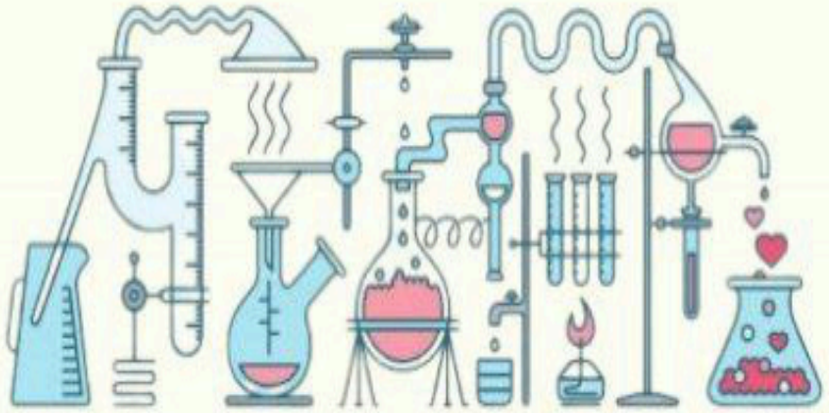
تفريغ تحليل آلي



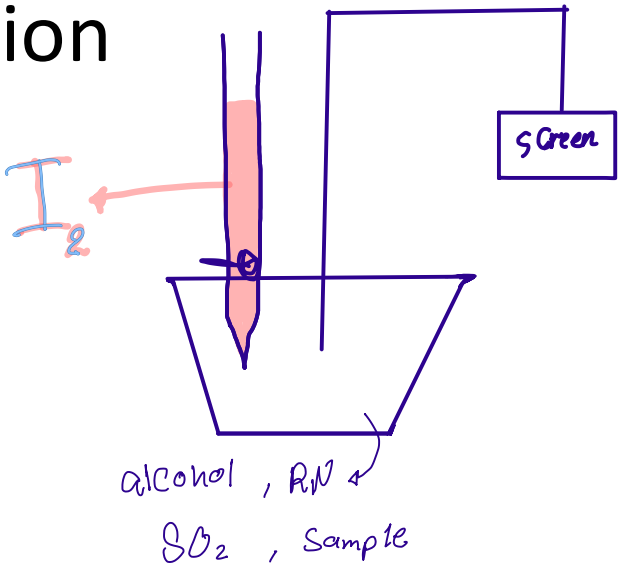
اسم الموضوع: ***Karl Fischer titration***
ELECTROANALYTICAL TECHNIQUES

إعداد الصيدلاني/ـة: ***Sara Jaber***

Soul Academy

ELECTROANALYTICAL TECHNIQUES

Karl Fischer titration



Paracetamol

صحب انه الشركة تشحن الدواء وهو مطبخ

وخلاص ، عتبتبع الوصفة للصانع وهم بنتجوها وبتوحنو نسبة

المصنع بشتري المواد الإضافية من موارد محلية والمادة الفعالة من الشركة إلي عندها براءة اختراع ويصنعها بإيدي عاملة قليلة الأجر وهيك بوفر فلوس 💵

الشركة صنعت الدواء على درجة رطوبة وقدرت تاريخ الانتهاء بعد سنتين

داخل مصنع آخر صنع الدواء على درجة رطوبة اعلى

* ما بقدر يخلي تاريخ الانتهاء بعد سنتين لأنه الدواء راح يتأثر بالرطوبة إلي موجودة داخل العرص وحوليه

- الدكتور طرح مثال الملابس المستوردة بكون في مواد معها بتسحب الرطوبة من وا البكتيريا والعفن ما بنمو على سطح الملابس وتتعفن وهي جديدة

وطرح مثال المعلبات

expire date

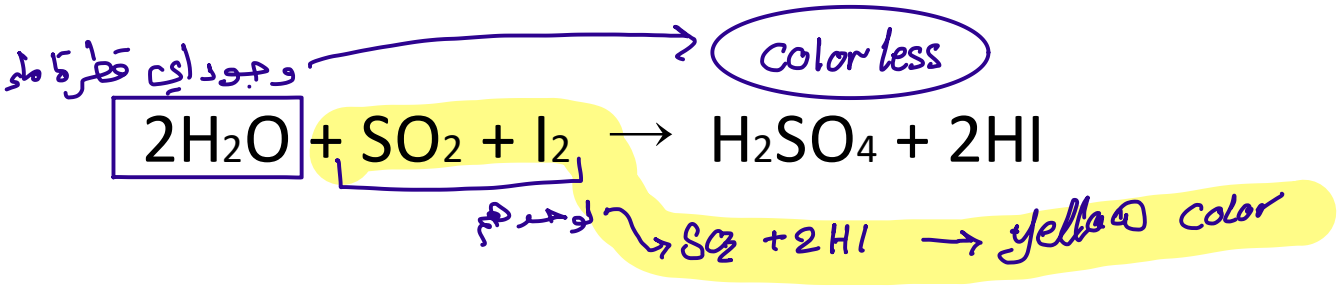
لسه ما خلص لكن الأكل داخل العلبة expired

