

Index

A

- abduction 132–137, 145
- absorber theory of radiation 283
- abstract entities
 - epistemology and 103
 - information as 5–6, 57, 331–334
 - in the mind 157, 304
 - metaphysics and 17, 25
 - ontology and 55
 - universals as 120
- acausality 71–77, 152, 172, 255
- action-at-a-distance 132–137, 233, 377
- actualism 23, 28–30, 107–117
- actual possible 25–27
- adenosine triphosphate (ATP) 323–326
- adequate determinism
 - as result of averaging 7, 198, 308
 - as statistical 219
 - detailed balancing and 291
 - free will and 68–69, 70–77, 163, 172, 247, 385
 - mental causation and 187
 - mind and 157, 189–198
 - physical laws and 218
- Aenesidemus 108
- agent causality 63, 76–77, 172
- Alexander, Samuel 298
- Allen, Woody 101
- Alston, William 114
- alternative possibilities
 - animals have 82
 - as agenda in mind 221–222
 - as metaphysical 27
 - come to mind 187
 - free will and 22, 70–77, 332–335, 392–393
 - Harry Frankfurt denied 113
 - in cosmic creation 412–415
 - past experiences as 405–407
 - quantum chance and 66, 157, 163
 - R. E. Hobart and 220–221
 - Schrödinger's cat and 274
 - the will evaluating 172
 - William James on 385
- amino acids 181
- analytic language philosophy
 - analytic-synthetic distinction 110, 122
 - as ambiguous 20
 - as language game 17, 103, 331
 - attack on metaphysics 53
 - causa sui an oxymoron 217–220
 - not philosophy of language 420
 - paradoxes of xiii
 - pseudo problems of 132
- Annas, Julia 64
- a posteriori* 29, 111–115, 150
- a priori*
 - as science foundation 116
 - Bertrand Russell on 219
 - epistemology and 107–111
 - information philosophy and xiii, 331–334
 - Kant and 111
 - metaphysics and 18–19, 28
 - mind and 150
- Aquinas 131
- Arceilaus 108
- Aristotle
 - determinism and 218, 223
 - entelechy and 12
 - epistemology and 104
 - mind and 151–153, 156
 - on being 19
 - on chance and free will 67–70, 379
 - on essentialism 41–42
 - on metaphysics 35–39, 50
 - on the good 80
 - on time 279
 - ontology and 55
 - on universals 119
- Armstrong, David 114
- Arrow, Kenneth 92
- arrow of time
 - cosmological arrow 277, 283
 - decoherence and 251, 254–257
 - growth of information 338, 343
 - historical arrow 281
 - irreversibility and 285
 - radiation arrow 282
 - thermodynamic arrow 277
- Aspect, Alain 238
- association of ideas 167, 173, 398
- atheism 68, 99, 382, 384
- ATP synthase 184–187, 321–329
- Augustine 185
- autocatalytic 314–317
- axiom of measurement 190, 192, 201, 234, 252–255, 367–372



Ayer, A. J. xi, 112–116

B

Baade, Walter 414–417
 Baars, Bernard 69, 70, 167, 403
 Bacon, Francis 83–89, 131
 Barthes, Roland 141
 Bauer, Edmond 212
 becoming 19
 behaviorism 141, 148
 being 19, 41, 50–52, 106
 Bell inequalities 237, 238
 Bell, John Stewart
 decoherence and 253–256
 on entanglement 245–247
 on his inequalities 237
 on measurement 213
 on observables and beables 192
 on the shifty split 211, 259
 Belsham, William 222
 Bergson, Henri 300
 Bertalanffy, Ludwig von 334–337
 beyond logic and language 153, 419–421
 binding problem 166, 168, 398
 biocommunications 41, 319–322, 419–421
 biological information processor 12–13, 141,
 148, 311–314, 320–323
 biological machines 319–329
 biosemiotics 20, 63, 419–421
 birefringent crystal 207–212
 blackboard model 69, 167
 Black, Max 32
 Bohm, David 213, 235, 237, 239, 253–256,
 266–267
 Bohr atom 135, 364, 387
 Bohr, Niels
 and Lord Rutherford 387
 denied light quanta 353
 measurement problem and 212
 on Copenhagen Interpretation 192, 201
 on Correspondence Principle 193, 198
 on decoherence 249–252, 258–261
 on free choice of experimenter 246–247
 on universals 123
 quantum postulates of 269
 uncertainty principle and 203
 von Neumann processes and 205
 Bois-Reymond, Emil du 223
 Boltzmann constant 334, 351

Boltzmann entropy
 arrow of time and 277
 cosmic creation and 413
 flows of 354
 measurement and 203, 209
 recurrence and 294
 Shannon entropy and 350
 Boltzmann, Ludwig
 arrow of time and 277
 Boltzmann factor and 290, 346, 352, 361
 Boltzmann principle 290
 H-Theorem of 93, 285, 334–337
 Loschmidt reversibility and 260–267
 on entropy increase 413–416
 on existence of atoms 46, 52–53, 134, 362
 on gas laws 161, 345, 382
 Born, Max , 250–253, 365, 376, 383
 Born rule 367–368
 bottom-up 160, 180, 186, 297, 306
 Brahe, Tycho 131
 Brentano, Franz 144
 Brillouin, Leon 278, 334–337
 British empiricists 121, 180
 Broad, C.D. 299
 Brownian motion 345
 Brown, Robert 134
 Buckle, Henry Thomas 348, 382
 Burke, Michael 34

C

Cajal, Santiago Ramón y 396
 calculus of probabilities 345, 381
 Calvin, Melvin 313
 Campbell, Donald 64, 177
 Campbell, Jeremy 319
 Carnap, Rudolf 52–53, 112–116, 126, 144, 159
 Carneades 108
 Cartesian theater 167
 carving nature at joints 44, 58, 126–129
 Cassirer, Ernst 211, 223
 causal closure
 bottom up 186, 297–298
 eliminative materialism and 172
 mental causation and 187
 of physical world xi
 philosophy of mind and 148
 causality
 agent. *See* agent causality
 Aristotle on 106



