21

COMPTON'S ENCYCLOPEDIA

Q
Rye

COMPTO
ENCYCLOPED

VOLUME

21

Q—Rye
pages 1-366

Compton's Encyclopedia

and Fact-Index

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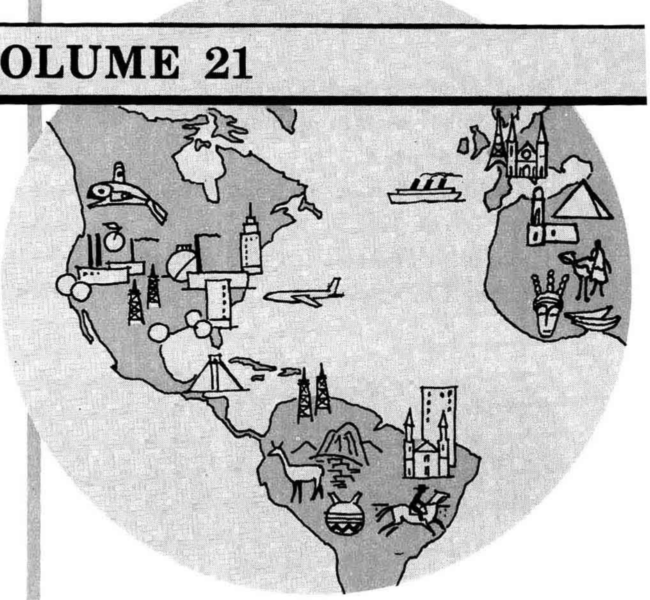
"Let knowledge grow from more to more and thus be human life enriched"

KEY TO PRONUNCIATION

Pronunciations have been indicated in the body of this work
only for words which present special difficulties.
For the pronunciation of other words, consult the FACT-INDEX.
Marked letters are sounded as in the following words:
cāpe, ăt, fär, fȧst, whạt, fa̤ll; mē, yĕt, fẽrn, thêre;
īce, bĭt; rōw, wȯn, fôr, nŏt, do̤; cūre, bŭt, rṳde, fụll, bûrn; *out*;
ü = French *u*, German *ü*; ġem, ḡo; *th*in, *~~th~~*en;
ṅ = French nasal (Jeaṅ); *zh* = French *j* (*z* in azure); *K* = German guttural *ch*.

HERE AND THERE IN VOLUME 21

AT ODD TIMES when you are just looking for "something interesting to read," without any special plan in mind, this list will help you. With this as a guide, you may visit faraway countries, watch people at their work and play, meet famous persons of ancient and modern times, review history's most brilliant incidents, explore the marvels of nature and science, play games—in short, find whatever suits your fancy of the moment. This list is not intended to serve as a table of contents, an index, or a study guide. For these purposes consult the Fact-Index and the Reference-Outlines.



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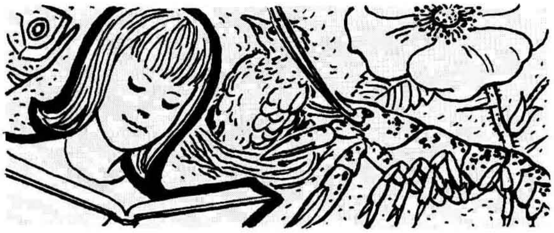
HERE AND THERE IN VOLUME 21



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Marvels of Science and Invention

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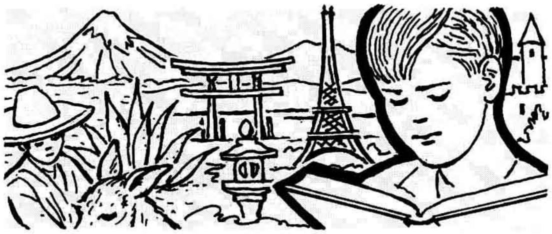

At Home and Abroad

EXPLORING COMPTON'S—VOLUME 21

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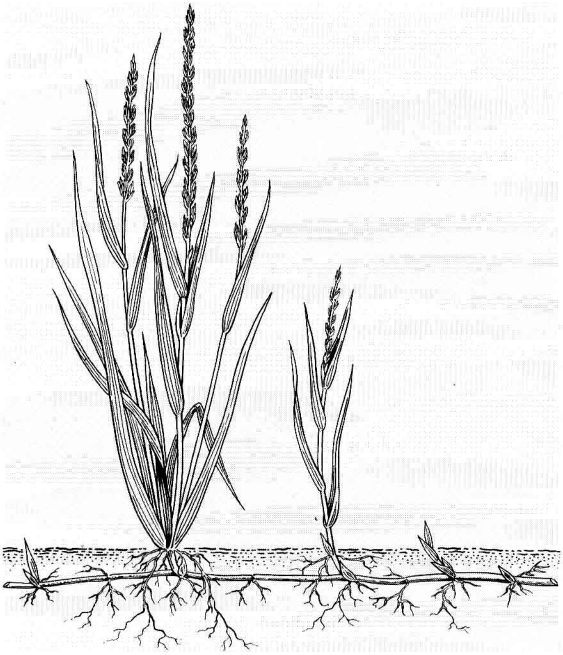
Q



HOW QUACK GRASS SPREADS
Beneath the ground is the plant's running rootstock. If the rootstock is cut, each part starts a new plant. The sharp-bladed leaves cut upward through obstacles and form clusters.

QUACK GRASS. One of our most troublesome weeds is quack grass. It grows above the ground to heights of from one to four feet and produces seed. Beneath the surface, yellowish-green rootstocks (rhizomes) push out over ever-wider areas and send up leaves. When the rootstocks are cut, each part starts new shoots. The plant chokes out other grassy growth.

Quack grass came from Europe. Now it is common in Canada and the United States wherever it can make a start in fairly good, moist soil. It has ruined vast areas of farm land for crops. Some plant poisons will kill the pest; but they must be expertly applied to avoid injuring other vegetation.

In some situations, however, quack grass is extremely useful. It binds loose soil on banks, and it provides cover for golf courses on sandy soil. It produces good forage and hay where better grasses do not thrive, particularly in the West.

Quack grass is a perennial, growing from the same roots year after year. This distinguishes it from crab grass, another common pest. Crab grass spreads by rootstocks, but it is an annual, surviving from year to year by seeding. Quack grass is also called couch grass, quick grass, quitch, devil's-grass, and witchgrass. It belongs to the barley group of grasses. The scientific name of quack grass is *Agropyron repens.*

THESE ARTICLES ARE IN THE FACT-INDEX

Quadrant
Quadrille
Quadros, Jânio da Silva
Quaestors
Quai d'Orsay

QUAIL. One wild bird that has gained from the opening of farms is the quail. It spends the summer and fall on farm lands, scratching for weed seeds and grains left after harvest. It retreats to the woods only in winter. The bird is a favorite for hunting.

The best-known quail is called bobwhite in the North and partridge in the South. Its Northern name comes from its questioning call—*bob-bob-white?* It nests eastward from the Rockies and southward from Canada to northern Texas and Florida.

California and mountain quail are found in humid regions along the Pacific coast. In the arid Southwest are Mearns's, Gambel's, scaled, and valley quail. Two kinds of Old World partridges, closely related to the American quail, have been introduced in the Northwest and Middle West. These are the blue-gray European, or Hungarian, partridge of central Europe and the chukar partridge of India. The California valley quail is the state bird of California. (For pictures in color of the California valley quail and the bobwhite, *see* Birds.)

