

Subject Index

References to figures are given in *italic type*; references to tables are given in **bold type**.

- abatement 130, 131–134, 159
 acetaldehyde 310, 388
 acetic acid 339–343, 342
 acetone 331, 343
 acetophenone 179
 acetylene 126, 393
 acetylsalicylic acid 360
 acrylic acid 324, 374, 389
 acrylonitrile 287
 active pharmaceutical ingredient
 (API) *see* pharmaceuticals
 activism 446
 4-acyl-1,2,3,4-tetrahydroquinoxalin-
 2-one 283
 adenine 195, 196
 adenosine triphosphate (ATP) 83, 224
 adipic acid 346, 380–382
 adiponitrile 287
 aflatoxin B₁ 21, 22
 agriculture 14, 164, 358, 369–370
 agrochemicals 264–265, 320–321
 air capture 415
 albedo 93, 109
 aldol condensation 282, 374, 394, 396
 alfalcidol 279, 280
 algae 356, 371–373, 400
 Alkali Acts (UK) 119
 2-alkylanthraquinone 181, 182
 7-aminocephalosporic acid 226, 227,
 308
 ammonia 127–128, 223, 429
 ammonium chloride 148
 Anastas, Paul 214, 216, 218
p-anisaldehyde 184–188, 185, **187**
 anisole 184, 185, **187**
 anisyl metabolites 22, 23
 Antarctic 455
 anthracene 285
 Anthropocene 11, 105
 anthropogenic impact 105
 see also exergy, analysis
 aqueous phase reforming 380, 396
 aqueous processing 394
 Aristotle 53, 54
 aromatics 382
 aspartic acid 384
 aspirin 360
 asymmetric catalysis 321
 atmosphere 75
 carbon dioxide 90–91, 92, 415
 components 96, **107**
 methane 99–104
 solar radiation and 88–90, 89
 see also greenhouse effect
 atmospheric lifetime 98, 102, 104
 atom efficiency 176–183, 200,
 219–220, 337
 azomethines 22
 Bacon, Francis 54
Bad Science 65
 balance yield 184–188

- BASF 127, 190–191, 244
BASIL process 244, 246
batch reactors 265
batteries 134–136, 431–432
Beer-Lambert law 278
benzene 331
Bhopal disaster 15, 268, 288
bioaromatics 382
biobutanol 376
biochar 379
bioethanol 375
biofuels 258, 344–348, 355–356,
394–396, 427
diesel 346, 356, 375, 387
2,5-dimethylfuran 377
ethanol 162–165, 375–377
hydrogen 379–380
oil 379
syngas 377–379
*The Biofuels Delusion: The Fallacy of
Large Scale Agro-biofuel
Production* 357
biohydrogen 379
biological catalyts 308–310, 346–347
biomagnification 71
biomass 36, 84, 87, 162, 238, 285,
346–348, 354, 355, 408, 427
algae 371–373, 400
aqueous processing 394–397
as chemical feedstock 359–361
chemical nature 361–366
combustion 393
fine chemicals and
pharmaceuticals 388–390
gasification 394
handling and transport 401
hydrogen production 429–431
non-food crops 366–369
oxygen-carbon ratio 364–366
processing 361–365, 390–397
products 380–390
see also biofuels
pyrolysis 394
sources 366–373
supply 401–402
technological restrictions 398–400
water as solvent 238
wood 370–371
world production 355
bio-oil 379, 394
biopolymers 361, 371
biorefineries 397–398
biostyrene 382
biosyngas 377
blackbody radiation 87–88
Borlaug, Norman 14
Borregaard Industries 390
bovine spongiform encephalopathy
(BSE) 221
BP 341
Brazil 364, 376
British Medical Journal 442, 455
Brundtland Commission 37
bryostatins 199–200, 201
BTX (benzene, toluene, xylenes)
379
buckminsterfullerene 210
bulk chemicals 297, 319–320
waste minimisation 124–125
by-products 118, 172, 229–230, 464
campholenic aldehyde 275
cancer 15, 16, 23
caprolactam 279
carbamylation 290
carbaryl (1-naphthyl methylcarbamate)
267
carbohydrate 79, 84, 238, 361, 366
carbon capture and storage 131–134,
160–161, 204–206, 379, 413–416
carbon cycle 79–87, 81
methane 99–104
carbon dioxide 79, 81, 290, 291
see also carbon capture and storage;
greenhouse effect
as feedstock 133–134, 165
atmospheric concentration 84,
90–91, 92
global warming potential **98**
sequestration 131–134, 160–161,
204–206, 379, 413–416
supercritical 241–242

