

**A NEW
DICTIONARY
OF
CHEMISTRY**

THIRD EDITION EDITED BY
L. MACKENZIE MALL

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A NEW DICTIONARY OF CHEMISTRY

EDITED BY

L. MACKENZIE MIALL, M.A., F.R.I.C.

WITH THE ASSISTANCE OF MANY EXPERT CHEMISTS



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 ABERDEEN

PREFACE TO THIRD EDITION

IN this dictionary will be found an explanation of the meaning of many of the terms used in chemistry and related sciences, and brief accounts of many chemical substances, chemical operations, and men who have contributed to the progress of chemistry. It is not intended for the expert, for instance for the organic chemist who wishes to look up an obscure organic reaction ; but chemistry has now become so wide a subject that a chemist, after he has qualified for many years, may find that he knows little about some branches of the science. Thus a physical chemist wishing to know the meaning of a biochemical term or the structure of a pharmaceutically important compound would hope to find it here. But chemists are not the only people who need information on chemical matters ; doctors, pharmacists, physiologists, physicists, schoolmasters, patent agents, lawyers, journalists, chemical engineers, works managers, and many others may from time to time need to refer to something that is included in so wide a subject as chemistry.

The first edition of this book was published in 1940, but unfortunately almost all the existing stocks were destroyed soon after publication when Paternoster Row was burnt down in the big air raid on the City of London in December of that year. A second edition was brought out as soon after the war as conditions allowed. Opportunity was taken to bring the first edition up-to-date, but at the time of writing but little of the spate of new work catalysed by the war had been published. In the period since the last war the advance in chemical knowledge has been more rapid than in any comparable time. This may not have been obvious over a period of any one year, but it has been astonishing to find how much alteration has been necessary in preparing the present volume. Not only have new compounds of great importance in industry and in medicine appeared, but theoretical knowledge has also grown at a great pace. Furthermore, the meaning of scientific words changes. Scientists have the bad habit of taking a word that has a perfectly definite meaning in one context, and using it with a slight, or sometimes even a big, change of meaning in another. Thus a word like epimeride may mean one thing in carbohydrate chemistry, but something slightly different when applied to sterols. Words go out-of-date

and newer words with the same meaning replace them. Conventions with regard to signs, symbols, and abbreviations have both altered and become more universally accepted in the last fifteen years.

The dictionary is not intended to supplant the admirable chemical treatises already in existence, some of which extend to a bulk that is too great to be conveniently used, except by those who have a very spacious library. It is intended to supplement these by providing in one volume of moderate size a mass of miscellaneous information on chemical matters in general. The requirement that this should remain approximately the same size as previous editions has necessitated that room has had to be made for all the additional matter included. This has been done to a slight extent by deleting articles about substances which no longer have their previous interest or importance, and more by cutting down the length of articles in the second edition. What to include and what to exclude is naturally a matter of opinion. A dictionary thus limited in size cannot possibly include all the substances, processes, and biographies that the reader will expect or hope to find.

It has not been easy to follow a consistent policy concerning the inclusion of trade names. In general it has been accepted that it is not proper to include the trade name of one manufacturer and not that of another, and that in a book of restricted size trade names should be avoided. But some substances are much better known by trade names than by other names, and are more liable to be looked up under trade names. These, therefore, have been included, though wherever possible—and it is strangely enough not always easy to find out—it has been stated that they are trade names.

The new and revised articles on the three branches of pure chemistry have been written by men on the staff of Imperial College of Science and Technology, University of London. Some of the articles on the more specialized and “applied” branches of chemistry have been revised by men on the staff of various colleges which are particularly concerned with these subjects. Thus the articles on chemical engineering, fuel, plastics, and rubber chemistry have been revised by men at the Borough Polytechnic; the articles on metals and alloys at Battersea College of Technology, those on dyestuffs at Huddersfield College of Technology, and those on pharmaceuticals at the School of Pharmacy, University of London. Other contributors are associated with research establishments, either governmental or industrial, which deal specifically with the topics they cover.

To say that I am grateful to all these contributors, whose names are on page ix, is a gross understatement; without

their hard work there would be no new edition. Above all I thank Dr. D. W. A. Sharp, Mr. R. D. W. Kemmitt, and Dr. J. A. Kitchener, who have assisted in the very tedious process of reading and correcting the proofs, and who have made many helpful suggestions leading to greater accuracy and better presentation of the facts. My thanks are due also to many others, too numerous to mention individually, who have helped with advice and criticism, and in many other ways. Some people have written calling attention to errors in the previous edition and suggesting amendments. I hope that if this should be necessary—and perfection, however hard one strives, always eludes one—others will do so again.

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ABBREVIATIONS

The abbreviations and symbols used in this dictionary are largely those recommended by the Symbols Committee of the Royal Society and published in 1951 under the title "Symbols, Signs and Abbreviations recommended for British Scientific Publications." The report can be obtained from the Royal Society or the Chemical Society, both of Burlington House, London, W.1, for 9d. a copy. The report recommends the specific letters to represent the various quantities or properties, and the typographic conventions for the different kinds of symbol.

Abbreviations and symbols used in this book include:

λ	Ångstrom unit (see article)
At.no.	Atomic number
At.wt.	Atomic weight
b.p.	Boiling point
B.Th.U.	British thermal unit
°C	Degree Centigrade
c	Velocity of light
d	Relative density
D-, DL-	See article "Optical activity"
E	Energy
°F	Degree Fahrenheit
G	Gibbs function (see article "Gibbs free energy")
g	gramme
h	Planck's constant (see article)
l	See article "Optical activity"
M (in formulae)	Any metal
ml	Millilitre
mol.wt.	Molecular weight
m.p.	Melting point
N	Avogadro's number (see article)
N	Normal solution (see article)
n (with subscript)	Refractive index
P	Pressure
pH	See article "Hydrogen ion concentration"
R	Gas constant
rH	See article rH
S	Entropy
sp.gr.	Specific gravity
T	Absolute temperature
X (in formulae)	Any non-metal (usually a halogen)
$[\alpha]$	Specific rotation. See Rotatory power, specific
γ	Surface tension
μ	Micron
ν	Frequency
(+)- and (-)-	See article "Optical activity".

