

# Index

- a.c. circuits 287–302, 304–9  
*see also* electric current  
a.c. current vs d.c. current 281–2  
capacitors 190  
power 304–9  
power factor 294
- alternating current 287–302  
*see also* electric current  
capacitive circuits 290–2  
inductive circuits 292–4  
resistive circuits 289–90  
RLC circuits 300–302, 306–309  
root mean square (r.m.s.) values 287–8
- a.c. generators 282–3
- adiabatic process, bicycle pump 11–12
- Ampere’s law  
magnetism/magnetic fields 256–7  
solenoids 257–8  
toroids 259
- angular frequency, simple harmonic motion (SHM) 61–3
- astronomy, Doppler effect 104
- atomic physics 311–44  
atom models 323–7  
atoms and nuclei 322–44  
black bodies 313  
Bohr model of the atom 324–5  
electronvolts 315  
Heisenberg’s uncertainty principle 319–20  
mass/energy relationship 333–4  
matter/radiation 312–21  
nuclear properties 329  
nuclear radiation 331–3  
nuclear reactions 335  
nuclear stability 329–30  
nuclear waste 340–1  
photoelectric effect 313–16  
radioactive half-life 336–9
- radioactive isotopes 339–40  
radioactivity 330–1  
Rutherford’s model of the atom 323–4  
strong nuclear force 327–8  
wave–particle duality of matter 317–19
- beats, standing waves 94–5
- bicycle pump, adiabatic process 11–12
- Biot–Savart law 253
- black bodies, atomic physics 313
- Bohr model of the atom 324–5
- Brownian motion 24  
diffusion 27–8
- capacitance 174–6
- capacitive circuits, a.c. 290–2
- capacitors  
a.c. circuits 190, 290–2  
charging 188–90  
constructing 176–8  
dipoles 177  
discharging 184–8  
electrical energy density 183  
electrostatics 173–90  
Gauss’s law 176  
Leyden jar 178–9  
in parallel 179  
in series 180  
uses 190–1
- charged particle movement  
electric fields 150, 240–2  
magnetic fields 240–6
- coherence, interference 131–3
- conduction electrons,  
electric current 200–1
- conductivity, electric current 201
- constructive interference,  
wave motion 85–6
- corpuscular theory,  
reflection/refraction 117–19
- coulomb, electric current 199–200
- Coulomb’s law, electrostatics 147–51
- current density, electric current 203–5
- Dalton’s law of partial pressures 23
- damping, oscillation 73–5
- d.c. current, vs a.c. current 281–2
- decibel, hearing 100–1
- destructive interference,  
wave motion 86
- dielectrics, electrostatics 176–8
- diesel engines 42–4
- diffraction  
diffraction grating 136–39  
single slit diffraction 133–6  
wave optics 120–4, 133–9
- Brownian motion 27–8
- Graham’s law 28–9
- dipoles  
capacitors 177  
electric fields 156–7
- Doppler effect, wave motion 102–4
- drift velocity, electric current 203–5
- Earth, magnetism/magnetic fields 238–9, 260–3
- eddy currents,  
electromagnetic induction 273–4
- efficiency  
heat engines 34, 44–5  
second law of thermodynamics 31–6
- electric current 196–230  
*see also* a.c. circuits;  
alternating current
- Biot–Savart law 253
- conduction electrons 200–1
- conductivity 201
- coulomb 199–200
- current density 203–5
- drift velocity 203–5
- electromotive force (e.m.f.) 205–7
- galvanometers 220–26
- Kirchoff’s rules 214–19
- magnetic fields 247–55
- magnetic force, current-carrying conductors 247–55
- measuring instruments 220–6
- potential difference (p.d.) 205–8
- potentiometer 226–8
- resistance 201–2, 206–11
- resistivity 201–2
- voltage 205–8
- Wheatstone bridge 226–8
- electric fields 143–60  
charged particles  
movement 155–6, 240–2
- dipoles 156–7
- electric potential 167–9  
vs gravitational fields 171
- parallel plates 154–5
- point charge 153–4
- strength 145
- electric generators 282–6
- electric potential  
electric fields 167–9  
electrical potential energy 169–70  
equipotentials 165–7  
point charge 164–5
- electrical energy density,  
capacitors 183
- electrical energy  
transmission 284–5
- electromagnetic induction 268–80  
eddy currents 273–4  
induced e.m.f. 269–73, 275–6