عشان هيك لازم احسب الرطوبة بشكل دقيق

Karl Fischer was the scientist who in 1935 developed the original Karl Fischer method for water determination

Fundamental principle:

- Bunsen Reaction between iodine and sulfur dioxide in an aqueous medium (Iodometric titration of SO_2 in water)



- Modified to determine water in non-aqueous medium, excess of sulfur dioxide

" food, drug → Related to human or animal "

- Using methanol as solvent, base (pyridine as buffering agent)

alcohol

Basic concept: water reacts with iodine until the water is consumed and the endpoint is reached

Karl Fischer reaction

- Step 1: The alcohol reacts with sulfur dioxide (SO_2) and base to form an intermediate alkylsulfite salt

$$ROH\ (Alcohol) + SO_2 + R'N \rightarrow R'NHSO_3R$$

Amine

(alkylsulfite salt)

- Step 2: Alkylsulfite salt oxidized by iodine to an alkylsulfate salt.

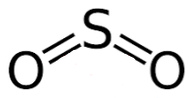
$$R'NHSO_3R + H_2O + I_2 + 2R''N \rightarrow 2[R''NH]I + [R'NH]SO_4R$$

Sulfate

$2H_2O + SO_2 + I_2 \longrightarrow 2HI + H_2SO_4$

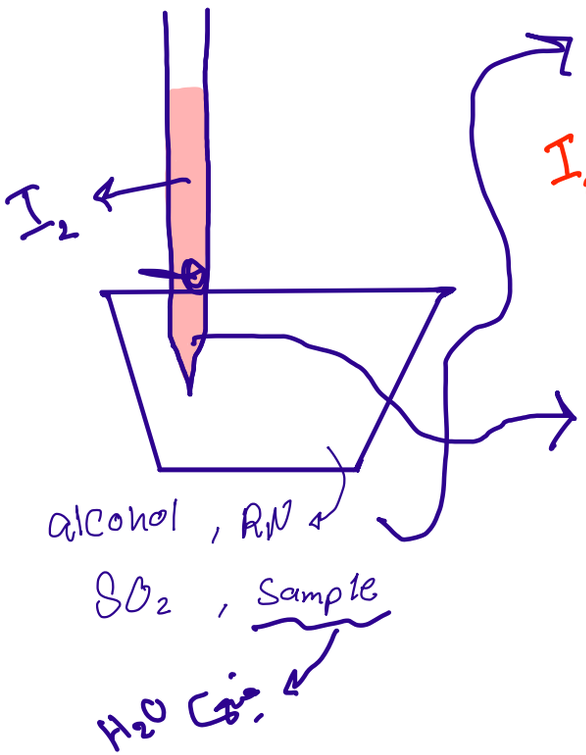
Water Reacte with Sulfer dioxide & I_2 → HI + Sulfuric acid

Color less



When water consumed completly

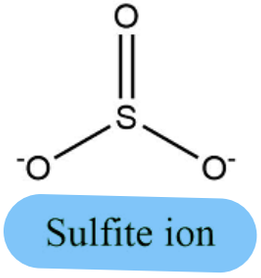
$SO_2 + I_2 \longrightarrow$ yellow color → indecate the end point