- determinism and 218
- event. *See* event causality
- mind as causal force 21, 57, 155
- causa sui* 69, 217, 218, 380, 386
- certainty 18–53, 110–114, 122–129, 190–195, 218, 231
- Chaisson, Eric 354
- Chalmers, David 22, 162, 168
- chance 379–393
 - as atheistic 68, 99
 - as fifth cause 106, 129, 379
 - as greedy in Darwin 420
 - as ontological 196–199, 335, 354, 409
 - as real 5, 345
- calculus of probabilities and 381
- cosmic creation and 412
- C. S. Peirce and 420
- De Moivre doctrine of 382
- determinism and 217
- Einstein's discovery of 291, 354, 369, 376, 388
- Epicurus on 379
- free will and 64, 76–77, 392
- God and 99
- metaphysics and 15
- ontology and 57
- open future and 219
- origin of life and 315, 322–325
- physicists on 261, 365
- Schrödinger's cat and 272
- second law and 382
- von Neumann process and 370
- chaperone 305, 318–329
- character 70, 73, 157, 163, 172, 221, 401
- chemiosmosis 323, 328
- Chisholm, Roderick 34, 40, 63, 114
- Chrysippus 34, 67, 109–113, 380
- Churchlands, Paul and Patricia 162
- Cicero, Marcus Tullius 108
- citric acid cycle 314, 329
- Clarke, Randolph 63
- Clauser, John 238
- coarse-grained 347, 350, 352
- codon 318
- Cogito 66, 109–113, 171
- cognitive science 12, 147, 340
- coinciding objects 33–35
- collapse of the wave function 225–231
 - actualizing a possibility 25, 190, 195–196
 - cosmic creation and 412
 - decoherence and 252–257
 - Einstein and 363
 - entanglement and 233, 235, 237, 240
 - irreversibility and 285
 - many worlds split by 29
 - measurement and 201
 - von Neumann process and 205
- colocation 33–35
- communication 10, 19
- community of inquirers 405–407
- compatibilism 67, 76–77, 157, 218, 223
- complementarity 123–129, 201
- complex adaptive system 313
- composition 39, 43
- Compton, Arthur Holly 64–66
- computational mind 148, 185, 311–314, 395–398
- computer model 332–335
- Comte, August 52
- concept of mind 153
- conceptual analysis 20–53
- connectionist 165, 171
- consciousness 165–169
 - binding problem and 166
 - emergence of 304
 - ERR and 395–398, 401–404
 - hard problem of 3, 22, 153, 341
 - measurement and 212
 - mind and 147, 151
 - mind-body and 157
 - self and 171, 173
 - Theater of 69
- conscious observer
 - biosemiotics and 420
 - dependence on 391
 - measurement by 189, 207, 210–214, 257–258
 - required 190, 198–199, 225
- conservation laws 240–243
- constitution 43, 44
- content-addressable memory 396
- contingency xiii, 23–25, 29, 49, 331–334
- continuity 7, 43, 46, 48, 58, 377
 - or discreteness 58
- Conway, John 246–247
- Copenhagen interpretation 189, 190, 192–195, 201, 241, 252–255, 377, 391
- copy theory 120
- correspondence principle 193, 197, 203–206, 267



- correspondence theory xiii, 6, 331–334
- cosmic creation process 409–417
- all information created by 10, 341
 - emergence and 297, 304
 - free will and 332
 - God and 98, 98–101
 - information structures and 191–192
 - measurement and 210–213
 - mind and 149
 - mind-body and 155
 - value and 86
- cosmology 50
- flatness problem 414
 - horizon problem 417
 - missing mass 416
- creativity 11–13, 64, 71–77, 81–89, 133–137, 157, 304
- Crick, Francis 162
- criterion
- for essence 32
 - for identity 31
- crystallization 413
- cybernetics 334
- D**
- Dalton, John 134
- Darwin, Charles 80–89
- Davidson, Donald 162, 177
- Davies, P. C. W. 245
- De Broglie, Louis 364, 377
- decoherence 249–267
- cosmic creation and 413
 - denies projection postulate 369
 - measurement and 194, 202
 - what's right with 261
 - what's wrong with 263
- deduction 132
- de-liberation 71
- Democritus 218, 347, 379
- De Moivre, Abraham 382
- Dennett, Daniel 28, 64–67, 162, 167, 403
- Derrida, Jacques 122, 140, 144
- Descartes, René
- knowledge and 51, 109
 - mind-body and 152, 156, 160
 - on Newton 237
 - reflex arc and 171
 - substances and 177, 304
 - value as Ergo and 83–84
- detailed balancing 290
- determination 217
- determinism 217–223
- adequate. *See* adequate determinism
 - chance and 379, 392
 - decoherence and 255
 - determination and 220
 - emergence of 186, 222, 297, 307, 342
 - free will and 66–69
 - history of 222
 - illusion of 5
 - indeterminism and 219
 - in physics 48–49
 - laws of motion and 190
 - measuring apparatus and 189
 - one future of. *See* one possible future
 - philosophers on 28, 110–114
 - return of 204, 365, 377
 - Schrödinger's cat and 269
 - statistical. *See* statistical determinism
 - superdeterminism and 245
 - time when no 308
- Dewey, John 112
- DeWitt, Bryce 253
- Diodorus Cronus 28, 107–111
- Dion and Theon 15, 34–36
- Dirac 3-polarizers 193, 238, 273, 275
- Dirac, P.A.M.
- projection postulate of 201, 214, 225, 234, 261
 - quantum mechanics and 250–253, 366–374
 - superposition and 270
- discovery 18, 21, 56, 98–101, 120–129
- discreteness 58, 336. *See also* continuity
- dissipative systems 313, 409–412
- DNA 80–89, 181–187, 194, 314–317
- Donald, Merlin 127, 150
- downward causation 160, 177, 187, 298, 303, 305
- Dretske, Fred 114
- Driesch, Hans 300
- dual-aspect 162
- dualisms 155, 162, 172, 304
- in metaphysics 49–50
- Duns Scotus, John 51–53
- dynamic information model 6, 7, 48, 332–335
- E**
- Eccles, John 157, 162
- Eddington, Arthur Stanley 277, 285, 295, 337–340