- laws 271–3
- magnetic energy density 278
- magnetic flux 268–9
- mutual inductance 273, 274–5
- self-inductance 274–5
- solenoids 276–7
- electromotive force (e.m.f.)
  - electric current 205–7
  - induced e.m.f. 269–73
- electronvolts, atomic physics 315
- electrostatics 141–92
  - capacitors 173–90
  - Coulomb’s law 1497–51
  - electric charge 143–60
  - electric potential 162–70
  - electrostatic forces vs gravitational forces 152
  - force calculations 149–50
  - Gauss’s law 152–3
  - Millikan’s oil drop experiment 157–9
  - Stokes’ law 158–9
- energy/mass relationship, atomic physics 333–4
- entropy, second law of thermodynamics 31–3
- equipotentials, electric potential 165–7
- first law of thermodynamics 9–20
  - forms 15–16
  - gases 16–20
  - internal energy 10–13
- frequency, simple harmonic motion (SHM) 60
- galvanometers
  - electric current 220–26
  - tangent galvanometers 261–2
- gases
  - Brownian motion 24
  - Dalton’s law of partial pressures 23
  - first law of thermodynamics 16–20
  - kinetic theory 21–30
  - laws 21–3
- Gauss’s law
  - capacitance 176
  - electrostatics 152–3
- Graham’s law of diffusion 28–29
- gravitational fields vs electric fields 171
- gravitational forces vs electrostatic forces 152
- half-life, radioactive, atomic physics 336–9
- harmonics, standing waves 92–4
- hearing 97–104
  - decibel 100–1
- heat engines 37–47
  - diesel engines 42–4
  - efficiency 34, 44–5
  - petrol engines 41–2
  - refrigerators 46–7
  - second law of thermodynamics 34
- heat pumps 46–7
- Heisenberg’s uncertainty principle, atomic physics 319–20
- Huygens’s principle
  - diffraction 120–1
  - reflection/refraction 116–17
  - wave fronts 111–12
- induced e.m.f.
  - electromagnetic induction 269–73, 275–6
  - inductance 275–6
- inductive circuits, alternating current 292–4
- inductors, alternating current 292–7, 298–302
- intensity, sound 98–9
- interference
  - coherence 131–3
  - constructive/destructive 85–6
  - interferometer 124–5
  - thin-film 125–7
  - wave motion 85–6
  - wave optics 120–33
  - Young’s double slit experiment 128–32
- internal energy, thermodynamics 5, 10–14
- kinetic theory of gases, thermodynamics 21–30
- Kirchoff’s rules, electric current 214–19
- lasers, Young’s double slit experiment 132
- Leyden jar, capacitors 178–9
- longitudinal waves 81–2
- loudness 98–101
- magnetic energy density, electromagnetic induction 278
- magnetic flux,
  - electromagnetic induction 268–9
- magnetism/magnetic fields 235–63
  - Amperé’s law 256–7
  - Biot-Savart law 254
  - charged particles movement 240–6
  - circular motion of particles 244–5
  - current-carrying conductors 247–55
  - Earth 238–9, 260–3
  - electric current 247–55
  - Thompson’s experiment 242–4
- mass/energy relationship, atomic physics 333–4
- mass-spring systems
  - periodic motion 55–6
  - time periods 67–9
- matter/radiation, atomic physics 312–21
- medical imaging, Doppler effect 104
- Millikan’s oil drop experiment, electrostatics 157–9
- molar mass 4
- moles 3–4
- musical instruments, standing waves 87–94
- mutual inductance, electromagnetic induction 273, 274–5
- nuclear properties, atomic physics 329
- nuclear radiation, atomic physics 331–3
- nuclear reactions, atomic physics 335
- nuclear stability, atomic physics 329–30
- nuclear waste, atomic physics 340–1
- organ pipes, standing waves 92–4
- oscillation 53–6
  - see also* periodic motion
  - damping 73–5
  - resonance 71–3
- pendulums
  - periodic motion 54
  - time periods 69–70
- periodic motion 53–78
  - see also* wave motion
  - mass-spring systems 55–6
  - oscillation 53–6
  - pendulums 54
  - simple harmonic motion (SHM) 56–71, 75–8
  - petrol engines 41–2
  - phases of matter 7–8
  - photoelectric effect, atomic physics 313–16
  - potential difference (p.d.), electric current 205–8
  - potentiometers, electric current 228–30
  - power factor, a.c. circuits 294
  - power a.c. circuits 304–9
- radar, Doppler effect 104
- radiation/matter
  - atomic physics 312–21
  - nuclear radiation 331–3
- radioactive half-life, atomic physics 336–9
- radioactive isotopes, atomic physics 339–40
- radioactivity, atomic physics 330–1
- ray diagrams 110, 113
- reflection
  - corpuscular theory 117–19
  - Huygens’s principle 116
  - wave fronts 113–14
  - wave motion 87