THE HANDSOME MOUNTAIN QUAIL
The mountain quail is usually found in the humid heights and cool valleys of the West coast. It sometimes frequents arid areas.

The plumage of the bobwhite is a mixture of mottled brown, buff gray, and white. The combination makes the birds almost invisible when they lie quietly in fields or woods. (For picture in color, *see* Birds.) If anyone comes near, they sit still unless the visitor is about to step on them. Then they take flight, with an almost explosive whirring of wings.

Quail nest in open, brushy fields that offer good cover. The nest holds from 12 to 18 white eggs. The chicks leave the nest immediately after hatching, but the family keeps together as a covey until the next spring. At night the birds sleep on the ground in a closely packed ring with heads facing outward, to be ready for flight at any alarm.

Quail and partridges belong to the family *Perdicidae.* True partridges of Europe and Asia belong to the subfamily *Perdicinae,* and the American quail to the subfamily *Odontophorinae.* The scientific name of the bobwhite is *Colinus virginianus;* of the scaled quail, *Callipepla squamata;* of the California and valley quail, *Lophortyx californica;* of the Gambel's quail, *Lophortyx gambeli;* of the mountain quail, *Oreortyx picta;* of the Mearns's quail, *Cyrtonyx montezumae;* of the Hungarian, or European, partridge, *Perdix perdix;* of the chukar partridge, *Alectoris graeca.*

QUAKERS. In 1652 George Fox, standing on high Pendle Hill in England, had a vision (*see* Fox, George). This was the beginning of the Religious Society of Friends. Its members are commonly called Quakers. A magistrate first used this name in Derby in 1650 when Fox was on trial for his beliefs. His followers trembled during religious excitement, and Fox bade the judge to "tremble at the word of the Lord."

George Fox believed, as the Puritans did, that the formal practices of the Church of England violated the spirit of Christianity. As a wandering preacher he won thousands to his view that men can worship God directly, without help from ministers.

His followers refused to attend the services of the Church of England or to pay tithes for its support. They refused to take oaths on the ground that an oath recognizes a double standard of truth. They were frugal and plain in dress and speech.

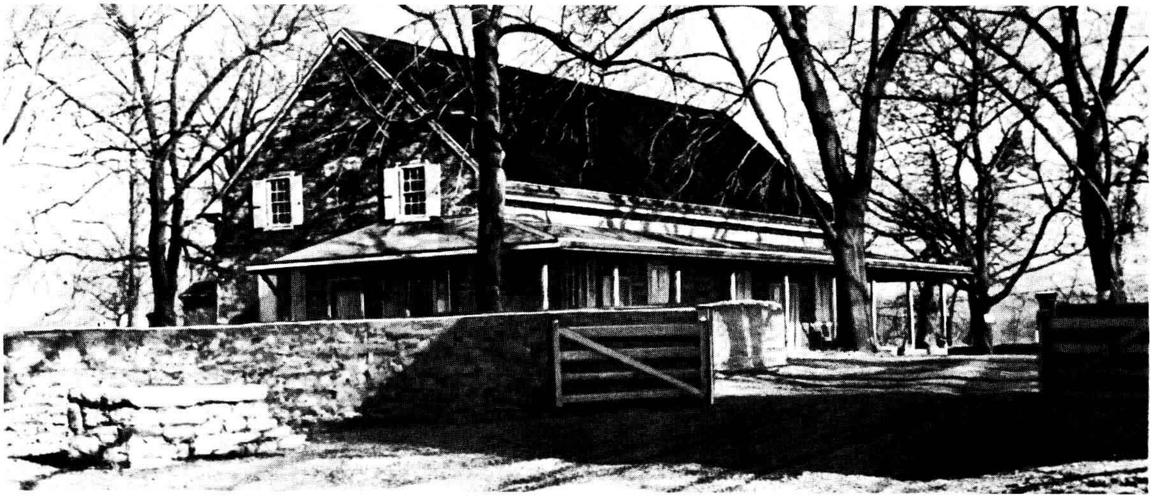
The authorities persecuted them with fines, confiscation of property, and imprisonment. Nevertheless the sect flourished. In 1689 the Toleration Act ended the persecution. Meanwhile, Quakers could settle freely in America on a large grant of land given to the Quaker William Penn in 1681 (*see* Penn). The Hicksites separated from the orthodox Quakers in 1827, but their differences now are unimportant.

Quakers still reflect the teachings of Fox. They do not sanction taking part in war because they feel that war causes spiritual damage through hatred. Therefore most Quakers refuse to give military service; but individuals follow their own convictions. Some do participate in war with the armed services.

The Friends have no ritual and do not observe baptism or the Lord's Supper. They have no ordained ministers but appoint elders and overseers to serve at each meeting. Men and women who have received a "gift" are recorded as ministers. The Meeting for Worship is held "on the basis of silence." Members speak in prayer or testimony as the Inner Light moves them. After an hour the meeting ends with the members shaking hands. In the Middle West and Far West of the United States, the Society accepts more Protestant practices in worship.

Congregations hold a Meeting for Business every month. Groups in a district have Quarterly Meetings; those of a region, Yearly Meetings. All can attend, but usually congregations send delegates.

Quakers are active in welfare work and social reform. The American Friends Service Committee, founded during World War I, organizes relief and service projects not only in the United States but also throughout the world.



A COUNTRY MEETINGHOUSE REFLECTS THE QUAKER SPIRIT

This old Friends Meeting House at Plymouth Meeting, Pa., is typical of the sturdy, simple faith. It is well built of stone and has an ample yard, used for horses and buggies in the old days. It has no ornamentation or sacred symbols.

QUALITATIVE AND QUANTITATIVE ANALYSIS

QUALITATIVE AND QUANTITATIVE ANALYSIS. One of man's oldest questions about matter is "What is it?" Some substances such as water are easily analyzed. Many others are highly puzzling. Until a little more than a century ago, no one knew how to analyze an organic substance such as meat. Today chemists have exact procedures for finding answers to many questions about matter. The methods they use form two major groups. *Qualitative analysis* answers the question "What is it composed of?" *Quantitative analysis* answers the question "How much of each component does it contain?"

Analysis by Blowpipe

One very old qualitative method of analysis is by blowpipe. The tools are a blowpipe and a block of charcoal. The substance to be analyzed is placed in a cavity made in the block. The block is held near a Bunsen burner flame, and a part of the flame is blown on the sample with the blowpipe.

The hot gases in the flame and the hot carbon (charcoal) will reduce many substances to the metals that are in them. Sometimes the metals can be recognized without further treatment. Usually, however, the metals are made to combine with other substances to produce a color which identifies the metal. When a sample is heated with borax, it forms a borax bead. If cobalt is present, the bead will be deep blue; if nickel is present, the bead will be brown. More accurate tests have largely replaced this method.

Analysis by Solution and Precipitation

Many substances are first separated from others before testing to identify them or to measure how much of them is present. The methods commonly used are distillation, precipitation, solution, diffusion, electroplating, and electric deflection in a mass spectrograph. Usually, after the substances are separated, some special test is used to identify a substance or to confirm the identification.

