

## Questions

### One

Lewis structure of  $Si(OH)_4$

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#### Step #1

Number of electrons =  $4 \times 6 + 4 \times 1 + 1 \times 4 = 32$ .

#### 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

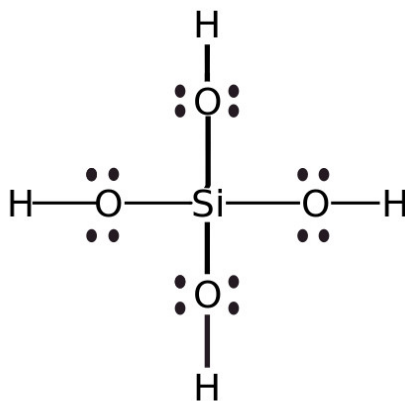


Figure 1: Silicon Hydroxide Lewis structure

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

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#### Step #1

Number of electrons =  $4 \times 6 + 4 \times 1 + 1 \times 3 + 1 = 32$ .

#### 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

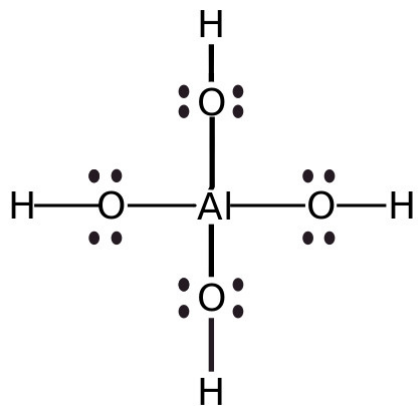


Figure 2: Aluminium Hydroxide Ion Lewis structure

### Lewis Structure of $Al(OH)_3$

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#### Step #1

Number of electrons =  $3 \times 6 + 3 \times 1 + 1 \times 3 = 32$

### 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

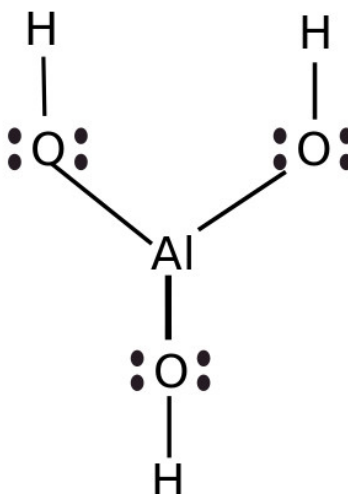


Figure 3: Aluminium Hydroxide Ion Lewis structure

## Two

(i)

### Step #1

Moles of EDTA added to EDTA standard

$$= \frac{0.914g}{372.24g \cdot mol^{-1}} = 2.4554 \times 10^{-3} mol$$

### Step #2

$$\text{Average Titrant volume} = 0.5 \times ((4.57 - 0.04) + (5.13 - 0.10)) ml = 4.78 ml$$

**Step #3**

Moles of EDTA in Titrant

$$= 2.4554 \times 10^{-3} \text{ mol} \times \frac{4.78 \text{ ml}}{250 \text{ ml}}$$

$$= 4.6947 \times 10^{-5} \text{ mol}$$

(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 =  $4.6947 \times 10^{-5} \text{ mol}$  of calcium where added then =  $4.6947 \times 10^{-5} \text{ mol}$  of calcium ions where used up from the titrand.

**Step #2**

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

(iii)

**Step #1**

Moles of Calcium chloride present in the original solution.

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

$$= 8.9465 \times 10^{-4}$$

**Step #3**

Moles of Calcium ions left in the original solution

$$= 8.9465 \times 10^{-4} \text{ mol} - 1.4084 \times 10^{-4} \text{ mol}$$

$$7.5381 \times 10^{-4} \text{ mol}$$

(iv)

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

(v)

#### Step #1

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

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

(vi)

#### Step #1

Grams of Calcium ions taken up per gram of Zeolite

$$\begin{aligned} &= \frac{3.0213 \times 10^{-2} \text{ g}}{0.104 \text{ g}} \\ &= 0.29051 (\text{g/g}) \end{aligned}$$

### 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

Pentyl ethanol is used:

1. as a flavourant in many foods.

2. As a solvent in paints.

## Eight

Zeolite is micro-porous, that is within its 3D chemical structure there is a regular arrangement of regular sized gaps/holes/pores, through which other molecules, if sufficiently small could pass through. molecules which are too large however, (such as molecules with a diameter greater than X in the figure below) can. Such molecules suffer size exclusion, as although they may have the correct chemical properties to react with binding sites on the interior, they are physically prevented from reaching these sites, as they are too large, and so cannot bind.

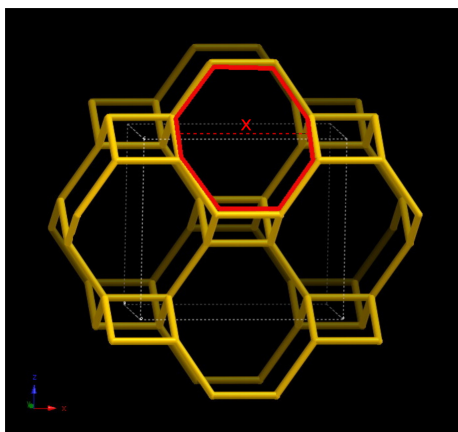


Figure 4: Zeolite Structure

## Aim

Two different experiments were performed with different aims.

The aim of experiment A was to determine the Ability of Zeolite to bind Calcium ions from solution. Both to determine how effective Zeolite could be as a cleaning/filtering agent to remove calcium impurities, and to approximate how much zeolite (by mass) would be necessary to remove calcium from a contaminated solution.

The aim of experiment B was to determine Zeolite ability to act as a Acid catalyst (in esterification.)

## Introduction

Zeolites Are complex three dimensional molecules formed from the condensation of  $\text{Si}(\text{OH})_4$  and  $\text{Al}(\text{OH})_4^-$  monomers. The striking feature of the complexes formed are the regularly sized and evenly space pores which the macro structure contains, (See the figure below).

## Results