

INDEX

- Abiotic synthesis, 41, 42
- Absorption
 - aerosol particle, 187–190
 - cross section, 195
 - effect on visibility, 200
 - effect on UV radiation, 189, 190, 278
 - efficiency, single-particle, 195–197
 - extinction coefficient
 - population of particles, 195
 - single particle, 188
 - defined, 181
 - gas
 - cross section, 182
 - effect on visibility, 200
 - extinction coefficient, 182, 183
 - infrared, 316–318
 - ultraviolet and visible, 181–183
- Abstraction, hydrogen, 96, 107, 108
- Accumulation mode (*see* modes)
- Acetaldehyde, 7, 98, 99, 105, 111, 228
- Acetic acid, 258, 260
- Acetone, 23, 78, 105, 247
- Acetyl radical, 99
- Acetylene, 105
- Acid, 133, 258
- Acid deposition, 254–272
 - defined, ix, 254
 - dry, 254
 - causes
 - hydrochloric acid, 254–257, 259, 260
 - nitric acid, 259, 263
 - sulfuric acid, 9, 254, 255, 259–262
 - effects
 - buildings and sculptures, 266, 268, 269
 - forests and crops, 264–266
 - health, 263
 - lakes and streams, 263, 264
 - rainwater pH in the United States, 264
- fog, 254, 260
- haze, 254
- history of, 7, 254–257
- locations of damage, 254–257, 263–266
- methods of reducing
 - ammonia, 270
 - ammonium hydroxide, 267
 - calcium carbonate, 268–269
 - calcium hydroxide, 267–268
 - sodium chloride, 269
 - sodium hydroxide, 267–268
- natural, 65, 258–260
- pH (*see* pH)
- rain, 254, 256–258
 - first coined, 256
 - regulation of, 219, 256, 270, 271
 - wet, 254
- Acid fog (*see* acid deposition)
- Acid Precipitation Act, U.S., 270
- Acid rain (*see* acid deposition)
- Acidification
 - sea spray, 119, 133
 - soil-particle, 134
- Acidity, 132
- Active chlorine, 292, 298, 300
- Addition process, 106–108
- Adiabatic process
 - compression, 158
 - expansion, 157
- Adsorption, 298

- Advection, 54
- Aerobic respiration (*see* respiration)
- Aerosol (definition), 3
- Aerosol particle, 116–142
- absorption (*see* absorption)
 - accumulation mode (*see* modes)
 - cloud condensation nucleus, 128
 - coarse mode (*see* modes)
 - coagulation of (*see* coagulation)
 - composition, 64, 135, 137–139
 - condensation onto (*see* condensation)
 - concentration (*see* concentration)
 - defined, 3
 - deposition of (*see* deposition)
 - dissolution into (*see* dissolution)
 - effect on climate, 316–319, 339–341, 347–9
 - BC-low-cloud-positive feedback loop, 341
 - daytime stability effect, 340
 - indirect effect, 341
 - particle effect through large-scale meteorology, 341
 - particle effect through surface albedo, 341
 - photochemistry effect, 340
 - semidirect effect, 341
 - smudge-pot effect, 340
 - effect on UV radiation (*see* radiation)
 - effect on health, 117, 140–142, 344
 - effect on tropospheric ozone, 190
 - effect on stratospheric ozone, 283, 344
 - emissions of (*see* emissions)
 - externally-mixed, 140
 - fine (*see* modes)
 - internally-mixed, 130, 140
 - liquid water content, 133, 136
 - long-range transport of, 166, 167
 - morphology (*see* morphology, aerosol particle)
 - nucleation of (*see* nucleation)
 - nucleation mode (*see* modes)
 - primary, 118
 - regulation (*see* aerosol particle, standards)
 - removal processes (*see* air pollution)
 - scattering (*see* scattering)
 - secondary, 118
 - sedimentation of (*see* sedimentation)
 - shape (*see* shape, aerosol particle)
 - size distribution (*see* size distribution)
 - standards, outdoor, 213, 214, 218, 225–238
 - visibility effects of (*see* visibility)
- Agricola, Georgius, 17
- Agriculture, invented, 333
- Air
- defined, 2,
 - density (*see* density)
 - pressure (*see* pressure)
 - specific heat (*see* specific heat)
 - temperature (*see* temperature)
 - thermal conductivity (*see* thermal conductivity)
- Air mass, 165
- Air pollution (*see also* smog; aerosol particle)
- defined, 4
 - chemicals in, 64
 - chemistry (*see* chemical reactions)
 - dispersion
 - plume (*see* plume dispersion)
 - vertical, 157–165
 - effect of clouds on, 167, 168
 - effect of ground temperatures on (*see* temperature)
 - effect of regulation on, 220–222
 - effect of soil liquid water on (*see* soil)
 - effect of winds on (*see* winds)
 - effect on health, 63–79, 140–142
 - effect on UV radiation (*see* radiation)
 - indoor (*see* indoor air pollution)
 - long-range transport of (*see* winds)
 - mortality, 84–86, 141, 226
 - Bhopal (*see* Bhopal)
 - Donora, 86–88
 - Edinburgh, 85
 - London, 86, 210, 229, 263
 - Meuse Valley, 86
 - outdoor (*see* smog)
 - regulation, 82–92, 204–233, 210–238
 - removal processes
 - aerosol particle, 137, 138
 - gas, 111, 137
 - time of peak pollution during day, 163
 - trends (*see* trends, air quality)
- Air Pollution Control Act of 1955 (*see* Regulation, United States)
- Air Quality Act of, 1967 (*see* Regulation, United States)
- Air Quality Control Region (AQCR), 212
- Air Quality Criteria (AQC), 212, 213
- Aircraft emission standards (*see* regulation of air pollution)
- Albedo, 313
- effect on climate, 338, 341
 - planetary, 313, 314, 328
- Alcohol, 23, 102, 104, 105, 109–111
- ethanol (*see* ethanol)
 - fuel program, 227, 228
 - methanol (*see* methanol)
- Aldehyde, 23, 24, 102, 104, 105
- Aleutian low, 153, 155
- Algae, 41, 303
- blue-green, 42, 43
- Alkali, (*see also* base) 18
- Alkali Act, 84, 256, 270
- Alkali industry, 254–257
- Alkaline acid air (*see* ammonia)
- Alkane, 23, 102, 104–106
- Alkene, 23, 102, 104–107
- Alkyne, 23, 105
- Allegheny County, Pennsylvania, 86, 87
- Allergen, 64, 242, 247
- Allergy, 75, 247
- Alpha particle, 245
- Alum, potassium, 9, 20
- Aluminum, 4, 5, 20, 30, 36, 37, 119, 127, 264, 339
- Aluminum hydroxide, 264
- Aluminum oxide, 187

- American Chemical Society, 76
 American Conference of Governmental Industrial Hygienists, Inc. (ACGIH), 251
 Amino acid, 41
 Ammonia
 aqueous, 136, 270
 gas
 as neutralizing agent, 270
 as refrigerant, 77, 286
 chemistry, 23, 41, 42, 46, 257
 discovery, 6, 9, 11, 13
 dissolution, 135, 267
 evolution in atmosphere, 39, 42, 43, 46
 sources and sinks, 19, 135
 Ammonification, 46
 Ammonium carbonate, 9
 Ammonium chloride, 6, 8, 9
 Ammonium hydroxide, 258, 267
 Ammonium ion (ammonium)
 abundance in accumulation mode, 135–139
 chemistry, 40, 46, 135, 136, 267, 270
 concentrations, 135, 137
 role in air pollution problems, 64
 sources and sinks, 119, 135–139
 Ammonium nitrate, 6, 9, 10, 136
 Ammonium sulfate, 6, 9, 10, 136, 187
 Anaerobic, 42
 Anaerobic respiration (*see* respiration)
 Aneroid barometer (*see* barometer)
 Anion, defined, 132
 Anoxygenic photosynthesis (*see* photosynthesis)
 Antarctic ice sheets (*see* ice sheets)
 Antarctic ozone depletion (*see* ozone)
 Antarctic ozone hole (*see* ozone)
 Anthracite (*see* coal)
 Anthropogenic emissions (*see* emissions)
 Anticyclone, 149
 Apparent centrifugal force (*see* forces)
 Apparent Coriolis force (*see* forces)
 Aqueous, 4
 Aragonite (*see* calcium carbonate)
 Arcanite (*see* potassium sulfate)
 Archean period, 327, 328
 Arctic ozone dent (*see* ozone)
 Area source (*see* emissions)
 Argon, 4, 5, 20, 21, 22, 30, 36, 61, 62, 314
 Aromatic
 chemistry, 104, 105, 107, 108
 compounds, 23
 nitrated (*see* nitrated aromatics)
 definition, 7, 23, 24
 emissions, 102
 Arrhenius, Svante August, 318
 Asbestos, 64, 242, 247, 248
 Asbestosis, 248
 Ash
 from industrial combustion (fly ash), 126, 127, 138, 139
 from biomass burning, 124, 138
 Asteroid, 36, 37, 329
 Asthma, 72, 75, 140–142, 248–250
 Athens, 91
 Atmosphere
 composition, 62–79
 history, 36–47
 Atmospheric window, 317, 318
 Atomic number, 2, 3
 Atomic oxygen (*see* oxygen)
 Atomic mass, 2, 3
 Atom, 2
 Attainment area, 213, 216
 Aurora, 33
 Australia, 32, 84, 125, 238, 345, 347
 Autotroph, 40, 41
 lithotrophic, 40, 41
 photo, 40, 41
 Autumnal equinox (*see* equinox)
 Avogadro, Amadeo, 59
 Avogadro's law, 58, 59
 Avogadro's number, 59–61, 353
 BC (*see* black carbon)
 Backscattering (*see* scattering)
 Bacteria
 airborne, 242, 248
 cyanobacteria, 40, 41, 43, 44, 303, 328
 decomposition by, 68
 effect on climate, 339
 hydrogen, 41
 iron, 41
 methanogenic, 41, 71
 methanotrophic, 71
 nitrifying, 41, 46
 nitrogen-fixing, 46
 nitrosifying, 46
 photosynthetic, 43
 purple and green, 41
 sulfur, 41
 Bacterial decomposition (*see* decomposition, bacterial)
 Baking soda (*see* sodium bicarbonate)
 Balard, Antoine Jerome, 5, 19
 Baldwin, Christopher, 6, 10
 Baldwin's Phosphorus (*see* calcium nitrate)
 Bangladesh, 342
 Barium, 18
 Barometer
 aneroid, 52
 mercury, 51
 Basal-cell carcinoma (*see* carcinoma)
 Basalt, 38
 Base (alkaline substances), 133, 258, 266–270
 Bay breeze, 170
 Beavvais, Vincent de, 6, 9
 Becher, Johann Joachim, 12
 Becquerel, Antoine Henri, 21, 244, 245
 Beijing, 91, 225, 235, 236
 Benz, Karl, 110
 Benzaldehyde, 107, 108
 Benzene, 78, 140, 230

