الكيمياء العامة

General Chemistry 1

301101

Text: Chemistry & Chemical Reactivity

6th ed., by John Brady

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ما هي الكيمياء

The science dealing with the composition and properties of substances , and with the reactions by which substances are produced from or converted into other substances

$$Na + Cl \rightarrow NaCl$$

Scientific Method

الطريقة العلمية

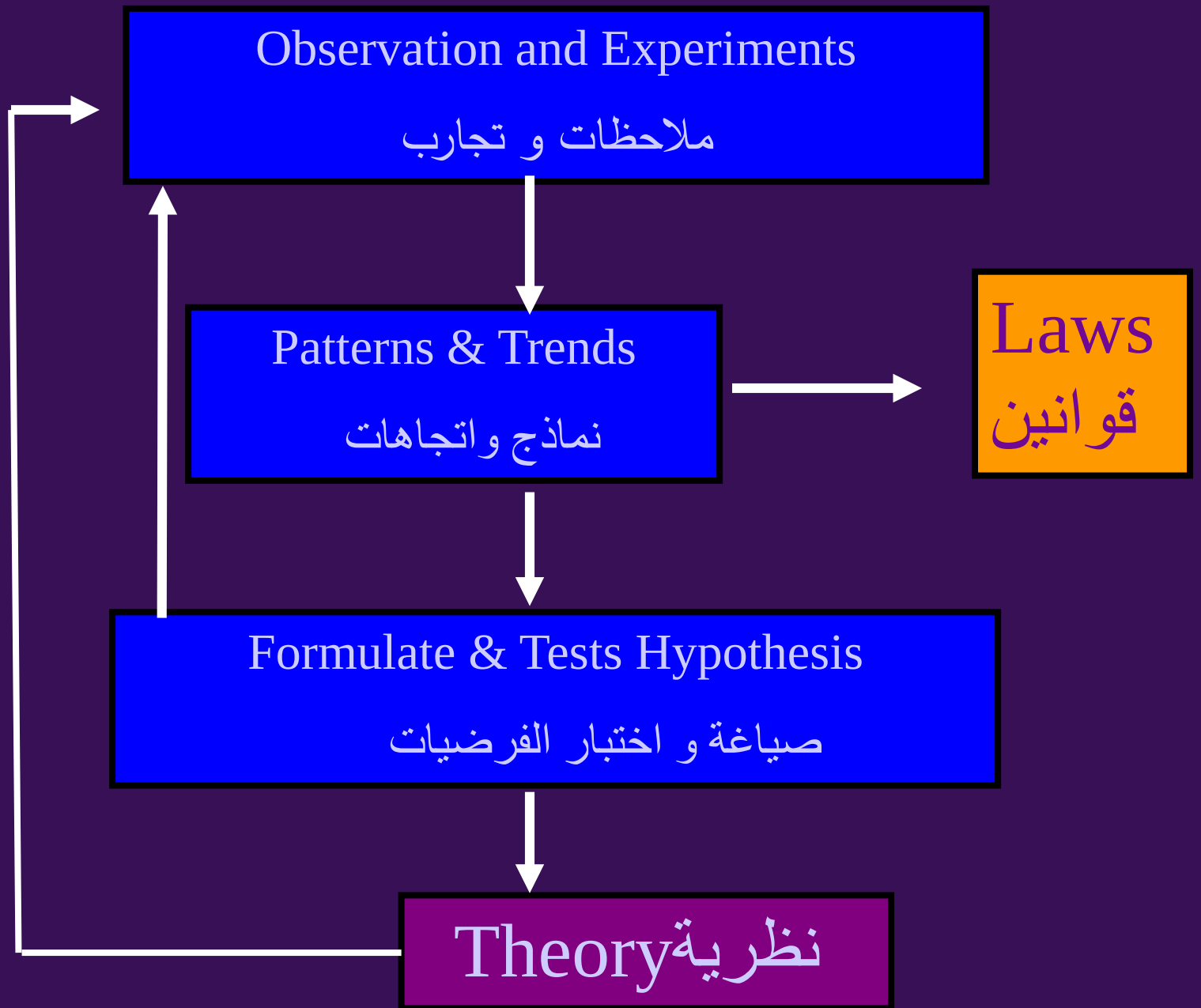
Scientific Approach to Problem Solving
الطريقة العلمية لحل المشكلات

1. Recognize Problem (Observation)
معرفة المشكلة (الملاحظات)
2. Propose Solutions (Hypothesis)
وضع الحلول (الفرضيات)
3. Test Hypothesis (Experiment)
اختبار الفرضيات (اجراء التجارب)