- refraction
  - corpuscular theory 117–19
  - Huygens's principle 117
  - wave fronts 114–15
- refrigerators, heat engines 46–7
- resistance, electric current 201–2, 206–11
- resistive circuits, a.c. 289–90
- resistivity, electric current 201–2
- resistors, a.c. 289–90, 94–8, 300–2
- resonance, oscillation 71–3
- reversible/irreversible processes, second law of thermodynamics 35–6
- RLC circuits, a.c. 300–2, 306–9
- root mean square (r.m.s.) values, a.c. 287–8
- Rutherford's model of the atom 323–4
  
- second law of thermodynamics 1–6
- self-inductance, electromagnetic induction 274–5
- simple harmonic motion (SHM)
  - angular frequency 61–3
  - displacement 62–6
  - energy 76–9
  - frequency 60
  - periodic motion 56–71, 75–8
- single slit diffraction 133–6
- solenoids
  - Ampere's law 257–8
  - electromagnetic induction 276–7
- sound 97–105
  - Doppler effect 102–4
  - intensity 98–9
  - speed of sound 101
- standing waves 87–94
  - beats 94–5
  - harmonics 91–4
  - organ pipes 92–4
  - strings 87–92
  - wavelength 90–2
- Stokes' law, electrostatics 158–9
- strong nuclear force, atomic physics 327–8
- superposition, wave motion 85
- tangent galvanometers 261–2
- temperature 6–7
- thermal equilibrium 5–6
- thermodynamics 1–47
  - entropy 31–3
  - first law of 9–20
- kinetic theory of gases
  - 21–30
  - second law of 31–6
  - temperature 6–7
  - thermal equilibrium 5–6
- Thompson's experiment, magnetism 242–4
- time periods 60
- mass-spring systems 67–9
- pendulums 69–70
- toroids, Ampere's law 259
- transformers 281–4
- transverse waves 81
- travelling waves 80–7
- voltage, electric current 205–8
- wave fronts 109–17
  - Huygens's principle 111–12, 116–17
  - reflection 113–16
  - refraction 114–17
- wave motion 80–105
  - see also* periodic motion
  - constructive interference 85–6
  - destructive interference 86
  - Doppler effect 102–4
  - interference 85–6
  - longitudinal waves 81–2
  - mathematical description 83–5
- reflections of waves 87
- speed 82
- standing waves 87–94
- superposition 85
- transverse waves 81
- travelling waves 80–7
- wave optics 108–39
  - diffraction 120–4, 133–9
  - interference 120–33
  - reflection/refraction 113–17
  - wave fronts 109–17
- wave-particle duality of matter, atomic physics 317–19
- wavelength
  - standing waves 90–2
  - travelling waves 81–3
  - wave optics 109–10
- Wheatstone bridge, electric current 226–8
- Young's double slit experiment, interference 128–32
- zeroth law, thermodynamics 5–6