- Benzene ring, 23, 24
 Benzylperoxy radical, 107, 108
 Bering land bridge, 334
 Bermuda-Azores high, 155
 Berzelius, Jöns Jakob, 5, 18–19
 Best available control technology (BACT), 217
 Beta particle, 245
 Bhopal (*see* India)
 Bicarbonate ion, 65, 67, 258
 Big Bang, 30
 Bimolecular reaction (*see* chemical reaction)
 Binary nucleation (*see* nucleation)
 Biogenic emissions (*see* emissions)
 Biomass energy, 222
 Biomass burning, 17, 65–78, 107, 119, 123–125, 321, 322
 composition of smoke from (*see* smoke)
 defined, 123
 indoor, 141
 mortality from, 141, 226
 map of African fires, 322
 Biotic evolution, 40–47
 Bisulfate ion, 135, 259, 261
 Bisulfite, 261
 Bisulfite ion, 261, 262
 Bituminous coal (*see* coal)
 Black carbon (BC) (*see also* soot)
 absorption of light by, 188, 278
 efficiency, 196
 coated, 124, 139, 140
 color (*see* colors)
 defined, 124
 effect on climate, x, 7, 310, 316–319, 339–342, 348, 349
 effect on health (*see* aerosol particle, effect on health)
 effect on visibility, 225
 lifetime, 348
 refractive index, 188
 role in air pollution problems, 64
 scattering efficiency, 196
 shape, 139, 140
 sources and sinks, 119, 124, 126, 138, 139, 319
 Blackbody, 33–36, 311
 Black, Joseph, 6, 12, 13, 15
 Black-lung disease, 140, 141
 Blue-green algae (*see* algae)
 Blue moon, 185
 Blue sky (*see* colors)
 Blue Mountains, 185
 Blue Ridge Mountains, 185
 Bohr, Niels, 2
 Boltzmann, Ludwig, 35
 Boltzmann's constant, 52, 60, 354
 Boundary layer, 54–56
 stable (nocturnal), 55, 56
 BoWash corridor, 167, 220
 Boyle, Robert, 58, 83
 Boyle's law, 58, 59
 Brand, Hennig, 5, 10
 Brazil, 110, 111, 227, 228
 Brimstone, 5
 Bromine, elemental, 4, 5, 19
 Bromine, atomic, gas, 293, 294, 300
 Bromine monoxide, 293, 294, 300
 Bromine nitrate, 294
 Bromocarbons, 287, 289
 Bronchial ailments, 72, 73, 75, 85, 140–142
 Brown cloud, Denver, 200
 Brownian motion, 128, 129
 Buffers (*see* neutralizing agents)
 Bussy, Antoine, 5, 20
 Butadiene, 78, 89
 Butane, 105
 Butene, 105
 Byron, Lord Percy Bysshe, 336
 Cairo, 225, 234
 Calcite (*see* calcium carbonate)
 Calcined soda (*see* sodium carbonate)
 Calcium, 4, 5, 18, 30, 36, 37, 119
 Calcium carbonate, 6, 8, 12, 13, 67, 82, 121, 134, 255, 268, 269, 328
 Calcium difluoride, 17
 Calcium hydroxide, 82, 258, 267
 Calcium ion, 67, 119, 134, 267, 268
 concentrations, 135, 137
 produced from weathering, 120, 268
 Calcium nitrate, 6, 10
 Calcium oxide, 12, 18, 82
 Calcium silicate, 67
 Calcium sulfate dihydrate (*see* gypsum)
 Calcium sulfide, 255
 Calcspars (*see* calcium carbonate)
 Calcutta, 226, 235
 California
 air pollution regulation in, 212–214
 air pollution standards, 213, 214, 219, 220
 Canada, 33, 226, 263, 268, 345, 347
 Canadian high, 156, 165
 Cancer, 78, 248–250 (*see also* carcinoma, melanoma)
 Carbohydrate, 43, 44
 Carbon, 3–5, 7, 30, 36, 119
 reservoirs, 65
 Carbon dioxide
 absorption of radiation by, 181, 182, 317
 buildup on Venus, 315
 characteristics, 65–68
 chemistry, 23, 39, 42–45, 67, 95, 134, 255, 268
 discovery, 6, 11–13, 15
 dissolution in rainwater, 258, 259
 effect of Milankovitch cycles on, 331–334
 effect of UV radiation on, 303
 effect on climate, ix, 316–319, 338, 339, 342–344, 348, 349
 effect on health, 68, 243
 evolution in atmosphere, 39–47, 326–336
 from soil-particle acidification, 134
 lifetime, 26, 348, 349
 mixing ratios, 47, 61–64, 68, 243, 259, 314, 315, 319, 320, 326–336, 342

- photosynthesis of, 19, 43–45
 regulation of, 345–349
 reservoirs (*see* carbon)
 solubility, 333, 339
 sources and sinks, 39–47, 65–68, 123, 124, 134, 242, 243, 255, 268, 321, 345
 structure, 22
- Carbon monoxide**
 characteristics, 68–70, 317
 chemistry, 23, 39, 95–97, 104, 107
 discovery, 7, 16, 17
 effect of catalytic converter on emissions, 216
 effect on health, 69, 70
 mixing ratios, 63, 69, 243
 role in air pollution problems, 64
 role in prebiotic atmosphere, 39
 smog alert levels for, 220
 sources and sinks, 17, 69, 70, 102, 103, 123, 124, 242, 243, 250
 standards
 emission, 212, 215
 indoor, 251, 252
 outdoor, 213, 214, 220, 226–238
 structure, 22
 time of peak mixing ratio during day, 163
- Carbon tetrachloride**, 287, 289–291, 305, 306, 317, 322
- Carbonate ion**, 67, 258
- Carbonic acid**, 67, 133, 258, 259
- Carboniferous period**, 327, 328
- Carbonyl sulfide**, 123
- Carbonyls**, 24
- Carcinoma**
 basal-cell, 302
 squamous cell, 302, 303
- Catalytic converter**, 77, 216, 226–238, 347
- Catalytic ozone destruction cycles** (*see* ozone)
- Cataract**, 302
- Cation**, defined, 132
- Caustic potash** (*see* potassium hydroxide)
- Caustic soda** (*see* sodium hydroxide)
- Cavendish, Henry**, 5, 6, 11, 13, 16, 59
- Ceiling concentration**, 251
- Cellular respiration** (*see* respiration)
- Celsius, Anders**, 52
- Cenozoic era**, 327, 329
- Centrifugal force**, apparent (*see* forces)
- Centripetal acceleration**, 145
- CFCs** (*see* chlorofluorocarbons)
- Chain length**, 281, 282, 292, 294
- Chaldeans**, 4
- Chalk**, 8, 120, 255
- Chapman, Sidney**, 279, 280
- Chapman cycle**, 278–280
- Chappuis, M. J.**, 181
- Chappuis bands**, 181
- Chaptal, Jean-Antoine**, 14
- Charcoal**, 255
- Charlemagne**, 247
- Charles, Jacques**, 58, 59
- Charles's law**, 58, 59
- Chemical lifetimes** (*see* lifetimes, chemical)
- Chemical reactions**
 air pollution, 99–111
 bimolecular, 24
 combination, 25
 heterogeneous, 298
 isomerization, 24, 25
 kinetic, 24
 nighttime, 95
 photolysis, 24, 93–111, 290–300, 340
 rate coefficient, 93
 reversible, 25, 133
 termolecular, 25
 thermal decomposition, 24, 25
 tropospheric, 93–99
 unimolecular, 24
- Chemical weathering** (*see* weathering)
- Chest pains**, 72
- Chile**, 228
- Chimney**, 166, 167
- Chimney effect**, mountain, 170, 171
- China**, 125, 235, 236, 263, 345
- Chloride ion (chloride)**
 chemistry, 133, 259, 269
 concentrations, 133, 135, 137
 role in air pollution problems, 64
 sources and sinks, 119, 138, 139, 259
- Chlorine**
 atomic, 290, 292, 299, 300
 elemental, 4, 5, 18
 percent of sea water, 119
 molecular, 7, 18, 123, 298, 299
 reservoirs, 292, 293, 298–300
- Chlorine activation**, 298
- Chlorine gas** (*see* chlorine, molecular)
- Chlorine monoxide**, 292, 299, 300
- Chlorine nitrate**, 64, 292, 293, 300
- Chlorine nitrite**, 299
- Chlorite**, 121
- Chlorocarbons**, 287, 289
- Chlorofluorocarbons**
 CFC-11, 64, 287, 288, 290–293, 305, 306, 317, 322
 CFC-12, 63, 64, 286–288, 290–293, 305, 306, 317, 322
 CFC-113, 287, 288, 291, 305
 CFC-114, 287
 CFC-115, 287
 chemistry, 286–301
 effect on global warming, 317, 319, 322, 346
 effect on stratospheric ozone, 64, 286–301
 emissions of, 286–292, 305, 322
 invention of, 76, 77, 286–288
 lifetimes, 287, 289–291, 294
 mixing ratios, 287, 289–291
 properties of, 286
 regulation of, 218, 303–306, 346
 trends in, 288, 305, 306
 uses for, 286–289

- Chlorophylls, 43, 44
 Chloroplasts, 43, 44
 Chromosphere (*see* sun)
 Cigarettes (*see* smoke and smoking)
 Clay, 121 (*see also* specific heat, thermal conductivity)
 Clean Air Acts, United Kingdom (*see* Regulation, United Kingdom)
 Clean Air Act, United States (*see* Regulation, United States)
 Cleve, Per, Theodor, 20, 21
 Clevite, 20
 Climate change (*see* global warming, greenhouse effect)
 Climatic optimum, 335
 Medieval, 335
 Cloud condensation nuclei (CCN), 128, 131, 341
 Cloud drop formation, 131
 Cloud layer, 55, 56
 Cloud
 color (*see* colors)
 effect on air pollution, 167, 168
 effect on climate, 338–341
 effect on UV radiation, 167
 Coagulation, 117, 128–130, 138, 139
 internal mixing by, 130
 Coal
 air pollution from, 82–86, 255, 320–323
 anthracite, 125
 bituminous, 125
 combustion products, 126, 255
 defined, 125
 energy, 222
 first formed, 327
 lignite, 125, 231
 mortality from, 140, 141, 226
 peat, 125
 reserves, 125
 sea, 82, 83, 254
 soft, 85
 sulfur content, 271
 Coal Workers' Pneumoconiosis (*see* black-lung disease)
 Coarse mode (*see* modes)
 Cold air mass (*see* air mass)
 Cold cloud (*see* cloud)
 Cold front (*see* front)
 Collection (*see* gravitational collection)
 Collision complex, 25
 Colors
 black carbon, 204, 268, 269
 cloud
 black bottom, 197
 white, 202, 203
 haze, 202, 203
 horizon, 186, 187, 204
 nitrated aromatics, 202, 278
 nitrogen dioxide, 74, 202
 ozone, 72, 205
 PAHs, 202
 rainbow (*see* rainbow)
 sky
 blue, 184, 185
 purple, 205
 red, 204
 smog
 black, 204
 red, brown, 202, 203
 soil dust, 204
 sun
 red, 185, 186
 white, 184, 185
 yellow, 185, 186
 Combination reaction (*see* chemical reaction)
 Compounds
 defined, 3
 history of discovery, 4–21
 Concentration
 aerosol particle
 mass, 116
 number, 116–118, 129
 volume, 116–118, 129
 gas, number, 60, 61, 116,
 hydrometeor particle, 116
 Condensation, 117, 130–132, 138–139
 Conditional instability (*see* stability)
 Conduction, 38, 52–54, 327
 Conductive heat flux, 53
 Conductivity, thermal (*see* thermal conductivity)
 Coning (*see* plume dispersion)
 Conservation of mass, law of, 15
 Contrast ratio, 198, 199
 liminal, 198
 Convection, 38, 53, 54, 157, 168, 169
 forced, 53, 54, 157
 free, 53, 54, 157
 Convective Brownian diffusion enhancement, 129
 Convective mixed layer (*see* mixed layer)
 Conventional heterotroph (*see* heterotroph)
 Copenhagen Amendments, 304, 305
 Copper, 4
 Coriolis force, apparent (*see* forces)
 Cornea, 302
 Corona (*see* sun)
 Cough, 72, 86, 87, 140–142
 Cresol, 107, 108
 Cretaceous period, 327, 329, 342
 Cretaceous-Tertiary (K-T) extinction, 329
 Criegee biradical, 106, 107
 excited, 25, 106, 107
 Criteria air pollutant, 69, 72–75, 213
 Crust, Earth's (*see* Earth)
 Cryfts, Nicolas, 11
 Curie, Marie, 5, 21
 Curie, Pierre, 5, 21
 Cutaneous melanoma (*see* melanoma)
 Cyanobacteria (*see* bacteria)
 Cycloalkane, 23
 Cycloalkene, 23
 Cyclopentene, 23
 Cyclone, 149, 165