Throughout the dictionary all temperatures are expressed in degrees Centigrade unless otherwise stated. Abbreviations for journals are those of Chemical Abstracts.

A NEW DICTIONARY OF CHEMISTRY

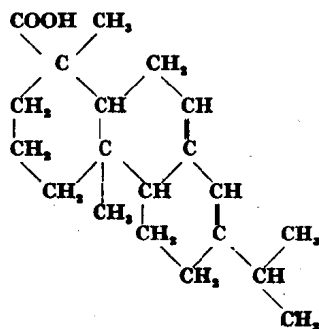
A

Abegg, Richard (1869-1910). Born at Danzig, Abegg was educated at the Universities of Tübingen, Kiel, Berlin, Leipzig, and Stockholm. In 1894 he became assistant to Nernst at Göttingen, and later professor of physical chemistry. In 1901 Abegg was appointed extraordinary professor at Breslau, and in 1909 professor of chemistry at Breslau Technical High School. Apart from his researches upon organic and physical problems, his name will live on account of his "Handbuch der anorganische Chemie."

Abel, Sir Frederick Augustus (1827-1902). Born in London, Abel was educated at the Royal Polytechnic and the Royal College of Chemistry. In 1851 he became demonstrator in chemistry at St. Bartholomew's Hospital, and in 1852 succeeded Michael Faraday as professor of chemistry at the Royal Military Academy, Woolwich. In 1854 he was appointed chemist to the War Department, and he retained this position until 1888. His work on explosives included in particular researches on the effect of grain-size of gunpowder on combustion. He was President of the Society of Chemical Industry in 1882-1883, and of the Chemical Society in 1875-1877, in which year he also received a Royal Medal of the Royal Society.

Abel, John Jacob (1857-1938). Abel was born at Cleveland, Ohio, and after graduating from the University of Michigan studied at Leipzig, Strassburg, Heidelberg, Vienna, and Berne. He became professor of materia medica and therapeutics in the University of Michigan in 1891, and in 1893 went to the Johns Hopkins University as professor of pharmacology. From 1932 onwards he was Professor Emeritus and Director of the Laboratory of Endocrine Research. Researches over a wide range gained him the Willard Gibbs (1927) and Conné Medals (1932).

Abietic acid, $C_{20}H_{30}O_2$.



I

A crystalline, tricyclic, terpene derivative, obtained from rosin, of which it is the chief constituent. It gives retene on dehydrogenation. It is used as a modifying agent in the manufacture of phthalic alkyd resins, and its soaps are used as detergents.

Abrin. A toxic substance, causing agglutination of the red blood corpuscles, found in the seeds of the *Abrus precatorius*, an Indian shrub. It is a mixture of two proteins.

Absolute temperature. A temperature on the "absolute" (or Kelvin) scale; the zero of this scale is the temperature at which a perfect gas would occupy zero volume if it could be cooled indefinitely without liquefaction or solidification. The absolute zero being -273.1° , and one degree on the absolute scale being equivalent to one Centigrade degree, an absolute temperature = the corresponding Centigrade temperature $+ 273.1^\circ$.

Absorptiometer. Two types of apparatus are called by this name. One is an instrument for determining the absorption of light by a liquid, the other for determining the solubility of a gas in a liquid.

Absorption. When a soluble component of a gas or vapour which is in contact with a liquid becomes dispersed in the liquid, the process is known as absorption. Selective absorption is employed to separate components of mixtures of gases or vapours, e.g. the removal of ammonia from coal gas by absorption in water or the removal of benzene from coal gas by washing in absorbent oils. The process may be carried out by bubbling the gas through the liquid, by spraying the liquid through the gas (as in centrifugal washers), or by passing the gas over surfaces wetted with the liquid (as in scrubbing towers). Counter-current treatment is generally employed to reduce the quantity of absorbent required, as in the tower scrubber, which may be empty or filled with packing designed to offer the maximum surface and the minimum resistance to the gas, the principle being that the gas at exit is in contact with the least concentrated solution, while the liquid at exit is in contact with the most concentrated gas. See Adsorption.

Absorption bands. See Absorption of light.

Absorption coefficient of a gas. The volume of gas measured at 0° and 760 mm pressure which will dissolve in 1 ml of a liquid. The absorption coefficients in water at 0° for several common gases are as follows: nitrogen, 0.024; oxygen, 0.040; ethylene,

0.25; carbon dioxide, 1.718; hydrogen sulphide, 4.66; sulphur dioxide, 79.8; hydrogen chloride, 506; ammonia, 1300.

Absorption coefficient of light. See Lambert's law and Beer's law.

Absorption of light. When light is incident on the surface of a transparent substance, part of the light is reflected, and the rest is transmitted unchanged. If, however, the light falls on a surface of lamp-black, it is neither reflected nor transmitted, but absorbed. Since this surface absorbs light of all wave-lengths, the process is called general absorption. A layer of chlorine, on the other hand, appears green in daylight, because it has absorbed all the radiations corresponding with the remainder of the spectrum. This kind of absorption is termed *selective*. If the spectrum of the transmitted light is examined, i.e. the absorption spectrum, certain regions will be found absent, and appear black. These regions correspond with the light absorbed by the chlorine, and are termed *absorption bands*. If the absorbing medium is a gas in the atomic state, the spectrum of the transmitted light shows dark lines, instead of bands. These *absorption lines* correspond with the light absorbed by the atoms.

The absorption of light is the converse of the emission of light. Whereas a molecule emits a band spectrum (*q.v.*), an atom emits a line spectrum (*q.v.*). Emission of light corresponds with the return of the atom or molecule from a state of higher to one of lower energy, while the absorption of light corresponds with the raising of the atom or molecule from a state of lower to one of higher energy. The energy thus absorbed may be utilized in inducing chemical reactions.