In many common methods of analysis, the material to be studied is first dissolved in water or some other solvent. The solution then may be tested in many ways. A testing substance, or *reagent*, is often added and the resulting reaction is observed. The reaction may consist of a change in color; or tiny bits of solid matter may settle out in the solution as a *precipitate*.

Many methods of analysis require apparatus such as test tubes for holding samples of solutions, and retorts (also called alembics) and condensers assembled as stills. Retorts and stills are used for boiling and distilling. These processes separate mixtures of liquids and also affect solutions in many ways.

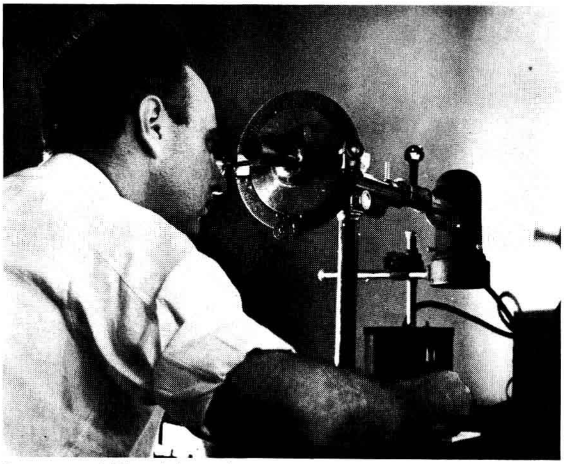
Tests of many solutions work because the substances in solution break into electrically charged parts called *ions* (*see* Ions and Ionization). Reagents also form ions; and all the ions together form new substances that may be insoluble or that can be identified by color, odor, or some other property.

For example, a reagent called hydrochloric acid has H^+ and Cl^- ions. Adding it to a solution of sodium sulfide which has Na^+ and $S^=$ ions produces a gas that smells like rotten eggs. The gas is hydrogen sulfide (H_2S). When ammonium thiocyanate (NH_4SCN) is added to a solution of iron chloride ($FeCl_3$), a deep red color is formed. This is a compound of iron ions (Fe^{+++}) and thiocyanate ions (SCN^-). Such precipitates and characteristic colors are called *positive tests* for elements or compounds. Substances used for reagents are chosen carefully to produce these effects or reactions.

A good example of how reagents are used is a series of tests which separates the compounds or the many elements that may be in a mixture into groups for further analysis. Certain elements are grouped by a scheme of cation (*kăt′ī-ŏn*) analysis, others by anion (*ăn′ī-ŏn*) analysis.

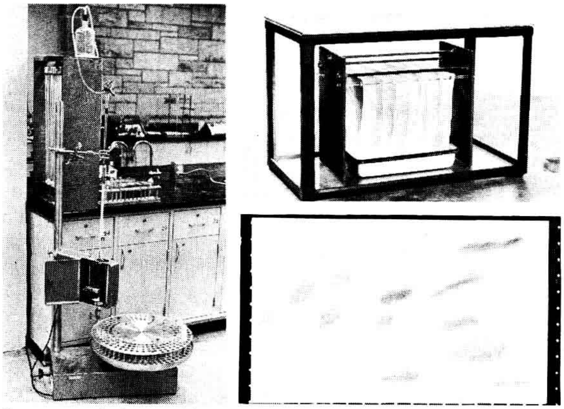
INSTRUMENTS FOR CHEMICAL ANALYSIS

Optically active chemicals can rotate polarized light. The degree of rotation, measured by a polarimeter (shown below), tells the concentration of the chemical.



By courtesy of Abbott Laboratories

In ion-exchange chromatography (left), ions adhere to separate areas of a resin. In paper chromatography (right), chemicals move varying distances on a sheet of paper.



By courtesy of (above only) Northwestern University

Sorting Elements by Cation and Anion Analysis

Elements that form cations (ions with + charges) can be separated by using a series of reagents. By making certain elements settle out in a precipitate, each step (except the last) removes cations that would interfere with the next step. The precipitates can be tested further, to identify each element in them, by a more complete procedure at each step, using positive tests. The series identifies 22 elements which form cations. It also identifies cations formed by the *molecule* (Hg_2) of mercury, and the radical ammonium (NH_4), which contains nitrogen. Finally, cations of lead (Pb) appear at two steps. Thus the series identifies 24 substances in 25 steps.

Anions (ions with − charge) can also be sorted out by a group procedure. Unlike cation analysis, however, each kind of ion must be identified by itself, usually in the original sample. For example, iodine ions are detected by the purple color produced in carbon tetrachloride when iodine ions are oxidized to free iodine. Sulfide ions give the odor of hydrogen sulfide when a sulfide is treated with hydrochloric acid. Fluoride ions produced by treating a fluoride with sulfuric acid will etch glass.

Quantitative Methods That Tell "How Much"

The two methods used for determining amounts of substances are called *gravimetric* and *volumetric* analysis. An example of gravimetric analysis is the method used for determining the percentage of silver in a silver coin. Such coins are alloys of silver and copper. The chemist dissolves the coin or a known portion of it in nitric acid, then adds hydrochloric acid, to form a precipitate of silver chloride. This is filtered out, dried, and weighed. Comparing the weight with that of the coin (or portion used) tells the percentage of silver in the coin.

Volumetric analysis can be used to find the percentage of chloride ions in a substance. A sample is dissolved, and a few drops of potassium chromate are added. Next, silver nitrate in a standard solution of accurately known concentration is added slowly from a burette. Silver and chloride ions unite until the last chloride ions are removed.

Once this point is reached, the silver ions start forming reddish-brown silver chromate with chromate ions from the potassium chromate. The appearance of this color indicates the end point of the test. The percentage of chloride in the sample can now be learned from data on the materials used. An important item is the volume of the silver nitrate; hence, the method is called "volumetric" analysis.

Uses of Electric Current

In many methods of analysis an electric current is used. A simple procedure is called analysis by *electrodeposition*. To determine the amount of copper in a silver coin, the coin (or a portion of it) is dissolved in nitric acid. Then hydrochloric acid is added to precipitate the silver ions. The precipitate is filtered out. The remaining solution is neutralized by adding ammonium hydroxide or potassium cyanide. The copper atoms become a part of complex ions.

TESTS FOR SEPARATING ELEMENTS

One method often used in qualitative analysis is a series of tests to separate and identify many unknown elements quickly. The procedure below separates 22 elements, and nitrogen in ammonium (NH_4).

This procedure tests elements which form + ions (cations) in solutions. Any of the elements present in a solution will settle out at the proper step in the procedure. The 24 substances covered are listed below by chemical symbol, with their ionic charges, as they settle out step by step in Groups I to V.