- Edwards, Jonathan 42
- Ego 171, 259–262
- Ehrenfest Theorems 252
- Eigen, Manfred 313
- eigenstate 192, 205–208
- einselection 252
- Einstein, Albert
- atoms existence proven by 46, 52
 - blackbody radiation and 353, 376
 - Bohr and 203
 - Bohr atom and 364
 - Born rule and 366
 - Brownian motion and 345
 - critic of quantum theory, as 217
 - determinism return and 365
 - discoveries in quantum mechanics 235
 - entanglement and 233, 377
 - father of quantum theory, as 354
 - fluctuations and 93
 - ghost field 365, 377
 - God and dice and 261, 354, 369, 384
 - incoming spherical waves and 282
 - induction failure and 134
 - light quantum hypothesis of 361–364, 377
 - local reality and 234
 - Maxwell-Boltzmann and 353
 - nonlocality and , 229
 - nonseparability and 234, 377
 - on faster than light 256
 - ontological chance and 99, 196, 261, 412–415
 - photoelectric effect and 362
 - Podolsky and Rosen and 235, 264
 - quantum statistics and 377
 - Schrödinger's cat and 269
 - transition probabilities and 377
 - visualization of reality and 192
 - wave-particle duality and 363, 377
- Einstein-Podolsky-Rosen 204, 231, 233, 237, 240
- electrochemical gradient 326
- electron transfer chain 328
- eliminative materialism 17, 23, 55, 148, 159–163, 172
- embodiment 92–95, 155, 163, 178, 185, 332–335
- emergence 297–309
- biological machines as 184
 - determinism as 220, 222, 307–308
 - dualisms and 162
 - ERR and 404
 - higher-level properties and 160
 - laws of motion and 190–193
 - major emergences 149–150
 - mental causation and 177
 - mind from matter as 179–180
 - of determinism 186
 - origin of life as 311
 - thoughts as emerging 63
 - three kinds of 339
- emotions 167
- empiricism
- British 51, 180
 - logical 112, 132
 - naturalism and 19
- endurance 60
- energy
- ATP carriers of 321–325
 - Boltzmann factor and 352
 - communicates information 16, 343
 - conserved 12, 16, 55, 155, 240
 - flows 354
 - free 313
 - levels in Bohr atom 269, 353, 364
 - matter converted to 43
 - mental causation and 185
 - momentum and 388
 - quanta of 353, 361, 363
 - solar 358
- entanglement 233–247
- decoherence and 252, 264
 - Einstein's discovery of 377
 - instantaneous information and 231
 - Schrödinger's cat and 269–270
- entelechy 12, 45, 301, 303
- entropy
- arrow of time and 277–283
 - Boltzmann. *See* Boltzmann
 - information and 334–337, 342
 - irreversibility and 288
 - mind-body and 155
 - negative. *See* negative entropy
 - second law and 7–9, 345–359
 - Shannon. *See* Shannon
 - value and 81–89
- Epicurus 64, 223, 379
- epiphenomenal 148, 160, 162, 174, 298
- epistemology 103–117
- history of 104



internalist 109
 metaphysics and 17, 106
 naturalized 115, 141
 other minds and 174
 Schrödinger's cat and 272
 equilibrium 409
 Ergo 83–89, 100, 171, 343
 Ergod 83–89, 100
 ergodic 84–89, 100, 311–314, 341, 411–414
 ERR. *See* experience recorder and reproducer
 error detection 421
 essentialism 16, 32, 42, 45–47, 331–334
 ethics 79–89
 event causality 63
 Everett III, Hugh 29, 42, 76, 225, 253–256, 267, 369
 Evil 91–95, 98
 evolution
 chance element in 315–318
 emergent 303
 ERR and 403
 metaphysics and 22
 mind and 149
 story of 311–314
 teleonomy in 41
 universe and 312
 excluded middle 106
 existentialism 79–89
 Exner, Franz 383
 experience recorder and reproducer 395–407
 binding problem and 398
 consciousness and 165, 401
 Donald Hebb and 6
 epistemology and 116
 free will and 63, 70
 ideas and 33
 material change and 358
 meaning and 139, 141, 144
 meanings of words and 48
 mind and 151, 405
 mind-body and 163
 neural correlates and 187
 self and 171–173
 speed and power of 399
 value and 82
 what it's like to be 405
 workings of 400
 extensionalism 32, 141, 145

external world
 alternative possibilities and 74
 epistemology and 107, 116, 153
 metaphysics and 21
 ontology and 56
 self and 173
 extrinsic information 30–35
F
 faster-than-light 61, 204–207, 230, 233, 234, 235, 256
 fatalism 218
 Feigl, Herbert 159, 162, 186, 309
 Feynman, Richard 226, 234, 270, 283, 345, 417
 Fischer, John Martin 64
 Fisher, R.A. 142
 Fitch, F. B. 24
 flagellum 321–329
 flatness problem 414
 flows
 communicating information 145, 333
 matter and energy 9, 12, 311, 317
 negative and positive entropy 313, 339, 354
 Foot, Phillipa 220
 form 5–8, 91, 119, 331–334
 Fouillée, Alfred 384
 Fox, George 328
 Frankfurt cases 113
 Frankfurt, Harry 113
 free choice of experimenter 195, 246, 250–253
 free creation 71, 137
 of human mind xvii, 134
 Freedman, Stuart j. 238
 freedom 67
 free energy 311–313, 354–357
 free will 63–77
 alternative possibilities and 74
 behaviorists denied 148
 chance and 385, 392
 creativity and 77
 determinism and 217–220
 emergence and 304
 information and 332, 342
 temporal sequence in 71
 two-stage model of 64
 Free Will Theorem 246–247
 Frege, Gottlob 9–13, 33, 126, 140, 144, 419–421
 fundamental question 280, 409–412



G

- Gabor, Dennis 142
 galaxies, stars, and planets
 cosmic creation and 11, 410–413
 downward causation and 180
 emergence of 304
 entropy and 341, 356
 measurement and 203
 mind and 153
 open universe and 8
 origins of 311–314, 316
 self-organization of 150
 Gatlin, Lila 314
 Geiger counter 202, 271
 genetic code 328
 geophysics 312
 Georgescu-Roegen, Nicolas 89
 Gettier, Edmund 113–114
 Gettier problems 113
 ghost in the machine 147, 157, 171, 304, 340
 Gibbs, J. Willard 279, 287
 Gifford Lectures 300
 Gisin, Nicolas 239, 245
 Global Workspace Theory 69, 167, 403
 God 97–101
 Aristotle's 50–53
 causa sui and 386
 chance and 68, 382
 determinism and 218
 Ergod and 99
 existence of 98
 foreknowledge of 336
 Kant and 147
 occasionalists and 162
 omniscience of 99
 theodicy and 98
 value and 79
 God does not play dice 261, 354, 369, 376, 390
 Goldman, Alvin 114
 Good 79, 91–95, 97, 150
 Google xviii, 396–399
 Gottfried, Kurt 250–253
 Great Year 293
 Grice, H. P. 141
 Growing Argument 15
 Guth, Alan 416

