AUTHOR INDEX

In this Author Index, all references are to pages *A* to *Q* of the Bibliography. An asterisk means that an author's name is listed also in the Subject Index.

Abbott, M. R. H
Accad, Y. N
*Airy, G. B. L
*Alfvén, H. O
Anati, D. A. J
Anderson, D. L. T. O
Anderson, J. E. M
Andrews, D. G. L
Andrews, F. C. B
Apostol, T. M. A
Arnoldi, R. A. E

Barber, N. F. H
Batchelor, G. K. AF
Bate, A. E. C
*Benjamin, T. B. HPQ
Beranek, L. L. CD
Blokhintsev, D. I. K
Booker, J. R. K
*Boussinesq, J. J
Braddock, R. D. N
Bradley, J. N. D
Brenner, H. G
Bretherton, F. P. KL
*Brunt, D. J
Budden, K. G. L
Burgers, J. M. F
Byatt-Smith, J. G. B. HP

Cartwright, D. E. N
Chow, V. T. G
Chu, V. H. P
Clemmow, P. C. B
Cowling, T. G. M
Crighton, D. G. F
Curle, N. A

Davey, A. P
Davies, A. M. N
Davies, H. G. L
Davies, H. J. A
Davies, P. A. N
Davies, R. M. F
Deacon, G. E. R. O
Defant, A. C
Defay, R. H
Driessche, P. van den N
Dungey, J. W. M

Eckart, C. J
Ekman, V. W. J
Everest, J. T. I

Fälthammar, C. G. O
Feir, J. E. P
Fenton, J. D. P
Ferraro, V. C. A. M
*Ffowcs Williams, J. E. EF
Flather, R. A. N
Fleming, R. H. C
*Frost, R. I
*Froude, W. I
Fultz, D. N

Gadd, G. E. I
Galvin, C. J. Q
Garabedian, P. R. B
Gardner, C. S. Q
Garrett, C. J. R. KL
Garrick, I. E. E
Gaydon, A. G. F
Goldburg, A. K
Goldstein, H. A
Goldstein, M. E. D
Gossard, E. E. J
Greene, J. M. Q
Greenspan, H. P. M
Greenwood, D. T. A
Grimshaw, R. JQ
Groves, G. W. H

Hammack, J. L. N
Happel, J. G
Harkrider, D. L
Haskell, R. E. M
Hasselmann, K. F. HPQ
Havelock T. H. I
Hawkings, D. L. E
Hayes, W. D. FP
Helliwell R. A. M
*Helmholtz, H. von H
Henderson, F. M. G
Hendershott, M. N
Herlofson, N. O
Hess, S. L. C
Hide, R. NO
Hinze, J. O. O
Hogben, N. I
Holt, E. H. M
Holton, J. R. C
Hooke, W. H. J
Howe, M. S. F
*Hugoniot, A. F
Hurle, I. R. E

Ibbetson, A. J. N
Iliff, E. F. M
*Inui, T. I

Jeffreys, B. S. B
Jeffreys, H. B
Johannesen, N. H. K
Johnson, M. W. C
Jones, D. S. A
Jordan, E. J. D

Karpman, V. I. M
*Kelvin, Lord IMN
Kenyon, K. E. Q
King, R. W. P. E
Kjelaas, A. G. J

Kompaneets, A. S. *D*
*Korteweg, D. J. *PQ*
Kruskal, K. D. *Q*
Kryter, K. D. *E*

Lake, B. M. *P*
Lamb, H. *D*
Lambrakis, K. C. *F*
Latham, E. C. *I*
Lee, Y. K. *H*
Leibovich, S. *MQ*
Lighthill, M. J. *BCEFHKLMNOP*
Long, R. R. *LNQ*
Longuet-Higgins, M. S. *KOPQ*
Lucassen, J. *H*
Lucassen-Reynders, E. H. *H*

McCormick, M. E. *H*
McDonald, D. A. *B*
McIntyre, M. E. *L*
McLachlan, N. W. *D*
Mason, W. P. *D*
Mei, C. C. *P*
Merzbacher, E. *C*
Miles, J. W. *HN*
Milford, F. J. *C*
Miller, G. R. *H*
Miller, J. C. P. *L*
Miura, R. M. *Q*
Moffatt, H. K. *O*
Moir, J. *D*
Moninger, W. R. *J*
Morse, P. M. *A*
*Mowbray, D. E. *K*
Müller, P. *Q*
Munk, W. H. *HN*
Mysak, M. E. *J*

Neumann, C. *C*
Nyborg, W. L. *G*

Olson, H. F. *D*
Oser, H. *N*
Owen, P. R. *F*

Pao, Y. H. *K*
Peady, G. W. *N*
Pekeris, C. L. *N*
*Peregrine, D. H. *I*
Phillips, E. G. *B*
Phillips, O. M. *GJPQ*
Pierce, A. D. *M*
Pierson, W. J. *C*
Plumpton, C. *M*
Pointon, A. J. *B*
Posey, J. W. *M*
Powers, W. M. *H*
Press, F. *L*
Price, R. B. *E*
Pridmore-Brown, D. C. *K*
Prigogine, I. *H*
Pritchard, W. G. *Q*
Proudman, J. *N*

Raizer, Yu. P. *D*
Rankine, W. J. M. *F*
Rarity, B. S. H. *K*
*Rayleigh, Lord *CFIP*
Reitz, J. R. *C*
*Reynolds, O. *GK*
Riehl, H. *C*
*Riemann, B. *F*
Riley, N. *G*
Rosenhead, L. *A*
*Rossby, C. G. *NO*
Rowlands, P. B. *O*
*Russell, J. Scott *IP*

Schiff, L. I. *C*
Schwartz, I. R. *E*
Schwartz, L. W. *P*
Scott, J. C. *H*
Seebass, A. R. *M*
Shercliff, J. A. *C*
Sneddon, I. N. *B*
Snodgrass, F. E. *H*
Sokolnikoff, I. S. *B*
Sommerfeld, A. *B*
Southwell, R. V. *B*
Soward, A. M. *O*

Squire, H. B. *G*
Stephens, R. W. B. *C*
*Stevenson, T. N. *K*
Stewart, R. W. *K*
Stewartson, K. *NOP*
Stix, T. H. *M*
Stoker, J. J. *G*
*Stokes, G. G. *HIP*
Stollery, J. L. *F*
Stuart, J. T. *G*
Stuart, R. D. *A*
Sugden, T. M. *E*
Sverdrup, H. U. *C*
Swinbanks, M. A. *L*