- DNA, 42, 45
- Daimler, Gottlieb, 110
- Dalton, John, 60
- Dalton's law of partial pressure, 60
- Davy, Sir Humphry, 5, 18, 20
- Decision, 229
- Decomposition, bacterial (*see* bacteria)
- Deforestation, 321, 322
- Dehydration, 119
- Denitrification
 - bacterial, 40, 43, 46, 74, 280
 - stratospheric, 299
- Denmark, 346
- Denovian period, 327, 328
- Density, air, 50–52, 58–62
- Denver (*see* brown cloud)
- Dephlogisticated air (*see* oxygen, molecular)
- Deposition, 111, 137 (*see also* sedimentation),
 - dry, 137, 138
 - wet (*see* rainout)
- Desertification, 321
- Des Voeux, Harold Antoine, 85
- Deuterium, 3
- Diabatic heating processes, 157
- Diamonds, 5, 7, 15
- Diesel, Rudolf, 126
- Diesel fuel, 126, 319
 - prevalence of, 126, 230
- Diffraction, 192, 193
- Dimer mechanism, 300
- Dimethyl sulfide (DMS), 73, 260
- Diminished nitrous air (*see* nitrous oxide)
- Dinitrogen pentoxide, 25, 26, 95
- Dioscorides, 5
- Directive, 229
- Dispersion, light, 192
- Dispersive refraction (*see* dispersion, light)
- Dissociation, 132
- Dissolution, 66, 67, 132–139
 - defined, 132
- Diterpenene (*see* terpene)
- Dizziness, 68, 78, 251
- Dobson, Gordon M. B., 274
- Dobson unit, 274, 275
- Doldrums, 150, 151
- Dolomieu, Silvain de, 121
- Dolomite, 8, 121
- Donnan, Frederick George, 3
- Dorn, Friedrich Ernst, 5, 21
- Drake, Edwin Laurentine, 109
- Drought, 343
- Dry deposition (*see* deposition)
- Dry ice, 315
- Dry adiabatic lapse rate (*see* lapse rate)
- Duryea, J. Frank and Charles E., 110
- E*-folding lifetime (*see* lifetime)
- Earth
 - core, 38, 39
 - inner, 38, 39
 - outer, 38, 39
 - comparison with other planets, 314–316
 - Crust, 37, 38, 327
 - density, 13, 38, 39
 - distance from sun (*see* sun)
 - evolution of, 36–40
 - interaction with solar wind, 32, 33
 - mantle, 38, 39, 67
 - pressure within, 38, 39
 - radiation spectrum of, 34–36
 - radius of, 39, 52, 312, 354
 - structure, 38, 39
 - temperature
 - equilibrium, 313, 314
 - inner, 39
 - near-surface air (*see* temperature)
- Eccentricity of Earth's orbit, 331–334
- Economy, effect of regulation on (*see* regulation, effect on economy)
- Eddy, 54
- Edward I, 83
- Egypt, 234
- Egyptians, ancient, 4, 5, 7, 8
- El Chichón, 283
- Electric motor, 85
- Electrolysis, 18
- Electrolyte, 132
 - solid, 136
- Electromagnetic wave, 33, 54
- Electron, 2, 3
- Electrostatic precipitator, 85
- Elemental carbon (*see* black carbon)
- Elements, 2, 3
 - history of discovery, 4–21
- Elementary reaction (*see* chemical reaction)
- Elevated ozone layers in smog, 173, 174
- Elevated pollution layers, 170–174
- Emissions
 - aerosol particle, 70, 118–127, 250
 - regulation of, 212
 - anthropogenic, 4, 118
 - area source, 103, 118
 - biogenic, 108
 - biomass burning (*see* biomass burning)
 - control techniques, 271
 - fossil-fuel combustion (*see* fossil-fuel combustion)
 - fugitive dust (*see* fugitive dust)
 - greenhouse gas, 102, 320–323, 345–347
 - incinerators (*see* incinerators)
 - industrial, 119, 127, 138, 139
 - meteoric debris (*see* meteoric debris)
 - mobile source, 103, 118
 - regulations (*see* regulation of air pollution)
 - natural, 118
 - point source, 103, 118
 - regulations (*see* regulations of air pollution)
 - power plant (*see* power plant emissions)
 - sea spray (*see* sea spray)

- Emissions (*cont.*)
 smelters (*see* smelter emissions)
 soil dust (*see* soil dust)
 stationary source, 103
 steel mill (*see* steel mill emissions)
 trends, 221
 volcanic (*see* volcanos)
- Emissivity, 35, 311, 313
- Emphysema, 72
- Energy, 222
 biomass (*see* biomass energy)
 coal (*see* coal)
 geothermal (*see* geothermal energy)
 hydroelectric (*see* hydroelectric energy)
 natural gas (*see* natural gas)
 nuclear (*see* nuclear energy)
 oil (*see* oil)
 renewable (*see* renewable energy)
 solar (*see* solar energy)
 wind (*see* wind energy)
 units, 353
- Engine, 109, 110
- Engine knock, 76
- Entrainment zone, 55, 56
- Environmental lapse rate (*see* lapse rate)
- Environmental Protection Agency, U.S. (U.S. EPA),
 213, 270
- Environmental tobacco smoke (*see* smoke, environmental tobacco)
- Eocene epoch, 327, 329
- Epidermis, 301
- Epsom salt (*see* magnesium sulfate)
- Epsomite (*see* magnesium sulfate)
- Equation of state, 58–62
 for dry air, 61
- Equatorial low-pressure belt, 150, 151
- Equilibrium temperature (*see* temperature)
- Equinox
 autumnal, 311, 312
 vernal, 311, 312
- Ethane
 chemistry, 98
 lifetime, 98
 mixing ratios, 63, 98
 structure, 23, 286
- Ethanol
 as vehicle fuel, 109–111, 227
 chemistry, 42, 111
 lifetime, 105, 110
- Ethanoloxo radical, 106
- Ethanyl radical, 106
- Ethene, 23, 63, 64, 105–107
- Ethene molozonide (*see* molozonide, ethene)
- Ethoxy radical, 98, 111
- Ethyl (*see* leaded gasoline)
- Ethyl radical, 98
- Ethylperoxy radical, 98
- Eukaryote, 40, 45, 327
- European Union, 228–230, 304, 347
- Evaporation, 63, 64, 66, 130–132, 168
- Evelyn, John, 83
- Excited criegee biradical (*see* criegee biradical)
- Exothermic, 42
- Externally-mixed particle (*see* aerosol particle)
- Extinction, species, 329, 343
- Extinction coefficient, 182, 199 (*see also* absorption, scattering)
- Eye irritation, 78, 86–90, 97, 98, 249 (*see also* lachrymator)
- Fahrenheit, Gabriel Daniel, 52
- Faint-Young Sun paradox, 327
- Famine, 343
- Fanning (*see* plume dispersion)
- Far-UV (*see* radiation)
- Feedbacks to climate
 aerosol particles (*see* aerosol particle, effect on climate)
 gases, 338, 339
 negative, 338
 positive, 338
- Feldspars, 38, 121
- Fennoscandian Ice Sheet (*see* ice sheets)
- Fermentation, 42, 43, 66
- Ferrel, William, 150
- Ferrel cell, 150–152
- Fertilizer, 46
- Fine particles (*see* aerosol particles)
- Finland, 268, 346
- Fire-air, 11
- Fixed air (*see* carbon dioxide)
- Fixed gases, 62
- Fluor acid (*see* hydrofluoric acid)
- Fluorine, 3–5, 17, 123
- Fluorite (*see* calcium difluoride)
- Fluorspar (*see* calcium difluoride)
- Fly ash (*see* ash)
- Fog, 86
- Forced convection (*see* convection)
- Forced ventilation (*see* ventilation)
- Forces acting on air
 apparent centrifugal, 147–154
 apparent Coriolis, 146–154
 friction, 147–154
 pressure gradient, 146–154
- Ford, Henry, 110
- Formaldehyde
 chemistry, 97, 104–106, 109, 110, 181
 effect on health, 97
 lifetime, 105
 mixing ratios, 63, 97, 243
 reactivity, 105
 role in air pollution problems, 64, 97, 242, 243
 sources and sinks, 97, 242, 243
 structure, 23
- Formic acid, 260
 excited, 25, 107
- Formyl radical, 97, 99, 104
- Forward scattering (*see* scattering)

- Fossil-fuel combustion, 17, 65–78, 107, 125–127
 aerosol particle products of, 119, 125–127, 138, 139
- Fourier, Jean Baptiste, 318
- Fowler, Alfred, 181
- France, 230, 231, 345
- Free convection (*see* convection)
- Free radical, 22, 74, 103
- Free troposphere (*see* troposphere)
- French Revolution, 16, 254
- Freon, 288
- Friction force (*see* forces)
- Front
 cold, 165
 polar, 152
 subtropical, 151
- Frontal inversion (*see* inversion)
- Fugitive dust, 120–122
- Fumarole, 36, 39
- Fumigation (*see* plume dispersion)
- Fungal spores, 64, 242, 248
- Galileo Galilei, 50, 52
- Gamma radiation (*see* radiation)
- Gary, Indiana, 86, 87
- Gas, 3, 11, 15
 concentration (*see* concentration)
 history of discovery, 11–21
 origin of word, 11
- Gas constant
 dry air, 61, 354
 universal, 60, 354
- Gas pingue (*see* ammonia)
- Gas scattering (*see* scattering)
- Gas silvestre (*see* carbon dioxide)
- Gasoline
 defined, 126
 leaded (*see* leaded gasoline)
 unleaded (*see* unleaded gasoline)
- Geber, 6, 8, 9
- General Motors, 76, 77, 286
- Geneva Convention on Long-Range Transboundary
 Air Pollution, 270
- Geometric regime, 196, 197
- Geostrophic
 adjustment, 148
 balance, 148
 wind (*see* winds)
- Geothermal energy, 222
- Germany, 84, 231, 232, 265, 345
- Geyser, 36, 39
- Glacier, 329, 330, 334, 335, 342
 Alaskan, 327, 330, 342
- Glaser, Christopher, 6, 10
- Glauber, Johann Rudolf, 6, 9, 10
- Glauber's salt (*see* sodium sulfate)
- Global ozone reduction (*see* ozone)
- Global warming 310–349
 aerosol particle contribution to, 316–319, 339–342,
 348, 349
 defined, ix, x, 310, 316
 discovered, 318
 effects, 342–344
 on ecosystems, 343
 on human health, 344
 on regional climate and agriculture, 343
 on sea levels, 342, 343
 on stratospheric ozone, 344
 on stratospheric temperatures, 324, 325, 344
 evidence of (*see* temperature, trends)
 greenhouse gas contribution to, 316–319, 338, 339,
 348, 349
 pollutants affecting, 64, 316–319
 regulation of, 345–349
- Glucose, 42, 44, 45
- Glycol aldehyde, 106
- Gobi Desert, 122, 235
- Gold, 4
- Goldilox hypothesis, 316
- Gossage, William, 256, 271
- Gradient wind (*see* winds)
- Grand Canyon, pollution in, 167
- Granite, 38, 120
- Gravitational collection, 129
- Gravity, 2, 354
- Greeks, ancient, 7, 8, 82
- Green vitriol, 9
- Greenhouse effect
 natural, 310, 314, 316–318, 328
 runaway, 315
- Greenhouse gases, 63, 65, 70, 310, 316–318
 emissions (*see* emissions)
 trends in, 319–323
- Greenland ice sheet (*see* ice sheets)
- Grew, Nehemiah, 6, 10
- Ground temperature, effect on air pollution
 (*see* temperature)
- Growth, particle (*see* condensation, dissolution)
- Gypsum, 6, 8, 120, 121, 136, 255, 268, 269
- Haagen-Smit, Arie, 89–91, 210
- Hadley, George, 150, 151
- Hadley cell, 150–152
- Halite (*see* sodium chloride)
- Halons, 218, 287, 289, 291, 293, 305
 H-1211, 287, 289, 293
 H-1301, 287, 289, 293
 H-2402, 287, 289
- Hartley bands, 181
- Hazardous air pollutants (HAPs), 78, 79, 215, 218, 249
- Haze, 202, 203
- HCFCs (*see* hydrochlorofluorocarbons)
- Headaches, 68, 69, 78, 251
- Health advisory, 220
- Health, Education, and Welfare, U.S. Department of,
 211–213
- Health effects (*see* acid deposition, aerosol particle, air
 pollution, global warming, radiation, smoke,
 smoking, and individual chemicals)

