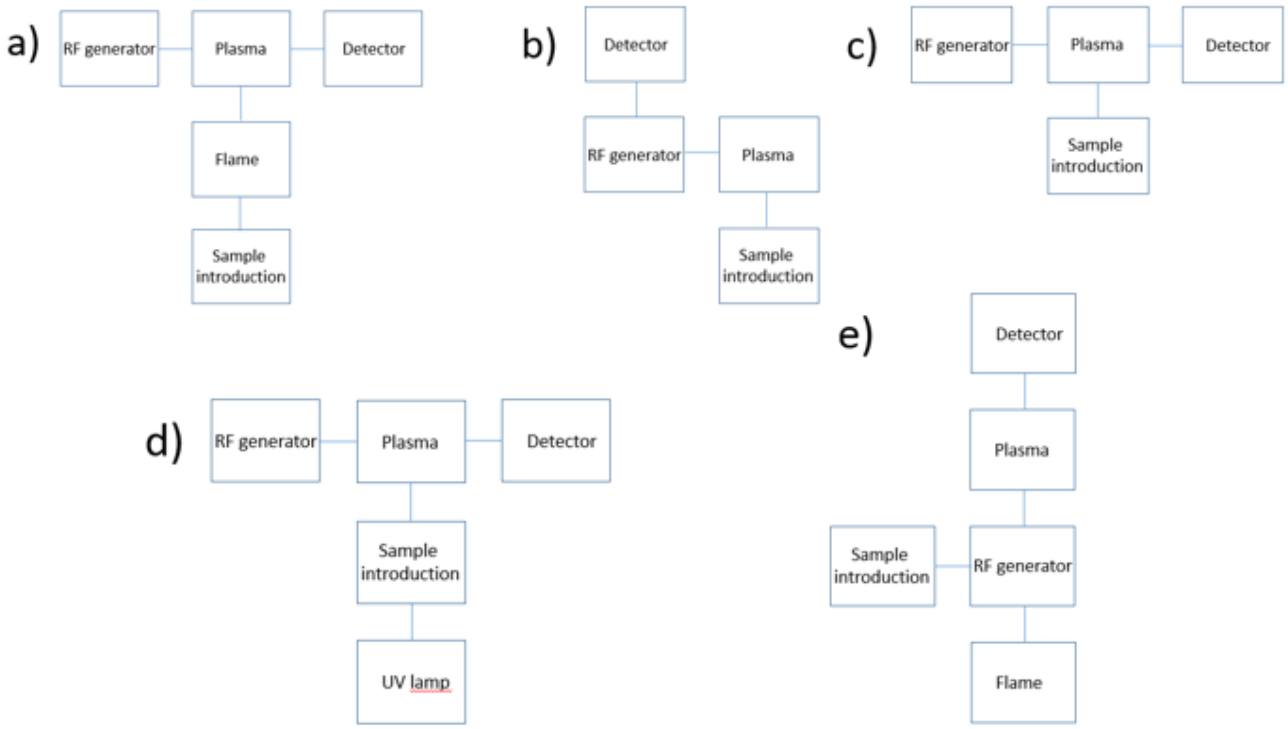
Ksp values: $Ca(OH)_2$ 5.0×10^{-6}

$Mg(OH)_2$ 1.8×10^{-11}

a) None of Ca^{2+} and Mg^{2+} would be precipitated: ineffective.
b) Only Ca^{2+} would be be precipitated: effective but the wrong way.
c) Only Mg^{2+} would be precipitated: effective.
d) Both Ca^{2+} and Mg^{2+} would be precipitated: ineffective.
e) They would both precipitate as carbonates: ineffective.

Question 6:

Which diagram below is correct to describe an ICP-OES instrument?



Question 7:

Which statement is true for ICP-OES instruments?

a) The nebulizer process allows the elimination of water from droplets.
b) The nebulizer sprays the liquid sample into a nebulization chamber.
c) The nebulization chamber selects larger droplets to maximize sample intake.
d) The nebulizer sprays droplets varying in size according to elements in the sample.
e) None of the above is true.

Question 8:

Calculate the binding energy of a photoelectron emitted at 550 eV (KE), if the X-ray source used was at 9.88 Angstroms and the work function of the instrument, 15 eV.

$h = 6.64 \times 10^{-34}$ J.s $c = 3.00 \times 10^{8}$ m/s 1 eV = 1.6×10^{-19} J 1 Angstrom = 1×10^{-10} m

a) 664 eV b) 752 eV c) 1804 eV d) 1789 eV e) 695 eV

Question 9:

For the following, give the order of increasing binding energies for iron 1s photoelectrons.

Fe Fe_2O_3 $FeCl_2$

a) Fe Fe_2O_3 $FeCl_2$
b) Fe_2O_3 Fe $FeCl_2$
c) Fe $FeCl_2$ Fe_2O_3
d) Fe_2O_3 $FeCl_2$ Fe
e) None of these answers

Question 10: NOT COVERED THIS YEAR

In secondary ions mass spectrometry (SIMS), time-of-flight (TOF) analyzers are often used in modern instruments. Calculate the time-of-flight of a calcium ion (Ca^{2+}) if the acceleration potential is 25.0 kV and the length of the tube 2 m.

Ca: 40.078 g/mol Avogadro's number = 6.023×10^{23} molecules/mole

a) 17 microseconds b) 4 microseconds c) 6 nanoseconds d) 3 seconds e) none of these