*Taylor, G. I. *FN*
Thomas, A. *E*
*Thomas, N. H. *K*
Thompson, P. A. *F*
Thompson, R. J. *K*
Thorpe, S. A. *Q*
Tolstoy, I. *J*
Turner, J. S. *J*

Ursell, F. *IJ*

*Väisälä, V. *J*
Varley, E. *G*
Vries, G. de *PQ*

Webster, R. B. *E*
Wehausen, J. V. *I*
Westervelt, P. J. *G*
*Whitham, G. B. *DFHMPQ*
Williams, C. E. *E*
Willmore, T. J. *B*
Wu, T. T. *E*

Yih, C. S. *J*
Young, J. M. *J*
Yuen, H. C. *P*

Zabusky, N. J. *Q*
Zeldovich, Ya. B. *D*

Cambridge University Press
978-0-521-01045-0 - Waves in Fluids
James Lighthill
Index
More information

SUBJECT INDEX

Numbers (1 to 469) refer to pages of the main text, while capital letters (*A* to *Q*) refer to pages of the Bibliography.

absolute frequency (not subject to Doppler shift) 326–8
accelerating frame of reference 54–5, 328, *A*
acceleration of fluid particle 1–2, 92, *A*
acoustic dipoles 23–30, *CDEF*
  distributed 61–3
  momentum of 27–30
  power output of 27, 30
  related to force 30, 61–2, 199
  strength of 25, 30, 36–9, 47, 51–6, 62, 68–9, 88
acoustic energy 11–16, 22, 293, *CD*
  conservation of 14–15, 106, 108
  dissipation of 76–85, 128–36, 154–65, 338–49, *DF*
  flow of, in tube 106, 113, 121–7, 135, 191–3, 422
  flux of (flow per unit area) 15–16, 21–2, 27, 78, 294, 323, 371–2
acoustic-gravity waves 10–11, 291–8, 425–8, 432–3, *JLM*
acoustic intensity 11–16, 21–2, 78, 290, 294, *CD*
  directional distribution 27, 73, 371–2
acoustic streaming 338–51, *DG*
acoustic waveguides (hard-walled ducts) 418–25, 436, *L*
acoustically compact source regions 25, 51, 64, *CDEF*
  cases with dipole far fields 35–41, 371
  cases with monopole far fields 31–5, 45, 66, 73, 370–1, 422–5, 436
  with dissipation allowed for 76–7
  with nonlinear effects 194–6
action (for wave propagation systems) 331–5, 456–9, *KP*
admittance 104–26, 186–7, 191, *ABCD*
  differential 144
  effective 110–12, 115–20, 123–4, 200
Aeolian tones 40, 87, *CDEF*
aerodynamic sound generation 57–64, *DEF*
Airy integral 385–99, *L*
Alfvén wave speed 445–9, *CMO*
alignment of water-wave crests to beach 218–19
amplitude of water waves 214
  local (slowly varying) 241, 252–5
  maximum (for deep-water gravity waves) 453–4, *P*
  on nonlinear theory 453–4
anisotropic wave systems in general 284, 309–12, 317–21, 325–31, 351–7, 361–71, 385–95, 399–403, *HKL*
aorta 109–13, 123, 145, *B*
Archimedes' principle 50, 54
area-conserving discontinuities inserted in waveforms 170–5, 183–4, 190–1, *DF*
argon, acoustic energy dissipation in 83, *DF*
arteries, blood pulse propagation in 90–9, 109–13, 123, 136, 200, *B*
asymptotics of Fourier integrals 248–53, 266–8, 281–2, 351–95, 400–17, 421–3, 435, *BHIL*
asymptotics of waveforms, in nonlinear acoustics 172–4, 190–8, *DF*
atherosclerosis 115, *B*
Atlantic, oceanography of 300–1, *CN*
atmospheric stratification 205, 306–8, *CFJKL*
  effects on waves, in general cases 322–5, 332–7, 426–8, 432, 468
  effects on waves, in isothermal case 193–9, 295, 427, 432–3
  stability of 287, 307–8
attenuation 76
  of internal waves 349–41, 359, 379–81, *K*
  of one-dimensional waves in fluids 112, 135–6, 189, 201, *FH*

attenuation (*continued*)
of sound waves 76–9, 337–49, *FG*
of water waves 229–37, 253–5, *H*

backward scattering 56, 87
barge in canal generating waves 246, 263–5
baroclinic modes, in ocean 441, *CO*
barotropic modes, in ocean 441–3, *CO*
beam 71
accurately parallel 75, 375–6
narrow conical 74–6, 339, 376, 448
'beats' 391, 394
bed slope, generating stationary waves on a stream 265–9, *HI*
Benjamin–Feir instability (for deep-water waves) 462, *P*
Bernoulli constant 201
Bernoulli equation 3, 452, *A*
Bessel functions 74, 435, *AB*
bifurcation (in tube or channel) 109–13
blood pulse propagation 90–9, 109–13, 123, 136, 200, *B*
blue light of the sky 56, *E*
boom, supersonic 196–9, 203, 270, *F*
bores 181–3, 189, *H*
Born approximation 56
boundary condition at free surface 207–8, 222–3, 234, 452
boundary condition at solid surface 128–31, 209, 214, 233
boundary layer 128–36, 209, 214–15, 229–33, 346–9, *A*
boundary value, forcing waves 265–7, 283, 362–3, 403–9
Boussinesq approximation 287–8, *J*
conditions for accuracy 291, 295–7, 306
simple improvement to 298, 324–5
bows, bulbous 409, *I*
Boyle's law 5–6
branching tubes or channels 91, 107–24, 200
Brunt–Väisälä frequency 287–309, 312–15, 322–4, 334–7, 358–9, 376–85, 396, 410–17, 426–8, 432–40, *JKL*
bubble pulsations 32–3
energy of 33–4
frequency of 34
sound fields of 32–5, 87
bulbous blows 409, *I*
bulk modulus 52, *B*
'bump on the bottom' generating stationary waves 265–9, *HI*
canal, wave generation in 246, 263–5, 436
capacitance of a cavity 113–20
capacity (electrostatic) 56–7
capillary waves 225, 263
group velocity 245
pattern of (generated by steady motion of small obstacle) 283
surface-tension contribution to wave energy flux 282
carbon dioxide, acoustic energy dissipation in 84–5, *DF*
cardiovascular system 90–9, 109–13, 123, 136, 200, *B*
catheter 123
Cauchy's theorem 249, 253, 266, 364, *AB*
caustics 277, 385–99, 403–4, 409–10, 448, *IL*
cavitation of liquids 35, 87, *A*
cavities in one-dimensional wave systems 113–20
central limit theorem 469
centred simple wave 153–5
centroid motion, affecting a body's equivalent dipole strength 38
characteristic curves 143, *B*
circumferential tension in elastic tube 96–9, *B*
cnoidal waves 465–7, *P*
coastline, behaviour of waves near 211, 217–19, 258, 428–31, *HJ*
coefficient of expansion 10, 300–1
combustion noise 35, *E*
compact source regions (for sound waves) 25, 51, 64, *CDEF*
cases with dipole far fields 35–41, 371
cases with monopole far fields 31–5, 45, 66, 73, 370–1, 422–5, 436
with dissipation allowed for 76–7
with nonlinear effects included 194–6
compact source regions (for waves in general) 371, 380–1
compactness of channel cross-sections, and junctions 95, 101–4, 126–8, 145–6
competition between waveform-changing influences 154–8, 163–5, 186, 201, 204, 463–8, *DFPQ*
complete set of orthogonal functions 420, *AB*
compressibility 1, 4, 33, 50–3, 87, 90, 92–8, 114, 124–5, 291–2
compression-pulse asymptotics 172–3, 190–4, *DF*
compression, work of 6–9, 80
condensation 84, 307–8, *CD*
conduction of heat 9, 80–2, 164, *F*
conductivity (electrical) 437, 443–4, *BC*
conical beam 71, 74–6, 339, 376, 448
conical horn 201, *D*
conical wavenumber surface 383–5