H

- Hadamard, Jacques 64
 Haldane, J.B.S. 313
 Hameroff, Stuart 162
 Hamilton, Sir William 223
 hard determinism 69
 hard problem. *See* consciousness
 Hartman, Hyman 328
 heat death 337–340, 355
 Hebb, Donald 6, 165, 397, 406–407
 Heidegger, Martin 21, 64, 122
 Heil, John 177
 Heisenberg, Werner
 on classical world 198
 on free choice 162, 212
 on observables 135
 on the cut (Schnitt) 193, 210, 249–252
 on visualization 192
 uncertainty principle of 202, 205, 307, 390
 Helmholtz, Hermann 337–340
 hidden variables 198, 204–207, 217, 237, 238,
 369
 history 9
 Holt, Richard 238
 Homer 101
 horizon problem 417
 Horne, Michael 238
 H-Theorem 93, 285–291, 287, 334–337, 351,
 383
 Hubble, Edwin 277, 414–417
 human ignorance xvii, 99, 379, 381, 382
 Hume, David
 on bundle theory of self 173–174
 on causality 219
 on chance and necessity 386
 on induction 131
 on metaphysics 110
 on naturalism and determinism 21, 84
 on “ought” from “is” 79
 on primary and secondary experience 121
 on religion 108
 on uniformity of nature 136
 Husserl, Edmund 32, 144
 hydrophobic 326
 hydrophylic 326
 hypothetico-deductive method 133



- I**
- icon 145
 - idealism 16–19, 49–50, 92, 155, 331–334
 - identity
 - Aristotle on 106–107
 - criterion for 31
 - relative 30
 - self- 30
 - transworld 24
 - illusion
 - determinism as 5, 345
 - free will as 77
 - metaphysics as 51
 - mind as 158, 298
 - Immanuel Kant
 - on noumena and phenomena 147
 - immaterial
 - abstract entities as 57
 - arrangement as 16
 - concepts, thoughts as 86, 172
 - Ego or self as 171
 - God as 97
 - human spirit as 52
 - hypothesis as 133
 - information as xiii, 3, 117, 306
 - mind as 63, 141, 147, 150, 155
 - Plato's forms as 91
 - probability and possibilities as 366
 - soul and spirit as 377
 - immortality 52–53, 86–89, 97–101, 147
 - indeterminacy
 - causa sui and 69
 - Heisenberg principle and 201, 265, 286, 307
 - ontological chance and 390
 - indeterminism 219–220
 - alternative possibilities and 74–75
 - as averaged over 198
 - as “true” 67, 380, 392
 - Dennett rejects 66
 - Descartes on 147
 - determinism and 217
 - Einstein and 377, 387, 391
 - free will and 75–76, 247
 - in biology 321
 - open futures and 412
 - quantum mechanics and 189
 - self and 171
 - some physicists deny 377
 - unhelpful in mind 160
 - von Neumann Process 1 and 370
 - indistinguishable 236, 240, 266–267, 270
 - induction 110–117, 131–137
 - information 331–343
 - age 149
 - consciousness 165, 402
 - generation 191, 313–316
 - immortality and 101
 - in biology 317–326, 419–421
 - intrinsic and extrinsic 30
 - negative entropy and 334, 342
 - not a conserved quantity 155, 191
 - objective value as 84
 - ontology and 55
 - origins of 311
 - out of order 306, 340
 - processing xi, 82
 - science 340
 - theory 340
 - information interpretation of quantum
 - mechanics 189–199, 234, 254–257
 - information philosophy
 - defined 3–4
 - three worlds of 9–13
 - information structures
 - arrangements of matter 155
 - as objective value 85–89, 92
 - biological machines as 319
 - brain as 141, 185
 - chaperones as 326
 - creation of 13, 94, 354–356, 411–414
 - dynamic models of 7, 48, 331–338
 - elementary particles as 356
 - emergence of 11, 198, 297, 302
 - ERR and 151, 166, 400
 - experiments and 133, 370
 - fundamental question and 280, 409
 - galaxies, stars, planets as 8, 46, 150, 153
 - good as embodied in 92
 - guides to action 404
 - in measurements 192–193
 - knowledge in mind as 21, 117, 158, 174, 185
 - life as 150
 - material objects as 120
 - negative entropy as 191–192
 - origins of 311–316
 - recorded experiences as 166
 - value to preserve 83
 - instinct 82, 169, 299, 403



intention 141, 333–336, 404–407
 interactionism 156, 162, 163
 interactor 48–49, 317
 internalism 109–113, 114
 interpretant 144, 145
 interpretations
 Copenhagen. *See* Copenhagen interpretation
 of signs. *See* biosemiotics
 other, of quantum mechanics 198
 statistical. *See* statistical interpretation
 intersubjective agreement 48, 111–117, 175
 intrinsic information 30–35, 49
 introspection 106–107, 110, 148, 151, 404. *See*
 also reflection
 invention 15, 18, 21, 56, 120–129
 ion pump 183, 306, 321–324
 iron-sulfur 328
 irreversibility 285–291
 arrow of time and 277
 cosmic creation and 413
 decoherence and 252–255, 257–260
 in measurements 208
 Loschmidt objection to 351
 quantum mechanics and 189
 von Neumann Process and 371
 isomorphism
 as experimental evidence 133
 as metaphysical facts 21
 correspondence theory and 117
 epistemology and 103
 in concepts 33
 knowledge as 5, 17, 153, 174, 331–334
 representation as 56

J

Jakobson, Roman 143, 421
 James, William
 on alternative possibilities 385
 on antipathy to chance 261, 274
 on compatibilism 218
 on dilemma of determinism 223
 on looseness in joints 180
 on neutral monism 161
 on stream of consciousness 167, 399
 on two-stage model of free will 64
 on unconsciousness 405
 Joos, Erich 251–254, 260–267
 Jordan, Pascual 192, 250–253