- carbon intensity 43, 44
- carbon sequestration 204, 379
- carbonylation 289, 339, 343
- Carnot cycle 152–154, 286
- Carnot efficiency 153, 286, 411, 432
- carrier species 78
- carrying capacity *see* environmental burden
- Carson, Rachel 15
- CAS registry 199
- cascade reactions 222
- cash flow 261
- catalysis 125, 182, 226, 302–303
 - biological 308–310
 - biomass 344–348
 - bulk chemicals 319–320
 - catalyst lifetime 318
 - catalyst recovery 330
 - development 325–326
 - economics 326–330
 - enantioselectivity 321–323
 - enzyme 224–225, 308
 - feedstock changes 323–325
 - fine chemicals 320–321
 - heterogeneous 306–308
 - homogeneous 308
 - metathesis 207–208, 209, 210
 - organocatalysis 310
 - performance
 - measurement 312–318
 - productivity 313
 - reactor productivity 314
 - selectivity 314–316
 - sustainability 334–344
- Catholic Church 59
- Cativa process 341
- caustic soda 118
- cavitation 288
- cellulose 244–245, 285, 345, 361, 363, 371, 395
- cellulose acetate process 372
- cephalosporin C 226, 227
- CFC-12 **98**
- char 110, 379, 394, 398
- Chemical Abstracts Index (CAS) 199
- chemical processing 345
- chemiosmosis 197
- chemoselectivity 314, 315
- chlorhydrin processes 179–180
- chlorine 22–23
- chlorofluorocarbons (CFC) 336
- chloromethane 171–172
 - see also* methyl chloride
- chlorophyll 83
- cholesterol 362
- choline 244, 362
- citation analysis 442
- citation searching 453
- Clift, Roland 37
- Climategate 446–449
- cloud condensation nuclei 109
- co-products 118, 171, 176
- coal 126, 254–255, 329, 365, 377, 382, 393, **419**
- coal-tar 117–118
- coke 117–118, 318, 392–394
- combinatorial catalysis 325–326
- combined heat and power (CHP) 415–416
- combustion 393
- commodities chemicals *see* bulk chemicals
- compartment models 75, 77
- composite materials 144–145
- Congo, Democratic Republic 204
- construction materials 36
- continuous stirred tank reactor 265–266, 266
- Control of Substances Hazardous to Health (COSHH) 220–221
- conversion 174
- Copernicus, Nicolaus 59
- copper pollution 76–77
- cradle-to-grave *see* product life-cycle
- crisp packets 144–145
- Crookes, Sir William 127
- crops 14, 164, 358, 369–370
 - non-food 366–369
- cross metathesis 206
- Crutzen, Paul 11