conservation of wave action 331–5, 456–9, *KP*
conservation of wave energy 4
for acoustic waves 14–16, 323
for internal waves 293–4, 323–4, 432
for nonlinear dispersive waves 458
for one-dimensional waves in fluids 106, 108
in general anisotropic systems 321–3, 357
constrictions in one-dimensional wave systems 116–20, 200
continuity, equation of 2, 58, 77, 92–3, 125, 129, 134, 141, 207, 232, 288–92, 428, *A*
for 'phase' 242, *H*
convective rate of change 1, 148–9, 326, *A*
Coriolis force 437–43, *CMNO*
correspondence principle of quantum mechanics 319–20, 330–1, *C*
crest shapes (constant-phase loci) 372–3, *IJKL*
for capillary waves generated by small obstacle 283
for internal waves 289, 313–16, 411–13, 416–17, 436
in Kelvin ship-wave pattern 276–9
critical depth of a stream 202–3, *G*
critical levels (two kinds of) for internal waves 335–7, *KL*
cumulus clouds 308, *C*
current (nonuniform) affecting water waves 331, *K*
curvature of wavenumber curve 366–8, 373
(Gaussian), of wavenumber surface 368–9, 373, 381, 383, *B*
cusps in rays 324, 335–6, 386
cusps in wave crests 277–8, 412–13
cut-off frequency 127–8, 200–1, 421, 472
cylindrical pulse (nonlinear theory) 194, 203, *DF*

decibel 16, *DE*
deep-water waves 209–14, 223–5, 235–6, 243, 272–80, 403–10, 436, 451–2, *CGHIP*
defect in reciprocal signal velocity 152, 174–5, 187–92
defect of volume flow, in boundary layer 132–3, 136, 230, *A*
density rise time in shock wave 164–5
derivative of ($\frac{1}{2}$)th order 20–1, 86, 196, 198, 201, 384
destructive interference 70, 76, 191, 247, 249
developable surfaces 381, *B*
diaphragms 70–6, 90, 146, *D*
circular 74
flush with tube wall 436
in shock, tubes 201–2
diatomic gases 8, 83
diffusivity 80
of magnetic field lines 443–4, *BC*
of sound 78–83, 155–7, 163–5, 339, *DF*
of vorticity 130–1, 443, *A*
dimensional analysis 275, *A*
dipoles 23–30, *CDEF*
distributed 61–3
momentum of 27–30
power output of 27, 30
related to force 30, 61–2, 199, 380
strength of 25, 30, 36–9, 47, 51–6, 62, 68–9, 88, 371
disentangling the different waves generated from complicated initial conditions 142–3, 352, 357
dispersion relationships 204–6, 242, 255, 265, 284, 310, 352, 362, 401
for gravity waves 210, 215–18
for interfacial waves 285
for internal waves 287–9, 294–6
for ripples 223–7
in acoustic waveguide modes 419
in a nonuniform wind 327
in gravity-acoustic waveguides 428
in rotating fluid 438–9, 441
dispersive systems in general 204–6, 209, 284, *HKLMPQ*
anisotropic 308–12, 317–22, 351–7, 361–73, 392–5, 399–403
isotropic 237–60, 306–1, 386–92
on nonlinear theory 450, 455–60, 463–7
with small dispersion 463–7
displacement excitation of simple waves 145–8, 152–8, 201
displacement thickness of boundary layer 230–1, 281, *A*
dissipation 9, *B*
in acoustic waves 76–85, 338–49, *DF*
in boundary layers 128–36, 229–32, *AD*
in shock waves 154–65, 193, *DF*
in surface waves 179–82, 232–7, 263–5, *H*
of internal waves 349–51, 359, 379–82, *K*
of magnetohydrodynamic waves 443–6, *CM*
distensibility 90–9, 114–15, 124–5, *B*

distortion of waveform ('shearing') 150–6, 170–5, 183–94, *F*
condition for it to overcome small dispersion 464–6, *PQ*
Doppler relationship 326–7, 399–400
'double models' (for ship hulls) 275, 406–9, *I*
downwind sound propagation (downward curvature of rays in) 334
drag, wavemaking 263, 275–6, 286, 408–9, *IJ*
ducts, as acoustic waveguides 418–25, 436, *L*
dust accumulation at nodes of standing sound wave 348, *C*
dynamics, classical 319, 455, *A*
of vibrations 33, 213, 221, 285, 287