K

Kane, Robert 63–66, 68, 76–77
 Kant, Immanuel
 on a priori reason 52
 on deterministic social laws 382
 on Hume skepticism 110–111
 on noumena and phenomena 91, 121, 152
 on scandal in philosophy 116
 Kelvin, Lord 223, 334–337
 Kepler, Johannes 131
 Kim, Jaegwon 15–53, 160, 162, 178, 186
 kleos 101
 knowledge 5, 103–117, 119, 139, 331–334
 Koch, Christof 162
 Kochen, Simon 246–247
 Kosslyn, Stephen 64
 Kripke, Saul 24–27, 32, 34, 77, 145
 Küppers, Bernd-Olaf 319

L

Landau, Lev 204, 213, 250–253
 language
 ambiguity-free 4, 48, 137, 139
 as game 17, 103, 331–334
 biosemiotics and 317–320
 philosophy. *See* analytic language philosophy
 Laplace, Pierre Simon, Marquis de 335–338,
 381
 Laplace's demon 28, 335–338, 342
 large quantum numbers 203, 265–267
 law of large numbers 193, 198
 laws of nature 21, 68, 186, 197, 220, 299, 343,
 383
 Layzer, David 64, 210, 280, 337–340, 356
 learning 404
 Lehrer, Keith 63
 Leibniz, Gottfried 4, 18–53, 48, 48–51,
 110–114, 139
 Leśniewski, Stanislaw 39
 Leucippus 218, 347, 379
 Lewes, George Henry 298
 Lewis, C.I. 114, 144
 Lewis, David 23, 25, 29, 42–44, 46, 47, 60, 76
 libertarian 67, 76–77, 157, 171, 222–223
 life
 emergence of 150
 information in 12
 love and death and 327
 origin of 311–329



- light quantum hypothesis 269, 353, 361–367
- linguistic analysis. *See* analytic language
philosophy
- linguistic turn 136
- Lloyd Morgan, C. 298
- Locke, John 51–53, 121
- logical empiricism 132
- logical positivism 132
- logical puzzles 17–21, 37, 103, 331–334
- London, Fritz 212
- Long, Anthony 64
- loopholes 239, 246–247
- Lorenz, Konrad 111, 150
- Loschmidt, Josef 260–267, 285, 293, 350, 383
- Loschmidt paradox 263–267, 287, 293
- Lowe, E. Jonathan 22, 34, 63, 64
- LUCA (last universal common ancestor) 322
- Lucretius 64–65, 379
- M**
- Mach, Ernst 52–53, 133, 161
- MacKay, Donald 142
- MacLeish, Archibald 99
- macroscopic superpositions 251
- man not a machine 152, 395
- many worlds 49, 204, 225, 253–256
- Marcus, Ruth Barcan 24, 47
- Margenau, Henry 64
- master argument 28
- material 11–13, 19–20, 151, 179–180
- materialism
eliminate. *See* eliminative materialism
idealism and 49, 92, 155, 331
in metaphysics 15–18
- Maxwell-Boltzmann 348, 352, 388
- Maxwell, James Clerk 134, 278, 345, 361
- Maxwell's Demon 184
- Mayr, Ernst 41
- McCall, Storrs 64
- meaning 139–145
as use 20, 140, 145, 318, 333
epistemology and 115
ERR and 395
in biosemiotics 419–421
information and 333
intension and extension as 125
of meaning 139–140
of messages 311, 317
of words 332
- problem of 4, 139
reference and 126
sense and 9, 33, 126
- measurement
apparatus 189, 202, 249
axiom of. *See* axiom of measurement
collapse and 215, 225
conscious observer and 211, 214
in decoherence 251
in Dirac 3 polarizers 375
in entanglement 234
in quantum physics 3
irreversible 208, 288
observation and 214
problem of 201–215
von Neumann Processes and 205
- measurement apparatus 189, 202–205,
207–210, 249–252
- measurement problem 201–215, 251–264, 275
- Mele, Alfred 64, 177
- mental causation 177–187
adequately determined 186
as downward causation 158, 160, 298
emergence of 179
ion pumps and 183
Kim on 179
molecular machines and 187
problem of 152
- mental event 177, 186
- mental state 405–407
- mereological essentialism 40
- mereological nihilism 40, 47
- mereological universalism 39, 47–50
- messages 141, 144, 311–314, 314–317,
317–320, 333
- messenger RNA 318
- Messiah, Albert 250–253
- metabolic cycle 314, 328
- metaphysicians 21
- metaphysicist 21, 22
- metaphysics 15–53
actualism and 28
Aristotle's 35, 106, 120
coinciding objects and 33
composition and 39
cosmic creation and 411
epistemology and 17, 106
essentialism in 45
history of 49–52



