Determination of Avogadro's Number

- An estimation of Avogadro's Number will be made by measuring the area of a monolayer of a known weight of oleic acid.

Principles

- Number of molecules in a mole is Avogadro's Number (N)
- Number of Molecules in a film that is one molecule thick can be counted

Principles

- Fatty acid will easily form one molecule thick layer that is roughly circular.
- Area of monolayer can be used to find Avogadro's Number.

Procedure

- Make a dilute acid solution from 900 ml of distilled water and 3 drops of 6M HCl.
- Put Dilute Acid solution in a pan and cover surface with piston oil.

Procedure

- Weigh a clean, dry test tube to nearest 1 mg.
- Add 4 drops (about 100 mg) of Oleic acid and reweigh the test tube.
- Using a pipet, add 10.0 ml of petroleum ether to the test tube.
- Mix well by swirling.

Procedure

- Dilute mixture by 1/10
- Dilute a second time by 1/10
- Dust Surface of oil coated water with lycopodium powder.

Procedure

- Put exactly 0.10 ml of diluted oleic acid on center of water.
- Suspend a glass plate over the pan and trace the outline of the oleic acid.

Safety

- It is important that you always keep your safety goggles on.
- Acid in the eyes can cause blindness!
- Petroleum ether is very flammable!

Calculations

Mass of oleic acid:

Mass of oleic acid in first test tube:

$$(\text{test tube} + \text{oleic acid}) - \text{test tube}$$

Calculations

Mass of oleic acid:

Mass of oleic acid in last test tube:

$$\frac{\text{mass of oleic acid(g)}}{10\ \text{ml}} \times \frac{1.0}{10.0} \times \frac{1.0}{10.0} \times 0.1\ \text{ml}$$

Calculations

Volume of one mole of oleic acid:

$$\frac{\text{mass of one mole}}{\text{density of the acid}} = \frac{282\,\text{g/mol}}{0.895\,\text{g/ml}}$$

Calculations

Volume of one oleic acid molecule:

If the total volume of acid is known,

$$\text{density} = \frac{\text{mass acid}}{\text{volume acid}}$$

$$\text{volume acid} = \frac{\text{mass acid}}{\text{density}}$$

Calculations

Volume = Area x Thickness

$$\text{Thickness} = \frac{\text{Volume}}{\text{Area}}$$

Calculations

If the molecule is assumed to be a cube, then

Volume of 1 molecule =

$(\text{Thickness})^3$

Calculations

Since Avogadro's Number is the number of molecules in one mole, the volume of one mole and the volume of one molecule can be used to obtain a value for Avogadro's Number.

$$\text{Avogadro's \#} = \frac{\text{volume one mole}}{\text{volume one molecule}}$$