I. Ag^{++} Hg^{++} Pb^{++}(part)
II. Pb^{++}(part) Hg_2^{++} Bi^{++} Cd^{++} Cu^{++} Sb^{++} As^{+++} Sn^{++}
III. Co^{++} Ni^{++} Fe^{++} Mn^{++} Al^{+++} Cr^{++} Zn^{++}
IV. Ca^{++} Sr^{++} Ba^{++}
V. Mg^{++} K^{+} Na^{+} NH_4^{++}

Hydrochloric acid (HCl) is added first and forms chlorides with certain elements. The chlorides are precipitated as

Group I. $AgCl$ Hg_2Cl_2 $PbCl_2$ **(part of the Pb)**

Very dilute hydrochloric acid and enough hydrogen sulfide (H_2S) to saturate the solution are added next. This forms sulfides which precipitate out as

Group II. PbS **(rest of the Pb)** HgS Bi_2S_3 CdS CuS Sb_2S_3 As_2S_3 SnS

The third step uses more hydrogen sulfide and ammonium hydroxide (NH_4OH). Seven more elements precipitate out as sulfides or hydroxides (with OH groups from ammonium hydroxide):

Group III. CoS NiS FeS MnS $Al(OH)_3$ $Cr(OH)_3$ ZnS

The remaining solution is boiled to drive off any remaining hydrogen sulfide. Ammonium chloride (NH_4Cl) and ammonium carbonate (NH_4CO_3) are added. The resulting carbonates settle out as

Group IV. $CaCO_3$ $SrCO_3$ $BaCO_3$

These ions if present will be left in solution:

Group V. Mg^{++} K^{+} Na^{+} NH_4^{++}

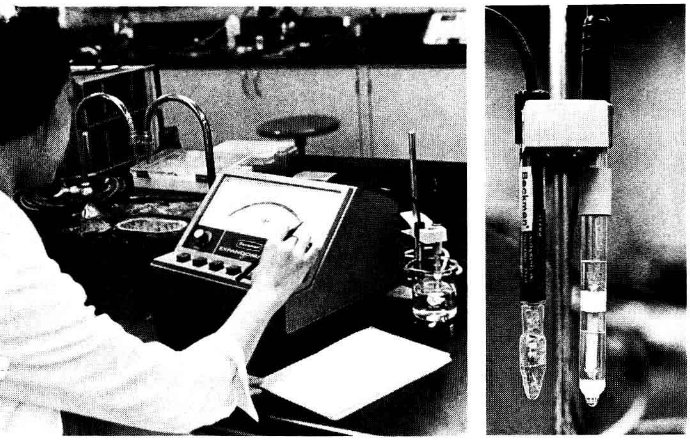
Each group can be analyzed further at each step with positive tests for the elements, as explained in the article.

Using platinum electrodes, direct current is now sent through the solution. The current changes copper ions to copper atoms which stick to the cathode. After all the copper ions are removed by this method, the electrode is weighed. The increase in weight of the electrode can be used to calculate the percentage of copper in the coin (or sample).

Another common use of electric current is in *conductimetric* analysis. A good example is a test for the amount of sulfuric acid in a solution. Two platinum electrodes pass a 1,000-cycle alternating current through a sample of the solution. (Such a current does not cause electrolysis.) The test depends upon the electrical conductivity of the solution. The greater the conductivity, the more current is transmitted at any given voltage.

The sulfuric acid in the solution forms ions ($2H^+$ and $SO_4^=$) immediately, and these conduct some current. Now barium hydroxide ($Ba(OH)_2$) is added from a burette. It too forms ions (Ba^{++} and $2OH^-$). The barium and sulfate ions yield insoluble barium sulfate, and the $2H^+$ and OH^- produce water. Each process removes ions from the solution, and hence reduces electrical conductivity. The reduction can be checked with a Wheatstone bridge (*see* Electricity).

By courtesy of Northwestern University



TESTING A SOLUTION
This pH meter (left) is used to measure the electrochemical properties of solutions. Two of its electrodes—one of glass and one of calomel—are shown at the right.

At length, practically all the ions (Ba^{++}, OH^-, H^+, and $SO_4^=$) have been removed, and conductivity is at a minimum. This is the *end point of titration.* ("Titration" means adding a known volume of a standard solution to another solution until a desired reaction is completed.) The end point can be recognized because adding more barium hydroxide gives more barium and hydroxyl ions, and conductivity increases again. From data on the barium hydroxide which produced minimum conductivity, the amount of sulfuric acid in the sample can be calculated.

With a method of testing called *polarographic* analysis chemists can identify metal ions and many other substances and test their concentrations. They use a *dropping mercury electrode* in which mercury falls drop by drop from a tiny-bore capillary tube into a solution of the substance to be tested. One electrode applies current to the solution through the drops of mercury, and another is connected through a standard cell. As each drop swells at the tip of the tube, it presents more surface to the solution, and this increases the current passing through. When a drop falls, it breaks contact with the electrode in the mercury, and the current fails until a new drop starts forming. A recording instrument amplifies the changes in the current and records the result on graph paper.

Various elements and compounds produce characteristic graphs as the voltage that drives the current is increased. The graphs identify the elements present and determine their concentration. The method does not destroy the sample, since the drops simply fall through the solution without entering into chemical combinations. This method is reliable for concentrations as low as 1/100,000 (0.00001) molar. ("Strength 1.0 molar" has the molecular weight, or sum of atomic weights in one molecule, in grams of the dissolved substance in one liter of water.)

USING RADIATION IN ANALYSIS
With the aid of the spectrophotometer, materials may be analyzed by the radiation they transmit. The device incorporates a source of controlled-wavelength radiation and a detector.

By courtesy of Northwestern University

Tests Based on Physical Properties

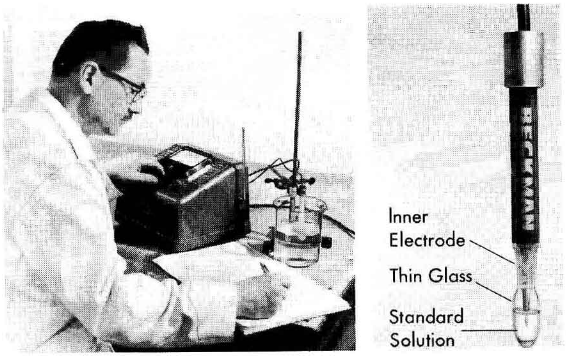
Many testing methods are based on the physical properties shown by elements or compounds in test situations. Perhaps the simplest is the *colorimetric* test for ions that give color to a solution, either by themselves or in combinations with reagents. The color identifies the ions, and its intensity indicates the concentration. This test usually is reliable for concentrations as low as 0.00001 molar.

More than a century ago, physicists learned to identify elements by the colored lines they give in a spectrum (*see* Spectrum). This method, called *spectroscopic* analysis, is a powerful and sensitive means for identifying tiny amounts of elements.

In 1912 the English physicist Henry G.-J. Moseley found that each element gives a distinctive pattern of X-ray lines that identifies it. This provided yet another tool for identifying elements. The *mass spectrograph* separates and identifies isotopes of the same element (*see* Atomic Energy).

A highly important division of modern analysis deals with identification of the hundreds of different radioactive substances—those found in nature and others that are produced artificially in a cyclotron or in an atomic pile. Prospecting for uranium ores with Geiger counters is one use of this method. The rate at which the radioactive element decays through a "half life" helps to identify it, and the intensity of the radiation indicates its concentration. Thus these radiochemical measurements can be used for both qualitative and quantitative analysis.