- Heart ailments, 79, 141
 Heat island effect, urban, 169
 Hebrews, ancient, 7
 Helium, 3–5, 20–22, 30, 31, 36–38, 62, 314, 315
 Hematite, 121, 187
 Hemiterpene (*see* isoprene)
 Heterogeneous nucleation (*see* nucleation)
 Heterogeneous reactions (*see* chemical reaction)
 Hemoglobin, 69
 Heterotroph, 40
 conventional, 40, 41
 lithotrophic, 40, 41
 photo, 40, 41
 High pressure systems (*see* pressure systems)
 HFCs (*see* hydrofluorocarbons)
 Holocene epoch, 327, 335, 336
 Holocene maximum, mid-, 335
 Homogeneous nucleation (*see* nucleation)
 Homomolecular nucleation (*see* nucleation)
 Homosphere, 54
 Horace, 82
 Horizon, color of (*see* colors)
 Horse latitudes, 150, 152
 Howard, Luke, 169
 Huggins bands, 181
 Huygens's principle, 192
 Hydration, 133
 Hydrobromic acid, 294
 Hydrocarbon
 alkane (*see* alkane)
 alkene (*see* alkene)
 alkyne (*see* alkyne)
 aromatic (*see also* aromatic)
 polycyclic (PAH), 124, 127, 140, 242, 339
 color (*see* colors)
 UV absorption by, 187–190, 272
 cycloalkane (*see* cycloalkane)
 cycloalkene (*see* cycloalkene)
 defined, 23
 emission standards for, 211, 212, 215
 nonmethane, 24
 oxygenated, 24
 terpene (*see* terpene)
 Hydrochloric acid
 adsorbed, 298, 299
 aqueous
 chemistry, 18, 133, 134, 259
 discovery of, 6, 9, 13
 gas
 acid deposition from (*see* acid deposition)
 discovery of, 7, 16, 18
 chemistry, 255, 269
 dissolution of, 133, 134, 259
 lifetime, 287, 290, 293
 mixing ratios, 287
 regulation of, 84, 256
 removal by rainout, 291
 role in acid deposition, 64, 254
 role in stratospheric ozone loss, 64, 291–293, 299–301
 sources, 17, 119, 123, 133, 134, 255, 260, 269, 291, 292
 Hydrochlorofluorocarbons (HCFCs), 287, 289, 290,
 305, 306
 HCFC-22, 287, 289–291, 305, 306, 317, 322
 HCFC-141b, 287, 305, 306
 HCFC-142b, 287, 306
 Hydroelectric energy, 222, 228
 Hydrofluoric acid, 7, 17, 18
 Hydrofluorocarbons (HFCs), 287, 289, 305, 306, 347
 HFC-134a, 287, 289, 305, 306
 Hydrogen
 atomic, 42, 95, 97, 104, 292, 314, 315
 elemental, 3–5, 19, 21, 30, 31, 36, 37, 38
 ion, 67, 132–136, 257–262, 267–270
 molecular (gas), 6, 11, 13, 23, 39–42, 47, 59, 97, 107,
 123, 282, 292, 314
 Hydrogen convection zone (HCZ) (*see* sun)
 Hydrogen oxides, 282
 Hydrogen peroxide
 aqueous, 262
 gas, 292, 294
 Hydrogen sulfide, 39, 40, 42, 43, 45, 73, 214, 255
 Hydrologic cycle, 39, 63
 Hydrometeor, 3
 Hydrometeor particle, 3, 116
 Hydroperoxy radical
 chemistry, 95–107, 244, 281, 282, 292, 294
 concentrations, 105, 244
 Hydroxide ion, 133, 257
 Hydroxyl radical
 chemistry, 23, 25, 39, 94–111, 261, 263, 281, 282,
 299, 315
 concentrations, 94, 105
 lifetime, 26, 244
 sources, 103, 104
 structure, 22
 Hygroscope, 11
 Hygroscopic, 139
 Hypochlorous acid, 7, 19, 298, 299
 Ice core record, 320, 326, 331, 335, 337
 Ice age
 last, 334
 Little, 335, 336
 Ice sheets
 Antarctic, 327, 329, 342
 East, 329, 342
 West, 329, 342
 defined, 329
 Greenland, 327, 330, 342
 Fennoscandian, 334, 335
 Laurentide, 334, 335
 Icelandic low, 155
 Ideal gas law, 58–60
 Igneous rocks (*see* rocks)
 Illite, 121
 Imaginary refractive index (*see* refractive index)
 Immune system ailments, 302, 303
 Incinerators

- backyard, 89, 90
 industrial, 127
 emissions from, 127
 India, 84, 125, 235, 345
 Bhopal, 235
 Indirect effect (*see* aerosol particle, effect on climate)
 Indonesian forest fires, 167
 Indoor air pollution, ix, 64, 242–252
 Industrial Revolution, 84, 254
 Infiltration, 242, 243
 Inflammable air (*see* hydrogen, molecular)
 Infrared radiation (*see* radiation)
 Inner core (*see* Earth)
 Inorganic compound, 23
 Intermediate interior (*see* sun)
 Internal variability in Earth's climate, 338
 Internally-mixed particle (*see* aerosol particle)
 Intertropical Convergence Zone (ITCZ), 150, 152
 Inversion, 55, 56, 160–165
 base height, 160, 161
 defined, 56, 160
 effect on air pollution, 56, 86, 91, 161
 frontal, 165
 large-scale subsidence, 162–164
 in Los Angeles, 163, 164
 in Mexico City, 227
 in Santiago, 228
 in Tehran, 234
 marine, 164
 popping, 163
 radiation (nocturnal), 162
 small-scale subsidence, 165
 strength, 160, 161
 thickness, 160, 161
 Involatile, 134
 Ion, 2, 22
 anion (*see* anion)
 cation (*see* cation)
 Iran, 234
 Iron, 4, 5, 30, 36, 37, 39, 119, 127, 264, 339
 Isobar, 148
 Isomerization reaction (*see* chemical reaction)
 Isoprene
 chemistry, 104, 108, 109
 lifetime, 105, 109
 sources, 102, 108
 structure, 23
 Isotope, 2, 244–246, 326
 Israel, 233, 234

 Janssen, Pierre, 5, 20
 Japan, 84, 236, 237, 263, 345, 347
 Jet streams
 polar front, 152, 275, 297
 subtropical, 151
 Johannesburg, 91, 237
 Junge layer, 123
 Jupiter, 314, 315
 Jupiter Ammon, Temple of, 9

 Jurassic period, 327, 328

 Kaolinite, 121
 Keeling, Charles David, 320
 Kerosene, 126
 Ketones, 23, 24, 104, 105
 Koschmieder equation, 199
 Krypton, 4, 5, 20, 21, 22, 62
 Kyoto Protocol, 347–349

 Lachrymator, 97, 98 (*see also* eye irritation)
 Lake breeze, 170
 Lakes of Natron (*see* Natron, Lakes of)
 Land breeze, 170, 171
 Landcover, 169
 Langlet, Nils Abraham, 20
 Lapse rate,
 adiabatic
 dry, 157–160
 wet, 157–160
 environmental, 157–160
 Large-scale subsidence inversion (*see* inversion)
 Last ice age (*see* ice age)
 Latent heat, 13, 151, 157
 Laughing gas (*see* nitrous oxide)
 Laurentide ice sheet (*see* ice sheets)
 Lavoisier, Antoine Laurent, 13, 15, 16, 18
 Lead
 characteristics, 19, 75–79, 245, 246
 concentrations, 78
 discovery, 4, 5
 effect on catalytic converter, 216
 effect on health, 76, 78, 79
 emissions, 70
 poisoning, 76, 78
 role in air pollution problems, 64, 234
 sources and sinks, 70, 75–77, 127, 245, 246
 standards
 emission, 212, 226–238
 outdoor, 213, 214, 226–238
 Leaded gasoline, 75–79, 226–238, 286 (*see also* lead)
 Leblanc, Nicolas, 254–256
 Lenoire, Étienne, 110
 Libavius, Andreas, 6, 9, 255
 Liebig, Justus von, 19, 20
 Life, earliest, 327
 Lifetime, chemical, 26
 Lightning, 24, 74
 Lignite coal (*see* coal)
 Lime
 quick- (*see* calcium oxide)
 slaked (*see* calcium hydroxide)
 Lime kilns, 82
 Limestone, 8, 82, 268, 269
 Limonene, 108, 247
 Liquids, 4, 15
 history of discovery, 4–10
 Liquid water content
 aerosol particles (*see* aerosol particles)
 soil (*see* soil)