earthquakes generating 'tsunamis' 442, *N*
Earth's liquid-metal core 437, 444, *O*
Earth's magnetic field 437, 444, 446, *MO*
Earth's rotation, effects of 437, 440–3, *CMNO*
eddy, radiating sound coherently 64, *DEF*
edge-waves 428–31, *IJ*
effective admittance 110–12, 115–20, 123–4, 200
eigenfrequencies, eigenfunctions, eigenvalues 419–25
theorem on number of 424, *B*
elasticity of tube 90–1, 96–9, *B*
elastomers 98–9, *B*
electrical quantities as analogues to wave quantities 113, *A*
capacitance 113–14
current 104, 113–14, 117
inductance 117
potential 104, 114
tuned circuit 119
electron behaviour in magnetohydrodynamic waves 449, *M*
electrostratic capacity 56–7
energy 6–10, *B*
acoustic 11–16, 22, 293, *CD*
conservation of, 14–16, 106, 108, 293–4, 321–4, 357, 432, 458
dissipation of 76–85, 128–36, 154–65, 179–82, 229–37, 259–60, 263–5, 337–51, 359, 379–82, 443–6, *ABCDFHKM*
exchange, between wavenumbers in triad 469, *Q*
exchange, between waves and flow 328–37, *KL*
flow of, in tube or channel 106, 113–14, 121–7, 135, 191–3, 422
flux of 15–16, 21–3, 27, 78, 256–60, 282, 290, 294, 297–8, 313, 321–4, 330–1, 369–72, 402, 432, 452–3, 459
internal 6–9, 80–5, 159–61, 227–8, *B*
loss per period 79, 135, 157, 231–2, 235, 339
of gravity waves 212–14, 220–1
of inertial waves 440
of internal waves 287, 293
of ripples 227–9, 282, *H*
on nonlinear theories 452–9, *MP*
propagation velocity 180, 236, 239–40, 254–60, 313, 316–18, 415, *HL*
surface 227–8, *H*
ensemble of integration surrounding position of stationary phase 354–6
entropy 8–10, 92–3, 124, 138–41, 148, 159–61, 166–8, 193, 286, *B*
envelope of rays 386, 391–2
equal-area rule, for discontinuities in simple waves 170–5, 183–4, 190–1, *DF*
estuary 91, 109–10, 181, 189, 285–6, *HJ*
Euler condition, in calculus of variations 458, 462
evaporation 84, 308, *CD*
excess density 288, 292, 310, 359, 434
excess pressure, definitions of 4, 11, 92, 206, 288
excess pressure, mean 330, 339, 434
excess signal speed 150–3, 170–5, 183, 187, 463–7
exchange of energy between wavenumbers in triad 469, *Q*
excitation of simple waves 145–58, 201
explosion of Krakatoa 428
exponential horn 127–8, 200

'fairly long' water waves 463–7, *PQ*
'fan' of rays, in case of developable wavenumber surface 381, 384
far field 22–3, 26–7, 32, 35–40, 45, 56–8, 62, 64, 72, 195–6, 371
Faraday's law 117, *ABC*
Ffowcs Williams and Lighthill film on aerodynamic sound generation 42–50
fjords 285–6
fluid particle motions in water waves 211–12, 219–20, 225
a second approximation 280
in edge-waves 429–30
flux 15
of energy 15–16, 21–3, 27, 78, 256–60, 282, 290, 294, 297–8, 313, 321–4, 330–1, 369–72, 402, 432, 452–3, 459

flux (*continued*)
of heat 81
of mass 59, 288
of momentum 59–60, 77, 329–30, 336–7, 469, *EKLQ*
of wave action 331–6, 458–9, *KLP*
foaming at wave crests 180–2, 264–5, 454, 459, 466–7, *HP*
force associated with dipole strength 30, 61–2, 199, 380
force generated by attenuated ultrasonic beam 339, *DG*
force, inertial (in accelerating frame) 54, 328–9, *A*
foreign body vibrating in fluid 32–5, 42–5, *ACDEFG*
constant-volume case 38–42, 48–50
equivalent dipole 38, 51
virtual mass 39, 54–6
Fourier transforms 73–6, 88, 248–53, 266–8, 282, 351–95, 400–17, 421–3, 434–5, *AB*
partial 375, 378
frame of reference, accelerating 54–5, 328, *A*
'local' 326–31
free energy 228, 237, *B*
free surface, boundary condition at 207–8, 222–3, 234, 452
frequency, conserved (along rays) in non-homogeneous systems 211, 217–18, 255–6, 318–19, 328
frequency, given an imaginary part to satisfy radiation condition 267–8, 364–5, *HL*
frequency, local 241–2, 255, 310–2, 317–20, 326–8, 457–60
frictional attenuation 128–36, 229–32, *AD*
Frost's poetry of stationary waves 261, 264, *I*
Froude number 274–9, 409, *I*

Gaussian curvature 368–9, 373, 381, 383, *B*
Gaussian distribution 80, 369, *O*
Gaussian integral 251, 356, 386, 388–90, 393, *AB*
generalised coordinates 33, 213, 221, 285, 287, 319, 455–9, *A*
generalised inertia and stiffness 33–4, 213–14, 221, 285, 287, *A*
geometrical acoustics 68–70, 75–6, 88–9, 122–3, 284, 317, 323, 332–4, *K*
nonlinear 190–9, 203, *F*
Gibraltar, Straits of 200
Glasgow and Ardrossan Canal 264, *I*
gravity-acoustic waveguide 425–8, 433, *JLM*
gravity effects on sound waves 10–11, 291–8, 425–8, 432–3, *J*
gravity waves 205
at water surface 205–21, 235, 243–4, 254, 256–8, 261–83, 360–1, 403–10, 451–67, *GHI*
interfacial 285–6, 305–6, *J*
internal 284–309, 312–16, 323–5, 334–7, 349–51, 358–60, 376–85, 396, 410–17, 425–8, 432–6, 468, *JKLMQ*
Green's law 122
group velocity 205, 239–43, *H*
as a vector in anisotropic systems 205, 284, 308–13, 321, 327, 356–7, 417, 439
as velocity of energy propagation 254–60, 313, 316–18, 401–2
by method of stationary phase 247–53, 351–7
'effective' (for nonlinear systems) 460–2
for acoustic-waveguide modes 420–2
for attenuated waves 253–5
for edge-waves 430
for gravity waves on water 243–4, 257, 262–3, 272–3
for internal waves 312–15
for long waves as affected by Earth's rotation 442
for ripples 245, 262–3, 283
for sinuous waves on thermocline 433
for waves in rotating fluid 439–40
in gravity-acoustic waveguide 428
in nonhomogeneous systems 255–6, 317–18
minimum, for deep-water waves 245, 252, 386, 393–4
parallel to crests, for particular wave systems 284, 312–15, 439
'splitting' of, in nonlinear theory 461–2
Gulf of Toulon 301, *J*

half-wavelength tube 112
Hall effect 449, *CM*
Hamilton's equations 319, *A*
Hamilton's principle 455–8, *A*
hardwalled ducts, as acoustic waveguides 418–25, 436, *L*
head shock wave 173–4, 190–6, *DF*
'healed' ray theory 385–6, 391–9, 435
hearing, threshold of 16, *C*
heat conduction 9, 80–2, 164, *F*
heat flux 81
helium, acoustic energy dissipation in 83, *DF*