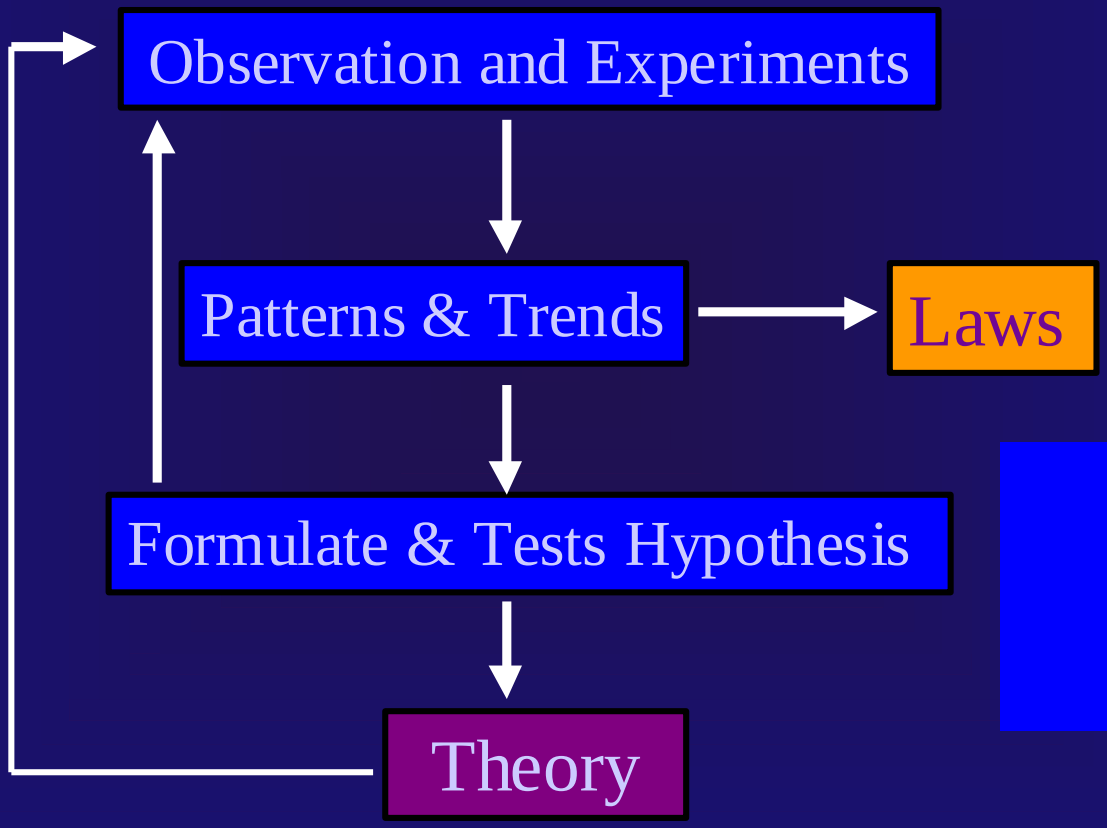
الطريقة العلمية
The Scientific Method

- A ***process*** of studying natural phenomena that involves making observations, forming laws and theories, and testing theories by experimentation
  - هي عملية دراسة لظاهرة طبيعية حيث يستلزم وضع الملاحظات ومن ثم تكوين قوانين ونظريات واختبار النظريات بالتجارب العملية .

The Scientific Method الطريقة العلمية



The Scientific Method الطريقة العلمية

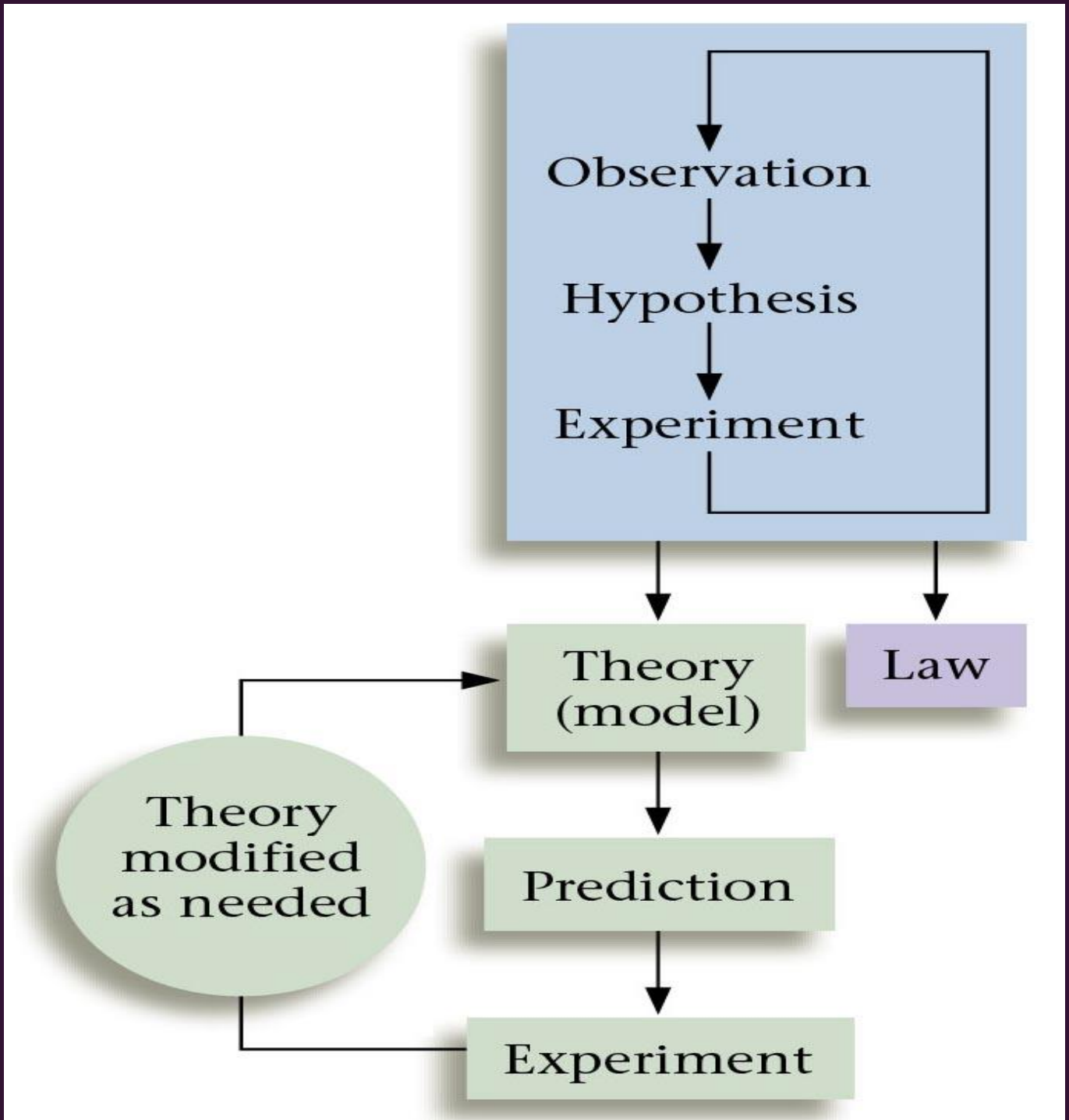


القانون= لم يفسر تكرار الملاحظات

الفرضيات : عبارة عن شروحات قابلة للإختبار للملاحظات

Is a set of tested hypothesesthat gives an overall explanation of some natural phenomenon