- Lithotroph, 40
 Lithotrophic autotroph (*see* autotroph)
 Lithotrophic heterotroph (*see* heterotroph)
 Little Ice Age (*see* ice age)
 Lockyer, Joseph Norman, 5, 20
 Lofting (*see* plume dispersion)
 Lognormal distribution (*see* size distribution)
 London, 82, 86, 210, 225, 229
 London Amendments, 304, 305
 London-type smog (*see* smog)
 Long-range transport of air pollution (*see* winds)
 Looping (*see* plume dispersion)
 Los Angeles air pollution, 88–92, 101–105, 109, 135–137, 163, 170–173, 202–204, 221, 225
 regulation of, 88–92, 210
 trends, 221
 Los Angeles Air Pollution Control District (LAAPCD), 210
 Loschmidt, Joseph, 24, 59
 Low pressure systems (*see* pressure systems)
 Lowest achievable emissions rate (LAER), 217
 Lung ailments, 72, 73, 75, 85, 97, 141, 246, 248, 250
 Lye (*see* sodium hydroxide)
- Madrid, 231
 Magma, 120, 123
 Magma oceans, 38, 327
 Magnesia, city of, 5, 20
 Magnesia (*see* magnesium oxide)
 Magnesia alba (*see* magnesium carbonate)
 Magnesite (*see* magnesium carbonate)
 Magnesium, elemental, 4, 5, 20, 30, 36, 37, 119
 Magnesium carbonate, 6, 12, 134
 Magnesium ion, 119
 concentrations, 135, 137
 Magnesium oxide, 20
 Magnesium sulfate, 6, 10, 121
 Mainstream smoke (*see* smoke, environmental tobacco)
 Manganese dioxide, 18
 Manganic oxide, 15
 Mantle, Earth's (*see* Earth)
 Marble, 8, 13, 120, 268, 269
 Marcus, Siegfried, 110
 Marine acid air (*see* hydrochloric acid, gas)
 Marine inversion (*see* inversion)
 Mars, 314–316
 Mascagnite (*see* ammonium sulfate)
 Mass, 2
 atomic (*see* atomic mass)
 of an air molecule, 52, 354
 Mass concentration (*see* concentration)
 Maximum Achievable Control Technology (MACT), 218
 Mayow, John, 11, 12
 Mean free path, 31
 Mechanical turbulence (*see* turbulence)
 Medieval climatic optimum (*see* climatic optimum)
 Melanin, 301
 Melanocyte, 302
 Melanoma
 cutaneous, 302
 ocular, 302
 Mendeleev, Dmitri, 2
 Mephitic air (*see* nitrogen, molecular)
 Mercuric oxide, 14, 15
 Mercury (element), 4, 14, 19, 127
 Mercury (planet), 314, 315
 Mercury barometer (*see* barometer)
 Meridional, 150
 Mesopause, 55, 57
 Mesosphere, 54, 55, 57
 Mesothelioma, 248
 Mesozoic era, 327, 328
 Metals from industrial emissions, 126, 127, 138–141
 Metamorphic rocks (*see* rocks)
 Meteoric debris, 127
 Meteorite, 36, 37, 327
 Meteorological effects on air pollution,
 Meteorological range (*see* visibility)
 Methacrolein, 109
 Methane
 bacterial production, 42
 characteristics, 23, 70–72
 chemistry, 23–25, 39, 41, 42, 96, 282, 283, 292
 constituent of natural gas, 126
 effect of Milankovitch cycles on, 333, 334
 effect on climate, ix, 64, 317–319, 339, 348, 349
 effect on health, 72
 emissions, 102, 321
 formation of chlorofluorocarbons from, 286
 lifetime, 71, 96
 mixing ratios, 63, 71, 96, 319, 320, 331
 regulation of, 347
 sources and sinks, 70, 71, 124, 282
 structure, 22
 Methanogenic bacteria (*see* bacteria)
 Methanol, 23, 110, 111
 Methanotrophic bacteria (*see* bacteria)
 Methoxy radical, 96, 97, 99, 110
 Methyl bromide, 287, 289, 293
 Methyl chloride, 63, 287, 289, 291, 317, 319
 Methyl chloroform, 287, 289, 291, 305, 306
 Methyl radical, 25, 96, 99, 282, 292, 293
 Methylene chloride, 78
 Methyleneethylketone, 78, 247
 Methylperoxy radical, 96
 Methylvinylketone, 109
 Mexico, 226, 227
 Mexico City, 91, 225–227
 Midgley, Thomas, 76, 77, 286–288
 Midlatitudes, 152, 195
 Mie, Gustav, 196
 Mie regime, 196, 197
 Milankovitch, Milutin, 331
 Milankovitch cycles, 331–334, 337
 Miller, Stanley, 41, 42
 Mineral
 defined, 120
 in soil, 121

- Miocene epoch, 327, 330
- Mites, dust, 247
- Mixed layer, 55, 56
- Mixing depth, 160, 161, 163, 164, 168, 169, 173
- Mixing ratio
 - saturation, 64
 - volume, 61, 62, 93
- Mobile source (*see* emissions)
- Modes, 116, 117
 - accumulation, 116, 117, 138, 197
 - importance for visibility, 197
 - coarse, 116, 117, 121, 138
 - fine, 117
 - nucleation, 116, 117, 138
- Moissan, Henri, 17
- Mojave Desert, 122, 155, 166
- Molarity, 132, 257
- Molecular hydrogen (*see* hydrogen)
- Molecular mass (*see* mass, of an air molecule)
- Molecular nitrogen (*see* nitrogen)
- Molecular oxygen (*see* oxygen)
- Molecular weight
 - atomic (*see* mass, atomic)
 - dry air, 61, 354
- Molecule, 3
- Molozonide, ethene, 106
- Monoterpene (*see* terpene)
- Monsoon, 156
- Montgolfier brothers, 54
- Montreal Protocol, 304, 305
- Moon, 314, 315
 - blue (*see* blue moon)
- Morey, Samuel, 109
- Morphology, aerosol particle, 139–140
- Morveau, Louis de, 20
- Moscow, 233
- Motor Vehicle Air Pollution Control Act of 1965 (*see* Regulation United States)
- Motor Vehicle Pollution Control Board, 211
- Mount Pinatubo, 283, 284
- Mount St. Helens, 123
- Mountain breeze, 171
- Mountain chimney effect (*see* chimney effect)
- Muriatic gas (*see* hydrochloric acid, gas)
- Nail polish remover, 78
- National Ambient Air Quality Standards (NAAQS), 69–74, 213–220, 251
- National Atmospheric Deposition Program (NADP), 270
- National Emission Standards for Hazardous Air Pollutants (NESHAP), 215, 217
- National Institute for Occupational Safety and Health (NIOSH), 251
- Natrite (*see* sodium carbonate)
- Natron, Lakes of, 7
- Natural gas, 70, 126, 222
- Nausea, 68, 78, 87, 251
- Near UV radiation (*see* radiation)
- Near-infrared radiation (*see* radiation)
- Negative-feedback mechanism (*see* feedbacks to climate)
- Neon, 3–5, 20, 21, 22, 30, 36, 62, 314
- Neptune, 314, 315
- Nerve damage, 78, 79
- Netherlands, 346
- Neutral stability (*see* stability)
- Neutralizing agents, 266–270
- Neutron, 2, 3
- New Delhi, 225, 235
- New Source Performance Standards (NSPS), 215, 217
- Newcomen, Thomas, 83
- Newton, Sir Isaac, 180, 192
- Nickel, 36, 37, 39, 127
- Niton (*see* radon)
- Nitrammite (*see* ammonium nitrate)
- Nitrate ion (nitrate)
 - abundance in coarse mode, 134–139
 - chemistry, 43, 46, 134, 259
 - concentrations, 135, 136, 190
 - dissociation reaction producing, 134, 259
 - effect on climate, 339
 - effect on visibility, 225
 - role in air pollution problems, 64
 - sources and sinks, 74, 119, 138, 139, 259
- Nitrate radical
 - absorption of UV radiation by, 181, 182
 - chemistry, 25, 26, 95, 103, 105, 108
 - concentrations, 105
- Nitrated aromatics
 - color (*see* colors)
 - imaginary refractive indices of, 189
 - UV absorption by, 187–190, 339
- Nitre (*see* potassium nitrate)
- Nitric acid
 - adsorbed, 298, 299
 - aqueous
 - chemistry, 15, 95, 133, 134, 259
 - discovery of, 6, 9
 - gas
 - acid deposition from (*see* acid deposition)
 - chemistry, 94, 181, 259, 263, 281
 - discovery of, 7, 16
 - dissolution of, 94, 119, 134, 259
 - lifetime, 94
 - role in air pollution problems, 64, 254
 - sources, 74, 134, 260, 263, 281
- Nitric acid dihydrate, 297
- Nitric acid trihydrate (NAT), 297
- Nitric oxide
 - characteristics, 74
 - chemistry, 23, 24, 46, 93–109
 - destruction of ozone with, 93, 173, 174, 280, 281
 - discovery of, 7, 16
 - effect on health, 74
 - lifetime, 26
 - mixing ratios, 63, 74, 93, 100, 101
 - role in air pollution problems, 64
 - sources and sinks, 17, 74, 255, 280, 281
 - time of peak mixing ratio during day, 163

- Nitric oxide (*cont.*)
 structure, 22
- Nitrification, 40, 46
- Nitrite ion, 40, 43, 46
- Nitrocalcite (*see* calcium nitrate)
- Nitrogen
 atomic, 42
 elemental, 3–5, 30, 36
 molecular
 absorption of UV radiation by, 58, 181, 182, 277, 279
 chemistry, 23, 25, 39, 42, 43, 45–47, 103
 discovery of, 7, 13, 14
 evolution in atmosphere, 40–47
 lifetime, 26
 mixing ratios, 47, 50, 61, 62, 314
 sources and sinks, 45–47, 123
 structure, 22
- Nitrogen cycle, 45–47
- Nitrogen dioxide
 absorption extinction coefficient, 182, 183
 absorption of UV radiation by, 181, 182, 278
 characteristics, 74, 75
 chemistry, 23–26, 39, 93–109, 263, 280, 281, 292, 294
 color (*see* colors)
 discovery of, 6, 16
 effect on health, 74, 75
 lifetime, 26
 mixing ratios, 63, 75, 93, 183, 199, 243
 role in air pollution problems, 64
 role in prebiotic atmosphere, 39
 smog alert levels for, 220
 sources and sinks, 17, 74, 75, 242, 243, 250, 263
 standards
 indoor, 251, 252
 outdoor, 213, 214, 220, 226–238
 structure, 22
 visibility reduction because of, 199
- Nitrogen fixation, 40, 46, 303
- Nitrogen oxides
 catalytic ozone destruction cycle, 280, 281
 chemistry, 89, 94, 100, 101, 111
 defined, 94
 emissions, 70, 102, 103, 124, 260, 281
 effect of catalytic converter on, 216
 standards, 211, 212, 215
 mixing ratios, 102, 103
- Nitrous acid, 103, 104
- Nitrous air (*see* nitric oxide)
- Nitrous oxide
 absorption of radiation by, 317
 chemistry, 46, 280
 discovery, 7, 16, 17
 effect on climate, ix, 317–319
 mixing ratios, 280, 319, 320
 regulation of, 347
 role in air pollution problems, 64
 sources and sinks, 17, 280, 281, 321
- Nitrum (*see* potassium nitrate)
- Noble elements, 20, 22
- Nocturnal boundary layer (*see* boundary layer)
- Nonattainment area, 213, 216
- Nonmethane hydrocarbon (NMHC) (*see* hydrocarbons)
- Nonmethane organic carbon (NMOC), 24
- Northern Lights (*see* Aurora)
- Norway, 268, 346
- Nuclear energy, 222, 224, 230
- Nucleation, 128, 138, 139,
 binary, 128
 heterogeneous, 128, 130
 homogeneous, 128
 homomolecular, 128
 ternary, 128
- Nucleation mode (*see* modes)
- Nucleus, atomic, 2
- Number concentration (*see* concentration)
- Obliquity, 312, 333
- Occupational Safety and Health Administration (OSHA), 251
- Oceans, formation of, 39, 327
- Ocular melanoma (*see* melanoma)
- Oil (petroleum) 109, 126, 222
 characteristics of, 126
 discovery of, 109
 formation of, 126
- Oil of sulfur (*see* sulfurous acid)
- Oil of vitriol (*see* sulfuric acid)
- Oligocene epoch, 327, 330
- OM (*see* organic matter)
- Organic chemistry, founding of, 19
- Organic compound, 19, 23, 40–45, 64
- Organic matter (OM)
 defined, 124
 effect on climate, with black carbon (*see* black carbon)
 in soil, 121
 particulate
 effect on visibility, 225
 refractive index, 188
 role in air pollution problems, 64
 sources, 119, 124, 126, 138, 139
- Otto, Nikolaus, 110
- Outer core (*see* Earth)
- Outgassing, 36, 39, 327
- Oxidants, 213
- Oxidation, 23, 42, 44
- Oxygen
 atomic
 excited, 94, 104, 278–280
 ground state, 24, 93–105, 278–282, 292, 293
 isotopically-enriched, 326
 elemental, 3–5, 15, 19, 30, 36, 37, 39
 molecular
 absorption of radiation by, 58, 181, 182,
 277, 278, 317
 aerobic respiration, 45
 chemistry, 13, 23, 25, 43, 44, 93–111, 278–280,
 292–294
 discovery of, 7, 12, 14–16

