Questions

One

Lewis structure of $Si(OH)_4$

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Step #1

Number of electrons = 4x6 +4x1 +1x4 = 32.

Step #2

After 8 electrons are assigned to each oxygen, and single bonds are formed between each species all species have a full octet, (except for hydrogen which has a full valence shell consisting of two electrons)

NOTE: As silica is a period two element overfilling of the octet is possible however any additional bond formation between the oxygen and the central silicon could only increase the formal charge and so may be discounted.

Step #3

Draw structure

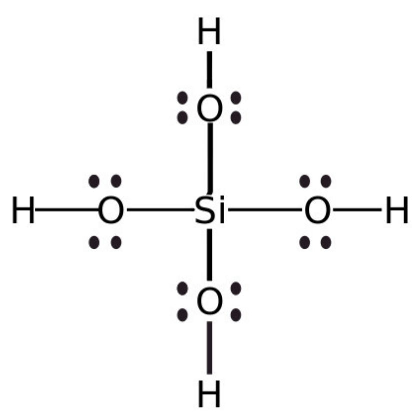

Figure 1: Silicon Hydroxide Lewis structure

Lewis structure of $Al(OH)_4^-$

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Step #1

Number of electrons = 4x6 +4x1 +1x3+1 = 32.

Step #2

After 8 electrons are assigned to each oxygen, and single bonds are formed between each species all species have a full octet, (except for hydrogen which has a full valence shell consisting of two electrons). Again overfilling by creating more bonds will only increase the formal charge.

Step #3

Draw Structure

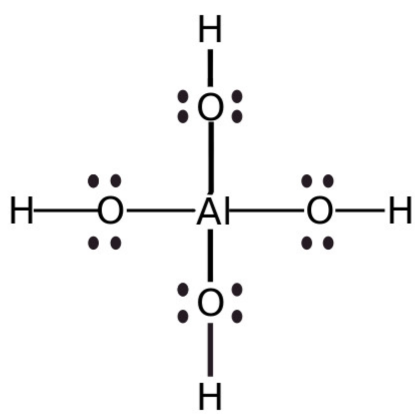

Figure 2: Aluminium Hydroxide Ion Lewis structure

Lewis Structure of $Al(OH)_3$

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Step #1

Number of electrons = 3x6 +3x1 +1x3= 32

Step #2

After 8 electrons are assigned to each oxygen, and single bonds are formed between each species all species have a full octet, (except for hydrogen which has a full valence shell consisting of two electrons). Again overfilling by creating more bonds will only increase the formal charge.

Step #3

Draw Structure

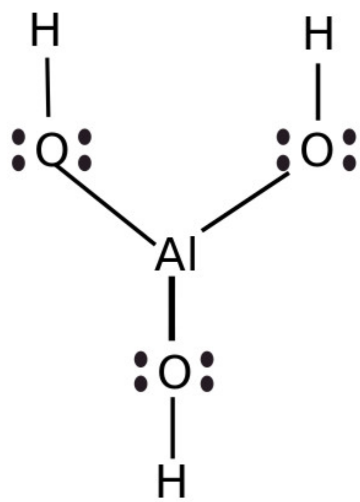

Figure 3: Aluminium Hydroxide Ion Lewis structure

Two

(i)

Step #1

Moles of EDTA added to EDTA standard

$= \frac{0.914g}{372.24g.mol^{-1}} = 2.4554 \quad x \quad 10^{-3}mol$

Step #2

Average Titrant volume $= 0.5x((4.57 - 0.04) + (5.13 - 0.10))ml = 4.78ml$

Step #3

Moles of EDTA in Titrant

$= 2.4554 \quad x \quad 10^{-3} mol \quad x \quad \frac{4.78ml}{250ml}$

$= 4.6947 \quad x \quad 10^{-5} mol$

(ii)

Step #1

At equivalence point of the titration all of the EDTA has reacted with calcium at the ratio of 1 mol EDTA: 1 mol calcium ions.

Hence If $= 4.6947 \quad x \quad 10^{-5} mol$ of calcium where added then $= 4.6947 \quad x \quad 10^{-5} mol$ of calcium ions where used up form the titrand.

Step #2

As the titrand contained only 25ml of the original calcium chloride zeolite solution, It can be interpolated that 3 $\quad x \quad 4.6947 \quad x \quad 10^{-5} mol = 1.4084 \quad x \quad 10^{-4}$ of calcium ions would have been used up from the entire solution.

(iii)

Step #1

Moles of Calcium chloride present in the original solution.

$= \frac{0.196g}{219.08g.mol^{-1}}$

$= 8.9465 \quad x \quad 10{-}4$

Step #3

Moles of Calcium ions left in the original solution

$= 8.9465 \quad x \quad 10^{-4} mol - 1.4084 \quad x \quad 10^{-4} mol$

$7.5381 x \quad 10^{-4} mol$

(iv)

Grams of Calcium chloride left in original solution. $= 7.5381 x \quad 10^{-4} mol \quad x \quad 40.08 g.mol^{-1}$
$= 3.0213 \quad x \quad 10^{-2} g$

(v)

Step #1

The amount of calcium ions taken up by the zeolite is equivalent to the amount fo calcium ions remaining in solution, as any calcium ions not bound would have been removed during the EDTA titration.

Hence there are $7.5381 \quad x \quad 10^{-4} mol$ of Calcium ions bound by the zeolite.

(vi)

Step #1

Grams of Calcium ions taken up per gram of Zeolite

$= \frac{3.0213 \quad x \quad 10^{-2} g}{0.104 g}$

$= 0.29051 (g/g)$

Three

This implies that zeolites may be very useful as detergents as they are capable of sequestering/removing relatively large quantities of dissolved ions from solution. (removing these ions will prevent them from resettling on whatever item is being cleaned, and increase the overall ability of the detergent to dissolve and remove unwanted deposits from the item being cleaned.)

Five

four acid sites are accosted with the EDTA. (one for each of the terminal carboxylic acid groups)

Six.

Yes. Sulphuric acid has the same activity of any normal acid catalyst, providing a ready source and sink for H^+ ions, facilitating the internal structural changes necessary for ester formation.

Seven

Introduction

Results