國立宜蘭大學教學大綱

科目名稱之

中文名稱：化學

英文名稱：**Chemistry**

授課教師：李大剛

開課系科別：化工與材料科學系

開課學制: □日間部五專、þ日間部大學、□日間部四技、□日間部二技、□日間部二專、□進修部四技、□進修部二技、□進修部二專

開課年級：þ一、□二、□三、□四、□五

開課學期：þ上、□下、□暑期

學 分 數：**3** 學分

演講時數：**3** 小時

實習時數：**0** 小時

教科書目：**Chemistry－Principles and Reactions By: W. L. Masterton and C. N. Hurley, 5th ed.(滄海)**

參考書目：**Chemistry－The Molecular Nature of Matter and Change By: M. S. Silberberg, R. Duran, L. P. Gold, 3rd ed.(滄海)**

教學目的：

本課程之教學目標，在高級中學科學教育基礎上，以正確的科學態度與實驗方法，輔導學生獲得相關基本觀念。一方面作為進一步學習相關學科之基礎，另一方面使學生熟知現代之生活相關知識。

上課方式：每週授課 **3** 小時

考試及成績計算方式：

小考 **20%**，期中考 **30%**，期末考 **30%**，平時 **10%**，筆記 **10%**。

課程大綱：

本學期課程內容涵蓋物質、週期表、化學鍵結、溶液、氣體化學反應之基本概念、氧化還原反應、酸與鹼、化學平衡、電化學、及應用化學學科之簡介。

課程進度：

週次	課程內容
1	課程內容簡介、第一章 物質與測量
2	物性、 小考、 第二章 原子
3	分子與離子、 、 分子軌域週期表、 小考
4	第三章 質量、 莫耳、化學式之質量關係
5	化學計量與質量關係、小考
6	第四章 水溶液及反應、 酸鹼反應
7	氧化還原平衡、 第五章 理想氣體
8	氣態反應之計量、 氣體動力論
9	期中考
10	第六章 量子數、 原子結構、 電子組態
11	原子物性之週期性、 小考、 第七章 路易士結構、
12	八隅體理論、 分子幾何學、 分子極性
13	分子軌域、 小考、第八章 熱卡計、 焓
14	熱化學反應式、 生成焓熱力學第一定律、 小考
15	第九章 液-氣平衡、 相圖、 分子間作用力
16	共價化合物、 離子固體、 金屬、第十章 濃度
17	溶解度、 依數性質
18	期末考

作業: 背熟週期表原子序 1- 30 及 IA 至 VIIIA 族元素之中、英文名稱、符號、原子序及原子量。

Ch.1 Matter and Measurements

Chemistry：Chemistry is the study of matter and its composition, structure, and properties; the changes that matter undergoes, and the energy associated with those changes.

§1-1 Type of matter

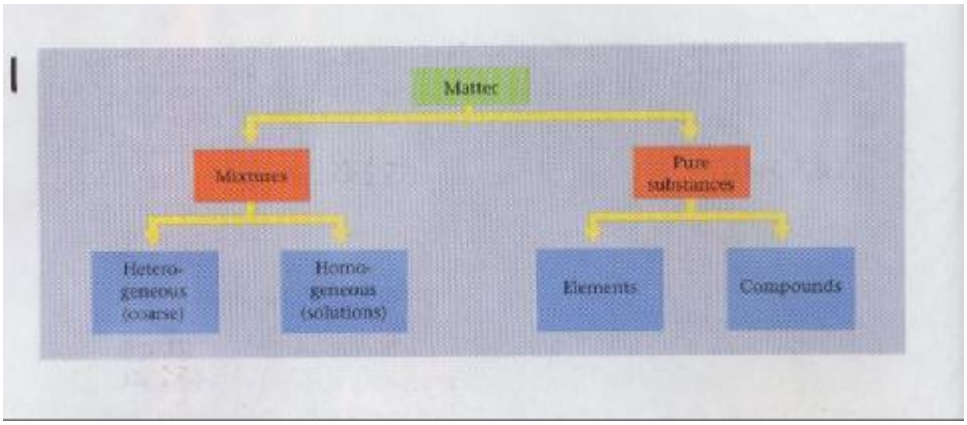
1. Matter：Matter is anything that has mass and occupies space.
It exists in three phases：

	Volume	Shape
Solid (**s**)	Fixed (O)	Fixed (O)
Liquid (**l**)	(O)	Not fixed (x)
Gas (**g**)	(x)	(x)

(O): Fixed; (x): Not fixed.