The relationships between the intensity of the incident light, the thickness, concentration, and the intensity of the transmitted light are embodied in Beer's law (*q.v.*) and Lambert's law (*q.v.*).

Absorption tower. The most widely used plant for the absorption of a gas in a liquid takes the form of a tower down which the liquid can be sprayed, the gas being passed counter-currently up the tower. The most important factor in designing such equipment is to make the ratio of surface area to volume and free space to volume as high as possible, and so to ensure complete absorption of the gas with minimum pressure drop in passing through the plant. To achieve this result, a packing material is used, this may be broken rock or coke, or a specially prepared ceramic packing such as Raschig rings.

These towers are also termed scrubbers,

especially when the object of the absorption is to remove impurities. See also Paulson acid tower.

Abyssinian gold. A yellow alloy of 90.7 % copper and 8.8 % zinc plated with gold on one side and rolled into sheets.

Acacia. See Gum Acacia.

Accelerators. Substances so-called because they accelerate and assist the vulcanization of rubber, in some cases conferring on it increased resistance to wear. Such substances comprise various inorganic pigments (e.g. litharge, antimony pentasulphide), organic compounds such as hexamethylene-tetramine, various dithiocarbamates and xanthates.

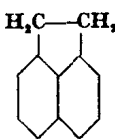
The word is also used for substances which act as catalysts in increasing the hardening rate of synthetic resins.

Acceptor. A substance which, while normally not oxidized by oxygen or reduced by hydrogen, can be thus oxidized or reduced in presence of a substance which is itself undergoing oxidation or reduction.

In connexion with molecular structure, an atom that has a deficit of one or more pairs of electrons, which can be supplied by a second atom with formation of a co-ordinate link (*q.v.*), is also called an "acceptor."

Accum, Friedrich Christian, born in 1769, near Hanover, came to London in 1798 and taught chemistry; he became a popular consulting chemist and a director of the Gas Light and Coke Co. He wrote a "Practical Treatise on Gas Light," the "Elements of Crystallography," and a "Treatise on the Adulterations in Food." He returned to Germany and died in 1888. See article by C. A. Browne in *J. Chem. Education*, 1925.

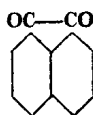
Acenaphthene, $C_{12}H_{10}$. Colourless needles, m.p. 95°, b.p. 278°. Soluble in hot alcohol. When passed $H_2C=CH_2$ through a red-hot tube acenaphthylene is obtained. Oxidation with acid dichromate gives naphthalic acid. Characteristic picrate, m.p. 161°.



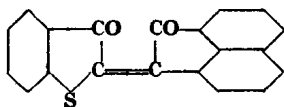
It occurs in the anthracene fraction of coal tar, from which it is readily separated. Can be obtained synthetically by the action of alcoholic potash on α -bromoethylnaphthalene.

It is of increasing importance as a dye-stuff intermediate, being much used as a source of nitro- and amino-derivatives.

Acenaphthenequinone. Yellow needles, m.p. 261°, very sparingly soluble in water; 100 g of glacial acetic acid at 15° dissolve 0.15 g. It is condensed with thioindoxyl and its derivatives to



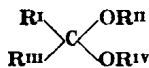
bright scarlet and red vat dyes of the type



These are known as Ciba Scarlet G, Ciba Red R, etc.

Acenaphthylene, $C_{12}H_8$. Crystallizes in yellow plates from alcohol, m.p. $92^\circ-98^\circ$, b.p. $265^\circ-275^\circ$, with decomposition. Soluble in alcohol and ether, insoluble in water, d_4^{20} 0.899. It is derived from acenaphthene by catalytic dehydrogenation and polymerizes to give plastic products.

Acetal, $CH_3 \cdot CH(OC_2H_5)_2$. A pleasant-smelling liquid, b.p. $104^\circ-105^\circ$, soluble to some extent in water and miscible in all proportions with alcohol and ether. It may be prepared by mixing aldehyde and ethyl alcohol in the presence of a catalyst, such as HCl, or by passing acetylene into alcohol in the presence of a catalyst. It is used in the preparation of derivatives, some of which are useful solvents. There are many other acetals of the general type shown.



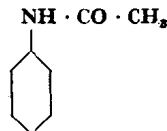
Acetaldehyde, Ethanal, $CH_3 \cdot CHO$, is a colourless liquid with a characteristic odour, d 0.8009, b.p. 20.8° . Miscible with water, alcohol, and ether; insoluble in concentrated calcium chloride solutions. Manufactured by passing alcohol vapours and air over a heated catalyst, usually copper or silver, or by the reaction of acetylene with water in presence of mercuric salts. Prepared on the small scale by the oxidation of alcohol with potassium dichromate and sulphuric acid; or by warming paraldehyde with 20 % sulphuric acid. Compounds are formed with many metallic salts; the crystalline sodium or potassium bisulphite compounds may be used to isolate and purify acetaldehyde. It is oxidized to acetic acid and reduced to alcohol. Polymerization readily occurs to give paraldehyde or metaldehyde: when heated with alkalis, a brown resin is formed. Aldol is formed by the interaction of two molecules of acetaldehyde. Acetic acid, acetic ester, butyl alcohol, and certain synthetic resins are manufactured from it.

Acetaldoxime, $CH_3CH:NOH$. A colourless crystalline solid, m.p. 47° , b.p. 115° . Soluble in water, alcohol, and ether.

Prepared by adding hydroxylamine to an aqueous solution of acetaldehyde. When heated with dilute acids it decomposes into acetaldehyde and hydroxylamine. Acetic anhydride converts it to acetoneitrile; used to identify or purify acetaldehyde.

Acetamide, $CH_3CO \cdot NH_2$. Crystallizes in long white needles which absorb water and finally liquefy. The crude substance has a strong odour of mice; m.p. 82° , b.p. 222° . Readily soluble in water and alcohol; sparingly soluble in ether. It may be prepared by the dry distillation of ammonium acetate or by the action of ammonia on ethyl acetate. Crystalline compounds are formed with NaBr, NaI, $MgBr_2$, $CaCl_2$, etc. Somewhat unstable salt-like compounds are formed with Na, K, Mg, Zn, and Hg, and also with mineral acids.