- evolution in atmosphere, 43–47
- lifetime, 26
- mixing ratios, 47, 50, 61, 62, 314
- photosynthesis production, 43–45
- sources and sinks, 43–46
- structure, 22
- Oxygenated hydrocarbons (*see* hydrocarbons)
- Oxymuriatic acid (*see* chlorine gas)
- Ozone
 - aqueous, 262
 - gas
 - absorption extinction coefficient, 182, 183
 - absorption of UV radiation by, 181, 182, 277, 278
 - chemistry
 - stratosphere, 280–282, 290–300
 - catalytic destruction cycles, 280–282, 292, 293, 299, 300
 - troposphere, 93–111
 - color (*see* colors)
 - column abundance, 274–276, 283–285
 - dent, Arctic, 275, 276, 285, 286, 295–301
 - discovery of, 7, 20
 - effect of aerosol particles on, 190, 283, 344
 - effect of climate on, 344
 - effect of UV radiation on, 190, 303
 - effect on climate, 317, 318
 - effect on UV radiation, 181, 274, 277, 278, 286
 - formation of elevated layers in smog, 173, 174
 - health, plant, and material effects, 72, 73, 89, 266, 274
 - hole, Antarctic, ix, 275, 284, 285, 295–301
 - area of, 295, 296
 - defined, 276
 - map of, 275, 296
 - indoor, 242, 243
 - isopleth, 100, 101
 - lifetime, 26
 - long-range transport of, 166, 167, 219
 - mixing ratios, 63, 72, 89, 93, 100, 101, 243, 276
 - peak stratospheric, 276, 277, 281
 - photostationary state (*see* photostationary state)
 - regeneration, 294, 300, 301
 - role in different air pollution problems, 64
 - smog alert levels for, 220
 - sources and sinks, 72, 242, 243
 - standards
 - indoor, 251, 252
 - outdoor, 213, 214, 218, 220, 226–238
 - stratospheric, 55, 57, 181, 182, 274–306
 - effect of bromine on, 293, 294
 - effect of chlorine on, 292, 293, 298–300
 - effect of global warming on, 344
 - effect of hydrogen on, 281, 282
 - effect of nitrogen on, 280, 281
 - evolution of, 45, 274
 - regulations relating to, 303–306
 - trends, 283–286, 305, 306
 - structure, molecular, 22, 24
 - time of peak mixing ratio during day, 163
 - Ozone Transport Assessment Group (OTAG), 219
 - PM₁₀, 70, 140, 213, 214, 217
 - emissions, 70
 - standards, outdoor, 213, 214
 - PM_{2.5}, 141, 213, 214, 218
 - standards, outdoor, 213, 214, 218
 - Pacific high, 153, 155
 - effect on air pollution, 162–164
 - Paired electrons (*see* electron)
 - Paleocene epoch, 327, 329
 - Paleozoic era, 327, 328
 - Pangea, 327, 328
 - Papin, Denis, 83
 - Paracelsus, 5, 6, 11, 59
 - Paralysis, 78
 - Paris, 230
 - Parthenon,
 - Partial pressure, 60, 61
 - dry air, 61
 - water vapor, 61
 - Particles
 - aerosol (*see* aerosol particles)
 - defined, 3
 - hydrometeor (*see* hydrometeor particles)
 - Pascal, Blaise, 50, 51
 - Path length, 183
 - Peak ozone densities (*see* ozone)
 - Peak stratospheric temperatures (*see* temperature)
 - Pearl ash (*see* potassium carbonate)
 - Peat coal (*see* coal)
 - Penumbra, 338
 - Pentane, 105
 - Perfluorocarbons, 287, 289, 347
 - Perfluoroethane, 287, 289, 322
 - Periodic table of the elements, 2, 3
 - Permafrost, 339
 - Permian period, 327, 328
 - Permissible exposure limit (PEL), 251
 - Peroxy radical, 100
 - Peroxyacetyl nitrate (PAN)
 - chemistry, 98, 99, 101, 110, 111
 - health and plant effects, 98, 99, 266
 - lifetime, 99
 - mixing ratios, 98
 - role in air pollution problems, 64, 228
 - time of peak mixing ratio during day, 163
 - Peroxyacetyl radical, 99
 - Peroxyacetic acid, 281
 - Personal cloud, 142
 - Petroleum (*see* oil)
 - pH, 132–136, 257–260
 - acid fog, 258, 260
 - acid rain, 258, 260
 - defined, 132, 257
 - distilled water, 258, 259
 - map, United States, 264
 - natural rainwater, 258, 259
 - scale, 258
 - sea water, 258, 269
 - Philosopher's stone, 20

- Phlogiston, 12, 13, 15
 Phosphorus, 4, 5, 10, 36
 Baldwin's (*see* calcium nitrate)
 Phosphorus of Brand (*see* phosphorus)
 Photoaging, 302
 Photoautotrophs (*see* autotroph)
 Photochemical smog (*see* smog)
 Photodissociation reaction (*see* chemical reaction)
 Photoheterotrophs (*see* heterotroph)
 Photokeratitis, 302
 Photolysis reaction (*see* chemical reaction)
 Photon, 24, 33, 54
 Photosphere (*see* sun)
 Photostationary-state relationship, 93–96, 102
 Photosynthesis
 anoxygenic, 43
 bacterial, 43, 66
 discovery of, 16
 oxygen-producing, 40, 43, 47, 327
 sulfur-producing, 43
 Phototroph, 40, 43
 Physical weathering (*see* weathering)
 Phytoplankton, 260, 303
 Pigment, 44
 Pinene
 alpha, 108
 beta, 108
 Pittsburgh, Pennsylvania, 86, 87, 268, 269
 Plagioclase feldspar (*see* feldspars)
 Planetesimal, 36
 Plant debris, 127
 Plants
 effect on climate, 40, 44, 45, 339
 first, 327, 328
 Plaster of paris, 8
 Pleistocene epoch, 327, 330, 331
 Pliny the Elder, 4, 5, 8
 Pliocene epoch, 327, 330
 Plumbism, 78
 Plume dispersion
 coning, 174, 175
 fanning, 174, 175
 fumigation, 174, 175
 lofting, 174, 175
 looping, 174, 175
 Pluto, 314, 315
 Point source (*see* emissions)
 Poland, 7, 21, 345, 347
 Polar cell, 150–152
 Polar easterlies (*see* winds)
 Polar front (*see* front)
 Polar front jet streams (*see* jet streams)
 Polar high, 150, 154
 Polar stratospheric cloud (PSC), 297–301, 344
 Type I, 297–299, 344
 Type II, 297–299, 344
 Polar vortex, 275, 297, 300
 Pollen, 64, 127, 247
 Pollutant
 primary, 100, 101, 118, 163, 171
 secondary, 100, 101, 118, 163, 171
 Polonium, 4, 5, 21, 245, 246
 Polycyclic aromatic hydrocarbons (PAHs)
 (*see* hydrocarbons)
 Popping the inversion (*see* inversion)
 Positive-feedback mechanism (*see* feedbacks to climate)
 Potash (*see* potassium carbonate)
 caustic (*see* potassium hydroxide)
 Potassium, 4, 5, 18, 119
 Potassium alum (*see* alum, potassium)
 Potassium carbonate, 13
 Potassium feldspar (*see* feldspars)
 Potassium hydroxide, 13, 18
 Potassium ion, 119
 Potassium nitrate, 6, 8, 9, 14, 15, 255
 Potassium sulfate, 6, 10
 Power plant emissions, 127
 Precambrian era, 327
 Precession, 333
 Precipitation, solid, 136
 Pressure, air, 50, 51, 58–62
 partial (*see* partial pressure)
 sea-level, 50
 units, 353
 Pressure gradient force (*see* forces)
 Pressure systems
 low, 149, 155, 156
 high, 149, 154, 155, 156, 164
 Prevailing visibility (*see* visibility)
 Prevent significant deterioration (PSD), 216, 217
 Priestley, Joseph, 5, 7, 12–18
 Primary colors, 180
 Primary particles (*see* aerosol particles)
 Primary pollutant (*see* pollutant)
 Primary rainbow (*see* rainbow)
 Primary standards (*see* standards)
 Prokaryote, 40, 42, 45
 Propane, 98
 Proterozoic period, 327, 328
 Proton, 2, 3, 132
 Pseudoadiabatic lapse rate (*see* wet adiabatic lapse rate)
 Public Health Service, U.S., 76, 77, 211
 Pyrolusite (*see* manganese dioxide)
- Quartz (*see* silicon dioxide)
 Quaternary period, 327
 Quicklime (*see* calcium oxide)
- Radiation, 33–35, 54
 defined, 33
 gamma, 33, 245
 infrared (IR), 34, 35
 solar (near)-infrared, 35, 180
 thermal (far)-infrared, 35, 63, 162, 310, 313–318
 radio, 34
 spectrum
 Earth, 34, 35
 Sun, 34, 35

- visible light, 180
- solar, 34, 35, 310
- ultraviolet (UV), ix, 34, 35, 45, 180
 - absorption by aerosol particles, 187–190
 - absorption by gases, 181–183
 - effect of clouds on (*see* cloud)
 - effect of ozone on (*see* ozone)
 - effect of air pollution on, 189, 190
 - effect on health and ecosystems, 301–303
 - effect on photolysis rates, 303
 - effect on tropospheric ozone (*see* ozone)
 - far-, 34, 35, 45, 277, 278, 290
 - near-, 34, 35, 277, 278
 - UV-A, 34, 35, 277, 278
 - UV-B, 34, 35, 45, 277, 278, 301–303
 - UV-C, 34, 35, 45, 277, 278, 301
 - variation with altitude, 189, 277, 280
- visible, 34, 35, 44, 74, 180, 277
 - absorption by aerosol particles, 187–189
- X-, 34
- Radiation (nocturnal) inversion (*see* inversion)
- Radioactive decay, 244–246
- Radioactive gases, 21, 244–246
- Radiosonde temperature record (*see* temperature)
- Radium, 21, 245, 246
- Radium emanation (*see* radon)
- Radius of the sun (*see* sun)
- Radon
 - concentrations, 246
 - discovery, 4, 5, 21
 - effect on health, 246
 - progeny, 246
 - role in air pollution problems, 64, 242, 244–246
 - sources and sinks, 242, 244–246
- Rainbow, 193–195
 - primary, 193
 - secondary, 193
- Rainout, 111, 138, 167
- Ramazzini, Bernardo, 6, 16
- Ramsay, Sir William, 5, 20, 21, 184
- Rate coefficient (*see* chemical reaction)
- Rayleigh, Lord Baron, 5, 21, 184
- Rayleigh regime, 196, 197
- Rayleigh scattering (*see* scattering)
- Reactive organic gas (ROG)
 - chemistry, 89, 100–111
 - defined, 24
 - emissions, 70, 102, 103
 - lifetimes, 104, 105, 111
 - mixing ratios, 100–102
 - time of peak mixing ratio during day, 163
- Reading, Pennsylvania, 86, 87
- Real index of refraction (*see* refractive index)
- Reasonably achievable control technology (RACT), 217
- Receptor region, 101, 102, 171
- Red horizon (*see* colors)
- Red nitrous vapor (*see* nitrogen dioxide)
- Red sky (*see* colors)
- Reduction, 23
- Reflection, 190, 191
- Reflectivity (*see* albedo)
- Refraction, 186, 191, 192
- Refractive index
 - imaginary, 188, 189
 - real, 188, 191
- Refrigerant, 77, 288
- Regulation, 82–91, 210–239, 251, 252, 270, 271, 303–306, 345–349
 - acid deposition, 270, 271
 - air pollution
 - indoor, 251, 252
 - outdoor, 82–91, 210–239
 - Australia (*see* Australia)
 - Brazil (*see* Brazil)
 - Canada (*see* Canada)
 - Chile (*see* Chile)
 - China (*see* China)
 - Denmark (*see* Denmark)
 - effect on economy, x, 222, 347
 - effectiveness, 220–222
 - Egypt (*see* Egypt)
 - European Union, 229
 - Finland (*see* Finland)
 - France (*see* France)
 - Germany (*see* Germany)
 - global warming, 345–349
 - Greece, ancient, 82
 - India (*see* India)
 - Iran (*see* Iran)
 - Israel (*see* Israel)
 - Japan (*see* Japan)
 - Mexico (*see* Mexico)
 - Netherlands (*see* Netherlands)
 - Norway (*see* Norway)
 - ozone reduction, stratospheric, 303–306
 - Rome, ancient, 82
 - Russia (*see* Russia)
 - South Africa (*see* South Africa)
 - Spain (*see* Spain)
 - Sweden (*see* Sweden)
 - United Kingdom, 84, 229, 230
 - Alkali Act (*see* Alkali Act)
 - Clean Air Act of 1956, 229
 - Clean Air Act of 1968, 229
 - Environment Act of 1995, 229, 230
 - Environmental Protection Act of 1990, 229
 - London, 82–85
 - United States, 84, 85, 210–225, 347
 - Acid Precipitation Act (*see* Acid Precipitation Act)
 - Air Pollution Control Act of 1955, 210, 211
 - Air Quality Act of 1967, 212, 213
 - aircraft, 215
 - Boston, 85
 - California (*see* California)
 - Chicago, 85
 - Cincinnati, 85
 - Clean Air Act of 1963, 211