النظرية : نموذج يشرح فرضيات خاضعة للإختبار ويمكن ان تكون صحيحة او خطأ


Observation
Hypothesis
Experiment
Theory (model)
Law
Theory modified as needed
Prediction
Experiment

Natural Law:
القانون الطبيعي

Generally observed behavior is formulated into a statement

Chapter 1:
Matter & Measurement

- المادة و القياس

1. Classifying Matter تصنيف المادة
2. Elements & Atoms العناصر والذرة
3. Compounds & Molecules المركبات والجزيئات
4. Physical Properties الصفات الفيزيائية
5. Units of Measurement وحدات القياس
6. Using Numerical Information استخدام الأرقام
7. Problem Solving مسائل محلولة

Matter and Measurement المادة والقياس

ما هي مواصفات المادة

What are the Characteristics of Matter?

1. Matter has Mass المادة لها كتلة
2. Matter Occupies Space وتشغل حيزاً من الفراغ

What Is the Composition of Matter? مم تتكون المادة

1. Matter is Composed of Elements تتكون من عناصر
2. Matter is Composed of Compounds وتتكون من مركبات

العناصر والمركبات

Elements and Compounds

Elements العناصر – لايمكن تحطيمها بالطرق الكيميائية وتمثل بالجدول الدوري

Can Not Be Broken Down by Chemical Means

- Represented by the Periodic Table (N, H, O …)

Compounds المركبات – يمكن تكسيرها الى مكوناتها من العناصر بالطرق الكيميائية

Can be broken down by chemical means into constituent elements (H_2O, CO, CO_2 …)

Properties of Matter صفات المادة

What are the 3 Physical States of Matter?

ما هي حالات المادة الفيزيائية الثلاثة

3 States of Matter 3- حالات للمادة

- Solid الحالة الصلبة
- Definite Shape and Volume شكل وحجم ثابت

- Liquid الحالة السائلة
- -Indefinite Shape Definite Volume شكل غير محدد وحجم ثابت (Incompressible Fluid)
- Gaseous الحالة الغازية
- -Indefinite Shape and Volume حجم وشكل غير محددين

Can you name a 4th State? Plasma

صفات المادة

Properties of Matter

- 1. **Physical Properties** **1* الصفات الفيزيائية**

- تصف الحالة الفيزيائية للمادة من حيث الطعم والرائحة واللون
- والحجم والحالة والكثافة .درجة الغليان والإنصهار

- -describe the physical state of matter, odor, color, volume, state, density, melting point, boiling pt, etc.

•2. **Chemical Properties** **2* الصفات الكيميائية**

- اال •تصف الترتيب الإلكتروني وتركيب وفاعلية المادة

•- describe the atomic arrangement, composition and reactivity of matter

ما هي أوجه الإختلاف بين التغيرات الفيزيائية والكيميائية ؟

What are the Differences Between Physical and Chemical Changes?

Physical Changes- التغيرات الفيزيائية

التغير في حالة المادة (انصهار, غليان.....) مع عدم تغير في ماهية المادة (الماء يمكن ان يكون سائل , بخار أو ثلج وفي كل الحالات هو ماء

changes in the state of matter (melting, boiling…) do not change the identity of a substance (water can be a liquid, vapor, or ice; it is still water)

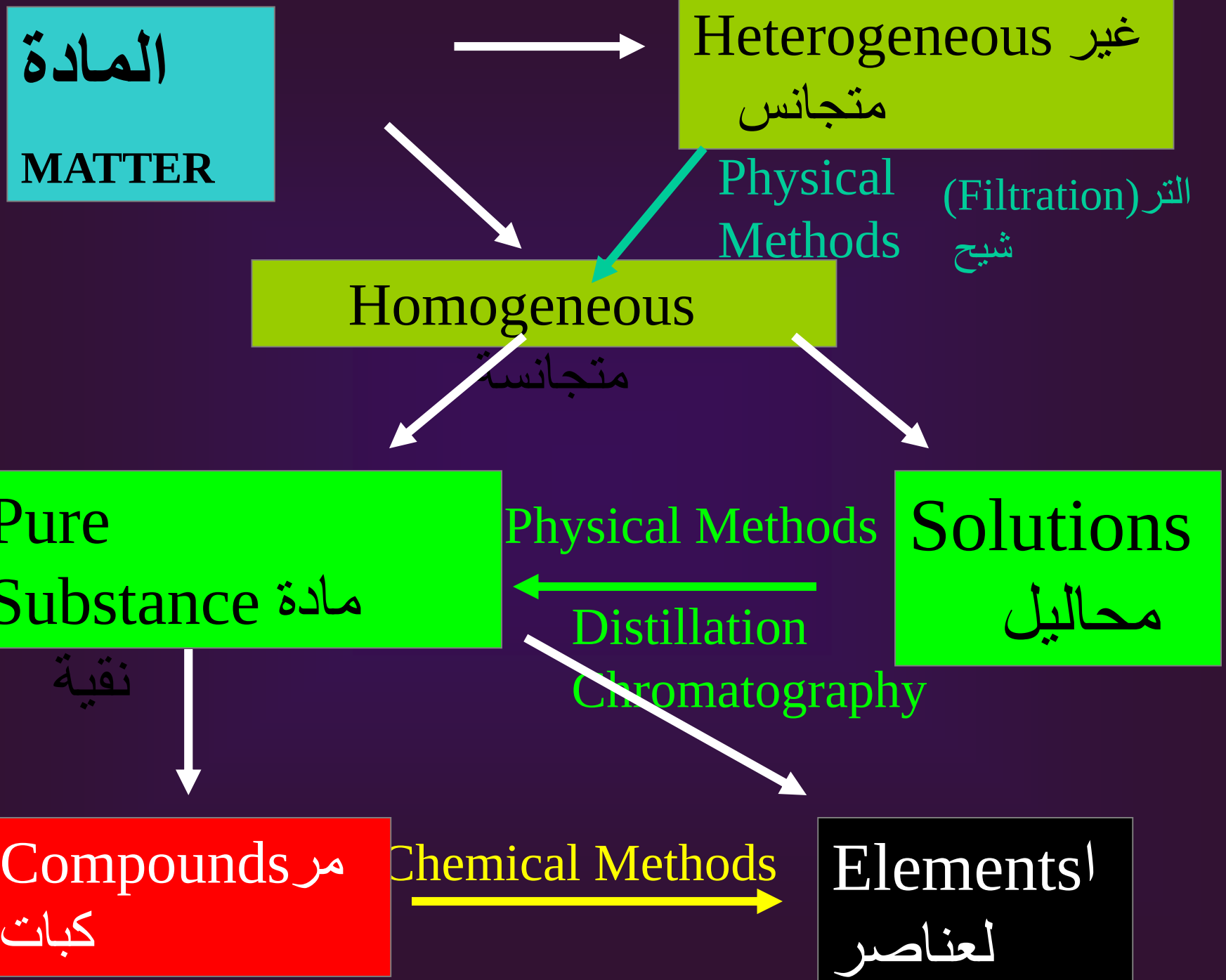
H_2O (s)→H_2O (l) → H_2O (g)