Aqueous (**aq**): 水溶液

2.



*** Pure substance**：has a fixed composition and a unique set of properties.

*** Mixtures**：composed of two or more substances.

*** Element**：a type of matter that cannot be broken down into two or more pure substances.

目前已知 113 元素(課文 115)，91 存在自然界，$_{92}U$ 以上超鈾元素，均爲人工合成，$_{83}Bi$ 以上爲放射性元素.

Compound：is a pure substance that contains more than one element. Ex：(H_2O; CH_4; C_2H_2). It has fixed compositions (H_2O : 11.19％ H ; 88.81％ O) properties of compounds different from those of the elements they

contain.

Ex：NaCl（white , unreactive solid）
Na is a shiny, extremely reactive metal; Cl_2 is a poisonous nonmetal.

*** Mixture**：contains two or more substances combined in such a way that each substance retains its chemical identity. It does not react with one another.

1.Homogeneous 均相：uniform mixtures
The composition is the same throughout 又稱 solution (Soda water; Brass)
分離方法：distillation.

2.Heterogeneons 非均相：nonuniform mixtures
The composition varies throughout (sand).
分離方法：filtration (to separate a heterogeneous solid –liquid mixture).

§1-2 Measurements

Scientific measurements are expressed in the **metric system.**

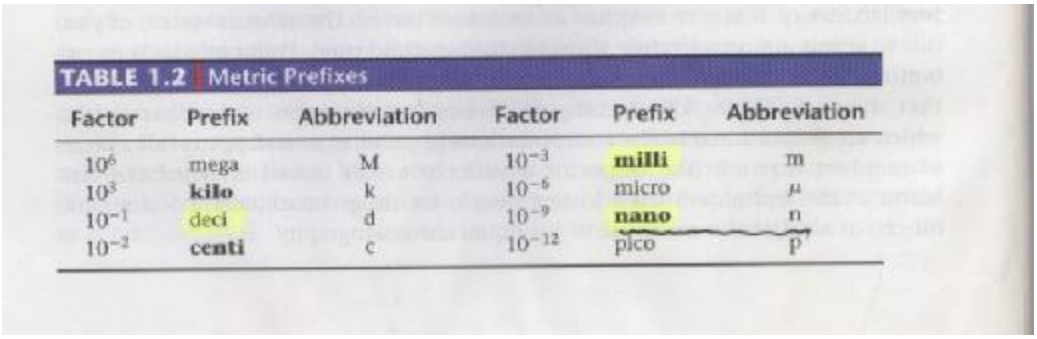


TABLE 1.2 Metric Prefixes

Factor	Prefix	Abbreviation	Factor	Prefix	Abbreviation
10^{6}	mega	M	10^{-3}	**milli**	m
10^{3}	**kilo**	k	10^{-6}	micro	μ
10^{-1}	deci	d	10^{-9}	**nano**	n
10^{-2}	**centi**	c	10^{-12}	pico	p

1. We will look at four familiar Quantities： length、volume、mass、temperature。

（1）Length: standard unit of **length** is the **meter.**

1 km = 10^{3} m	1 ft = 12 in	1 in = 2.54 cm
1 cm = 10^{-2} m	1 yd = 3 ft	1 m = 39.37 in
1 mm = 10^{-3} m	1 mi = 5280 ft	1 mi = 1.609 km
1 nm = 10^{-9} m = 10 Å		
1 Å = 10^{-10} m		

（2）體積(volume)