- Hume on 110
 - identity and 30
 - immaterial information and 3, 331
 - mind and 147, 151, 153, 156, 307
 - modal logic is not 47
 - naming and 24
 - nature of reality and 15
 - ontology and 56
 - panicky 53, 63
 - possibilities in 5, 19
 - possible worlds and 22
 - puzzles in 37
 - self and 171, 175
 - Stoics and 35–37
 - temporal parts in 42
 - universals and 119
 - microscopic reversibility 263
 - Miller, Stanley 313
 - Mill, John Stuart 84–89, 140, 298
 - mind 147–153
 - as immaterial 147, 148, 155
 - causal closure of 152
 - computational 148, 185, 311, 395
 - ERR and 163
 - identical to brain 158–163
 - information evolved to 149
 - mind-body and 155–163
 - model of 63, 150–151, 166, 175, 395
 - not a computer 395
 - of conscious observer 206–209
 - other minds and 173
 - over matter 172
 - philosophy of 149, 152, 161, 177, 405
 - scandal in psychology 147
 - mind-body problem 91, 155–163, 186
 - mind-brain identity 158, 162, 163
 - Minsky, Marvin 167
 - mirror neurons 406, 419–421
 - missing mass 416
 - mitochondria 184–187
 - Mnesarchus 35, 38
 - modal logic 47–53
 - models. *See* two-stage model; mind, model of
 - as knowledge representation 48
 - as visualizations 4
 - biological machine 320–329
 - connectionist 152
 - dynamical 6
 - of information structures 331
 - Wittgenstein's xiii
 - modern 128
 - molecular disorder 285, 287
 - monadology 162
 - Monod, Jacques 41
 - Moore, G. E. xi
 - moral responsibility 72–77, 75–77
 - morphology 318, 419–421
 - motion we call heat 355
 - motive power 326
 - mysteries
 - of entanglement 233, 266
 - of nonlocality 241
 - of quantum mechanics 157, 204, 226, 234
- ## N
- Nagel, Thomas 142
 - naturalism 19, 52–53
 - naturalized epistemology 117, 141
 - natural kinds 32, 45–49, 58
 - necessity. *See also* possibilities
 - Aristotle and 107
 - chance and 19, 379
 - contingency and 24
 - determinism and 223
 - Hume on 219
 - in natural world none 18, 49
 - Leucippus on 218
 - metaphysical 47
 - modal logic and 47
 - necessitism and 25
 - of identity 5, 24, 49
 - of naming 24, 145
 - parts as 45
 - true in all possible worlds 49
 - truth and xiii, 331
 - negative entropy
 - as objective good 92
 - as providence 86
 - as Shannon entropy 335
 - as value 8, 89
 - biosemiotics and 419
 - communications and 143
 - cosmic creation and 409–414
 - decoherence and 258–261
 - dissipative processes and 313–316
 - emergence of 338
 - Ergod and 100
 - flows of 94, 143, 339, 355–359



- in economics 89
 - information as 8, 191
 - Layzer on 280
 - life feeds on 183, 303, 334
 - measurement and 215
 - moral code and 84
 - negentropy or 278
 - order out of order 306
 - quantum physics and 361
 - neural correlates 158, 165, 187
 - neurons
 - ion pumps in 183, 325
 - mirror 406, 419
 - wired together 165, 406
 - neuroscience 147, 177
 - neutral monism 161
 - Newell, Allan 69, 167, 403
 - Newton, Isaac 84, 131, 278
 - Nietzsche, Friedrich 21, 293
 - noise 157, 258, 332–335, 392
 - nominalism 119
 - non-contradiction 106
 - non-existent objects 58
 - nonlocality
 - as mystery 241
 - decoherence and 252
 - Einstein's discovery of 233–236, 363, 376
 - in entanglement 265–266
 - in quantum world 198
 - of entangled particles 233
 - of single particle 229
 - outside space and time 246
 - non-reductive physicalism 163, 185
 - nonseparability 377
 - Einstein's discovery of 235–237, 377
 - in entanglement 234, 241
 - normal distribution 382
 - nothingness 412
 - noumenal 21, 91–95, 121–129, 147
 - nucleotide 318–321
- O**
- objective value 89
 - observable 135
 - Occam's Razor 43
 - Occam, William of 131
 - O'Connor, Timothy 63
 - Ogden, C.K. 140
 - omnipotence 97–99
 - omniscience 97
 - one possible future 5, 23, 28, 67, 217, 219, 361, 386
 - ontological chance 196, 345, 412–415
 - ontology 17–23, 50, 55–61, 119, 150
 - open future 67, 217, 361, 380
 - Operin, A.I. 313
 - order
 - out of chaos 11, 61, 302, 313–316, 339–342
 - out of order 183, 303, 306, 339–342
 - origin of information 311–329
 - origin of life 311–329
 - other minds 173–175
 - otherwise 23, 67
 - ought from is 79
 - outside space and time
 - as solution to nonlocality 246
 - determinism restored 217
 - ideal world as 9
 - information not 16
 - Kant's noumena as 152
 - Plato's forms as 91
 - truth as 19, 49
- P**
- pain 174
 - panicky metaphysics 53, 63
 - panpsychism 149, 161, 162
 - paradoxes 331
 - parallel universes 198, 234
 - Parmenides 19, 50–53
 - part 44
 - path 206
 - path information
 - collisions erase 258, 262–263
 - determinism conserves 288
 - irreversibility and 287–290
 - unobservable 135, 206
 - Pauli exclusion principle 270
 - peculiar qualifications 30, 36
 - Peirce, Charles Sanders 10, 132, 384, 405–407, 419–421, 420–421
 - Penrose, Roger 64, 162, 244, 282
 - perdurant 60
 - Perrin, Jean 134
 - persistence condition 35, 42, 60
 - phase space 346–351, 383
 - phenomena 21, 91–95, 121–129, 147
 - Philo of Larissa, 108



- philosophy
 - of information 420
 - of language 3, 420
 - of mind 177
- photons
 - as fundamental particles 10, 410
 - as light quanta 361
 - Einstein's discovery of 361
 - in cosmic background 309
 - in EPR tests 238
 - measurement of 207
 - photosynthesis and 326
 - solar 94, 312, 317
 - waves large numbers of 264
- physicalism 15, 156, 297
- picture of reality 48, 145, 331–334
- Pittendrigh, Colin 41
- Place, U.T. 159
- Planck constant 142, 193, 202–205, 288, 307, 347
- Planck, Max 235, 269, 274, 294, 346–353, 361, 387
- Plato 19, 80–89, 91, 104–109, 119, 151
- Platonic ideas 5, 16, 119, 156
- Plutarch 36
- Podolsky, Boris 235
- Poincaré, Henri 64, 294, 351, 386
- pointer states 258–261, 262–267
- Popper, Karl 9–13, 112–116, 126, 137, 157, 162
- positivism 52–53
- possibilism 25, 49
- possibilities. *See* alternative possibilities
 - actualization of 189, 195
 - existence of 5, 412
 - free will and 71–77
 - function 190, 196
 - in horse race 229
 - in mental causation 185
 - in metaphysics 15, 19, 22
 - metaphysical 19–20
 - possible worlds and 22, 49
 - truths not basis for 47
 - universe expansion and 16
 - wave function as 265
- possible worlds 18, 47, 49, 53, 76, 112–117
- post-modern 128, 141
- pragmatics 318, 419–421
- pre-determinism 67, 186, 217, 223, 241, 307
- prediction 404
- Presocratics 104
- Price, Huw 246
- Prigogine, Ilya 313
- principle of sufficient reason 110
- principle of superposition
 - as standard quantum physics 190, 367–372
 - collapse and 225, 231
 - decoherence and 252–255
 - entanglement and 234–235
 - in Dirac 3 polarizers 371–375
 - measurement and 201, 208
 - Schrödinger's cat and 270
- probabilities
 - calculus of 345, 381
 - for each possibility 196
 - near certainty 68
- probability amplitude
 - as immaterial 366
 - Born rule 366, 389
 - collapses 225
 - entanglement and 240
 - evolving deterministically 255, 371
 - for two particles 266
 - in decoherence 254
 - interference with itself , 272, 229–230
 - in two-slit experiment 229
 - measurement and 201
 - wave function as 29
- problems
 - measurement. *See* measurement problem
 - metaphysical. *See* metaphysics
 - mind-body. *See* mind-body problem
 - of evil. *See* evil
 - of free will. *See* free will
 - of induction. *See* induction
 - of knowledge. *See* epistemology
 - of meaning. *See* meaning
- processes, von Neumann
 - process 1 205, 208, 214, 265–267, 285, 370
 - process 2 206, 265–267
 - process 3 207
- projection postulate 367–371. *See*
 - also* collapse of the wave function
 - actualization of possibilities 195–196
 - as standard quantum physics 190, 197, 231
 - decoherence and 202, 251–254, 261–262
 - entanglement and 234
 - in measurement 201, 214