$ROH + RN + SO_2 \longrightarrow R'NH\,SO_3R$

alkylSulfite Salt

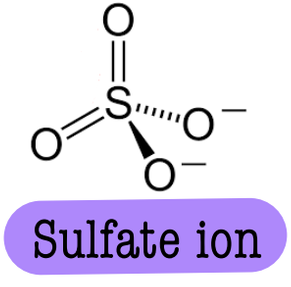
التفاعل داخل البيكر قبل اضافة I_2



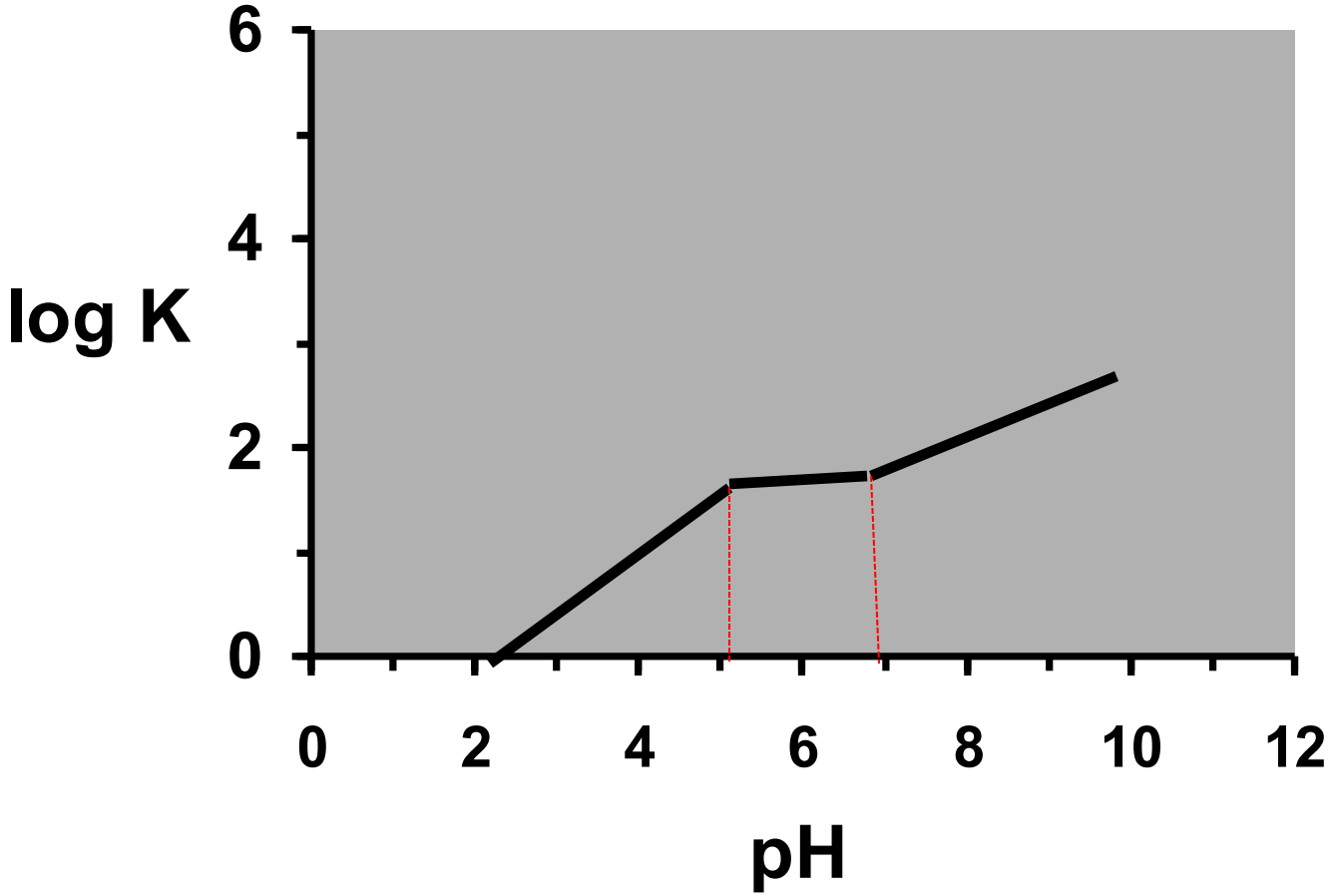
$R'NHSO_3R + H_2O + I_2 + 2R''N \rightarrow$

$2[R''NH]I + [R'NH]SO_4R$

alkylSulfate salt



pH dependency



Optimum: pH range between 5 and 7

لونه اصفر، لما تخلص H_2O من العينة بوقف التفاعل و بيبين اللون ← yellow color

$$ROH\ (Alcohol) + SO_2 + R'N \rightarrow RN'HSO_3R$$

$$RN'HSO_3R + H_2O + I_2 + 2R''N \rightarrow 2[R'NH]I + [R''NH]SO_4R$$

Sulfite — H_2O في داخل العينة ← Color less — I_2 بمشي التفاعل ← بعاي العراقية — Sulfate

- This oxidation reaction consumes water
- Water and iodine are consumed in a 1:1 ratio in the above reaction