The sensitivity of the method depends in part upon the intensity of the radiation. For example, cobalt has a very intense radiation. Therefore the method will detect one part of cobalt in 100 million parts of sample. Several elements can be detected in concentrations as low as one part in 100 trillion. Element 101 (mendelevium) was discovered by radioactive analysis in a sample which contained only 17 atoms of



A GLASS ELECTRODE TESTS ACIDITY
A thin-walled glass electrode (right) holds a standard solution. If this is placed in another solution, the difference in acidity (or basicity) between the solutions creates an electric charge across the glass. A voltmeter (left) registers the amount.

the element. The method cannot be used, however, for elements which have very short radioactive half lives. (*See also* Radioactivity.)

Testing Acidity and Basicity

Many important problems in chemistry, biology, and medicine are concerned with the acidity or basicity of a solution. Formerly chemists tested the solutions with *indicators*. These are substances which change color when placed in a solution, according to whether the solution is acidic or basic.

Perhaps the oldest of these is *litmus paper*—paper impregnated with litmus, a vegetable dye. It turns red in acid and blue in solutions of bases. The compound phenolphthalein is red in bases and colorless in acids.

Today a *glass electrode* is used for this test. The solution to be tested is separated from another having known acidity by a glass membrane. When a current is passed through the apparatus, the different solutions create a voltage change that can be read on a voltmeter. The amount of change corresponds to some degree of acidity or basicity on a scale which uses hydrogen ion concentration (also called pH value) as a measure (*see* Hydrogen).

The total amount of acid or base in a solution can be learned by titration. This process measures acidity by testing a sample against a weaker basic solution of known strength. The sample is added bit by bit to the standard solution until an indicator changes from "acid" to "neutral." The acidity of the sample is now neutralized; and the amount of sample used tells the acidity of the solution under test. This end point of neutralization is usually found today with a glass electrode.

Special Methods of Analysis

One of the many special methods available to chemists is used to identify and determine the amounts of certain organic isomers such as sugars (*see* Organic Chemistry). The isomers rotate the plane of polarized light; and an instrument called a polarimeter is used to measure the rotation. (*See also* Light.) Another method, called *chromatographic* analysis, is used to separate ions and molecules of different substances. The solution to be tested is poured onto a column filled with adsorbent material, or it is placed at one end of a paper treated with the adsorbent. (Capillarity draws the solution along the paper.) Each kind of material forms a band in the column or a spot on the paper at a location which helps to identify it. The name "chromatography" is used because identification of materials in the bands or spots is often completed by their color.

Chromatographic analysis is especially effective for separating elements that have very similar properties, such as the rare earths. This method is also effective for dealing with very small amounts of a substance. It was used to identify the synthetic elements of atomic weight greater than that of uranium, and it is now used to separate and analyze gases.

THESE ARTICLES ARE IN THE FACT-INDEX

Quantrill, William Clarke
Quantz, Johann Joachim
Qu'Appelle River
Quarles, Benjamin
Quarles, Donald A(ubrey)

QUARRYING. The great structures of ancient Egypt and Greece and the roads built by the Romans prove that men have been skilled quarry workers for thousands of years.

The building stones taken from quarries may be classified as limestones, sandstones, granites, marbles, and slates. Oölitic limestone has a fish-egg texture. Commercial granite includes a group of metamorphic rocks, such as schist and gneiss, and the igneous rock called granite. Limestone and sandstone were formed as bodies of water deposited sediment through

AN OHIO SANDSTONE QUARRY
This quarry near South Amherst, Ohio, has already yielded huge blocks of stone. Channeling machines cut the blocks, and cranes lift them onto cars for transport to the mill.

geologic epochs. These are the most easily quarried because they usually have definite layers of stratification. Granite and other igneous rock also have lines of easy cleavage although they are not stratified. (*See also* Rock; Geology.)

Limestone, marble, and granite are still much used for buildings and monuments (*see* Limestone; Marble; Granite; Slate). Cheaper substitutes, such as tile and special glasses, have been developed for building purposes. Most of the output of United States quarries is crushed stone, used in concrete or for road construction (*see* Concrete). Much limestone goes into making lime and portland cement (*see* Cement).

After the overburden is stripped from a quarry, the next step is *channeling.* This frees blocks of stone by cutting grooves. The channeling machine looks like a small locomotive that travels back and forth on a track pinned to the rock. It strikes on one or both sides of the track with sets of chisels placed at different angles. Air pressure vibrates the chisels up and down, cutting a channel about an inch and a half wide and generally ten feet deep. The ordinary channeling machine makes only vertical cuts. A horizontal channeler called a *gadder* is used for undercutting.

The key block on the quarry floor may be removed by a derrick pulling on it while one side is wedged or pried. Separation of blocks of stone is usually continued by the less expensive *plug-and-feather* method. Quarrymen drill a row of holes, in general not more than ten inches deep, along the line of the expected split. In each hole they place two *feathers*—flat pieces of steel rounded on one side to fit the curve of the hole. A narrow tapered wedge called a *plug* is driven between the feathers. Then in succession they strike all the plugs. The splitting force of the wedges is enough to break the rock away from its ledge. Sometimes compressed air is blown into the holes to further the action of a crack already started.

Explosives were once used extensively for detaching large blocks of stone. Since explosives shatter the building stone, using them is no longer good quarry practice. High explosives, such as dynamite, are used when the rock is to be broken into fragments.

The rectangular masses of stone may weigh tons. Great cranes swing these onto cars which haul them to the stone mill. There the stone is cut by saws of various types—swinging gang saws with chisellike teeth, circular saws, or smooth, flat blades fed with flint sand and water. Finishing is done by hand carving, planing machines, or lathes. Some stones are polished. For crushed stone, pieces are broken in crushers.

THESE ARTICLES ARE IN THE FACT-INDEX

Quartermaster
Quarter-sawed lumber

QUARTZ. The two commonest chemical elements in the earth's crust, oxygen and silicon, combine to form quartz. This is the most abundant of all minerals except feldspar (*see* Feldspar). Most sands are broken-down and waterworn fragments of quartz. Sandstone and quartzite are the same materials built up into rock again. Quartz is also an important constituent of granite. (*See also* Granite; Sand.)

Quartz is hard enough to scratch glass but not as hard as diamond, sapphire, or topaz. It occurs in masses of very fine crystals, such as flint, jasper, and agate. It also is found as large crystals often beautifully colored by impurties (*see* Crystals; Silicon). Quartz, quartz sand, and sandstone are used for making sandpaper and other abrasives, such as grindstones, polishing powders, and soaps; for building materials; for heat-resisting materials (refractories); and for the bearings of precision instruments.

Clear natural quartz, called *rock crystal* or *quartz crystal,* is used in radio transmitters to maintain a constant wave frequency (*see* Radio). This type of quartz is somewhat rare. It is found in abundant quantities only in the Brazilian states of Bahia and Minas Gerais. The need for electronics equipment during World War II made quartz crystals a critical item. The United States imported millions of pounds by airplane to meet the increased demand.

To prevent future shortages in the quartz crystal supply, scientists have developed a method of "growing" the mineral in laboratories or industrial plants. A "seed," or small piece, of natural quartz crystal is held in a dilute alkaline solution, with a quantity of silica to act as "feeder" material. Under heat and pressure, the silica undergoes change and slowly deposits on the seeds. This action gradually builds up a piece of almost flawless crystal.