Helmholtz resonator 116, 119–20, *H*
Helmholtz's theorem 3, *A*
horn, loudspeaker 89–90, 126–8, 189, 200–1, *D*
horse of W. Houston, Esq., discovering drag reduction 264, *I*
hovercraft wavemaking 404
Hugoniot law 160–6, 177, *DF*
hybrid analysis of dispersion in nonhomogeneous system 352, 361
hydraulic jump 175–83, *GH*
  incorporated within a simple wave 182–3
  in stratified fluid 468, *Q*
  rate of loss of mechanical energy 178–82, 466–7
  stationary 202–3, 467
  'turbulent' 181–2, 467
  'undular' 180–2, 466–7
hydraulic mean depth 95, 110, 122
hydrostatic relationship, 10, 92, 94, 206, 286
hyperbolic functions 215–21, 226, 231, 243, 257, 266–9, 280, 283

iliac bifurcation 109, 113, *B*
imaginary part, significance of 131, 135
  given to frequency to satisfy radiation condition 267–8, 364–5, *HL*
  given to phase to estimate Fourier integral 249–50, 266–8, 354, 364–5, 387–8, 421
impedance 105, 118–20, *A*
incident wave 50–1, 53, 56, 101–2, 105–10, 200, 348–50, 432
inductance 117–20, 200
inertial force (in accelerating frame) 54, 328–9
inertial waves (in rotating fluid) 440, *MN*
initial-value problems 85–7, 141–4, 248–53, 282, 315–16, 352–61, 386–94, 433–5
insect wings, buzzing of 40
instability of periodic waves on deep water 461–3, *P*
instability of stratified fluid 287, 301–2, 307–8, *CJ*
Institute of Oceanographic Sciences 443, *N*
intensity 11–16, 21–2, 78, 290, 294, *CD*
  directional distribution 27, 73, 371–2
intercostal arteries 109, *B*
interface waves 285–6, 305–6, *J*
interference 70, 76, 191, 247, 249
interferogram 169
internal energy 6–9, *B*
  components of 80–5
  discontinuous change in, at shock wave 159–61, 165
  of liquid 227–8
internal waves 284–90, *JKLMQ*
  attenuation of 349–51, 359, 379–81
  generated by oscillating source 376–85
  generated by steady motion of obstacle 410–17, 435–6
  group velocity of 312–15
  in atmosphere 295, 306–8, 323–5
  in nonuniform wind 334–7
  in ocean 298–306, 433, 435
  initial-value problem for 358–60, 433–5
  interaction with sound waves 291–8, 425–8, 432–3
  nonlinear phenomena in 468
  reflection of 432
Inui's classic work on bulbous bows 409, *I*
'inversion' (temperature increasing with height) 334, 398–9
ionisation 84, 446, 449, *BD*
ionosphere 437, 444–8, *MO*
irrotational motion 3–5, 128–31, 207, 229–34, 265, *A*
isothermal atmosphere 193–9, 295, 427, 432–3

Jacobian determinant 193, 354, 356–60, *A*
Jacobian elliptic function 465, *P*
jet, generated by ultrasonic beam 343–5, *DG*
jet, generating sound 63–4, *DEF*
jet, generating waves on a stream 282–3
junctions (between tubes or channels) 100–6, 127–8, 145–6

Kelvin ship-wave pattern (wedge) 273–9, 404–10, *I*
'Kelvin wave' (tidal) 442, *N*
kinematic viscosity 128–36, 201, 230–1, 235, 281, 349–50, 359, 379, *A*
Kirchhoff's laws 113, *A*
knitting needle, generating capillary waves 283
Korteweg–de Vries equation 463–7, *PQ*
Krakatoa, explosion of 428
Kronecker delta 59, 77, 330, 434

lag in attaining thermodynamic equilibrium 78, 80–5, 157, 164, 229, 237, *DFH*
Lagrange's equations 455, *A*
Lagrangian density 455–62, *AMP*
Laplace's correction to Newtonian sound speed 5–8, *D*
Laplace's law for circumferential tension 96, *B*

latent heat 307–8, *B*
least-time paths (rays of sound) 67–70, 191–2, 197
lee waves 307, 416, *JL*
lift 87, 199
line source 20–1, 86
linear-theory assumptions 1–4, 11–13, 93, 204–8, 222, 288, 438, 441, 445–6
link, joining paths of integration 250–2, 387–9
liquid sodium 444
lobes of equal area 170–5, *DF*
lobes, side 74, 87
local amplitude 241, 252–5, 310, 317, 320, 323–4, 332–5, 359, 382, 460–2
local frame of reference 326–31
local frequency and wavenumber 241, 252–5, 309–12, 317–20, 326–8, 457–62
local mean velocity 326–37, 340–9
local phase 241, 253, 309–11, 317–18, 326, 457–60
local sound speed 138–41, 148
'long' waves 91–6, 110, 112, 214–21, 428–31, *GHJMNO*
  on nonlinear theory 140–1, 145, 148–9 175–83, 186, 189, 466–7
  transverse motions in 95–6, 199–200
  with Earth's rotation taken into account 441–3
'long-crested' water waves 214, 238
longitudinal waves 90–8, 124–5, 128, 134, 418
Lorentz force 443–4, 449, *BC*
loudspeakers 23, 70, 89–90, 126–7, 146, 189, 200–1, 436, *D*
low-Reynolds-number hydrodynamics, of acoustic streaming 340–4, *DG*