- cups, disposable or
 reuseable 139–143
- cyanogen 310
- cycles, carbon 79–87
 also hydrological; water;
 geochemical; biogeochemical;
 nitrogen
- cyclisation 374
- cyclohexane 279
- cyclohexanol 332
- cyclohexanone oxime 279
- N*-cyclohexyl-*N*-methyl-2-
 nitrobenzenesulfonamide 305
- dams 417–418
- Darwin, Charles ix, 57, 61–62, 64
- databases 452
- DDT 15, 16, 17, 21, 22, 73, 267
- decarbonylation 374
- decarboxylation 374
- decision-making 23–24, 444–445
- Deepwater Horizon 413
- degradability 228
- dehydration 374
- dematerialisation 45, 158, 353
- depolymerisation 332–333
- derivatisation 223–226
- deserts 427
- deuterium 427–428
- dialkoxyphenylphosphines 244
- 1,2-diaminoethane 269–270, 337
- diastereomeric excess 3163
- dibutyl ketone 383
- dichlorodiphenyltrichloroethane *see*
 DDT
- dicyclopentadiene 209
- Diels-Alder reaction 176, 238–239,
 239, 246, 285, 383
- diesel *see* biofuels
- dihydroxyacetone 374
- dilactide 388, 389
- dimethyl carbonate 289, 291
- dimethyl isosorbide 369
- 2,5-dimethylfuran 377, 394–395
- diquat 64
- distributed manufacture 273
- di-*t*-butyl carbonate 337
- DuPont 242, 284, 361, 385, 387, 397
- dynamic kinetic resolution 316
- E-factor 120–122, 184, 297, 319, 320
- Earth 5–9
 atmosphere *see* atmosphere
 carrying capacity 40–45
 energy balance 90
- Earth Observing System satellite 6–7
- Earth systems science 40, 105
- Eco-Efficiency Analysis 190
- ecological footprint 47–48
- ecology 292
- economics 25–28
 biomass use 399–400, 400–401
 catalysis 326–330
 ecological 354
 environmental 354
 environmental accounting 354
 externalities 138, 354
 investment and risk 260–263
- economies of scale 256
- ecosphere 110, 159
- effect chemicals 125
- efficiency (reaction) 171–172
 atom efficiency 176–183, 219–220
- Ehrlich, Paul 14
- electricity use 234
- electrochemistry 286–287
- electrolysis 118
- electrolytes 287
- emissions 117
- enantiomeric excess 316
- enantioselectivity 315, 321
- end-of-pipe treatment 122, 335
- endofullerenes 211
- endothermic reactions 146–148
- energy intensity 43, 45
- energy mix 136, 419
- energy production 407–408, 418–420
 hydroelectricity 416–418
 primary sources 408–409
 see also biofuels; fossil fuels;
 renewable energy
- energy reserves 408

- energy sources 408–413
 energy storage 428, 432
 batteries 134–136, 431–432
 hydrogen 429–431
 energy (thermodynamic) 145, 153
 energy usage 42–43
 microwave stimulation 284–285
 minimisation in processes 223
 enthalpy 146, 146–148
 entropy 146
 waste and 149–151
 see also exergy
 environmental burden 40–45, 353, 413
 environmental chemistry 72–75
 carbon cycle 79–87
 geochemical cycling 77–79
 geology 75–77
 environmental compartments 77
 Environmental Protection Agency (EPA) 23
 Environmental Sustainability Index (ESI) 46–48
 enzymes 224–225, 308
 1,2-epoxypropane *see* propylene oxide
 esterification **282**
 ethanal *see* acetaldehyde
 ethanoic acid *see* acetic acid
 ethanol 364, 375–377
 production 160–167, **167**
 biogenic 162–165
 conventional process 161–162
 idealised process 165–166
 ethene 161, 229–230
 ethics 437
 ethylene glycol 229–230
 ethylene oxide 179–180
 ethyne *see* acetylene
 eugenol 391
 EvonikHeadwaters 182
 exergy analysis 154–160, 357
 exothermic reactions 146–148, 273
 experience curves 256–259
 Factor 4 or Factor 10 45, 130, 353
 falsifiability 57
 fatty acid methyl esters (FAME)
 366–368, 368, 371, 387
 feedback mechanisms 96, 97, 108, 109
 feedstocks 126, 323–325, 331–334, 398–399
 fermentation 375, 380, 385, 394–397
 fertility rates 11
 Feynman, Richard x
 fine chemicals 125, 263–264, 320–321, 388–390
 Fischer-Tropsch synthesis 378–379
 flow reactors 272–274
 fluid catalytic cracking (FCC) 318
 flux (geochemical) 78, 88
 see also carbon cycle; nitrogen cycle
 food crops 14, 164, 358
 as biofuel source 369–370
 footprints 46–48, 358
 formic acid 374
 fossil fuels 7, 36, 353–354, 410–416
 carbon dioxide emissions 97
 formation 254–255
 reserves 411–412
 fragmentation 374
 fructose 238, 361, 365, 366, 367, 374, 377
 fuel cells 286, 431–432
 fuels
 biogenic *see* biofuels
 fossil *see* fossil fuels
 fullerenes 208–212
 fumaric acid 384
 2,5-furandicarboxylic acid 383, 384
 furans 367
 fusion power 427–428
 Gaia hypothesis 40–41, 105–107
 see also Earth systems science
 Galileo Galilei 53, 59, 407
 gasification 393
 gasoline 164
 gate-to-grave *see* product life-cycle
 genetically modified (GM) food 8, 24, 35, 359
 geochemistry 75–77
 cycles 77–79