For purposes where the crystalline structure of natural quartz is not essential, noncrystalline fused quartz is used. This is made by melting pieces of natural quartz in an electric furnace.

Fused quartz shows virtually no expansion or contraction under changes in temperature. This makes it valuable for mirrors and lenses that must remain accurate in widely varying conditions, such as those used in telescopes. It is also used for condensing lenses in motion-picture machines, where the heat of the high-intensity arc light often breaks glass. It is one of the best electric insulators known.

As clear as air itself, fused quartz transmits heat rays, light, and ultraviolet rays better than any form of glass. Mercury-vapor lamps with tubes of fused quartz are powerful sources of the ultraviolet radiation used in medicine. Rays, visible or invisible, entering one end of a fused quartz rod will for the most part follow the rod around corkscrew twists and right-angle turns, instead of coming out through the sides. Thus light can actually be "piped around corners." Fused quartz resists hot acids and is widely used for test tubes and other containers that hold chemicals in reaction.

THESE ARTICLES ARE IN THE FACT-INDEX

Quasimodo, Salvatore
Quassia
Quatre Bras, Belgium
Quay, Matthew Stanley

QUEBEC

Modern Industrialized Province Where Old France Lives On

Quebec is both the oldest and the largest of Canada's ten provinces. It is a rich province, with a distinctive culture that has evolved from the intermingling of French and English heritages. The vast natural resources of "La Belle Province," some still unexploited, have provided the base that enables Quebec to yield one fourth of Canada's gross national product.

The predominantly French character of the province makes Quebec unique in North America. Outdoor bread-baking ovens are still being used in some of the small towns of southern Quebec. In each village the spire of a Roman Catholic church can be seen. The province's recreational facilities—from luxurious hotels to wilderness areas—provide for every interest in every season.

When Jacques Cartier sailed up the St. Lawrence River in 1535, he found an Indian village on a 30-mile-long island. Montreal, the largest city in Canada today, stands on the site which Cartier is said to have named for its "royal mountain" (*Mont Réal*).

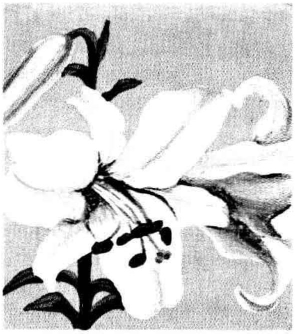
Quebec's name comes from an Algonquian Indian word meaning "where the river narrows." Cartier also explored the area where Samuel de Champlain founded the city of Quebec in 1608 at this narrowing of the St. Lawrence River. The ancient walled city, capital of the province, preserves many relics of the colorful and romantic past. The St. Lawrence was the highway from the Atlantic Ocean into the interior of the continent used by the explorers and the first settlers.

Most of the population and industry of the province of Quebec are still concentrated on the shores of the St. Lawrence River and its tributaries. The river carries two thirds of Canada's international trade. The St. Lawrence Seaway is the passage into the heartlands of two of the world's largest nations. The numerous rivers draining into the St. Lawrence system have a hydroelectric power potential unmatched in Canada. (*See also* Saint Lawrence River.)

From the land north of the St. Lawrence come aluminum and paper; from the recently developed northeast, iron ore. In southern Quebec, agriculture and asbestos predominate. The Gaspé Peninsula produces copper, and the Gulf of St. Lawrence supports the saltwater fishing

COAT OF ARMS

SEAL



FLORAL EMBLEM

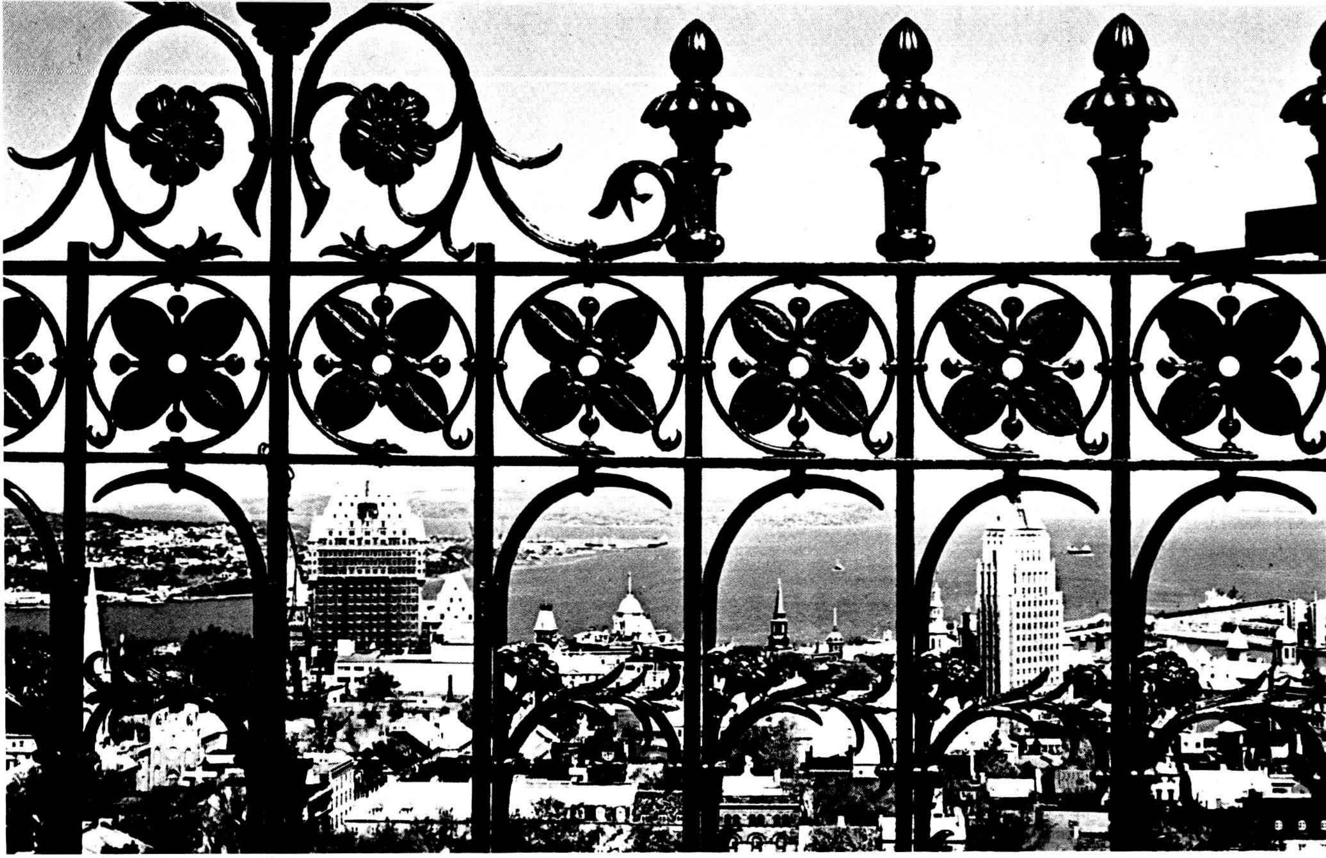
COAT OF ARMS: Shield in three sections: top, three fleurs-de-lis; middle, golden lion on red background; bottom, sprig of three maple leaves; crest, royal crown of England.