Chemical Changes- التغيرات الكيميائية

تغير يحدث في ماهية المادة , مثل تحلل الماء الى هيدروجين واكسيجين

changes in the identity of a substance, into Hydrogen and decomposition of water Oxygen

$$2\ H_2O\ (l) \rightarrow 2H_2(g) + O_2(g)$$


المادة
MATTER
Heterogeneous غير متجانس
Physical Methods
الترشيح (Filtration)
Homogeneous متجانسة
Pure Substance مادة نقية
Physical Methods
Distillation
Chromatography
Solutions محاليل
Compounds مركبات
Chemical Methods
Elements العناصر

ما هو الإختلاف بين المادة المتجانسة و غير المتجانسة ؟

What is the Difference Between Homogeneous and Heterogeneous Matter?

1. Homogeneous المتجانسة

مادة نقية تظهر بشكل منتظم (الحليب , الماء ....)
وممكن ان تكون مخلوط ومادة نقية .

-a pure substance, appears uniform throughout

May be a Mixture or Pure Substance

2. Heterogeneous الغير متجانسة

مخلوط من عدة مواد مختلفة

-a mixture, has parts which are obviously different

فصل المخلوط
Separation of Mixtures

1. **Heterogeneous Mixtures** **المخلوط الغير متجانس**

الترشيح : تفصل الحبيبات نسبة الى حجمها

- Filtration Separates particles based on mesh size

2. **Homogeneous Mixtures** **المخلوط المتجانس**

-التقطير : باستخدام تقنية اختلاف درجات الغليان لفصل المواد

-Distillation- uses different boiling pts to separate substances

-الكروماتوغرافي : يستخدم تقنية اختلاف قابلية المذيبات في طبقات اخرى في عملية الفصل

-Chromatography- uses different affinities of solutes to a substrate for separation

الصفات الفيزيائية
Physical Properties

صفات ممكن ملاحظتها وقياسها من غير تغيير في تكوين وماهية المادة

Properties which can be observed and measured without changing the chemical composition of matter

نوعان من الصفات الفيزيائية
Two Types of Physical Properties

1. Intensive Properties الصفات

صفات يمكن التعرف على المادة من النوعية خلالها وهي ثابتة (اللون ,درجة الغليان, الكثافة)

2. Extensive Properties **الصفات الكمية**

- هى الصفات التي تعتمد عل كم المادة .ولا تستخدم في تعريف المادة . (الحجم , الكتلة , الطول ,الشكل)

$$Density = \frac{Mass}{Volume}$$

هل الكثافة صفة نوعية أو كمية ؟

الحرارة Temperature

صفة تعين اذا كانت الحرارة تنتقل بين الأجسام .

Selected Densities كثافة بعض المواد

Substance	State @ 20°C, 1atm	Density (g/mL)
Hydrogen	gas	0.000084*
Oxygen	gas	0.00133*
Ethanol	liquid	0.789
Water	liquid	0.9982
Aluminum	solid	2.70
Iron	solid	7.87
Lead	solid	11.34
Mercury	liquid	13.6
Gold	solid	19.32