立方公分(cubic centimeters, cc)　$1\ cm^3 = (10^{-2}\ m)^3 = 10^{-6}\ m^3$

公升(liter, L)　　$1\ L = 10^{-3}\ m^3 = 10^3\ cm^3$

毫米(milliliters, mL)　　$1\ mL = 10^{-3}\ L = 10^{-6}\ m^3$

1 gal = 4 qt = 8 pt　　$1\ mL = 1\ cm^3$

$1\ qt = 57.75\ in^3$　　1 L = 1.057 qt

（3）In the metric system mass is most commonly expressed in grams (g), kilograms (kg), or milligrams (mg)

$1\ kg = 10^3\ g$ $1\ mg = 10^{-3}\ g$ $1\ metric\ ton = 10^3\ kg$	1 lb = 16 oz 1 short ton = 2000 lb	1 lb = 453.6 g 1 g = 0.03527 oz 1 metric ton = 1.102 short ton

There is a distinction between mass and weight.

質量(Mass)：is a measure of the amount of matter in an object.

重量(Weight)：is a measure of the gravitational force acting on the object.

質量(Mass)：受測樣品內物質的含量，由天秤稱重而得。

重量(Weight)：受測樣品所受重力吸引程度的量度。

(4）Temperature

Temperature is the factor that determines the direction of heat flow.

＊攝氏(Celsius，°C)　　$T_{°C} = 5/9(T_{°F} - 32)$

＊華氏(Fahrenheit，°F)　　$T_{°F} = 1.8T_{°C} + 32$

＊凱氏(Kelvin，K，又稱爲絕對溫度 absolute temperature)

$K = T_{°C} + 273.15$

絕對零度 (absolute zero) 理論上的最低溫，K = 0 (-273.15°C).

Any true ideal gas goes to zero volume at 0 K.

Ex 1.1: Mercury thermometers are being phased out because of the toxicity of mercury vapor. A common replacement for mercury is the organic liquid isoamyl benzoate，Which boils at 262℃，what is its boiling point in °F = ? K = ?

isoamyl benzoate 苯甲酸異戊酯 $C_6H_5COOCH_2CH(CH_3)_2$

Ans：

a)

$$T_{°F} = 1.8 \times 262 + 32 = 471.6 + 32$$

$$= 503.6\ °F = 504\ °F$$

b)

$$T_K = 262 + 273.15 = 535.15K$$
$$= 535K$$

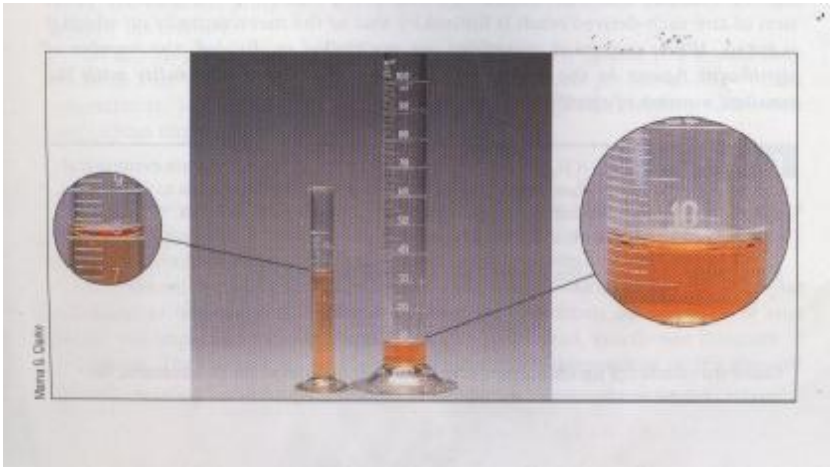
The SI units for the four quantities discussed are:

Length ：meter (m) **Mass：kilogram (kg)**

Volume：cubic meter (m^3) **Temperature：Kelvin (K)**

§ Uncertainties in Measurements：Significant Figures 有效數字

Significant figures = measurement figures + uncertainity figures



There is an uncertainty of at least one unit in the last digit.