Acetanilide, C_6H_5ON . White crystals, m.p. 114° , b.p. 304° . Very sparingly soluble in cold, more so in hot water, readily soluble in alcohol, ether, and chloroform.



It is prepared by refluxing excess acetic acid with aniline, finally fractionating away the water formed during the reaction.

It has been used medicinally, under the name of antifebrin, as an antipyretic and analgesic, but its chief use is in the direct nitration to *p*-nitroacetanilide. It is hydrolysed by dilute acids and alkalis at 100° to aniline. It chlorinates more slowly than aniline to *o*- and *p*-chloro-acetanilides.

Acetarsol, 3-acetyl-amino-4-hydroxy-phenylarsonic acid.



White crystals, m.p. 240° . Almost insoluble in cold water, more soluble hot. Soluble in alkalis. Insoluble in alcohol. Prepared from 3-nitro-4-hydroxyphenylarsonic acid. It is used in the treatment of dysentery, vaginitis, and congenital syphilis in infants.

Acetates. Salts or esters of acetic acid.

Acetic acid, Glacial acetic acid, CH_3COOH , is a colourless liquid with a pungent, irritating odour, m.p. 16.7° , b.p. 118.5° , d_{20}^{20} 1.0492. Miscible with water, alcohol, and ether. Manufactured very largely from acetylene by converting this to acetaldehyde which is oxidized by air under pressure at 60° in presence of manganese acetate or other catalyst. It is also made by heating sawdust with sodium hydroxide under pressure or by the dry distillation of sawdust. Dilute alcoholic liquors produced by fermentation are treated with acetic acid bacteria which oxidize the alcohol to

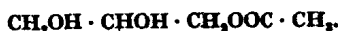
acetic acid. Vinegar is produced in this way. The dilute acids produced from wood or by fermentation are concentrated by distillation with benzene, dichlorethylene, or butyl acetate. It attacks most metals but has no action on tin, while aluminium is not attacked by acetic acid unless more than 10 % water is present. Acidic, basic, and normal salts are formed with metals. Oxidizing agents such as nitric and chromic acids have no action on it. Used in the preparation of various metallic acetates and esters; as an inert solvent for many organic compounds, and in large amounts in the manufacture of cellulose acetate.

Acetic anhydride, $C_4H_6O_3$, is a colourless liquid with a pungent odour, d^{20}_4 1.082, b.p. 139.5°. Soluble in cold water to the extent of 12 per cent.; decomposed to acetic acid by boiling water; miscible with ether and benzene. Manufactured by heating sulphur chloride with sodium acetate, or by passing acetylene into acetic acid in presence of mercuric salts and heating the ethylidene diacetate so formed. Other methods involve the removal of water from acetic acid by passing the vapours of the acid over a heated catalyst, or, more simply, by heating them to 600°-1000°. It reacts with compounds containing $-OH$ or $-NH_2$ groups to give acetyl compounds. Used in the manufacture of such products as cellulose acetate and aspirin.

Acetic ester, Acetic ether, Ethyl acetate, $C_4H_8O_2$, $CH_3COOC_2H_5$, is a colourless liquid with a pleasant fruity odour, d 0.9245, b.p. 77°. Slightly soluble in water; miscible with most organic liquids. Manufactured from acetaldehyde by the catalytic action of aluminium ethoxide or butoxide, or from alcohol and acetic acid in presence of sulphuric acid. It is a useful solvent; acetoacetic ester is manufactured from it.

Acetin, Triacetin. See Acetins.

Acetins are acetates of glycerol. There are five possible acetates, two mono-, two di-, and one tri-acetate. Only four of these have been prepared in the pure state; the commercial acetins are mixtures of the various acetates and form colourless or slightly brown syrupy liquids. Monoacetin, d^{20}_4 1.221, b.p. 180°-182°/2-3 mm, contains chiefly the α -acetate



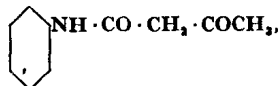
It is very soluble in water, and is not thrown out of concentrated solutions by sodium chloride; soluble in chloroform, but not very soluble in ether. Prepared by heating

molecular proportions of glycerol and acetic acid with sulphuric acid, or by heating triacetin with glycerol. Used as a solvent for the dyes employed in printing paper bags. Diacetin, d^{20}_4 1.18, b.p. 250° is chiefly the 1:3-diacetate



Soluble in water and alcohol, but not in ether or benzene if water is present. Obtained as a by-product in the manufacture of triacetin. Used as plasticizer for cellulose acetate lacquers and as a solvent for basic dyes. Triacetin, d^{20}_4 1.16-1.17, b.p. 260°, is about 90 % glycerol triacetate and 10 % diacetate. Slightly soluble in water; soluble in ether. Prepared by heating glycerol with large excess of acetic acid and extracting the triacetin from aqueous solution with ether. Used as a plasticizer for lacquers and as a solvent for certain gums and resins.

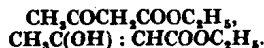
Acetoacetanilide,



m.p. 85°. Prepared by the action of acetoacetic ester on aniline. Used for the preparation of pigment dyestuffs by coupling with diazotized bases.

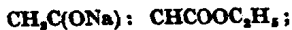
Acetoacetic acid, Acetonecarboxylic acid, $C_4H_6O_3$, $CH_3CO \cdot CH_2COOH$. A colourless and strongly acid syrup. It is unstable, and decomposes into acetone and carbon dioxide below 100°. Prepared from acetoacetic ester. It occurs in traces in normal urine, but is characteristically present in increased amount in the urine of diabetic patients. Aqueous solutions of the acid give a distinctive violet colour with ferric chloride.