نستخدم وحدة جم/لتر للغازات

* Usually use units of g/L for gases

قياس درجة الحرارة
Temperature Measurement

3- قياسات

3 SCALES

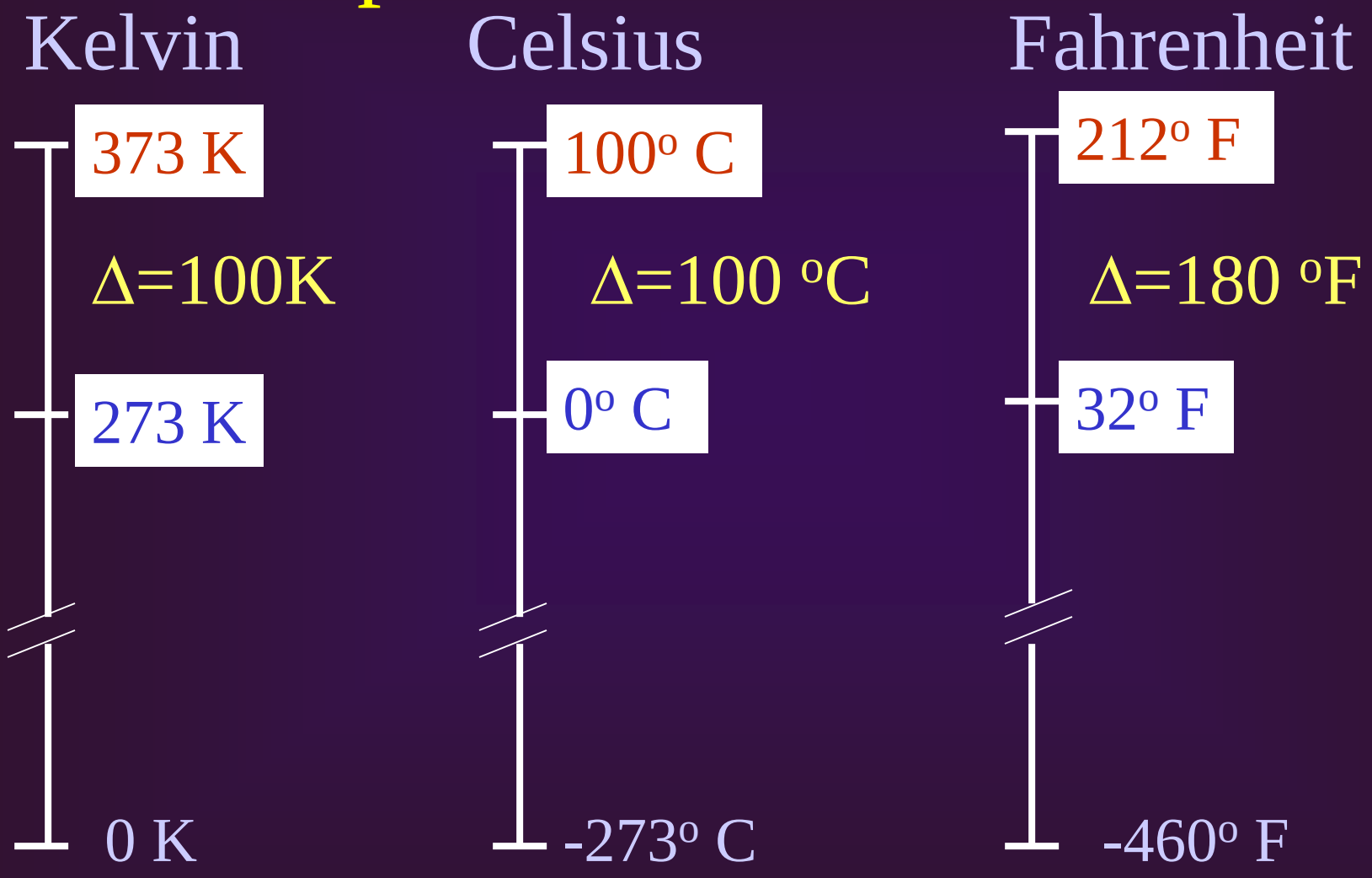
Fahrenheit Scale (F) مقياس الفهرنهيتي

Celsius Scale (C) مقياس الدرجة المؤية

Kelvin Scale (K) مقياس كيلفن

قياس درجة الحرارة

Temperature Measurement



التحويل بين درجات الحرارة
Temperature Conversions

Given: $\Delta 100^{o}C = \Delta 180^{o}F$ اذا كان

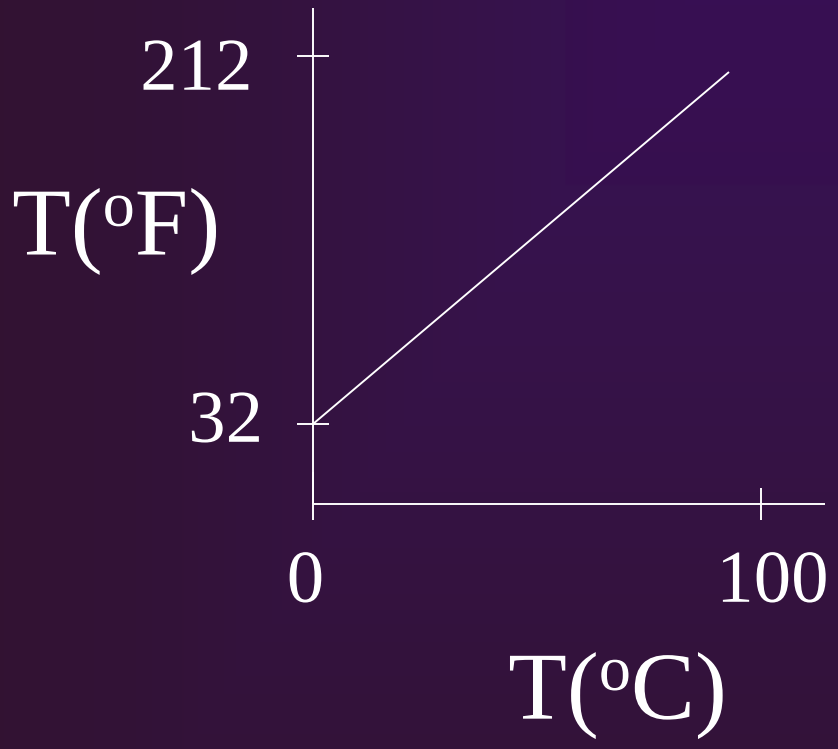
dividing by 180 gives:

$$\Delta 1^{o}F = \Delta(1/1.8\ )^{o}C$$

and dividing by 100 gives:

$$\Delta 1\ ^{o}C = \Delta(1.8)^{o}F$$

التحويلات بين درجات الحرارة
Temperature Conversions



$$y = mx + b$$

$$^0F = \frac{212-32}{100-0}\,^0C + 32$$

$$= \frac{180}{100}\,^0C + 32$$

$$= \frac{9}{5}\,^0C + 32$$

$$= 1.8\,^0C + 32$$

التحويلات بين درجات الحرارة
Temperature Conversions

$$^{\circ}C = \frac{1}{1.8}(^{\circ}F - 32)$$

$$^{\circ}F = 1.8(^{\circ}C) + 32$$

At what Temperature do these scales converge?