- geoengineering 109–110
geophysiology *see* Earth systems science
geothermal energy 408, 419, 421
Gibbs free energy 146
Glaciergate 448
Glaze, William 182, 463
Glendoe project 417
global warming 90–91, 93, 456
 see also greenhouse effect
global warming potential 97–99
glucaric acid 384
glucose 238, 285, 346, 361, 365, 374, 380, 381, 390, 391, 396, 397
glutamic acid 384
glyceraldehyde-3-phosphate 83
glycerol 346, 362, 366, 374, 375, 384, 385–387, 386
glyceryl triacetate 387
Goldacre, Ben 65, 440
Gorgias 438
green chemistry
 history 214–217
 principles 215, 216, 217–235, **218**, 462–466, **463**
 general points 235–236
Green Chemistry: Theory and Practice 216
green engineering 216, **254**
green revolution 14
greenhouse effect 93–97, 95
 see also global warming
greenhouse gases **98**, **106**
 see also carbon dioxide; methane; nitrous oxide
Greenland 76–77
gross domestic product (GDP) 27–28, 42–43

Haber process 127, 223
half-life 219
 see also persistence
Halley, Edmund 60
Handbook of Green Chemistry 216
The Happiness Hypothesis 52
hazardous materials 228–229

Headwaters Technology 182
heat 152–154
 of reaction 146–148
heat transfer 232, 273, 283
heating 281–285
heavy water 427–428
hemicellulose 361, 363
Herschel, John 53, 64
heterogeneous catalysis 306–308
high throughput methods 283, 326
homoeopathy 65
homeostasis 108
homogeneous catalysis **306**, 308
human population 10–12, 17, 35, 126–127
 environmental impact 105
Hulme, Mike 6, 52
Human Development Index 48
Hutton, James 105
hydrazine 148
hydrodesulfurisation 336–337
hydroelectricity 416–418, **419**
hydrofluorocarbons (HFC) 336–337
hydroformylation 177, 239–240
hydrogen 165, 379–380
 energy storage 429–431
hydrogen chloride 294
hydrogen peroxide 180–182, 181, 273
hydrogenation 305, 374, 375
hydrogenolysis 374
hydrological cycle 80
hydrolysis **282**, 374
hydrosphere 75
hydrothermal upgrading 393
 (S)- β -hydroxy- γ -butyrolactone 384
hydroxyl radicals 102–103, 430
5-(hydroxymethyl)furfural (5-HMF) 245, 377, 374, 378, 394
3-hydroxypropionic acid 384
p-hydroxystyrene 397
hyperdisciplinarity 25–26
hypotheses 57–58
hypsicity 190