Acetoacetic ester, Ethyl acetoacetate,



A colourless, mobile liquid with a pleasant odour, d^{20}_4 1.0256, b.p. 181°-182°, 80°/20 mm. Slightly soluble in water; miscible with alcohol, ether, benzene. Prepared by the action of sodium or sodium ethoxide on acetic ester, or of ethanol on diketene. The reaction is complex and its precise course has been the subject of much discussion. It is the classical example of *keto-enol tautomerism*, and normal preparations of the ester contain 92.6 % keto form and 7.4 % enol form. The proportion of the two forms is altered by change of temperature or by solution in solvents. Separation of the keto and enol forms has been effected by distillation from quartz or

pyrex apparatus: the pure components revert to the original equilibrium mixture on standing. Metallic derivatives are formed with sodium and other metals; these are of the type



they react with alkyl halides to give alkyl acetoacetic esters $\text{CH}_3\text{CO} \cdot \text{CHR} \cdot \text{COOC}_2\text{H}_5$. These also form sodium derivatives, reacting with alkyl halides in a similar manner to give di-alkyl esters. Acetoacetic ester and the alkyl derivatives react with strong alkalis to give acetic and alkyl acetic acids respectively. Dilute alkalis or acids react to give ketones. With many nitrogen compounds it reacts to form nitrogen-containing rings: thus urea gives methyl uracil; hydrazines give methyl pyrazolones; aniline gives methyl quinoline. Prolonged boiling causes decomposition with loss of alcohol and formation of dehydracetic acid. It is a valuable means of synthesizing a wide variety of compounds and is used in the manufacture of phenazone. Detected by the violet colour given with ferric chloride.

Acetoin, Acetyl methyl carbinol, $\text{C}_4\text{H}_8\text{O}_3$, $\text{CH}_3\text{CH}(\text{OH})\text{COCH}_3$, is a colourless liquid, m.p. 15° , b.p. 148° . Miscible with water and alcohol; insoluble in ether. Produced from propylene and butylene glycols by the action of the acetic acid bacteria; and from acetaldehyde by yeast. Prepared by the reduction of diacetyl. Forms a crystalline compound with sodium bisulphite. Reduces Fehling's solution. When distilled, it forms diacetyl.

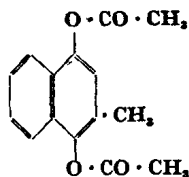
Acetol, Hydroxyacetone, Pyroracemic alcohol, Pyruvic alcohol,



is a colourless liquid with a pleasant odour, d_4^{20} 1.082, b.p. 145° - 146° , $54^\circ/18$ mm. Miscible with water, alcohol, and ether. Prepared by the action of chloroacetone on potassium acetate; also formed by the action of certain *acetobacter* on α -propylene glycol. Tends to polymerize; methyl alcohol has a stabilizing effect. It has an acid reaction and reduces potassium permanganate and ammoniacal silver nitrate in the cold. Detected by the formation of the fluorescent hydroxy methyl quinoline when treated with *o*-aminobenzaldehyde.

Acetolysis is the name given to the process of removing acetyl groups from an organic compound. It is usually carried out by heating the acetyl compound with aqueous or alcoholic alkalis, whereby the acetyl groups are removed as acetic acid.

Acetomenaphthone, 1:4-diacetoxy-2-methylnaphthalene, $\text{C}_{15}\text{H}_{14}\text{O}_4$.



A white powder, m.p. 112° - 115° , almost insoluble in water, soluble in hot alcohol. Prepared by reducing menaphthone with zinc and acetic acid in the presence of acetic anhydride. It has the same action as menaphthone (*q.v.*), but can be taken by mouth.

Acetone, Dimethyl ketone,



is a colourless, volatile liquid with a pleasant, ethereal odour: it is highly inflammable, d_4^{20} 0.8186, b.p. 56.2° . Miscible with water, alcohol, and ether; sparingly soluble in solutions of calcium chloride. Prepared by the dry distillation of barium acetate. It is manufactured by the dehydrogenation of isopropanol and as a by-product in other processes based on petrochemicals. Production from starch by the acetone-butanol fermentation using *Clostridium acetobutylicum* is now of less importance. It occurs in significant amounts in blood and urine in certain pathological conditions. Crystalline compounds are formed with sodium and potassium bisulphites; compounds are also formed with mercuric sulphate and oxide. Ammonia reacts with boiling acetone to give diacetoneamine. Sodium hydroxide causes condensation to diacetone alcohol; under more vigorous conditions mesityl oxide and phorone are produced. These are also formed, together with mesitylene, by the action of small amounts of mineral acids. Reduction of acetone gives isopropyl alcohol and pinacol. Crystalline derivatives are formed with hydroxylamine, phenyl hydrazine, and semicarbazide. It is detected by the formation of iodoform when treated with iodine and sodium hydroxide. Sodium nitroprusside and ammonia give a red colour with acetone, which changes to violet on addition of acetic acid. Acetone is used as a solvent, and as an intermediate in the manufacture of plastics, other solvents, and many other chemicals.

Acetone alcohol. See Acetol.

Acetone bodies. The acetone bodies, acetone, $\text{CH}_3 \cdot \text{CO} \cdot \text{CH}_3$, acetoacetic acid, $\text{CH}_3 \cdot \text{CO} \cdot \text{CH}_2 \cdot \text{COOH}$, and β -hydroxy-butyric acid, $\text{CH}_3 \cdot \text{CHOH} \cdot \text{CH}_2 \cdot \text{COOH}$, are excreted in the urine in severe cases of diabetes. They are formed by the incomplete breakdown of fatty acids and of

amino-acids with an even number of carbon atoms (ketogenic amino-acids) in all cases of carbohydrate shortage. The presence of the acetone bodies is the most serious aspect of diabetes, as they are strong acids and seriously upset the neutrality regulation of the body. Their neutral sodium salts are also toxic. This condition, known as ketosis, if untreated, leads to coma and eventually death.