proper part 41–43, 44
 propositions 103, 136
 Protogoras 95
 Providence 21, 81–89, 99
 pseudo-isotropy 291
 pseudo-problems 132
 psychology
 behaviorism in 141
 information in 3
 metaphysics and 51
 reduction of epistemology to 115
 scandal in 147
 two-stage model in 64
 without a psyche 147
 psychology without a psyche 147, 160
 psycho-physical parallelism 162, 163, 249–252
 purpose. *See also* teleonomy
 in artifacts 41, 44
 in biology 181, 301–304, 311, 318, 409
 in the universe 12, 20, 117, 150, 315
 Putnam, Hilary 244
 Pyhrro of Ellis 108

Q

quantum cooperative phenomena 311–314
 quantum jumps 241, 242, 252–259, 269
 quantum mechanics 361–377
 basics of 366
 determinism and 217
 Dirac's 3 polarizers in 371
 Einstein's discoveries in 376–377
 entanglement and 233
 foundations of 251
 God and 99
 information interpretation of 189–199
 irreversibility in 285
 measurement problem in 201
 other interpretations 198
 quantum of action 347
 quantum-to-classical transition 190–193,
 251–254, 263–267, 291, 307
 quantum world 198
 quasi-molecule 286
 Quételet, Adolph 348, 382
 Quine, Willard Van Orman 24–53, 60,
 112–116, 126, 141, 144

R

radiation distribution law 352–353
 Ramsey, Frank 114
 randomness 67, 189, 217, 304, 325–328. *See also* chance; indeterminism
 reader-response theory 144
 receiver 144, 332–335
 recurrence
 entropy and 351
 extreme improbability of 295
 problem of 293–295
 Zermelo and 351
 red blood cells 183, 305
 redistribution 85
 reductionism
 bottom-up 161
 causal closure and 160
 emergence vs 297
 mental causation and 177
 of biology to molecules 180, 319
 of life to machines 147
 of mind to brain 158
 to physics and chemistry 117
 reduction of the wave packet 195, 205, 225,
 254–257
 reflection 151, 404. *See also* introspection
 reflex arc 171
 reflexology 171
 Reid, Thomas 63, 223
 relative identity 30–33, 58
 Renouvier, Charles 384
 representation 332–335
 dynamical model as 6
 Frege on 33, 144
 information as 47–53
 in mind 120, 153
 isomorphism as 56
 possible world as 77
 reproductive success 315
 responsibility
 free will and 73, 332–335
 information creation and 343
 moral 72, 222
 self and 172
 ultimate 76
 ribosome 181–187, 305, 318, 321–324, 328
 Richards, I.A. 140
 Rietdijk, C.W. 244
 RNA 181–187, 314–317, 328



Rosen, Nathan 235
 Russell, Bertrand xi, 53, 112–116, 140, 144,
 162, 219, 386
 Russell's Residue xiv
 Rutherford, Lord Ernest 261–267, 369, 387
 Ryle, Gilbert 153

S

Santa Claus 97
 Sartre, Jean-Paul 123, 196
 Saussure, Ferdinand de 140, 420–421
 scandal
 in philosophy 63, 65, 116
 in psychology 147
 Scarani, Valerio 245
 Schlick, Moritz 52–53, 112–116
 Scholastics 131
 Schopenhauer, Arthur 122
 Schrödinger equation
 decoherence and 251, 255, 263
 determinism and 7, 259–263
 evolving deterministically 197
 in metaphysics 29
 interference and 365
 measurement and 201–207, 210
 reversibility and 285, 288–289, 367
 standard quantum physics 190–193
 visualization of 242
 Schrödinger, Erwin
 decoherence and 250, 253
 no particles or quantum jumps 253
 on determinism 217, 383–384
 on entanglement 233–235, 241
 on entropy and information 334
 on indeterminism 377
 on order out of order 127, 183, 303, 305
 physical laws are statistical 383
 Schrödinger's cat 269–275
 visualization and 192, 241
 wave equation of 364–365
 What Is Life? 303
 Schrödinger's cat 191, 202, 204, 251–254,
 256–259, 269–275
Scientific American 281
 scientific method 137
 Searle, John 64
 second law of thermodynamics.
 See thermodynamics, second law of
 Sedley, David 64

self 171–175
 self-contemplation 316
 self-determination 172
 self-identity 30–35
 self-organization 304
 self-replication 304, 315–318
 semantics 27, 77, 318, 419–421
 semiosis 317, 419–421
 sender 144, 332–335
 sense. *See* meaning
 reference and 126, 140, 144
 teleonomic 44
 Sextus Empiricus 108
 Shannon, Claude 141, 197, 280, 317–320,
 334–337, 350, 412
 Shannon entropy 143, 203, 209, 350, 421
 shifty split 211–214, 259
 Shimony, Abner 162, 238
 Simon, Herbert 69, 167, 403
 Simonton, Dean Keith 64
 simulations 332
 Skeptics 34, 41, 58, 104, 108–112
 Skinner, B. F. 148
 Smart, J.J.C. 159, 186
 smartphone 7, 83–89, 97, 332–335
 Smith, Adam 84
 social contract 87–89
 Socrates 105
 software in the hardware
 free will and 63
 ideas as 18
 information as 61
 mind as 57, 155, 165, 185
 multiply realizable 307
 Solvay conference 203, 229, 235
 soul
 Aristotle on 152
 as immaterial 15
 Descartes and 156
 information and 52, 149, 306, 340, 343
 non-physical 178
 psychologists deny 147
 self or ego as 171–172
 space and time 16
 outside of. *See* outside space and time
 special frame 242–245
 special theory of relativity 28, 134, 235, 277,
 362
 Sperry, Roger 177