-40°C=-40°F

التحويلات بين درجات الحرارة
Temperature Conversions

+40/-40 Method

1. Add 40 to number
2. If going from C to F, multiply by 1.8

   (the change is greater)

   If going from F to C, divide by 1.8

   (the change is smaller)
3. Subtract 40 from number

التحويلات بين درجات الحرارة
Temperature Conversions

0 K Is Called Absolute Zero and Is Thermo-dynamically the Coldest Possible Temperature

1. What Is Absolute 0 in Degree Celsius?
2. Use the +40/-40 Technique to Determine Absolute 0 in Degree Fahrenheit?

وحدات القياس

Units of Measurements

SI Units - *Systeme International d'Units*

Mass	Kilogram	kg
Length	Meter	m
Time	Second	s
Quantity	Mole	mol
Temperature	Kelvin	K
Electric Current	Ampere	A
Light Intensity	Candela	cd

Measurements of Mass قياس الكتلة

Kilogramالكيلوجرام

Mass is the Quantity of matter present in an object. Weight refers to the force gravity pulls on a mass with. An object on the earth or the moon would have the same mass, but different weights.

1kg=1000g

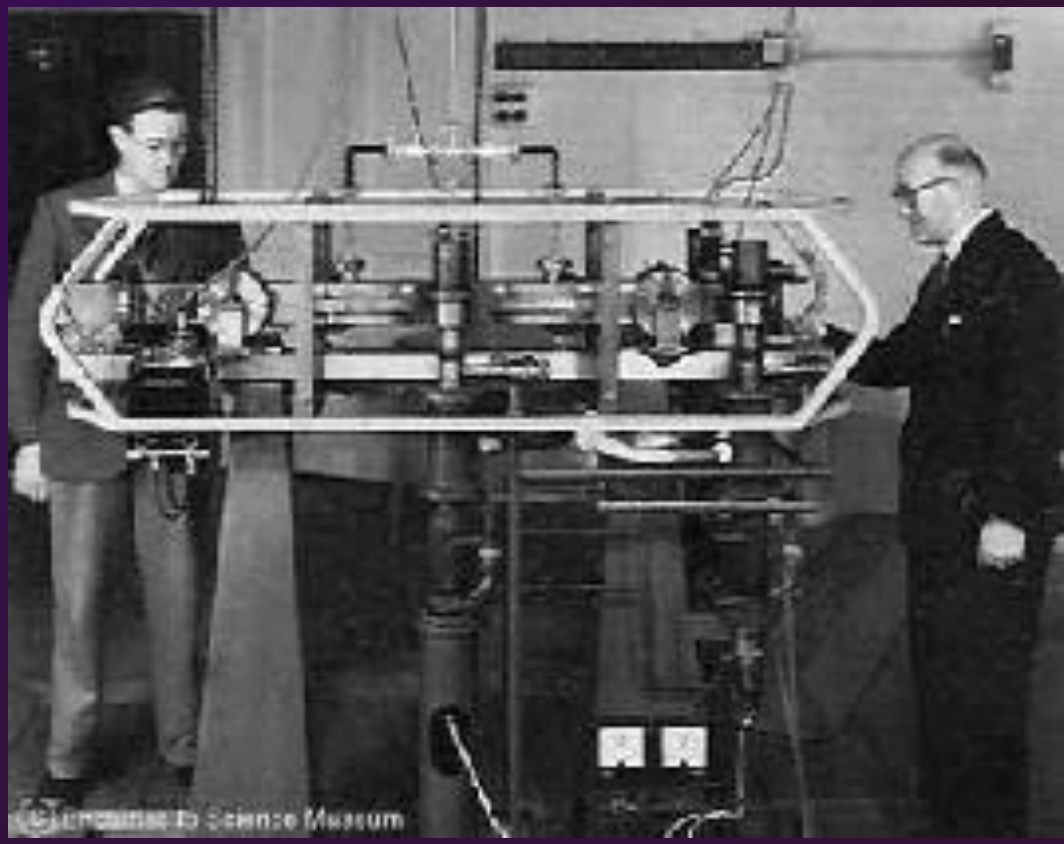
1g=1000mg

1lb=453.59g

1kg = mass of a standard Pt-Ir alloy bar kept in a French Vault

Measurement of Time

Second



Based on Cesium Beam Atomic Clock

Related to the frequency of radiation coming from the cesium 133 isotope

http://tycho.usno.navy.mil/cesium.html

Measurement of Temperature

Kelvin

The Fraction 1/273.16 of the temperature of water at the triple point

The triple pt. is the temperature at which water, ice and steam can coexist in equilbrium

Measurement of Quantity

Mole

Number of particles equal to the number of carbon-12 atoms in 12 grams of carbon-12

Derived SI Units

Units of Measurement Derived From the Fundamental SI Units

Volume - liter, $1L=1dm^3$

All measurable quantities can be measured in terms of the 7 SI units

Force –Newton

$$1N=1Kg\text{-}m^2/sec^2$$

Measurements of Volume

Volume Is the Space Matter Occupies, Which Can Be Described in Terms of the 3 Dimensions of the Cartesian Coordinate System.