Mach angle 271
Mach number 162, 330
magnetic pressures 444–8, *BC*
magnetohydrodynamics 443–9, *BCDMO*
Majorca 200
mass flux 59
  upward component of 288
matching admittances 105, 135
maximum amplitude for deep-water gravity waves 453–4, *P*
maximum wave energy for deep-water gravity waves 454, *P*
Maxwell's equations 443–4, *BC*
Maxwell's equivalent stress system 444-5, *BC*
Maxwell's relationship (in thermodynamics) 9, *B*
Mediterranean 200, 300–1
mercury 444
method of steepest descent 251–2, 387–90, *B*
  second approximation 281–2
minimum group velocity (on deep water) 245, 252, 386, 393–4
minimum wave speed (on deep water) 224, 245, 262–3
Mistral 301, *J*
model tests on ship hulls 275, 406, 409, *I*
modulated deep-water waves 460–2, *P*
moment of source strength 36–8, 371
momentum, equation of 2, 58–9, 77, 92, 129–30, 141, 176–7, 207, 288, 429, 438, 441, 445–6, *A*
momentum flux 59–60, 77, 329–30, 336–7, 469, *EKLQ*
  excess of 60, 63–4, 77
momentum per unit area, for waves on deep water 279–80
monatomic gases 7–8, 83, 148
Mowbray's schlieren picture of 'St Andrew's Cross' 314, *K*

near field 26–30, 32, 35, 42, 58
Newtonian speed of sound 5, 8–10, 299–300
nitrogen, acoustic energy dissipation in 83, *DF*
nodes of standing sound wave, dust accumulation in 348, *C*
noncompact source regions 65–76, 371–2
nonhomogeneous wave systems (general theory) 91–2, *DFGHKL*
  anisotropic systems 317–12, 352, 361, 433–4
  frequency conserved along rays 255–6, 318–19, 328
  isotropic systems 255–6
  one-dimensional waves (linear theory) 120–8, 133–6
  one-dimensional waves (nonlinear theory) 183–90
  wave-flow interactions 325–32, 459
nonlinear theory 1, 89–92, *DFGMPQ*
  of one-dimensional wave systems with uniform properties 140–3
  of one-dimensional wave systems with nonuniform properties 183–90
  of plane waves 137–40
  of pulse asymptotics 172–4, 190–8
  of simple waves 143–56
  of simple waves incorporating weak shock waves 165–75

nonlinear theory (*continued*)
of the propagation of dispersive waves 450–69
Norwegian fjords 285–6
number ('smoothed') of eigenfunctions in interval of eigenfrequencies 424, *B*
N-wave 174, 195–8

oblique stationary waves 262, 264, 269–70
obstacle in steady stream, generating stationary waves 260–70
obstacle in uniform motion, generating waves 262–4
ship 269–79, 395, 403–10
small obstacle, generating capillary waves 283
taking nonlinear effects into account 452–3, 459
within stratified fluid 410–17, 435–6
ocean stratification 205, 298–306, 324, *CJO*
ocean waves 236, *CGH*
generated by localised disturbance of limited duration 238, 246, 360–1
near a coastline 211, 217–19, 258, 428–31, *HJ*
'long-wave' phenomena 428–31, 441–3, *NO*
travelling over long distances 236, 238, *H*
'oil on troubled waters' 237, *K*
one-dimensional waves 19–23, 67, 76, 89–203, 418–25, 448–9
one-sided waveguides 418–19, 425–31
open channels, 'long' waves in 91–6, 110, 122, 199–200, 214–21, *GHM*
on nonlinear theory 140–1, 145, 148–9, 175–83, 186, 189, 466–7
orthogonal functions 420–5
oxygen, acoustic energy dissipation in 84, *DF*

'packets' of waves 247
parallel, addition of admittances in 108–9, 115
Parseval's theorem 76, 254, 357, *A*
partial Fourier transforms 375, 378
particle motions in water waves 211–12, 219–20, 225
a second approximation 280
in edge-waves 429–30
pendulums, used in demonstration of group velocity 281
Peregrine's photographs of the Severn bore 181–2
perfect gases 6–8, 80–5, 148–50, 161–3, 166–71, 185–7, 192–9, 202, 295, 307, 432–4, *B*
phase, local 241, 253, 309–11, 317–18, 326, 457–60
phase shift (Θ) 356–60, 367, 369, 402
'phase velocity' 180, 242, 420
piston exciting simple waves 145–8, 152–8, 201
planar wavenumber surface 374–6, 445, 448
plane walls, radiation from 70–6, 88, 372, 375–6
plane waves 4–5, 19–22, 76, 137–40, 289–90, 316, 350, 352, 363–4
Poisson's ratio 97–9, *B*
poles on path of integration 266–8, 363–5, *HIL*
polyatomic gases 8, 83–5
pond, stone thrown into 239–40, 245, 393–4
potential, velocity 3–5, 14–15, 17–18, 28, 40, 65–6, 68, 117–18, 199, 207–15, 219–21, 230, 233–4, 256–7, 265–6, 279, 429, 452–3, *A*
power output (acoustic) 16–17, *CDEF*
of dipole 27, 30, 86
of simple source 21–3, 86
of source distribution 370–2, 422–5
of turbulent jet 64
of ultrasonic beam 339–45
of vibrating body in fluid 33, 67, 76, 87
power output generating water waves 263, 270, 275–6, 286, 408, *I*
on nonlinear theory 452–3, 459, *P*
power output of general source in general system 370, 402–3
pressure excitation of simple waves 145–7
pressure–volume diagram 160–1, 163–4
principal axes 355–6, 358, 367–9, 381
propeller, noise of 40–1, *E*
proximal field 27, 30, 32, 57
pulse asymptotics, in nonlinear acoustics 172–4, 190–8, *DF*

quadrupole 48–9, 57–8, 63–4, 70, 88, *DEF*
quantum mechanics, analogies with 305, 319–20, 330–1, 398, *C*
quarter-wavelength tube 112–13, 119, 124
'quartz wind' (acoustic streaming) 339–45, *DG*
quasi-one-dimensional waves in fluids 418–19, 429, 436

radiation condition 267–8, 363–5, 377, 413, 421, *HIL*
radiation stress 434
Rayleigh scattering 56, *E*