ibuprofen 337–339, 340, 341, 342
ICI plc vi, x, 64, 126, 262, 371

- Independent on Sunday* 440–442, 441
 indigo 360
 individual actions 445–446
 industrial ecology 291–298
 Ingeo 388
 inherent safety 288–290
 intelligent design 57
 intensification *see* land-use intensification; process intensification
 Intergovernmental Panel on Climate Change (IPCC) 28, 40, 67, 79, 87, 93, 414, 448
 intermittency 420, 421
 internal combustion engine 134–136
 intrinsic waste minimisation 123
 investment 260–263, 412–413
 iodine 64
 ionic liquids 243–247
 IPAT equation 41
 isobutyraldehyde 376–377
 isocyanates 133, 289–290, 289, 293–294, 293
 isomerisation 374
 isophorone 241, 242
 isoprene 362
 itaconic acid 384
Ivory Bridges: Connecting Science and Society xii
 Jevons paradox *see* rebound effect
 Joule 407–408
 journalism 438
 Kalundborg 295, 296
 Kepler, Johannes 60
 kinetics 148, 219
 catalysis 303–306
 intrinsic 269
 Lake Kivu 204
 Kletz, Trevor 288
 Kraft process 371, 375
 Kroto, Harry 210
 Kuhn, Thomas 54–55
 Kyoto Protocol 40, 97
 L-DOPA 323, 324
 lactic acid 346, 347, 374, 387–388, 388, 389
 lactose 345
 land use 355
 land-use intensification 18–19
 landfill 6, 333
 language use 65–66
 lanolin 19
 lazabemide 337, 338
 Leblanc process 119, 292
 lecithin 362
 levoglucosan 394, 395
 levulinic acid 230, 345, 374, 383, 384
 life's origins 195–198
 life expectancy 14
 life-cycle analysis 136–143, 246, 137, 345
 cups 139–143
 light 8, 277–281
 lighting 8, 9
 lignin 244, 361, 363, 364, 371, 382
 lignocellulose 361, 366, 376, 382
 limonene 362, 371
 Linnaeus, Carl 61
 linoleic acid 371
 lipids 361
 liquid chromatography 316
 literature searches 451–454
 lithosphere 75
 load factor 417, 421
 Lovelock, James 67, 105
 Lucite International 343
 maize 369
 malaria 21
 maleic anhydride 285
 malic acid 384
 Malthus, Thomas 10, 27
 market economies 26
 market mechanism 354
 Mars 107–108, 107
 Masdar City 291
 mass balance 102, 173–174, 231
 mass conservation 173–174
 mass production 356–358