Acetone-chloroform,



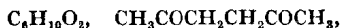
is a white, crystalline substance with a camphor-like odour, m.p. 97°, b.p. 167°. Slightly soluble in cold water; soluble in hot water, alcohol, or acetone. Manufactured by the action of potassium hydroxide on a cold mixture of acetone and chloroform. It is volatile in steam.

Acetone dicarboxylic acid, β -Ketoglutaric acid, $C_5H_8O_6$; $CO \cdot (CH_2COOH)_2$, crystallizes in colourless needles, m.p. 135° (decomp.). Soluble in water and alcohol; insoluble in benzene and chloroform. Prepared by the action of sulphuric acid on citric acid. Readily decomposed by boiling water, acids, or alkalis to acetone and carbon dioxide. Gives a violet colour with ferric chloride and a white precipitate with mercuric sulphate. The acid or its ethyl ester reacts with sodium in a manner similar to acetoacetic ester. The ester is used in organic syntheses.

Acetone monocarboxylic acid. See Acetoacetic acid.

Acetonyl. The name given to the radical CH_3COCH_2- .

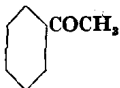
Acetonylacetone, 2 : 5 Hexadione,



is a colourless liquid which becomes yellow on standing, d^{20}_D 0.970; b.p. 191°. Miscible with water, alcohol, and ether. It is obtained as a by-product in the manufacture of acetic acid from acetylene; also obtained by boiling 2 : 5-dimethylfuran with dilute sulphuric acid. It readily condenses with a variety of substances to give derivatives of furan, thiophene, and pyrrole, and is a solvent for cellulose acetate.

Acetophenone, C_8H_8O . Colourless plates, m.p. 19.7°, b.p. 202°, sp.gr. 1.024 at 25°. Odour resembling bitter almonds. Insoluble in water, miscible in all proportions with alcohol, ether, and benzene.

It occurs in coal tar. Prepared by the action of acetyl chloride upon benzene in the presence of aluminium chloride.



It has typical ketonic properties, forming a characteristic oxime, m.p. 60°, and phenylhydrazone, m.p. 105°. It is oxidized by potassium permanganate to phenylglyoxalic acid.

It is used as a solvent for cellulose ethers.

Acetoxime $(CH_3)_2C : NOH$, crystallizes in colourless prisms; it is volatile and has an odour like that of chloral, m.p. 59°, b.p. 134°-135° at 730 mm. Soluble in water, alcohol, and ether. Prepared by adding hydroxylamine to an aqueous solution of acetone and allowing the mixture to stand for 24 hours. It is decomposed by warming with dilute acids into acetone and hydroxylamine, and is used as a means of isolating and identifying acetone.

Acetory. The name given to the radical CH_3COO- .

Acetylacetone. $C_5H_8O_3$,

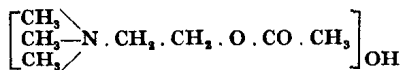


A diketone with enolic properties. It forms stable complexes with many metals, e.g. ferric acetylacetonate, $FeAc_3$; these complexes are soluble in organic solvents and are often appreciably volatile.

Acetylation is the name given to any process for introducing acetyl groups into an organic compound containing $-OH$, $-NH_2$, or $-SH$ groups. It is carried out by heating the compound with acetic anhydride, or acetyl chloride, usually in presence of an inert solvent such as benzene or acetic acid. In many cases, zinc chloride or pyridine is used to hasten the reaction.

Acetyl chloride, $CH_3CO \cdot Cl$. A colourless liquid with a pungent odour; it fumes in moist air, producing acetic and hydrochloric acids. d^{20}_D 1.130, b.p. 55°. Soluble in ether and benzene, but reacting with water and other $-OH$ compounds. Prepared by the distillation of a mixture of acetic acid and phosphorus trichloride or oxychloride. It is used to prepare acetyl derivatives of hydroxy- and amino-compounds.

Acetylcholine. $C_7H_{11}O_2N$.



Available as the chloride, a white hygroscopic crystalline powder, soluble in water and alcohol, insoluble in ether. Easily hydrolysed by hot water or alkali to choline and acetic acid. Acetylcholine occurs in the animal body, in ergot, and in various plants. It is liberated in small quantities in the body on stimulating the parasympathetic nerves,

and causes dilatation of the arteries and a rapid fall in blood pressure at a dilution of one part in ten millions. It is destroyed in the body by the action of cholinesterase.

Acetylene, C_2H_2 . A colourless gas, which when pure has a pleasant smell; it can be liquefied below 37° and solidified in liquid nitrogen. It is soluble in several organic solvents and in water; acetone absorbs about 25 times its volume at 15° and 760 mm; at lower temperatures it absorbs very much more, and this property is used in the industrial storage of acetylene. Both the gas and the liquid are very explosive. Acetylene was discovered by E. Davy in 1836 and studied by Berthelot in 1862. It is prepared by acting on calcium carbide with water, by heating methane in the presence of a catalyst, by heating ethylene to 1100° , and in other ways. It is used on a large scale in conjunction with oxygen for the production of a very hot flame for welding and for cutting steel by means of a blow-pipe, and for lighting; in the cutting of steel the metal is made red-hot by an oxygen-acetylene flame, and a jet of oxygen is directed on to the hot metal. The oxidation of the metal produces enough heat to fuse it, and by drawing the blow-pipe along a cut can be made. The oxy-acetylene blow-pipe is also used in metal spraying; a wire of metal is fused by the blow-pipe and distributed on the surface to be sprayed by a stream of compressed air. Fine layers about 0.002 in. thick, of very many metals are so deposited on iron, steel, wood, glass, paper, etc.

Acetylene is used for the production of acetic acid, alcohol, and acetone. It forms many compounds with metals and metallic salts, some of which are explosive. It easily polymerizes at a high temperature, forming benzene and other hydrocarbons. It can be polymerized to form vinylacetylene, $CH_2:CH \cdot C:CH$, which yields butadiene, $CH_2:CH \cdot CH:CH_2$, chloroprene, $CH_2:CCl \cdot CH:CH_2$, or isoprene, which themselves polymerize to form rubber-like substances.