Rayleigh's law, for acoustic streaming 348–9, *C*
rays 67–71, *FHKLM*
in general systems 312, 318–22, 367–9, 385–6, 391–9, 434
in internal waves 313–15, 322–4, 334–7, 378–84, 386, 434
in magnetohydrodynamic waves 445
in nonlinear acoustics 191–2, 196–7
in nonuniform winds 327–37, 434
ray tubes 67–8, 70, 89, 91–2, 99, 122–3, 191–9, 320–3, 331–2, 367–9, 384
reciprocal polar of wavenumber surface 372–3, *L*
reciprocal signal velocity 151–2, 174–5, 187–8
reciprocal slope of waveform 151, 171–3
reflection 102–11, 121, 432
from cavity 117
from constriction 120, 200
from discontinuity in gradient of admittance 126, 201
negative 106, 119
positive 105–6, 109–10, 113
total 105–6, 119
refraction 191, 199, 256, 318, 327, *HK*
relative (Doppler-shifted) frequency 326–8, 330–7, *KL*
becoming zero at special kind of critical level 335–7
resistivity (electrical) 443–4, 446, *BC*
resonance 40, *A*
for bubbles 53, 87
for one-dimensional wave systems 113, 116, 119–20, 124, 135, *BCD*
for sound waves in a duct 420–2, *L*
for water waves in a tank 279
reversible processes 9–10, 82, 237, 286, 292, *B*
Reynolds number 340–5, 349, *A*
Reynolds pendulums (demonstration of group velocity) 281
Reynolds stress 330, 336–9, 346, 348, 434, *K*
Riemann's nonlinear theory of plane waves of sound 137–43, *F*
ripples 221–9, 235–7, 245, 252, 261–4, 282–3, 393–4
ripple speed 41–2, 223–7, 271
ripple tank 41–50
correct choice of depth 41, 225–7
simulation of dipole 44–7
simulation of quadrupole 48–50
simulation of simple source 42–3, 45
rise time for density in shock wave 164–5
Rossby waves 443, *MNO*
rotating fluids, waves in 437–43, *CMNOQ*
rotational component of internal energy 81–5, *BDF*
rotations of axes, to facilitate estimations of integrals 355–6, 364–9, 374, 377–8, 383, *HL*
rubber tubes, fluid-filled 98

St Andrew's Cross (shape of crests) 314–15, 377, 439, *KN*
salinity 298–302, 313, *CJ*
salt fingers 302, *J*
saturation vapour pressure 307, *BC*
scattered waves 48, 50–7, 87, *E*
schlieren optical system 313–15, *K*
Schrödinger's equation 305, 398, *C*
Scott Russell's descriptions of wave motions 264, 465, *I*
second law of thermodynamics 10, 159–61, *B*
series, addition of impedances in 118–19
Severn 'bore' 181–3, 189, *H*
shearing distortion of waveform 150–6, 170–5, 183–94, *F*
condition for it to overcome small dispersion 464–6, *PQ*
ship waves 269–79, 395, 403–10, *I*
shock tube 201–2
shock waves 152–65, *DF*
entropy change at 166–7, 193
'head' 173–4, 190–6
incorporated into simple wave 165–75
speed of 159, 162
strength of 161–3, 166–8
'tail' 173–4
thicknesses of 162–5
union of 202
'weak' 166–75, 190–9
shortest path (ray in homogeneous system) 67–70, 191–3, 196–7, 311–12, 367–9
side lobes 74, 87
Sierra Wave 468
signal speed in simple wave 148–50
excess 150–3, 170–5, 183, 187, 463–7
silence, zone of 333
simple pendulums (experiment demonstrating group velocity) 281
simple sources 17–23, *CDEF*
compared with case of incompressible fluid 18
distributed 60–1, 370–2, 376, 382, 421–5
in one dimension 19–23, 67, 432–5
in two dimensions 20–1, 86
power outputs of 21–3, 86
strengths of 19, 52

simple waves 143–56, *DF*
incorporating weak shock waves 165–75
in open channel 148–9, 182–3
in perfect gas 148–50, 166–71
sinuous waves on thermocline 305–6, 398, 433, 435, *J*
sinusoidal waves 79, 84–8, 111–20, 124, 126–8, 130–6, 200
on deep water 208–14, 223–5, 235–6
on water of uniform depth 214–21, 225–7, 229–35, 256–7
theory for general systems 258–60, 316, 352, 362–3
siren 31, 87–8
sky, blue light of the 56, *E*
'smoothed' number of eigenfunctions in interval of eigenfrequencies 424, *B*
Snell's law 323, 333
solids, mechanics of 96–9, 104, *AB*
solid surface, boundary condition at 128–31, 209, 214, 233, *A*
solitary wave 465–7, *IPQ*
in stratified fluid 468, *Q*
'soliton' 467, *Q*
'sonic wind' (acoustic streaming) 339–45, *DG*
sound speed 4–11
'frozen' 84–5
in perfect gases 6–8
in stratified fluid 291–8
in water 10–11, 95, 206
local 138–41, 148
Newtonian 5, 8–10, 299–300
source regions, acoustically compact 25, 51, 64, *CDEF*
cases with dipole far fields 35–41, 371
cases with monopole far fields 31–5, 45, 66, 73, 370–1, 422–5, 436
case with dissipation 76–7
with nonlinear effects included 194–6
source regions, compact (for waves in general) 371, 380–1
source regions, noncompact 65–76, 371–2
spatial distortion of temporal waveforms 151–2, 174–5, 187–99
spatial waveforms, temporal distortion of 150–1, 165–74
specific heats 6–10, 82–4, 148, 161–2, 185–7, 202, 295, 300, 307, 426–7, 432–4, *B*
speedboats generating waves 274, 279
spheres, radiation from 33–5, 39–40, 65–70, 87–8
scattered 50–7, 87, *E*
spherical attenuation factor 19, 24, 26
spherical pulse (nonlinear theory) 194–6, 203, *DF*
splitting of general standing wave into travelling waves 379, 384
standing waves 279
of sound in a tube, generating streaming 347–8
splitting of, into travelling waves 379, 384
stationary phase 70–1, 76, 88, 191, 197, 247–53, 270, 351–7, 366–9, 383–4, 386–93, 434, *BHL*
to second approximation 281–2
stationary waves 260–70, 282–3, 452–4, *IP*
statistical assemblage of waves 468–9, *Q*
steady streaming generated by wave attenuation 337–51, *G*
steady stream, stationary waves on a 260–70, 282–3, 452–4, *IP*
steam siren 87–8
steepening of waveform's compressive phase 150–6, 161, 169–74
steepest ascent (direction of particle motion in surfaces of constant phase) 289–90, 350
steepest descent, method of 251–2, 387–90, *B*
second approximation 281–2
step in bed of stream, generating stationary waves 261
Stevenson's studies of internal-wave generation 315–16, 379–82, 433, 436, *K*
Stokes boundary layer 130–6, 229–32, 281, *A*
Stokes calculation of internal dissipation in water waves 232–6, *H*
Stokes drift 280
Stokes edge-wave 429–30, *I*
'stokeslet' velocity field 341–3, *G*
stone thrown into pond 239–40, 245, 393–4
Straits of Gibraltar 200
stratification 286–98, 308–9, 312–16, 322–3, 332, 358–60, 376–85, 395–8, 410–17, *CFJKLMO*
of atmosphere 11, 197–9, 205, 295, 306–8, 323–5, 332–7, 398–9, 425–8, 432–3, 468
of ocean 205, 298–306, 324
stability of 287, 301–2, 307–8
stratified-fluids experiments 313–16, 380–2, 411–13, *JKL*
stratosphere 307, 428, *C*
stream, stationary waves on a 260–70, 282–3, 452–4, *IP*
stream-function 452–3, *A*