- mass transfer 232, 271
materials design 219–220
Medawar, P. B. 54
media 454–456
media communication 5, 13–14,
22–23, 439–440, 446–448
Mendeleev, Dmitri 62
L-menthol 326
Merkel, Angela 37
Merton, Robert 55, 437
mesosphere 89
Metabolix 371
metals 398
metathesis 206–207, 209, 210, 303
methane 99–104, 100, **101**, 132, 133,
329–330
 global warming potential **98**
methanol 294, 329, 329–330, 339
methoxybenzene *see* anisole
methoxycarbonylation 343
methyl chloride 171–172, 294
 see also chloromethane
methyl isocyanate 268
methyl methacrylate 343–344
methyl-*tert*-butyl ether (MTBE) 276
2-methyl-5-ethylpyridine 338
2-methyl-5-ethylaniline 328
metolachlor 327, 328
metrics 170–171, 189–192, 202
 atom efficiency 176–183
 balance yield 184–188
 catalyst productivity 313–314
 conversion 174–175
 mass balance 173–174
 reaction mass efficiency 188–190
 reaction yield 171–173
 see also E-factor; Eco-Efficiency
 Analysis; productivity
microbial biomass 371
microreactors 273–274
microwaves 281–285
Miscanthus giganteus 370
mixed economies 26–27
mixing 268–271, 274–275
mixing ratio 84, 104
MMR vaccine 439
molten salts *see* ionic liquids
Monsanto 287, 339
Montreal Protocol 104, 126, 336
Müller, Paul 21
myrcene 362
nanotechnology 121
National Renewable Energy
 Laboratory 382, 426
natural products 21–22, 359–361
Nature 23, 194, 454, 455
Nature Chemistry 194–195
net primary production (NPP) 84, 355
Newton, Isaac 60
nicotinamide adenine dinucleotide
 (NAD) 375
nicotinamide adenine dinucleotide
 phosphate (NADP) 375
nitric acid 271
nitrogen cycle 104
nitrogen fixation 127–128, 224–225
nitrogen oxides (NO_x) 128
nitroglycerine 271
nitrous oxide **98**, 104, **105**, 231,
331–332
Nobel Prizes 14, 21, 40, 196, 197, 206,
223, 323
 fullerenes 208–213
 metathesis 206–207
nuclear fission 418
nuclear fusion 427–428
nuclear spin 63, 430
nucleic acids 196
nucleophile substitution **282**
oil 255, 411–412
 biogenic 379
 see also fossil energy; plant-seed oils
olaparib 259–260
oleic acid 371
oleum 271
open-mindedness 443–444
ores 36
Organisation of Petroleum Exporting
 Countries (OPEC) 412–413
organocatalysis 310

- Orgel, Leslie 196
On the Origin of Species 61–62, 64
oseltamivir phosphate 202–204, 203, 205
Oxford English Dictionary 214
oxidation **282**
oxidation level index 190
oxygen 235
oxygen-evolving complex 281
ozone 89, 102, 311
- packaging 144–145
paclitaxel 213–214
palmitic acid 367
Paracelsus 221
patenting 264–265, 320
peak oil 411–412
peer review 30, 58–59
Pelamis 'sea snake' 422–423
periodic table 62–63, 62
persistence (of products) 228
Peru 23
PET *see* poly(ethylene terephthalate)
petrochemicals 391–392
petrol (gasoline) 164, 369, 376, 378, 410
Pfizer 262
pharmaceuticals 21–22, 262, 265, 316, 320–321, 388–390
phenol 331–332
1-phenylethanol 179
phosgene 268, 289, 294
phosphatidic acid 362
photochemistry 277–281
photosynthesis 79, 83, 84, 153, 224–225, 254, 281, 358, 361
photovoltaics 134–136, 424–427, 429–430
phytoplankton 79
phytoremediation 378, 398
pilot plants 255
 α -pinene 274–275, 362, 371
planetary motion 60
plant-seed oils 366–369
platform chemicals 382–388
Plato 438
pollution 73–75, 118–120
 Greenland 76–77
 see also waste
Pollution Prevention Act (US) 215
polymers 332–334, 347, 388
poly(alkylenes) 334
polyesters 347, 348
poly(ethylene terephthalate) (PET) 18–19, 333–334, 385
poly(hydroxyalkanoates) (PHA) 371
poly(hydroxybutyrate) (PHB) 21, 371
poly(lactic acid) (PLA) 346, 388, 389
poly(trimethylene terephthalate) 385–387
poly(vinyl chloride) (PVC) 118
Popper, Karl 54–55, 59–63
population growth 10–12, 17, 35, 126–127
potassium permanganate 235
power density 422
power generation *see* energy generation
prebiotic chemistry 195–199
precautionary principle 20, 120, 235
Presidential Green Chemistry Challenge Awards 182, 213–214, **213**, 236, 345, 346, 371, 394
previtamin D₃ 279
primary sources 66, 452–453
process chemistry 183–184
 balance yield 184–188
 reaction mass efficiency 188–189
process choice 234
process engineering 255–256, 465
process integration 290–298, 397–398
process intensification 272–273
 microreactors 273–274
 reactive distillation 275–276
 spinning disc reactor 274–275
process monitoring 228
product development 256–258, 263–264
product life-cycle 136–143, 137
productivity 230, 312
prop-2-enoic acid *see* acrylic acid
propan-1,2-diol 374