$1ml = 1cm^3 = 1cc$

$1L = 1dm^3 = 1000cm^3$

Derived SI Units

Units of Measurement Derived From the Fundamental SI Units

1. Volume - liter, $1L=1dm^3$
2. Density - Mass/Volume
   - -Solid/liquid - g/ml
   - -gas - g/L

Selected SI Prefixes

Yotta-	Y	10^{24}
Zetta-	Z	10^{21}
Exa-	E	10^{18}
Peta-	P	10^{15}
Tera-	T	10^{12}
Giga-	G	10^{9}
Mega-	M	10^{6}
Kilo-	K	10^{3}
Deci-	d	10^{-1}
Centi -	c	10^{-2}
Milli-	m	10^{-3}
Micro-	μ	10^{-6}
Nano-	n	10^{-9}
Pico-	p	10^{-12}
Femto-	f	10^{-15}
Atto-	a	10^{-18}
Zepto -	z	10^{-21}
Yocto-	y	10^{-24}

Measurements of Length

kilometer	km	10^{3} m
meter	m	1 m
decimeter	dm	10^{-1} m
centimeter	cm	10^{-2} m
millimeter	mm	10^{-3} m
micrometer	μm	10^{-6} m
nanometer	nm	10^{-9} m
Angstrum	Å	10^{-10}m

Measurements of Mass

Mass is the Quantity of matter present in an object. Weight refers to the force gravity pulls on a mass with. An object on the earth or the moon would have the same mass, but different weights.

1kg=1000g

1g=1000mg

1lb=453.59g

Uncertainty in Measurement

Exact Numbers - Counted Quantities

Inexact Numbers - Measured Quantiities

-Values Depend on Scale

-Report 1st Uncertain Value

-Guess the Value Between the Smallest Units of the Scale

-Different Measurements Will Give Different Values

Uncertainty in Measurement

Accuracy - How Close a Measured Value Is to the True Value.

Precision - How Close Successive Measured Values Are to Each Other

Significant Figures - first uncertain and all certain digits of a measured number

How can we Represent the Accuracy of a Measurement?

% Error

$$\%E = \frac{\left|Measured\ Value - Theoretical\ Value\right|}{Theoretical\ Value}$$

Where the Theoretical Value is the Accepted Value

- Note the text does not use absolute values
- Can you think of an advantage to using absolute values?

(The average percent error does not go to zero)

How can we Represent the Precission of a Measurement?

Average Deviation:

$$Av.\,Dev = \sum_{i=1}^{n} \frac{\left|M_i - M_{ave}\right|}{n}$$

M_i = Measured Value of i^{th} Measurement
M_{ave}=Average Measured Value
n = Number of Measurements

How can we Represent the Precission of a Measurement?

Standard Deviation (σ):

$$\sigma = \sqrt{\sum_{i=1}^{n} \frac{\left(M_i - M_{ave}\right)^2}{n}}$$

Estimated Standard Deviation (s):

$$s = \sqrt{\sum_{i=1}^{n} \frac{\left(M_i - M_{ave}\right)^2}{n-1}}$$

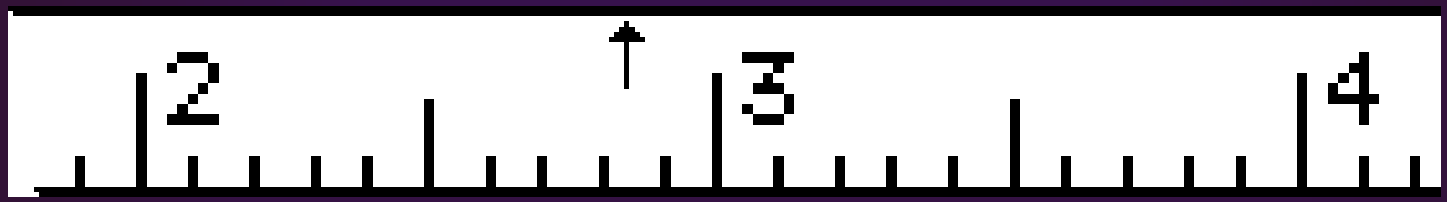
-Use s unless you have a very large number of measurements

How do we Express The Uncertainty of a Measured Number When We Write It?

Significant Figures - first uncertain and all certain digits of a measured number

Uncertainty in Measurement

Read the following measurement to the correct number of significant figures.

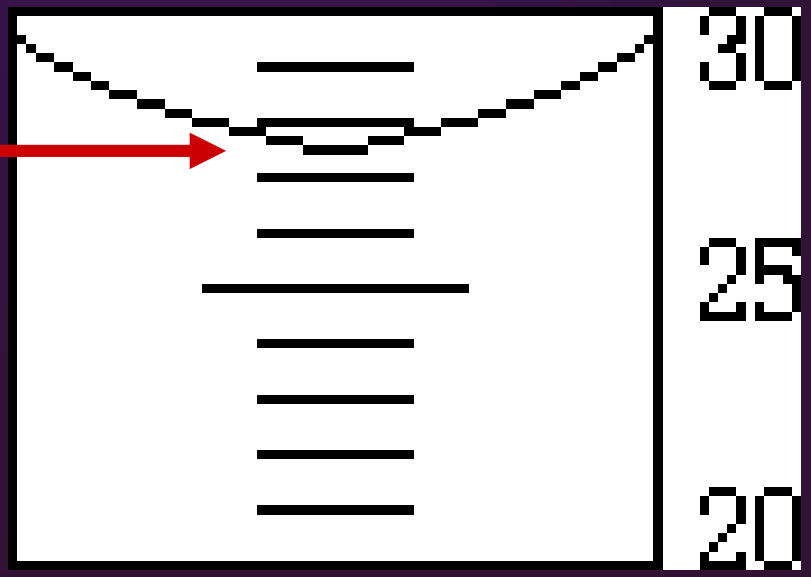


2.84 or 2.85, maybe 2.83

Uncertainty in Measurement

Read the following measurement to the correct number of significant figures.