بتقدر وجود الماء باستخدام اليود

- All of the water present in sample is consumed by iodine
- Excess iodine is then detected voltametrically by the titrator's indicator electrode or visually

Two types of methods (differ in how iodine is generated):

بوجود اعداء Sulfate ⟶ Sulfite

1- Volumetric Titration method:

1- خلصنا من الـ H_2O ما بصير التفاعل و بصير color change

2- لما تخلص الـ H_2O بتخلص الشحنات

Iodine directly added, reagent volume measured

$$\%\text{Water (W/W)} = \frac{\text{Volume(ml) of TS for Water Determination consumed} \times \text{f (mg/mL)}}{\text{Weight of the sample(mg)}} \times 100\%$$

f = Water mg/ml

TS = Titrant standard

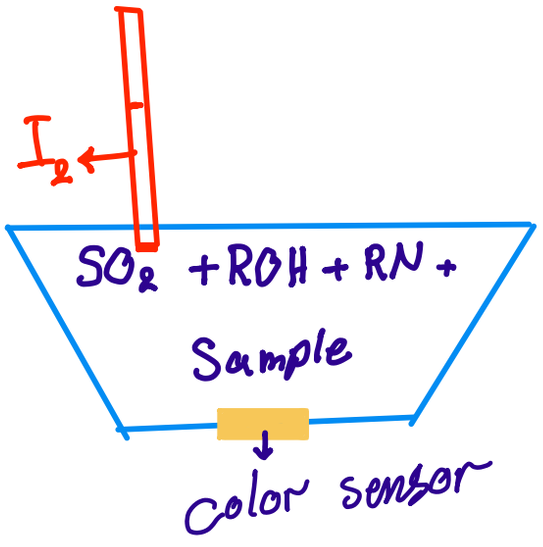
هون في نسبة خطأ؟ بأس فيها ليش؟

- لأنه آخر قطرة يود لما تنزل بالبيكر بتغير اللون ← ما تفاعلت مع H_2O بالتالي انحسبت قطرة اليود وما كان في قطرة مي مكافئة إلها

بكون عندي Sensor للضوء متى ما تغير اللون بوقف الـ titration وبحسب كمية اليود وبالتالي بقدر أوجد كمية الماء

اتمنى انكم فهمتوا

Lary sample size


I_2
SO_2 +ROH + RN +
Sample
color sensor

2-Coulometric Titration method:

معتمد على الشحنات

- Iodine generated electrochemically during the titration

★أكثر دقة★

Small sample size

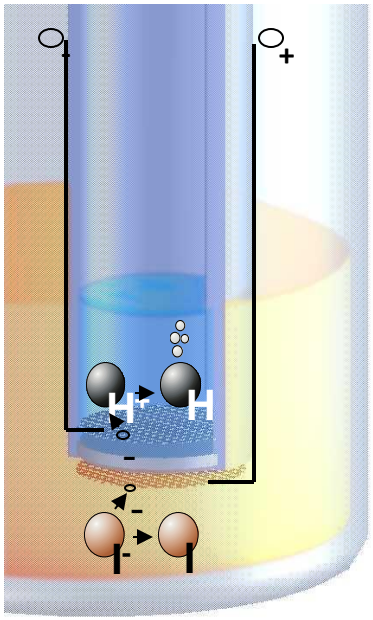
- Water is quantified on the basis of the total charge passed (Q), as measured by current (amperes) and time (seconds)