SEAL: An impression of the provincial seal is used on official papers, such as letters patent.

FLORAL EMBLEM: Madonna lily (adopted 1963).

MOTTO: Je Me Souviens (I Remember).

FLAG: For picture in color, *see* Flags of the World.



Quebec Department of Tourism

The view of the city of Quebec from the tower of the main Parliament Building is spectacular. The St. Lawrence River lies beyond the copper-roofed Château Frontenac, a city landmark.

industry. Agriculture and forestry, which accounted for 80 percent of Quebec's output half a century ago, now equal less than 10 percent of the total.

Quebec covers 594,860 square miles and is larger than Alaska and more than twice the size of Texas. All of France would be swallowed up in its vast, almost uninhabited northland. The province extends for 1,225 miles from the northern tip of the Ungava Peninsula to the United States border on the south. The span from Ontario, on the west, to the Labrador mainland of Newfoundland, on the east, is nearly a thousand miles. The coastline along James Bay, Hudson Bay, Hudson Strait, Ungava Bay, and the Gulf of St. Lawrence totals 4,850 miles.

Province of Contrasts

The province of Quebec is unusual in its contrasts between the old and the new, between two civilizations and two periods of time living side by side. The most distinctive aspect of the province has been its long desire to maintain its French culture. It remains bilingual, all official publications being printed in French and in English.

The population of Quebec is 6,027,764 (1971 census). Ten percent of the population is of British origin or descent; another 10 percent is of other European nationalities. About 80 percent of the people are descendants of the French who founded the province. In a largely English-speaking nation, they have kept their

Population (1971): 6,027,764—rank, 2d province. Urban, 80.6%; rural, 19.4%. Persons per square mile, 11.5—rank, 5th province.

Extent: Area, 594,860 square miles, including 71,000 square miles of water surface (1st province in size). Greatest length (north to south), 1,225 miles; greatest width (east to west), 982 miles.

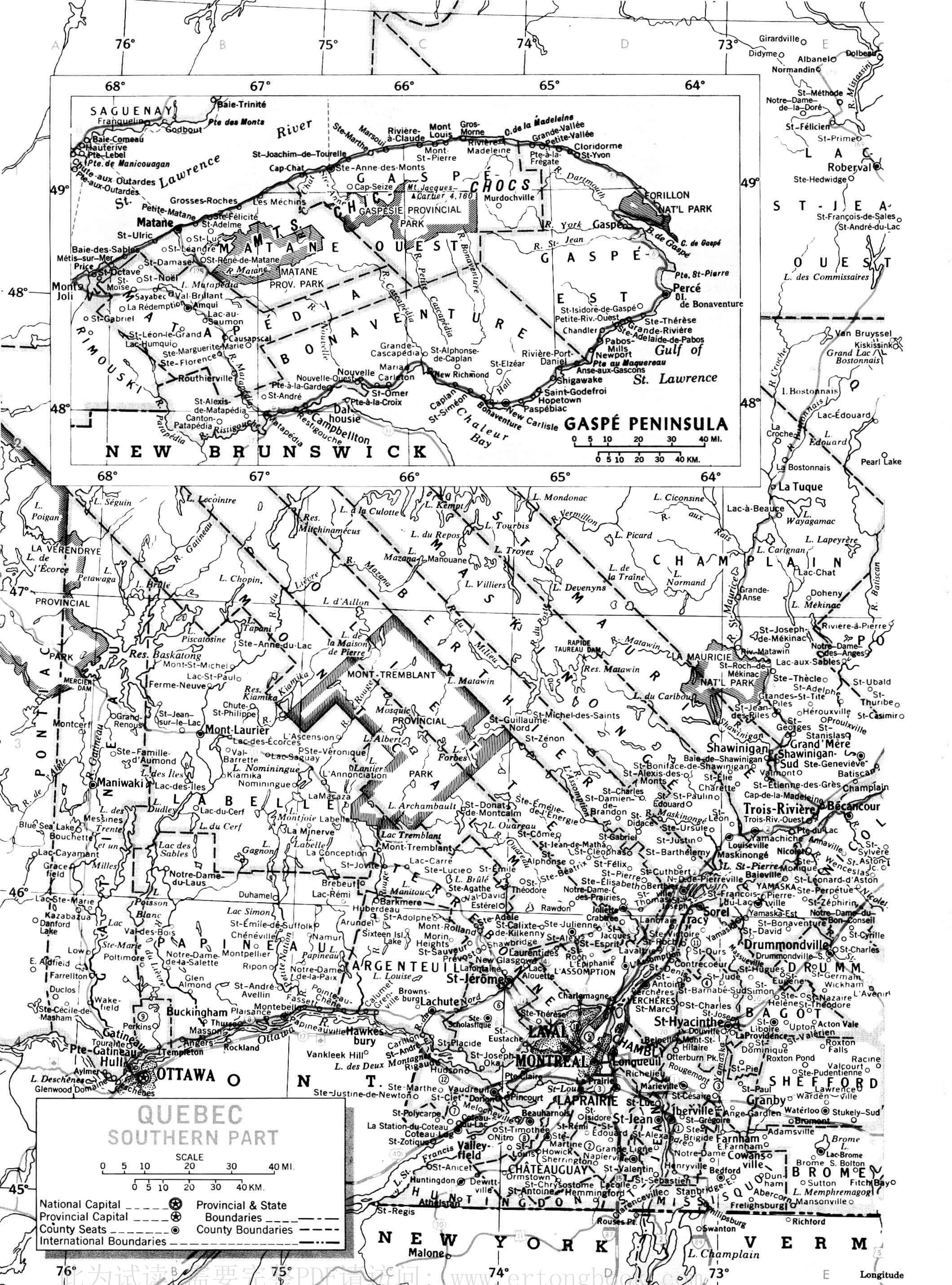
Elevation: Highest, Mount Jacques-Cartier, 4,160 feet; lowest, sea level; average, 800 feet.

Temperature (°F.): Extremes—lowest, −66° (Doucet, Feb. 5, 1923); highest, 104° (Ville-Marie, July 6, 1921). Averages at Inoucdjouac (Port-Harrison)—January, −13.0°; July, 48.0°; annual, 19.5°. Averages at Quebec—January, 11.3°; July, 66.7°; annual, 39.9°.

Precipitation (inches): Average annual total—Inoucdjouac, 15.51; Quebec, 41.67. Average annual snowfall—Inoucdjouac, 64.5; Quebec, 119.8.

Land Use: Agricultural, 3%; forest, 72%; urban, waste, and other, 25%.

For statistical information about Communication, Education, Farm Products, Fishing, Fur, Government, Lumber, Manufactured Products, Minerals, Population Trends, Trade, and Transportation, see QUEBEC FACT SUMMARY.