Ex1.2： Using different balances ,three different students weigh the same object. They report the following masses：How many significant figures does each value have ?

Ans：

1.611	4 位有效數字
1.60	3 位有效數字
0.001611	4 位有效數字

§ **Exponential notation 指數記號**

In general, any ambiguity concerning the number of significant figures in a

measurement can be resolved by using exponential notation (scientific notation).

5.00×10^2	3 位有效數字
5.0×10^2	2 位有效數字
5×10^2	1 位有效數字

§ 有效數字計算：

乘除：乘除後，取最少有效數字四捨五入。

Ex 1.3: A US Airway flight leaves Philadelphia in the early evening and arrives in Frankfurt 8.05 hours later. The airline distance from Philadelphia to Frankfurt is about 6.6 x 10^3 km, depending to some extent on the flight path followed. What is the average speed of the plane, in kilometers per hour ?

Ans:

$$speed = \frac{\mathbf{l}}{t} = \frac{6.6\times10^3}{8.05}\ \frac{km}{h}$$

$$= 819.875776\ \ km/h$$

$$\therefore speed = 8.2\times10^2\ \ km/h$$

加減：小數點下最少的有效數字爲準，先四捨五入再加減。

Ex:

Instant coffee	10.21 g	⇨	10 g
Sugar	0.2 g		0 g
Water	256 g		+ 256 g
			266 g

§ Conversion of units:

It is often necessary to convert a measurement expressed in one unit to another unit.

Ex1.4：A gasoline station in Manila, Philippines, charges 37.57 pesos per liter for super unleaded gasoline at a time when one U.S. dollar (USD) buys 47.15 Philippine pesos (PHP). The car you driving has a capacity of 14.00 U.S. gallons, and gets 24 miles per gallon.

（a）What is the cost of super unleaded gasoline in Manila in U.S. dollars per gallon？

（b）How much would a complete thankful of super unleaded for your car cost in dollars？

（c）Suppose you have only 1255 pesos, and the car's tank is almost empty. How many Kilometers can you expect to drive if you spend all your money on super unleaded gasoline？

Ans:

a). $37.57 \frac{PHP}{L} \times \frac{1\ \text{USD}}{47.15\ \text{PHP}} \times \frac{1\ \text{L}}{1.057\ \text{qt}} \times \frac{4\ \text{qt}}{1\ \text{gal}} = 3.015\ \text{USD/gal}$

b). $14.00\ \text{gal} \times \frac{3.015\ \text{USD}}{1\ \text{gal}} = 42.21\ \text{USD}$

c). $1255\ \text{PHP} \times \frac{1\ \text{USD}}{47.15\ \text{PHP}} \times \frac{1\ \text{gal}}{3.015\ \text{USD}} \times \frac{24\ \text{miles}}{1\ \text{gal}} \times \frac{1.609\ \text{km}}{1\ \text{mil}} = 3.4 \times 10^2\ \text{km}$

§ 1-3 Properties of substances

Intensive (本質的) properties:

The properties independent on amount. Ex: temperature、pressure.

Extensive (非本質的) properties:

The properties depend on amount. Ex: volume、weight.

Chemical properties: 化性，反應性

When the substance takes part in a chemical reaction, a change that converts it to a new substance.

物質在經過化學反應後，將完全消失而形成新物質，取代原來的物質。

$2\ H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ (氫氣在氧氣中燃燒形成水蒸氣)

Physical properties: can be measured without changing the identity of a substance.

Ex：Melting point；boiling point.

Density： $D = \frac{m}{V} = \frac{\text{mass}}{\text{volume}}$

Ex 1.5： Palladium (Pd) is an element with properties similar to those of platinum. It is useful in eliminating harmful emissions produced by internal combustion engines. Two students were given identical cylindrical "palladium" bars with the following data:
mass = 96.03 g, length = 10.7 cm, diameter = 9.82 mm, density = 12.02 g/cm^3.