- propane 324–325
1,2-propanediol 346
1,3-propanediol 21, 387
propionaldehyde 177
propylene glycol 389
propylene oxide 180
protection/deprotection 223, 225–226
proteins 196, 311–312
public debate 13
public perception 439–443
pyrolysis 394
2-pyrone-4,6-dicarboxylic acid 347,
348, 383
pyruvic acid 374
- quinine 225–226
- radiative forcing *see* global warming
potential
- raw materials 223
- REACH programme 263–264
- reaction mass efficiency (RME)
188–189
- reactions
enantioselectivity 321–323
heat 146–148
mass efficiency 188–189
rates 330–331
sequence 267–268
stimuli 276–288
yield 171–173
see also catalysis
- reactive distillation 275–276, 385
- rebound effect 44
- recycling 332–334
carpet material 333–334
- reductionism 54
- regioselectivity 315
- regulation 336–337
- remediation 122, 335, 378
- renewable energy 344–348, 418–428
possibility of reliance
upon 357–359
problems 420
see also biomass
- renewable feedstocks 345, 354
- reporting 466
- reproducibility 56
- residence time 78
- retrofitting 122–123
- rhetoric 438–439
- β -ribocytidine-2',3',-cyclic
phosphate 198
- riboflavin 308–310, 309
- ribonucleotides 197, 198
- ring-opening polymerisation
metathesis (ROMP) 207, 209
- risk 220, 228, 260–263
- Royal Society 59
- Rubik cube 151
- rubisco 79
- safety 234–235, 288–290
- St. John's Wort 21
- salinity gradient energy 417–418
- salt 73
see also sodium chloride
- satellite imaging 6–8
- scale-up 233, 255, 256, 273, 284, 344,
465
- scepticism 200–201, 443–444, 456
- Schiff bases 22
- Schneider, S. H. 446
- science
activism and advocacy 446
bad practice 64–65
Climategate 446–449
definition 52–56
ethics 437
historic successes 60–63
information 58–59
laws 57
logic and fairness 444–445
method 56–57
public presentation 13–14, 64–65,
439–443, 454–456
technology and 59–63
use of language 65–66
see also environmental science
- Science* (journal) 66, 194, 448, 454
- Science Wars 13, 438
- scientific method 56–57

- SciFinder 451
 Scopus 451
 sea level **107**
 searching 451–454
 seaweed 371–373
 security of supply 332, 401
 selectivity 175–176, 321, 464
 catalysis 314–316
 semiconductors 424
 sequestration 130, 204, 413–414
 serpentinisation 197
 sertraline 236, 237, 316, 317
 Severn (river) 423
 sheep 18–19, 20
 shikimic acid 202, 389, 391
Silent Spring 15
 sinks (geochemical) 78
 carbon dioxide **81**
 methane **101**
 Snow, John 67
 soda ash 119
 sodium carbonate *see* soda ash
 sodium chloride 73
 see also salt
 sodium hydroxide *see* caustic soda
 solar constant 88
 solar energy 87–93, 163, 408,
 424–427
 photochemistry 277
 radiation flux 88
 see also solar energy
 solid-phase synthesis 222
 Solomon, Susan 456
 solventless processes 222
 solvents 22, 236–237
 ionic liquids 243–247
 supercritical fluids 240–242
 see also water
 sonochemistry 287–288
 sorbitol 94, 370, 374, 384
 sound 287–288
 sources (geochemical) 78
 South Korea 43
 soya beans 356
 space-time yield 230, 314
 sperm counts 440–442
 spinning disc reactor 274–275
 state functions 145
 statistics 66–68
 steam reforming 328, 377, 379,
 429
 stereoselectivity 315–316
 Stern review 25, 27, 28
 steroids 361
 stratosphere 89
 succinic acid 384
 sucrose 361, 365, 385
 sugar cane 369–370
 sugars 365, 394–396
 see also glucose
 sulfur hexafluoride **98**
 sulfur oxides 128
 sulfur-iodine cycle 429–430
 supercritical fluids 240–242
 supported catalysts 307
*Sustainable energy – without the hot
 air* 407, 446
 sustainability 35–40, 37, 158–160,
 355, 465
 catalysis and 318–319
 sustainable development
 definition 37–38
 economics 25–28, 27–29
 role of experts 28–30
 switchgrass 370
 synthesis gas 133, 328–329, 378
 biogenic 377–379
 tall oil fatty acids 375
 tame problems 24
 Tamiflu 202–204, 203, 205, 225
 Tate & Lyle plc 361, 387
 Taxol 213–214
 technology 8–9, 59, 63–64
 development 259–260
 technosphere 110, 159
 terpenes 362, 370–371, 382
 terpinolene 362
 tetrahydrofurans 367
 thalidomide 321–323
 thermochemistry 146–148, 232, 364,
 365