QUEBEC
SOUTHERN PART
SCALE
0 5 10 20 30 40 MI.
0 5 10 20 30 40 KM.
National Capital
Provincial Capital
County Seats
International Boundaries
Provincial & State Boundaries
County Boundaries
GASPÉ PENINSULA
0 5 10 20 30 40 MI.
0 5 10 20 30 40 KM.
76°
75°
74°
73°
68°
67°
66°
65°
64°
49°
48°
47°
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45°
A
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Longitude
SAGUENAY
Baie-Trinité
Franquelin
Godbout
Pte des Monts
Baie-Comeau
Hauterive
Pte-Lebel
Pte. de Manicouagan
Chute-aux-Outardes
Pte-aux-Outardes
St. Lawrence River
Grosses-Roches
Les Méchins
Petite-Matane
Matane
St-Ulric
Baie-des-Sables
Métis-sur-Mer
Price
Mont-Joli
St-Octave
St-Moïse
St-Noël
St-Damase
Sayabec
Val-Brillant
Amqui
La Rédemption
St-Gabriel
Lac-au-Saumon
St-Léon-le-Grand
Causapscal
Lac-Humqui
Ste-Marguerite-Marie
Ste-Florence
Routhierville
St-Alexis-de-Matapédia
Canton-Patapédia
Ristigouche
Matapédia
Restigouche
Campbellton
Dalhousie
Pte-à-la-Croix
St-Omer
Carleton
Maria
Nouvelle
Nouvelle-Ouest
Pte-à-la-Garde
St-André
New Richmond
St-Alphonse-de-Caplan
Caplan
St-Siméon
Bonaventure
New Carlisle
Paspébiac
Hopetown
Saint-Godefroi
Shigawake
Port-Daniel
Rivière-Port-Daniel
St-Elzéar
Grande-Cascapédia
Chaleur Bay
Pte au Maquereau
Anse-aux-Gascons
Newport
Pabos-Mills
Chandler
Grande-Rivière
Ste-Adelaide-de-Pabos
Ste-Thérèse
Petite-Riv.-Ouest
St-Isidore-de-Gaspé
Percé
Ol. de Bonaventure
Pte. St-Pierre
Gulf of St. Lawrence
C. de Gaspé
B. de Gaspé
Gaspé
FORILLON NAT'L PARK
Cloridorme
St-Yvon
Grande-Vallée
Petite-Vallée
C. de la Madeleine
Pte-à-la-Frégate
Murdochville
Rivière-Madeleine
Mont-St-Pierre
Gros-Morne
Mont-Louis
Rivière-à-Claude
Marsoui
Ste-Marthe
St-Joachim-de-Tourelle
Cap-Chat
Ste-Anne-des-Monts
Cap-Seize
Mt. Jacques-Cartier 4,160
GASPÉSIE PROVINCIAL PARK
CHIC-CHOCS
MTS.
MATANE PROV. PARK
St-Félicité
St-Adelme
St-Luc
St-Léandre
St-René-de-Matane
L. Matapédia
MATANE
MATAPÉDIA
RIMOUSKI
BONAVENTURE
GASPÉ-OUEST
GASPÉ-EST
NEW BRUNSWICK
R. York
R. St-Jean
R. Dartmouth
R. Cascapédia
R. Petite Cascapédia
R. Bonaventure
R. Patapédia
R. Nouvelle
R. Matapédia
R. Matane
Girardville
Dolbeau
Didyme
Albanel
Normandin
St-Méthode
Notre-Dame-de-la-Doré
St-Félicien
St-Prime
LAC
Roberval
St-Hedwidge
ST-JEAN
St-François-de-Sales
St-André-du-Lac
OUEST
L. des Commissaires
R. Mistassini
Van Bruyssel
Kiskissink
Grand Lac Bostonnais
R. Croche
L. Bostonnais
Lac-Édouard
L. Édouard
La Croche
Pearl Lake
La Bostonnais
La Tuque
Lac-à-Beauce
L. Wayagamac
L. Lapeyrère
L. Carignan
CHAMPLAIN
Lac-Chat
Grande-Anse
Doheny
L. Mékinac
R. Batiscan
Rivière-à-Pierre
St-Joseph-de-Mékinac
Notre-Dame-des-Anges
LA MAURICIE NAT'L PARK
Riv.-Matawin
St-Roch-de-Mékinac
Lac-aux-Sables
Ste-Thècle
St-Adelphe
Grandes-Piles
St-Jean-des-Piles
Hérouxville
St-Ubald
St-Thuribe
St-Casimir
St-Georges
St-Stanislas
Proulxville
Shawinigan
Grand'Mère
Shawinigan-Sud
Baie-de-Shawinigan
St-Boniface-de-Shawinigan
Ste-Geneviève
Batiscan
Valmont
Champlain
St-Étienne-des-Grès
Cap-de-la-Madeleine
Trois-Rivières
Bécancour
Trois-Riv.-Ouest
Yamachiche
Pte-du-Lac
Louiseville
Maskinongé
Nicolet
L. St-Pierre
YAMASKA
Sorel
Tracy
Drummondville
DRUMMOND
BAGOT
St-Hyacinthe
Acton Vale
SHEFFORD
Granby
Waterloo
Stukely-Sud
Bromont
BROME
Cowansville
Farnham
Bedford
Sutton
Mansonville
L. Memphremagog
Fitch Bay
Frelighsburg
Richford
Philipsburg
Swanton
L. Champlain
VERMONT
NEW YORK
Malone
Rouses Pt.
St-Regis
MISSISQUOI
HUNTINGDON
Huntingdon
CHÂTEAUGUAY
Valleyfield
Beauharnois
LAPRAIRIE
St-Jean
Iberville
ST-JEAN
Chambly
Longueuil
MONTREAL
LAVAL
St-Eustache
Ste-Thérèse
Terrebonne
Repentigny
L'ASSOMPTION
Joliette
Berthierville
Rawdon
St-Jérôme
Lachute
ARGENTEUIL
Hawkesbury
Vankleek Hill
Rigaud
Hudson
Vaudreuil
Dorion
Pincourt
Ste-Anne-de-Bellevue
St-Lazare
Coteau-du-Lac
St-Zotique
St-Polycarpe
Buckingham
Masson
Angers
Thurso
Papineauville
Plaisance
Montebello
Rockland
Templeton
Gatineau
Pte-Gatineau
Hull
OTTAWA
Aylmer
Deschênes
Glenwood Domaine
L. Deschênes
ONT.
PAPINEAU
Wakefield
Perkins
Farrellton
Low
Duclos
Kazabazua
Danford Lake
Ste-Cécile-de-Masham
Lac-Ste-Marie
Gracefield
Bouchette
Blue Sea Lake
Lac-Cayamant
Maniwaki
Montcerf
Grand-Remous
LA VÉRENDRYE PROVINCIAL PARK
Mont-Laurier
Ferme-Neuve
Lac-des-Écorces
Lac-Saguay
L. Nominingue
Nominingue
LABELLE
Labelle
La Minerve
L'Annonciation
L'Ascension
La Conception
Mont-Tremblant
St-Jovite
Lac Tremblant
MONT-TREMBLANT PROVINCIAL PARK
Ste-Agathe
Val-David
Ste-Adèle
St-Sauveur
Morin Heights
St-Donat-de-Montcalm
MONTCALM
TERREBONNE
BERTHIER
MASKINONGÉ
ST-MAURICE
L. Taureau
Rapide Taureau Dam
R. Matawin
Res. Baskatong
Res. Mitchinamécus
Res. Kiamika
R. Gatineau
R. du Lièvre
R. Rouge
R. St-Maurice
R. Ouareau
R. L'Assomption
Ottawa River
St-Lawrence
Mercier Dam
Sherbrooke