Acetylene dichloride. See Dichloroethylenes.

Acetylene tetrachloride, *sym*-Tetrachloroethane, $HCCL_2CHCl_2$, is a colourless liquid with a chloroform-like odour, d^{20}_4 1.600, b.p. 146° . Insoluble in water; miscible with benzene; it is volatile in steam. Manufactured by passing chlorine and acetylene separately into a solution of antimony pentachloride in acetylene tetrachloride; ferric chloride and aluminium chloride are also used. It is an excellent solvent for fats, oils, resins, cellulose acetate, and

sulphur and phosphorus. It is non-inflammable, but its vapour is toxic, causing jaundice and a fatty degeneration of the organs. In presence of moisture, metals are slowly attacked by it and dichloroethylene is formed. Reacts with dilute alkalis to give trichloroethylene; more concentrated alkalis form the spontaneously explosive mono- and di-chloroacetylenes. Used chiefly in the manufacture of trichloroethylene.

Acetylides. Carbides (*q.v.*) which have the carbon atoms in pairs forming the $(C \equiv C)^{2-}$ anion. Formed by the elements in Groups I, II, III, and transition elements. On hydrolysis these compounds yield acetylene. Most of the heavy metal acetylides are explosive.

Acetyl methyl carbinol. See Acetoin.

Acetyl radical. The group $CH_3 \cdot CO$,

which occurs in the free state during the photolysis of acetone. It is dissociated above 60° into CO and CH_3 .

Acetyl value. The acetyl value of a fat is the number of milligrammes of potassium hydroxide required to neutralize the acetic acid liberated when one gramme of acetylated fat is saponified. It is a measure of the number of free hydroxyl groups in the fat.

Acheson, Edward Goodrich (1856-1931). Born at Washington, U.S.A., Acheson was compelled at an early age to seek employment. Mechanically minded and interested in electricity, he was engaged by Thomas Edison, and worked for him in Italy, Belgium, and Holland. Returning to the United States he was the pioneer in the development of the electric furnace for such products as carborundum and graphite. The lubricants oildag and aquadag are also the results of his researches. He was awarded the Perkin Medal of the Society of Chemical Industry in 1910.

Achroodextrins. See Dextrins.

Acid. An acid on the aqueous system is defined as a substance which is capable of forming hydrogen ions when dissolved in water. Most inorganic acids may be regarded as a compound of an acidic oxide and water; where the oxide concerned is that of a metal, that oxide may exhibit amphoteric character, that is act sometimes as an acid and sometimes as a base. Aqueous solutions of acids have a sharp taste, turn litmus red, and liberate carbon dioxide from a metallic carbonate.

Since free protons cannot exist, acidic properties can only be shown when the solvent can act as a proton acceptor, i.e. as a base. Thus aqueous solutions of acids contain the hydroxonium ion, H_3O^+ , and, since ammonia can also solvate a proton to

give the ammonium ion, NH_4^+ , substances which dissolve in ammonia to give the ammonium ion, e.g. NH_4Cl , are acids in that system.

Liquid water is ionized,



this ionization being the reverse of the neutralization reaction in water; substances giving hydroxyl ions are bases in water. Liquid ammonia is also ionized,



and amides are bases on this system. This concept has been extended to solvents which are ionized and yet do not contain hydrogen: a substance giving the appropriate positive ion is an acid on that system. Thus bromine trifluoride ionizes,



and a substance giving the BrF_2^+ ion in solution, e.g. $\text{BrF}_3 \cdot \text{SbF}_6^-$, is an acid in the system.

Typical organic acids contain the $-\text{COOH}$ group, but many other acid groupings, e.g. the sulphonic $-\text{SO}_3\text{H}$, give acidic properties to organic compounds. Phenols have acidic properties and are classified with enols as pseudo-acids.

The term acid has been further extended by Lewis to include substances which are electron deficient. Thus AlCl_3 (being electron deficient) can accept electrons from a chloride ion and is a Lewis acid.

The "strength" of an acid is measured by the value of its dissociation constant, "strong" acids, e.g. HCl , HNO_3 , being substantially fully ionized in solution and "weak" acids predominately unionized.

Acid dyes are the sodium salts of the sulphonic acids, as well as of such dyes as contain phenol groups associated with nitro groups. They are substantive to wool, upon which they fix themselves from a bath acidified with dilute sulphuric or acetic acid. They do not form lakes with tannin. They have little affinity for cotton.

Some acid dyes are applied most successfully from a neutral or very slightly acid dye bath, i.e. at pH 6-7. This group is characterized by much higher wet fastness than the typical "level-dyeing acid dye" (which requires sulphuric acid in the dye bath), and is used in the dyeing of silk and some synthetic fibres.

Acid egg. Device, made of acid-resistant material, into which acid is run, to be distributed by means of compressed air through pipework, a valve being provided to close the inlet when pressure is applied.

Acid exchange resins. See Ion exchange.

Acid (steel or process). Used with reference to the nature of the slag in steel production.

Acid tar. A tarry residue produced in the wet refining of petroleum fractions with sulphuric acid.

Acid value. A measure of the free acid content of a substance. It is the number of milligrams of potassium hydroxide required to neutralize one gram of the substance, using phenolphthalein as an indicator. The term is used for fats, oils, resins, plasticizers, and solvents.

Aconite, monkshood, or wolfbane, is the dried root of *Aconitum napellus*. It contains the intensely poisonous alkaloid aconitine to which it owes its medicinal properties.

Aconitic acid, $\text{C}_6\text{H}_4\text{O}_6$. The most easily obtained form is the *trans* acid, this crystallizes in colourless leaflets, m.p. 194° , with decomposition. Soluble in water, sparingly soluble in ether. It can be

prepared by dehydrating citric acid with 50 % sulphuric acid. It is present in cane molasses.