- Regulation (*cont.*)
 Amendments of 1970, 69–74, 78, 213–216, 270, 347
 Amendments of 1977, 216, 217, 237
 Amendments of 1990, 217, 218, 244, 248, 249, 270, 271, 304
 Revision of 1997, 218, 219
 Los Angeles (*see* Los Angeles air pollution)
 mobile source, 211, 212, 215
 Motor Vehicle Air Pollution Control Act of 1965, 211, 212
 Pittsburgh, 85–87
 point source, 211
 St. Louis, 85
 Relative humidity, 131, 132
 Renewable energy, 222–224, 231, 232, 347, 348
 Residual layer, 55, 56
 Respiration
 aerobic, 45, 66
 anaerobic, 42, 45, 66
 cellular, 45
 Respiratory ailments, 68, 73, 75, 89, 141, 248–250
 Reversible reaction (*see* chemical reaction)
 Rice paddy, 70, 71
 Rock-forming elements, 36
 Rocks
 defined, 120,
 igneous, 120
 metamorphic, 120
 oldest, 327
 sedimentary, 120
 Romans, ancient, 8, 82
 Rubber, 72, 89
 Rubey, William W., 39
 Ruhr region, 231
 Runaway greenhouse effect (*see* greenhouse effect)
 Russia, 84, 125, 232, 233, 347
 Rusting, 15, 46
 Rutherford, Daniel, 5, 7, 13, 14
 Rutherford, Ernest, 245
- S(IV) family, 261
 conversion to S(VI) family, 261, 262
 S(VI) family, 261
 Sahara desert, 122
 Sal ammoniac (*see* ammonium chloride)
 Sala, Angelus, 6, 9
 Salt, common (*see* sodium chloride)
 Salt cake (*see* sodium carbonate)
 Saltpeter (*see* potassium nitrate)
 Sand
 specific heat (*see* specific heat)
 thermal conductivity (*see* thermal conductivity)
 Santa Ana winds (*see* winds)
 Santiago, 91, 228
 Sao Paolo, 225, 226, 227
 Satellite temperature record (*see* temperature)
 Saturation mixing ratio (*see* mixing ratio)
 Saturation vapor pressure (SVP), 130–132
 high molecular-weight organic gases, 132
 sulfuric acid, 132, 261
 water over ice, 131
 water over liquid, 130, 131, 339, 344
 Saturn, 314, 315
 Savery, Thomas, 83
 Scattering
 aerosol particle, 190–197
 back-, 193, 339
 cross section, 195
 defined, 190, 193
 effect on visibility, 200
 efficiency, single-particle, 195–197
 extinction coefficient, 195
 forward, 193, 194
 efficiency, single-particle, 196, 197
 geometric (*see* geometric regime)
 Mie (*see* Mie regime)
 Rayleigh (*see* Rayleigh regime)
 side-, 193
 Tyndall (*see* Tyndall absorber, scatterer)
 gas, 183, 184
 atmospheric colors resulting from, 184–187
 cross section, 184
 effect on visibility, 199, 200
 extinction coefficient, 184
 meteorological range due to, 199
 Rayleigh, 184, 199
 Scattering cross section (*see* scattering)
 Scheele, Karl Wilhelm, 5, 7, 14–18
 Schönbein, Christian Friederich, 7, 20
 Scintillate, 192
 Scrubber, 256, 271
 Sea breeze, 101, 170, 171
 effect on pollution, 101, 170, 171
 Sea coal (*see* coal)
 Sea ice, 327, 329, 330, 336, 342
 Sea level, changes in, 327–335, 342, 343
 Sea spray, 64, 117–119, 138, 139
 acidification (*see* acidification)
 Sea water composition, 119
 Second-hand smoke (*see* smoke, environmental tobacco)
 Secondary pollutant (*see* pollutant)
 Secondary rainbow (*see* rainbow)
 Secondary standards (*see* standards)
 Secret sal ammoniac (*see* ammonium sulfate)
 Sediment analysis, ocean floor, 326
 Sedimentary rocks (*see* rocks)
 Sedimentation
 gas, 137
 particle, 117, 137
 time required for, 121, 122
 Semipermanent pressure system, 154–156
 Sesquiterpenes (*see* terpene)
 Shape, aerosol particle, 139, 140
 Shear, turbulent (*see* turbulent shear)
 Shelley, Mary Wollstonecraft, 336
 Shells, 8, 326, 327
 Short radio wavelengths (*see* radiation)

- Short-time exposure limit (STEL), 251, 252
- Short ton, defined, 69
- Siberian high, 156
- Sick-building syndrome, 251
- Sidescattering (*see* scattering)
- Sidestream smoke (*see* smoke, environmental tobacco)
- Silicon, 4, 5, 18, 19, 30, 36, 37, 119, 123
- Silicon dioxide, 19, 38, 67, 121, 126, 187
- Silver, 4
- Sintering, 326
- Size distribution, 116–118, 135–139
 - lognormal, 116–118
- Skeletons, 8, 120
- Skin cancer (*see* carcinoma, melanoma)
- Skin color, cause of, 301
- Skin irritation, 78, 247–249, 251
- Sky color (*see* colors)
- Slaked lime (*see* calcium hydroxide)
- Small-scale subsidence inversion (*see* inversion)
- Smectite, 121
- Smelter emissions, 127
- Smith, Robert Angus, 256, 257
- Smog (*see also* air pollution)
 - chemicals in, 64
 - defined, ix, 85
 - effect on health (*see* air pollution)
 - London-type, 82, 85, 86, 88
 - photochemical, 82, 87–92, 99–111
 - regulation (*see* regulation, air pollution)
- Smog alerts, 219–221
- Smoke
 - biomass burning (*see also* biomass burning)
 - composition of, 119, 123–125, 138, 139
 - environmental tobacco, 64, 248–250
 - concentrations, 249
 - effect on health, 248–250
 - mainstream, 248–250
 - sidestream, 248–250
- Smokestacks (*see* chimneys; plume dispersion; Sudbury)
- Smoking, effect on health, 246, 248–250
- Smudge-pot effect (*see* aerosol particle, effect on climate)
- Snell's law, 191
- Snowblindness (*see* photokeratitis)
- Soap, 7, 84, 85, 255
- Soda ash (*see* sodium carbonate)
- Sodium
 - elemental, 4, 5, 18, 30, 36, 37
 - percent of sea water, 119
 - ion, 134, 135, 137, 269
- Sodium bicarbonate, 258
- Sodium carbonate, 6, 7, 85, 86, 254, 255
- Sodium chloride, 6, 8, 9, 19, 119, 187, 255, 269
- Sodium hydroxide, 6, 18, 258, 267
- Sodium ion, 119, 135, 137, 138
- Sodium sulfate, 6, 9, 10, 255
- Soil
 - composition, 121
 - defined, 120
 - liquid water, 168, 169
 - effect on air pollution, 168, 169
- Soil dust
 - absorption of UV radiation by, 187, 278
 - color (*see* colors)
 - composition, 119, 121, 138
 - defined, 121
 - effect on visibility, 225
 - effect of winds on, 165, 166
 - emissions, 117, 119–122, 165, 166
 - light absorption by, 187, 188
 - role in air pollution problems, 64
 - source regions, 122
 - storms in China, 235
- Soil-particle acidification (*see* acidification)
- Solar albedo (*see* albedo)
- Solar constant, 311, 312, 354
- Solar energy (from photovoltaics), 222–224
- Solar nebula, 30, 36
- Solar radiation (*see* radiation)
- Solar spectrum (*see* spectrum, solar)
- Solar wind (*see* sun)
- Solid electrolyte (*see* electrolyte)
- Solids, 15
 - history of discovery, 4–10
- Solstice
 - summer, 311, 312
 - winter, 311, 312
- Solubility, 132, 333, 339
- Solute, 4, 132
- Solution, 4, 132
- Solvay, Ernst, 257
- Solvent
 - defined, 4, 132
 - industrial, 78
- Soot (*see also* black carbon, organic matter)
 - blackened buildings because of, 268, 269
 - coated, 124, 139, 140
 - composition of, 124–126
 - defined, 124
 - effect on climate (*see* black carbon)
 - effect on plants, 266
 - health effects (*see* aerosol particle, effect on health)
 - size of aged particles, 139, 140
 - size of emitted particles, 125, 139, 140
 - morphology, 139, 140
 - shape, 139, 140
 - sources, 12, 66, 124, 125, 126, 139, 255
- Source region, 101, 102, 171
- South Africa, 84, 237, 238
- South Coast Air Quality Management District (SCAQMD), 89, 220, 221
- Southern Lights (*see* Aurora)
- Spain, 231
- Specific heat, 13, 155, 168, 169
 - air, 155
 - clay, 155
 - liquid water, 155
 - sand, 155