spirit 171, 306, 340, 343, 365, 377
 spooky action at a distance 229, 237, 256–259
 standard argument against free will 65, 75–77
Stanford Encyclopedia of Philosophy xviii
 Stapp, Henry 162
 statistical determinism. *See* adequate
 determinism; quantum-to-classical
 transition
 close to certainty 218
 decoherence and 254–257
 emergence of 307
 for large objects 68, 288
 laws of nature and 7
 mind and 189
 quantum theory and 364
 statistical interpretation
 Born rule 366, 389
 Einstein's original idea 368
 statistics 377
 Statue and the Clay 15, 34
 Stern-Gerlach 214, 250–253
 stimulated emission 388
 Stoics 34–38, 41, 109–113
 Strawson, Galen 75–77, 162
 Strawson, P.F. 53, 63
 Suarez, Antoine 245
 subjectivity 151
 substance
 Descartes' immaterial 147, 177, 304
 dual aspect 162
 in Aristotle's metaphysics 35
 in chemistry 299
 in mind-body problem 155, 307
 in vitalism 300
 Stoics on 59
 Sum of human knowledge 83, 85–89, 104, 150,
 171, 401
 Sun 91, 94, 132, 197, 317–320
 superdeterminism 245
 supernatural 21, 147
 superposition. *See* principle of superposition
 supervenience 160, 185, 300
 swerve 379
 syntax 318, 419–421
 synthetic a priori 111, 122–129
 Szilard, Leo 334

T

tautology 112
 Tegmark, Max 251, 252–255
 teleology 300
 teleonomy
 as purpose in artifacts 46
 as purpose in biology 12, 304
 as purpose in metaphysics 41
 emergence of 303
 epistemology and 117
 in biocommunications 410–413
 in metaphysics 44
 teleology and 20
 telos 41, 44, 46, 409–412
 temporal parts 42–45, 60
 temporal sequence 71–77
 tetrads 129
 Theater of Consciousness 69, 70, 167, 403
 theodicy. *See* evil
 theology
 good and 80
 ideas about 97
 in metaphysics 50
 theory 376, 377
 thermodynamic equilibrium 262, 280
 thermodynamics
 arrow of time and 277
 good and evil and 93
 information and 143
 mind-body and 155
 value and 81
 thermodynamics, second law of
 chance in 382–384
 cosmic creation and 413
 entropy and 7, 345–359
 equilibrium and 280
 Ergod and 100–101
 information creation and 191–194, 338
 irreversibility and 285
 Maxwell's Demon and 184
 thermonuclear reactions 312
 thermostat 402
 Thomson, William 223
 Tibbles, the Cat 34–37
 time. *See* arrow of time
 working backwards in 327–329
 top-down 180, 298
 tradition 128
 transcription 317



transfer RNA 318
 translation 317
 transworld identity 26, 27
 triads 128, 126–129
 truth 18–53, 79–89, 103, 111–117, 147
 two-particle state 233, 236, 240–243, 245,
 266–267, 269
 two-slit experiment 99, 196, 225–226,
 227–229
 two-stage model 63–77, 171, 172, 220, 385,
 392
 two-step creation process 258–261

U

ultimate responsibility 76
 uncertainty 157
 uncertainty principle 201, 279, 390, 412–415
 undetermined liberty 74–77, 171
 Unger, Peter 40
 uniformity of nature 132, 136
 universals 119–129, 155
 universe
 Einstein on 376
 heat death of 337, 355
 universe of discourse 22
 Urey, Harold 313
 use, meaning as 20–53, 140, 145, 318–321

V

value 79–89
 Ergo as 171
 information as basis for 3, 332, 341
 van Inwagen, Peter 40, 46
 verification 145
 Vienna Circle 53, 112, 115, 158, 309
 visualization 4, 49, 189, 192, 241, 366
 vitalism 300
 von Neumann, John
 Bell shifty split and 258–261
 decoherence and 249–252
 irreversibility and 285
 measurement problem and 202
 on entropy and information 334–337
 projection postulate and 201
 processes of. *See* processes, von Neumann

W

Wächtershäuser, Günter 328
 Watson, John B. 148

wave function. *See* collapse of the wave
 function
 Schrödinger's equation for 377
 visualization of 189, 225–229
 wave-particle 377
 wave-particle duality 123, 194–197, 269
 way of talking 38
 Weaver, Warren 334–337
 Weinberg, Steven 416
 Weizsäcker, Carl von 211
 what it's like to be 404–407
 Wheeler, John 251–254, 252–255, 283
 Whitehead, Alfred North 42, 162
 whole 44
 Wiener, Norbert 83–89, 99, 334
 Wiggins, David 22, 24, 34
 Wigner, Eugene 212, 258–261
 Wikipedia 101, 290
 Williamson, Timothy 47
 Wilson cloud chamber 202, 258–261
 Wittgenstein, Ludwig
 on logical empiricism 112
 on logical positivism 53
 on material implication 144
 on meaning as use 20, 140, 318–321
 on models of reality xiii, 320–323
 on science as true propositions 48
 Popper on 137
 Woese, Carl 322, 328
 words and objects, connections in ERR 6, 331
 worlds
 biological 12
 ideal 13
 many. *See* many worlds
 material 11
 Popper's three worlds 126
 possible. *See* possible worlds
 quantum. *See* quantum world

Y

Yockey, H. 319

Z

Zarathustra 100
 Zeh, H.D. 202, 251–263
 Zermelo, Ernst 287, 293, 351
 Zermelo paradox 287, 293
 Zufall 261–267, 369, 389
 Zurek, Wojciech 202, 251–255