Note: Read from the bottom of the meniscus



27.5 or 27.6 maybe 27.8

Representing Significant Figures

1. Non Zeros are always significant

2. Leading Zeros are never significant.

3. Captive zeros are always significant

4. Trailing zeros are only significant if the number has a decimal point

Predict the number of sig figs for the following numbers

1. 0.0053	1. 2
2. 2300	2. 2
3. 32.00	3. 4
4. 34.483	4. 5

Scientific Notation

Scientific Notation-Convention of Expressing Any Base 10 Number As a Product of a Number Between One and 9,multiplied by 10 to the Power of Some Exponent

$1 = 1 \times 10^{0}$ $2 = 2 \times 10^{0}$

$10 = 1 \times 10^{1}$ $20 = 2 \times 10^{1}$

$0.1 = 1/10 = 10^{-1}$ $0.2 = 2 \times 10^{-1}$

$100 = 1 \times 10^{2}$ $200 = 2 \times 10^{2}$

Scientific Notation

Advantages of Scientific Notation:

- Allows Awkwardly Large and Small Numbers to Be Expressed in Terms of Compact and Easily Written Numbers

- Allows Accurate Representation of the Number of Significant Figures in a Number, That Is a Measurement's Precision, the "Certainty" of Our Measurements

Sig Figs in Calculations

1. Addition and Subtraction

-Result is limited to precision of least precise measurement

2. Multiplication and Division

-Result is limited to the number of significant figures of the value with the least number of significant figures

Determine Sig Figs for the following Calculations

a) $13.7325 - 14.21 =$ -0.4775= -0.48

b) $\dfrac{(1.1)(2.62)(13.5278)}{2.650} =$ 14.712121= 15

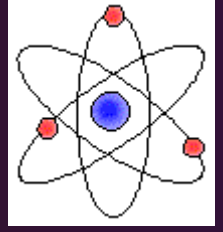
Rounding off Numbers

Often your calculator will give answers with more numbers than are significant, how do we deal with this?

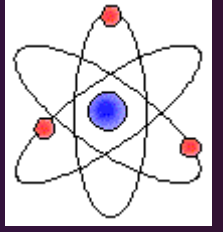
1. If digit to be removed is less than 5, preceding digit stays the same **(Round Down)**.

2. If digit to be removed is greater than or equal to 5, preceding digit is increased by 1 **(Round Up).**

NOTE: during calculations, use all digits and round off at the end, according to preceding rules



Symbols of the Elements



Elements with Non English Symbols

Sb - Antimony (*Stibium*)

Cu - Copper (*Cuprum*)

Au - Gold (*Aurum*)

Fe - Iron (*Ferrum*)

Pb - Lead (*Plumbum*)

Hg - Mercury (*Hydrargyrum*)

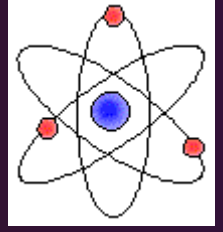
Ag - Silver (*Argentium*)

Na - Sodium (*Natrium*)

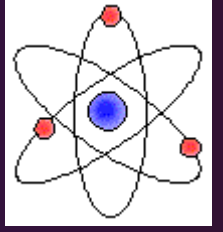
Sn - Tin (*Stannum*)

W- Tungsten (*Wolfram*)

K - Potassium (*Kalium*)



Symbols of the Elements



Tricky Elements

Mg – Magnesium

Mn – Manganese

Ra – Radium

Rn – Radon
(noble gas)

There is no such thing as manganesium!

Dimensional Analysis

-The Incorporation of Units Into Algebraic Solutions

1 foot & 12 inches are identical lengths, therefor ;

$$1ft = 12in$$

Equivalence Statement

$$\frac{1ft}{12in} = \frac{12in}{12in} = 1 = \frac{1ft}{1ft} = \frac{12in}{1ft}$$

Conversion Factors

$$\frac{1\text{ft}}{12\text{in}} = \frac{12\text{in}}{12\text{in}} = 1 = \frac{1ft}{1ft} = \frac{12in}{1ft}$$

To convert from:

ft to in , multiply by 12in/ft

in to ft , multiply by 1ft/12in

Conversion Factors

Tricks

1. Algebraically cancel units in calculations
2. Start calculations with given quantities
3. Visualize answer in desired quantities

Important

Always Include Units In Calculations

Check All Solutions for Proper Dimensions

-Answers Without Units Will Be Considered Wrong

Note: Many instructors do not like dimensional analysis because you can solve problems without understanding the underlying concepts.

Solve the Following Problem

Give the volume in liters of a box which is 2.4 yards by 2.4 inches by 2.4 feet in size

$$2.4\,yd\,(2.4\,ft)(2.4in)\left(\frac{3\,ft}{yd}\right)\left(\frac{12in}{ft}\right)^2\left(\frac{2.54cm}{in}\right)^3\left(\frac{mL}{cm^3}\right)\left(\frac{1L}{1000mL}\right)$$
$$=98L$$

Solve the Following Problem

What is the value of a gold bar with dimensions of 1.5cm x 2.5cm x 2.0cm if gold sells for $300/oz and has a density of 19.32g/ml?

$$1.5cm(2.5cm)(2.0cm)\left(\frac{1mL\$15}{cm^3}\right)\left(\frac{19.32g}{mL}\right)\left(\frac{16oz}{453.59g}\right)\left(\frac{\$300}{oz}\right)$$

$$=\$1500$$