- thermodynamics 129–130, 143–148
 entropy 149–151
 exergy 154–157
 second law 145, 150
 work 152–154
- thermosphere 88
- thiourea 316
- Thomas Swann & Co. 242
- Three Gorges Dam 417
- tidal power 423–424
- time horizon *see* global warming
 potential
- time-to-market 320–321
- timescales for technology
 deployment 63, 259, 414, 426
- tipping point 9
- tipranavir 207, 210
- p*-toluidine 222
- Toray process 279
- torcetrapib 262
- toxicity 22, 220–221, 222
- transmaterialisation 45, 158, 353
- transport 134–136, 364, 393, 401,
 430–431
- tricyclo[6.2.1.0]undec-9-en-3-one
 177
- triglycerides 362, 368, 371, 375
- trilemma 9–10
- tripeptides 311
- tritium 428
- trophic levels 71
- troposphere 89
- turn-over frequency (tof) 313–314
- turn-over number (ton) 313
- turpentine 371
- ultraviolet radiation 277
- uncertainty 66
- United States, energy usage 43,
 409
- The Unnatural Nature of Science*
 53
- utilities 465–466
- valerolactone 230, 374, 383, 385
- o*-vanillin 222, 389–390, 391
- Vega Science Trust v, 223
- Venus 107–108, 107
- vinyl chloride 294
- Virent Energy Systems 394
- viscose process 372
- vitamin D₃ 279, 280
- Warner, J. C. 216, 218
- waste 129–130, 218–219
 definition 116–117
 entropy and 149–151
 as feedstock 331–334
 historical trends 126–128
 laboratory 235
 minimisation *see* waste
 minimisation
- Waste Framework Directive (EU)
 116
- waste minimisation 122–123,
 217–219, 288–290
 bulk chemicals 124–125
 fine chemicals 125
 hierarchy 123–125
 industrial ecology 290–298
- water
 chlorination 23
 hydrolysis 165
 as solvent 238–240
 usage 46, 47, 234
 see also hydroelectric power
- water footprint 46, 358
- water-gas shift reaction 328, 339,
 429
- Watergate 447
- wave power 422–423
- waxes 362
- wealth creation 27
- Web of Knowledge 451, 452
- Weinberg, Steve 55
- wicked problems 23–24, 357, 444
- Wieland-Miescher ketone 310, 311
- Wiener, Norbert 17, 194
- Wilson, E. O. 52
- Wilson, Paul 13
- wind power 419, 421–422
- wood 370–371, 390

- wool 19
- work 152–154, 155–156
 - see also* exergy
- World Health Organization 21

- xylitol 384
- xylose 361

- yew trees 213–214
- yield 171–173
 - balance 184–188

- Zambia 24
- zeolite 318, 329, 334, 382, 448
- Ziman J 55, 437