- Spectrum (*see* radiation)
 Speed of light, 191, 353
 Spirit of nitre (*see* nitric acid, aqueous)
 Spirit of salt (*see* hydrochloric acid, aqueous)
 Spores, 127
 Spray cans, 288, 304
 Spume drops, 119
 Squamous cell carcinoma (*see* carcinoma)
 Stability, atmospheric
 absolutely stable, 159, 160
 absolutely unstable, 159, 160
 conditionally unstable, 159, 160
 criteria, 159
 defined, 158–160
 effect on climate, 340, 341
 neutral, 159
 stable, 158–160
 unstable, 158–160
 Stable boundary layer (*see* boundary layer)
 Stahl, Georg Ernst, 12
 Standards
 primary, 213–215
 secondary, 213–215
 State Implementation Plan (SIP), 213, 215
 Stationary source (*see* emissions)
 Steam engine, 83–85
 Steam wells, 36, 39
 Steel mills, 86, 87, 127
 Stefan, Josef, 35
 Stefan-Boltzmann constant, 35, 313, 354
 Stefan-Boltzmann law, 35, 311, 313
 Stratopause, 55, 57
 Stratosphere, 54, 55, 57
 color following volcano, 205
 effect of global warming on, 324, 325, 344
 Stratospheric ozone (*see* ozone)
 Stromatolites, 328
 Strong acid (*see* acid)
 Strong electrolyte (*see* electrolyte)
 Strutt, John William (*see* Rayleigh, Lord Baron)
 Strutt, Robert John, 181
 Styrene, 78, 247
 Subcloud layer, 55, 56
 Sublimation, 132
 Subpolar-low-pressure belts, 150, 152, 153
 Subtropical front (*see* front)
 Subtropical high-pressure belts, 150, 152
 Subtropical jet stream (*see* jet streams)
 Sudbury, 167, 271
 Sulfate ion (sulfate)
 abundance in accumulation mode, 135–139, 197
 chemistry, 120, 134, 135, 259, 261, 262, 268
 concentrations, 135, 137
 effect on climate, 339
 effect on visibility, 197, 225
 role in air pollution problems, 64
 role in limestone erosion, 268, 269
 sources, 118, 120, 126, 134–139, 261, 262
 standard for, outdoor, in California, 214
 structure, 22
 Sulfite ion, 261, 262
 Sulfur, elemental, 4, 5, 9, 30, 36, 37, 43, 119
 Sulfur dioxide
 aqueous, 262
 gas
 characteristics, 73
 chemistry, 23, 261
 discovery of, 7, 16
 dissolution in rainwater, 262
 effect on health, 73
 effect on visibility, 205, 224, 225
 emission control techniques, 271
 long-range transport of, 166, 167, 261
 mixing ratios, 63, 73, 86, 244
 role in air pollution problems, 64
 role in prebiotic atmosphere, 39
 sources and sinks, 5, 17, 70, 73, 102, 103, 123, 242, 244, 254, 260, 261
 standards
 emission, 212
 indoor, 251, 252
 outdoor, 213, 214, 226–238
 structure, 22
 Sulfur hexafluoride, 287, 289, 322, 347
 Sulfur oxides, 102, 103
 Sulfur triangle, 231
 Sulfur trioxide, 102, 261
 Sulfuric acid
 aqueous
 absorption of solar radiation by, 187, 188
 acidification by (*see* acidification)
 chemistry, 11–13, 41, 133, 135, 255, 259, 261
 discovery of, 6, 9
 health effects, 73
 refractive index, 188
 role in acid deposition (*see* acid deposition)
 role in air pollution problems, 64, 254
 sources and sinks, 5, 73
 gas
 acid deposition from (*see* acid deposition)
 condensation of, 117, 132, 134, 135, 259
 nucleation of, 128
 sources and sinks, 73, 123, 255, 260, 261
 Sulfurous acid, 6, 8, 12, 261, 262
 Summer solstice (*see* solstice, summer)
 Sun
 chromosphere, 31, 32
 color (*see* colors)
 core, 31
 corona, 31, 32, 37
 distance from earth, 32, 311, 354
 hydrogen convection zone (HCZ), 31, 32
 intermediate interior, 31
 mass, 31
 origin, 30
 photosphere, 31–36, 310, 311
 radiation spectrum, 34–36
 radius 31, 311, 354

- solar wind, 31, 32, 36, 37
 structure, 31, 32
 temperature, 30–32, 310, 354
 Sunburn, 303
 Sunspot, 338
 Supercooled liquid water, 297
 Surface (heterogeneous) reaction (*see* chemical reaction)
 Surface layer, 55, 56
 Surface winds (*see* winds)
 Surgeon General, U.S., 76, 77, 211
 Swartout, H. O., 89
 Sweden, 263, 267, 346
 acidified lakes, 263

 T-Tauri stage, 37
 Tambora, 336
 Taxes, environmental, 231, 232, 345, 346
 Tehran, 226, 234
 Tel Aviv, 233
 Temperature
 air, 50, 52, 56–62
 effect of Milankovitch cycles on, 331–334
 equilibrium, of planets, 310–316
 ground, effect on pollution, 168
 inner Earth (*see* Earth)
 peak stratospheric, 57
 structure of the atmosphere, 54–58
 sun (*see* sun)
 trends
 historical, 326–337
 recent
 from radiosonde, 323–326
 from satellite, 323–326
 from surface stations, 323–326
 tropospheric, 323–326
 stratospheric, 323–326
 Temperature inversion (*see* inversion)
 Termolecular reaction (*see* chemical reaction)
 Ternary nucleation (*see* nucleation)
 Terpene, 23, 108, 109
 diterpene, 23, 108
 hemiterpene (*see* isoprene)
 monoterpene, 23, 108
 sesquiterpene, 23, 108
 Tertiary period, 327
 Tetraethyl lead (*see* leaded gasoline)
 Thenardite (*see* sodium sulfate)
 Theophrastus, 6, 8
 Thermal, 54
 Thermal conductivity, 53
 air, 53
 clay, 53
 liquid water, 53
 sand, 53
 Thermal decomposition reaction (*see* chemical reaction)
 Thermal pressure system, 155, 156, 170
 Thermal speed of an air molecule, 52
 Thermal turbulence (*see* turbulence)
 Thermal-IR radiation (*see* radiation)

 Thermometer, liquid-in-glass, 52
 Thermoscope, 52
 Thermosphere, 54, 55, 58
 Thorium, 18, 245, 246
 Time-weighted average threshold limit values
 (TWA-TLVs), 251, 252

 Tin, 4
 Tire particles, 64, 127, 138
 Titanium, 124, 127
 Tobacco smoke (*see* smoke, environmental tobacco)
 Tokyo, 91, 173, 237
 Toluene
 chemistry, 107, 108, 132
 health effects, 78
 lifetime, 105
 mixing ratios, 63, 107
 reactivity, 105
 role in air pollution problems, 64
 sources, 78, 107, 247
 structure, 23, 24
 Torricelli, Evangelista, 50–52
 Total organic gas (TOG), 24
 Total suspended particulates (TSP), 213
 Trade winds (*see* winds)
 Tragedy of the commons, x
 Transboundary air pollution, 167, 219, 235, 261, 270
 Travers, M. W., 5, 21
 Trends, air quality, 220–238
 Triassic period, 327, 328
 Tritium, 3
 Tropic of Cancer, 312
 Tropic of Capricorn, 312
 Tropopause, 55–57
 Troposphere, 54–57, 63
 boundary layer (*see* boundary layer)
 free, 54–57
 Tucker, Raymond R., 89
 Turbulence, 54
 mechanical, 54
 thermal, 54
 Turbulent inertial motion, 129
 Turbulent shear, 129
 Tuvulu, 342, 343
 Twilight, 186, 187
 Twinkle, 192
 Tyndall, John, 196, 318
 Tyndall absorber, scatterer, 196

 Ultraviolet (UV) radiation (*see* radiation)
 Umbra, 338
 Unimolecular reaction (*see* chemical reaction)
 United Kingdom, air pollution laws (*see* Regulation,
 United Kingdom)
 United Nations Framework Convention on Climate
 Change, 346

 United States
 Air pollution laws (*see* Regulation, United States)
 Dept. of Health, Education and Welfare (*see* Health,
 Education, and Welfare, U.S. Dept. of)

- Environmental Protection Agency (*see* Environmental Protection Agency, U.S.)
 Public Health Service (*see* Public Health Service, U.S.)
 Surgeon General (*see* Surgeon General, U.S.)
 Unleaded gasoline, 77, 216
 Unstable atmosphere (*see* stability, atmospheric)
 Uranium, 244–246
 Uranus, 314, 315
 Urban air pollution (*see* smog)
 Urey, Harold, 41, 42
- Vacuum, 33, 50, 191
 Valley breeze, 171
 Van Helmont, John Baptist, 6, 11, 13
 Van Niel, Cornelius, 45
 Vapor deposition,
 Variable gas, 62, 63
 Vehicle emission regulations, 211, 212, 215
 Ventilation
 forced, 243
 natural, 243
 Venus, 314–316
 Vermiculite, 121
 Vernal equinox (*see* equinox)
 Vienna Convention for the Protection of the Ozone Layer, 304
 Vinci, Leonardo da, 11, 185
 Vinegar (*see* acetic acid)
 Vinyl chloride, 78, 214
 Viruses, 127, 242, 248
 Visibility, 197–202
 defined, 197
 effect of aerosol particles on, 196, 197, 199, 200
 accumulation mode, 196, 197
 effect of gases on, 199, 200
 meteorological range, 198–200, 225
 prevailing, 197, 200–202, 224, 225
 standards, 224, 225
 trends, 200, 201, 224, 225
 visual range, 197
 Visible spectrum (*see* radiation)
 Visual range (*see* visibility)
 Vitamin D, 301
 Vitriolic acid (*see* sulfuric acid)
 Vitriolic acid air (*see* sulfur dioxide)
 Volatile organic compounds (VOCs), 24, 242, 246, 247, 251
- Volcanos
 effect on climate, 329, 336
 effect on stratospheric color, 205
 effect on stratospheric ozone, 283, 284, 291, 292
 El Chichón (*see* El Chichón)
 emissions, 17, 36, 39, 66, 73, 117, 119, 123, 260, 291
 Mount Pinatubo (*see* Mount Pinatubo)
 Mount St. Helens (*see* Mount St. Helens)
 origin of name, 123
 Tambora (*see* Tambora)
 Volume concentration (*see* concentration)
 Volume mixing ratio (*see* mixing ratio)
- Warm cloud (*see* cloud)
 Washing soda (*see* sodium carbonate)
 Water
 aerosol liquid water content (*see* aerosol particles)
 hydration (*see* hydration)
 ice (*see also* hydrometeor particles and Polar stratospheric clouds)
 heterogeneous chemistry on, 298, 299
 sublimation, 132
 liquid (*see also* hydrometeor particles)
 absorption efficiency, 197
 chemistry, 41–44, 67, 95, 120, 134, 257, 258, 262, 267
 percent of sea water, 119
 refractive index, 188
 scattering efficiency, 197
 specific heat (*see* specific heat)
 thermal conductivity (*see* thermal conductivity)
 soil liquid water content (*see* soil)
 vapor (gas)
 absence on Venus, 315
 absorption of radiation by, 181, 182, 317
 characteristics, 63, 64
 chemistry, 19, 23, 25, 39, 41, 94–111
 condensation of, 117, 128, 130–132, 261, 282, 283
 constituent of early atmosphere, 39
 depositional growth of, 132
 effect on climate, 315–319, 338, 339
 effect on health, 64
 measurement of, 11
 mixing ratios, 63, 64, 130–132, 182, 314
 sources and sinks, 39, 63, 64, 123, 282, 283, 316
 structure, 22
 Waterwheel, 83
 Watt, James, 83, 84
 Wavelength, 24, 33
 Weak acid (*see* acid)
 Weathering
 chemical, 66, 67, 120
 physical, 120
 Weichselian (*see* ice age, last)
 Weight, 2
 Wells, H. G., 21
 Westerly winds (*see* winds)
 Wet adiabatic lapse rate (*see* lapse rate)
 Wheezing, 73
 White night, 187
 Wien, Wilhelm, 33
 Wien's law, 33
 Wind energy, 222, 223, 232, 347, 348
 Winds
 bay (*see* bay breeze)
 causes of, 146–154
 effect on pollution, 165–167, 170–175
 long-range transport, 166, 167, 219, 261, 270
 geostrophic, 148
 gradient, 149
 lake (*see* lake breeze)
 mountain (*see* mountain breeze)
 Polar easterlies, 150, 154

- Santa Ana, 165, 166
sea (*see* sea breeze)
southwesterly, 150
surface
 along curved isobars, 149, 150
 along straight isobars, 148, 149
trade, 150, 152
valley (*see* valley breeze)
westerly, 150, 151, 154, 195
Winter solstice (*see* solstice)
Wisconsin (*see* ice age, last)
Wöhler, Friedrich, 5, 20
Würm (*see* ice age, last)
- X radiation wavelengths (*see* radiation)
Xenon, 4, 5, 20, 21, 22, 62
- Xylene
 chemistry, 108, 132
 health effects, 78
 mixing ratios, 63, 108
 reactivity, 104, 105
 role in air pollution problems, 64
 sources, 78, 108, 247
- Year without a summer, 336
Younger-Dryas period, 334, 335, 337
Youngstown, Ohio, 86, 87
- Zinc emissions, 87, 127, 138
Zonal, 150
Zonally averaged, 56, 57, 150, 274