(a). Student X was asked to determine whether her bar was made of pure palladium.

(b). Student Y was asked to determine how many grams of ethyl alcohol (d= 0.789 g/cm^3) his bar would displace.

Show the calculations that Students X would do for the assigned tasks.

Ans：

(*a*) $D = \frac{m}{V} = \frac{96.03\ g}{p \times r^2 \times l} = \frac{96.03}{p \times (0.982/2)^2 \times 10.7} = \frac{96.03\ \text{g}}{8.10\ \text{cm}^3}$

$= 11.8498\ \frac{g}{cm^3}$

= 11.8 g/cm^3

(*b*) m (alcohol) = 8.10 cm^{3}x 0.789 g/cm^3

= 6.39 g

§ Solubility (溶解度)

At constant temperature, the amount of solute can be dissolved in a certain solvent. Solute dissolves in a solvent is ordinarily a physical rather than a chemical change. Unit: g solute/100 g solvent; M (molarity).

Ex 1.6: Sucrose is the chemical name for the sugar we consume. Its solubility at 20℃is 204g/100g water 100℃ is 487g/100g water. A solution is prepared by mixing 139 g of sugar in 33.0 g of water at 100℃.

(a) What is the minimum amount of water required to dissolve the sugar at 100℃？

(b) What is the maximum amount of sugar that can be dissolved in the water at 100℃？

(c) The solution is cooled to 20℃. How much sugar (if any) will crystallize out？

(d) How much more water is required to dissolve all the sugar at 20℃？

Ans：

a) 487 ： 100 = 139 ： x

x = 28.5 g water

b) 33.0 ： y = 100： 487
y = 161 g sugar

c) 33.0 : y = 100 : 204
y = 67.3 g sugar

∴ 會有 139 – 67.3 = 72 g sugar 沉澱析出.

d). 139 : x = 204 : 100
x = 68.1 g water

∴ 需要多加 68.1 – 33.0 = 35.1 g 水.

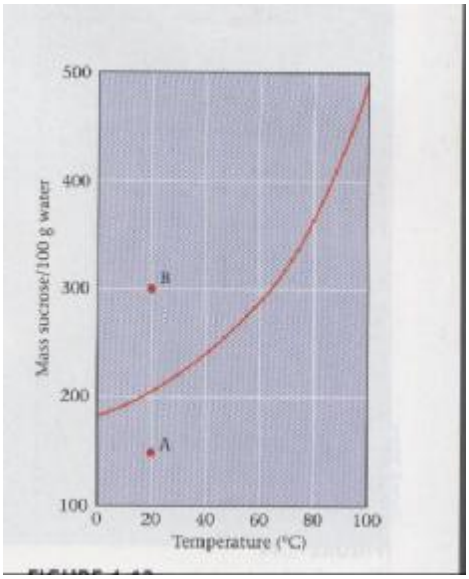


Fig 1.12: Solubility of table sugar.

We can say that it gives the concentration of sugar in a **saturated** solution; at various temperatures. (At 20℃ the solubility of sugar is 204 g/100g ⇒ a saturated solution of sugar contains 204 g sugar in 100 g water)

Unsaturated: **Below the curve in Figure 1.12** is unsaturated solution. Point A
(150g sugar per 100 g water at 20℃**)**

Supersaturated：Above the curve in Figure 1.12. point B (300 g sugar per 100 g water at 20℃). Such a solution could be formed by carefully cooling a saturated solution at 60℃ to 20℃. Here a saturated solution contains 204 g sugar per 100 g water. The excess sugar stays in solution until a small seed crystal of sugar is added.

§ Color; Absorption Spectrum:

Some of the substances you work with in general chemistry can be identified at least tentatively by their color. (Ex: Gaseous nitrogen dioxide has a brown color；

vapors of bromine and iodine are red and violet). The colors of gases and liquids are due to the selective absorption of certain components of visible light.

The wavelengths of visible light range from 400-700 nm regions.

(＜400 nm is ultraviolet；＞700 nm is infrared）