Q = 1 C (Coulomb) = 1 A x 1 s

حسابه بطريقة النسبة والتناسب

where 1 mg H2O = 10.72 C

حفظ



الـ Sensor هون مش الفولت ← الشحنات

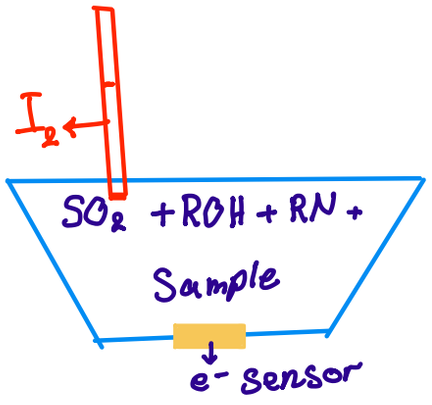
كل ما اليود يتحرر 2e⁻ بوجود الماء

الـ Sulfite ← راح يتحول لـ Sulfate

SO_3 ← SO_4

2e⁻

لما يتوقف انتاج الإلكترونات ← بتوقف الـ titration



1 mg of water → 10.72 C

كل واحد ← mg من H_2O بتنتج عند تفاعله شحنة

10.72 كولوم

ف ← لما يقرأ الجهاز 10.72 كولوم ← بعرف انه

العينة تحتوي على 1 mg Water

الحسابات المعتمدة على التجربة

Q a) Response of sensor = 8.3 → كم كان الوزن

1mg → 10.72 C

x → 8.3

$x = \frac{8.3}{10.72} = 0.77$ mg of water

Q b) Sample Wieght = 90 mg → H_2O كم نسبة

$\%\ water_{(w/w)} = \frac{0.77\ mg}{90\ mg} \times 100\% = 0.0085\%$

✅ نسبة H_2O قليلة

Approved

Karl Fischer reagent

- Original reagent prepared by action of sulphur dioxide on iodine in a mixture of anhydrous pyridine and anhydrous methanol dried

لكن شو ماكان dried بيقل في نسبة رطوبة فغيروا المواد عشان تعطي دقة اكبر

- Methanol unstable, different alcohols used instead: methoxyethanol, trifluoroethanol, cholorethanol

- Pyridine , too weak, is replaced these days (imidazole or primary amines)

Standerdization ← وبرغم ذلك لسا في رطوبة

$$ROH\ (Alcohol) + SO_2 + R'N \rightarrow RN'HSO_3R$$
$$RN'HSO_3R + H_2O + I_2 + 2R'N \rightarrow 2[R'NH]I + [R'NH]SO4R$$

ROH The solvent is generally methanol.

Methanol is the common solvent used as media

When analyzing Aldehydes and ketones, do not use methanol as a media. These compounds reacts with methanol to form additional water.

Number of iodines is equivalent to number water molecules in the reaction of iodine consumption.

KF degrades itself with atmospheric air and moisture, since the oxidation happening to sulfur dioxide.

so that the standardization of KF should be done frequently(Daily once).

Each ml of KF can neutralize (here react to consume) 5-6 mg of water. This will be exactly known by standardization of KF with DST(Disodium tartarate dihydrate) or Water.

هاد المركب ما برتبط في جزيئين H_2O فكمية الرطوبة منه معلومة

Commercially KF reagents available in two types with respect to concentration.
1) 2 mg/ ml
2) 5 mg/ml

↳ f factor

Karl Fischer reagent (Standardisation Procedure)

لو انا حضرت الـReagents لازم اعمل Standardisation قبل ما أبدأ الـtitration ليش؟
- لو كان في المواد المستخدمة رطوبة راح تعطيني قراءة خاطئة

Standardisation:

1. 36 ml methanol + sufficient KF reagent to end point
2. Add 150 – 250 mg sodium tartarate ($C_4H_4Na_2O_6 \cdot 2H_2O$ MWt.= 230.08) and titrate with KF to end point

$2H_2O$ (MWt. 36.04)/ $C_4H_4Na_2O_6 \cdot 2H_2O$ (MWt.= 230.08)= 0.1566

3. Water equivalence factor (f) = 0.1566 x W/V

f = Water mg/ml reagent

W = weight of sodium tartarate in mg

V = volume of KF reagent in ml

Determination of Water by KFR

- Procedure:

1. Add 25 ml of titrant standard to titration flask
2. Titrate to end point with KFR
3. Weigh/measure sufficient sample to contain 10-50 ml of H_20
4. Quickly transfer to flask, stir vigorously, titrate with KFR
5. Water content in sample

$$\%\ \text{Water(W/W)} = \frac{\text{Volume(ml) of TS for Water Determination consumed} \times \text{f (mg/mL)}}{\text{Weight of the sample(mg)}} \times 100\%$$

Advantages of Analysis

1. High accuracy and precision - typically within 1% of available water, i.e. 3.00% appears as 2.97 - 3.03%

2. Selectivity for water

3. Small sample quantities required

4. Easy sample preparation

5. Short analysis duration

6. Nearly unlimited measuring range (1ppm to 100%)

7. Volumetric method: range of application 0.1%-100% depends on sample size

8. Coulometric method: range of application 0.001 % - 1 % (10 µg - 200 mg absolute water content), mainly liquids and gases

9. Suitability for analyzing: solids, liquids , gases

Challenges with KF Method

Water has to be accessible and easily brought into methanol solution. Foods such as chocolate, release water slowly and with difficulty and this requires additional efforts to reliably bring the total water content into contact with the Karl Fischer reagents

fat
air bubbles
solid