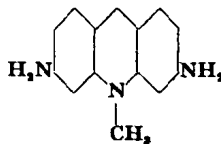
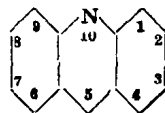
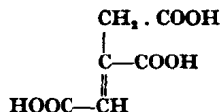
The *cis* form has m.p. 125° and is converted into the *trans* form on heating.

Aconitine, $\text{C}_{30}\text{H}_{48}\text{O}_{10}(\text{OCH}_3)_4(\text{OH})_2\text{N}$. Structural formula unknown. Colourless hexagonal crystals, m.p. 197° . Very slightly soluble in water, soluble in 40 parts of alcohol; $[\alpha]_D + 14.6^\circ$. It is an intensely poisonous alkaloid obtained from *Aconitum napellus*.

Acridine, $\text{C}_{13}\text{H}_9\text{N}$. Crystallizes in colourless needles, m.p. 111° . It is soluble in alcohol and sparingly soluble in hot water. It occurs in the high-boiling fraction of coal tar.

Acridiflavine is a mixture of 2 : 8-diamino-10-methylacridinium chloride hydrochloride (formula shown), and 2 : 8-diaminoacridine dihydrochloride. It may be prepared by partially quarternizing diacetyldiaminoacridine and hydrolysing the product with hydrochloric acid. It is a red crystalline powder, soluble in water and alcohol, but insoluble in chloroform. It is used for the same purposes as proflavine (q.v.).

Acrilan. A brand name for a synthetic fibre, based on a copolymer of acrylonitrile with minor proportions of other unspecified vinyl monomers. See also Orlon.



Acrolein, Acraldehyde, Acrylic aldehyde, C_3H_4O , $CH_2 : CH \cdot CHO$. A colourless, volatile liquid, with characteristic odour. The vapour is poisonous, and intensely irritating to eyes and nose; d^{20}_4 0.8427, b.p. 53° . Soluble in water and alcohol. It is prepared by the distillation of a mixture of glycerin, potassium sulphate, and potassium bisulphate. It is manufactured by direct oxidation of propylene or cross-condensation of acetaldehyde with formaldehyde.

When exposed to sunlight, it is converted to a white insoluble resin, disacryl. Oxidized by air to acrylic acid; small amounts of hydroquinone will inhibit this. Bromine forms a dibromide which is converted by barium hydroxide into DL-fructose. The acrid odour of burning fats is due to traces of acrolein. It is used in the production of methionine.

Acrylic acid, Vinylformic acid, $C_3H_4O_2$, $CH_2 : CH \cdot COOH$, is a colourless liquid having an odour resembling that of acetic acid, d^{20}_4 1.062, m.p. 18° , b.p. 141° . It is miscible with water. Prepared by oxidizing acrolein with moist silver oxide, or treating β -hydroxy-propionitrile with sulphuric acid. Slowly converted to a resin at ordinary temperatures. Important glass-like resins from ethyl acrylate and methyl acrylate are now manufactured.

Acrylic resins. The two important polymers included within this group are polymethyl acrylate and polymethyl methacrylate.

Polymethyl acrylate, manufactured from the liquid monomer by emulsion polymerization, is a tough rubbery material. It is used, usually as manufactured in emulsion form, for certain textile and leather finishes, lacquers, emulsion paints, pressure sensitive adhesives, and safety-glass interlayers.

Polymethyl methacrylate is formed as a hard clear thermoplastic resin by the polymerization of methyl methacrylate in the presence of peroxide catalysts. Mass polymerization of the monomer in closed plate-glass cells gives rise to sheets of perspex (a brand name), a thermoplastic well known for its high optical clarity and ease of fabrication by hot forming, cementing, and machining. The polymer when produced by emulsion or pearl polymerization is compounded to give materials for injection moulding and extrusion. The extensive use of certain acrylic resins, especially polymethyl methacrylate, in dental and general surgical prosthetics is now well established.

I*

Acrylonitrile. Vinyl cyanide,



is a volatile liquid, b.p. 78° , d^{20}_4 0.8060. It is manufactured by dehydration of ethylene cyanhydrin or by the addition of hydrogen cyanide to acetylene in the presence of cuprous chloride. It is miscible with alcohol and most organic solvents.

Acrylonitrile is very active, both in polymerization and in undergoing ready addition to compounds containing active hydrogen (e.g. the process of cyano-ethylation). Polymers and copolymers of acrylonitrile are industrially important as synthetic fibres (see Orlon), nitrile rubbers, and as components in several thermoplastic compositions.

A.C.T.H. See Corticotrophin.

Actin. See Actomyosin.

Actinides. The elements actinium, thorium, protactinium, uranium, neptunium, plutonium, americium, curium, berkelium, californium, einsteinium, fermium, and mendelevium are collectively known as actinides. Those with atomic numbers 93 and above are artificial and are produced by irradiation of uranium or other artificial elements with neutrons, alpha particles, or carbon or nitrogen ions. In the actinide elements the 5f shell is being filled and they are thus analogous to the rare-earth elements. But there is less shielding of the 5f electrons and valencies greater than three are common, particularly among lighter members of the series. See "The Chemistry of the Actinide Elements", by J. J. Katz and G. T. Seaborg.

Actiniohaematin. A respiratory catalyst of the same type as helioerythrin which occurs in certain *actinia*. It contains haem, but has a different protein constituent from that of haemoglobin.

Actinium, Ac. At.no. 89, At.wt. 227, m.p. 1050° . Actinium has a face-centred cubic structure, $a = 5.311 \text{ \AA}$. It occurs naturally as a minor constituent in uranium ores but in view of the long and tedious methods required for separation it is best obtained by irradiation of radium with neutrons. Actinium is separated from other elements by ion-exchange or solvent extraction. Even the most stable isotope is extremely radioactive, the metal glowing blue in the dark. Actinium metal has been prepared by reduction of actinium fluoride with lithium vapour at 1200° . It is silvery-white in colour and is highly reactive.

Actinium compounds. Because of its intense radioactivity very few actinium compounds have been isolated. In its compounds the element is trivalent, forming