streaming generated by wave attenuation 337–51, *G*
strength of a discontinuous wave 161
hydraulic jump 177–83, 466
shock wave 161–3, 166–71, 192–9, 202
strength of a source of waves 19
dipole 25, 30
'equivalent' dipole 38–41, 47, 51–6, 68–9, 88
per unit volume 61, 370, 376, 382, 421
quadrupole 58, 63–4
simple source 19, 22–6, 28–9, 31, 36–7
'total' 31–3, 51–3, 73, 87–8, 370–1, 423
stress tensor 77, 81, 129, 132, 155–7, 163, 233–4, *A*
supercritical flow of a stream 177, 203, *G*
supersonic boom 196–9, 203, 270, *F*
surface dissipation (in water waves) 229, 237, *K*
surface energy 227–8, *H*
surface tension 33–4, 207, 222–9, 237, *H*
surfaces of constant phase 289, 313–16, 372–3, 411–13, 416–17, 436, *JKL*
surge (wind-enhanced tidal action) 111, 442–3, *N*

'tail' shock wave 173–4
Taylor column 440, *N*
temporal distortion of spatial waveforms 150–1, 165–74
temporal waveforms, spatial distortion of 151–2, 174–5, 187–99
tension, in elastic tube 96–9, *B*
tension, surface 33–4, 207, 222–9, 237, *H*
'tethered' elastic tubes 98–9, *B*
thermocline 302–8, 398, 433, 435, *CJ*
thickness of boundary layer 131–6, *A*
thickness of shock wave 162–5, *DF*
Thomas–Stevenson studies of viscous effects on internal waves 379–82, *K*
threshold of hearing 16, *C*
tides 91, 136, 181, 189, 200, 285, 442–3, *CNO*
total reflection 105
negative 106, 119
positive 105–6
Toulon, Gulf of 301, *J*
translational component of internal energy 80, 82–3, *B*
transmitted wave 102–11, 121–2, 201
'transparency' of half-wavelength tube 112
transverse motions in 'long' waves 199–200
trapped waves 302–8, 334, 398–9, 433, 435, *CJ*
travelling forcing effects 399–417, 439–40, *LN*
triad of wavenumbers allowing resonant energy exchange 469, *Q*
triangular pulse 172–3, 190–4
trifurcation 107
tropopause 307, *C*
tsunamis 442, *N*
turbulence 49, 57, *O*
contrasted with statistical assemblage of waves 450–1, 469, *Q*
dissipative effect of 136, 189, 202, *H*
in jet generated by ultrasonic beam 344
sound radiation from 57–64, *DEF*

ultrasonic beam 339–45, *DG*
union of shock waves 202, *F*
upstream influence of obstacle in stratified fluid flow 416–17, *L*
upward component of mass flux 288
upwind sound propagation (upward curvature of rays in) 334

Väisälä–Brunt frequency 287–309, 312–15, 322–4, 334–7, 358–9, 376–85, 396, 410–17, 426–8, 432–40, *JKL*
van der Waals equation of state 86, *B*
vapour pressure 307, *BC*
variational theory for nonlinear dispersive waves 455–63, *MP*
varicose waves on thermocline 305, 435
vector group velocity 205, 284, 308–13, 321, 327, 356–7, 417, 439
vector wavenumber 289–90, 352–8, 362–72, 400–2, 432–3, 438–9, 446–7
local 309–13, 317–20, 326–8
velocity potential 3–5, 14–15, 17–18, 28, 40, 65–6, 68, 117–18, 199, 207–15, 219–21, 230, 233–4, 256–7, 265–6, 279, 429, 452–3, *A*
Venturi effect 409, *A*
vibration of foreign bodies in a fluid 32–5, 42–5, *ACDEFG*
constant-volume case 38–42, 44–50
equivalent dipole 38, 51
producing streaming motions 351
virtual mass 39, 54–6
vibrational component of internal energy 81–5, *BDF*
vibration theory in general 12, 33, 213–14, 221, 285, 287, *A*
virtual mass 39, 54–6, *A*
viscous dissipation 9–10, 77–8, 80–1, 83, 85, 91, 93, 128–36, 164, 201, 206, 209, 215, 229–37, 337–51, *A*
internal (for water waves) 232–6, *H*

viscous dissipation (*continued*)
surface (for water waves) 237, *H*
within internal waves 349–51, 359, 379–81, *K*
viscous force per unit volume 129, 233, 340, *A*
volume flow, as variable in one-dimensional waves 103–10, 114, 117–19, 122–8, 133–6
volume-flow defect in boundary layer 132–3, 136, 230, *A*
volume-flow excitation of simple waves 145–6
vortex lines 3, 437–43, 450–1, *AM*
vorticity 2–3, 128, 131–2, 207, 360, 437–43, 450–1, *AM*

water vapour 84, 307–8, *BC*
water waves 205–8, *GH*
attenuation of 229–37, 253–5, *H*
energy of 212–14, 220–1, 227–9, 282
energy of, gained from opposing current 331, *K*
'fairly long' (on nonlinear theory) 463–7, *PQ*
(gravity) on deep water (linear theory) 209–14, 232–7, 243, 272–80, 403–10, *I*
(gravity) on deep water (nonlinear theory) 451–62, *MO*
(gravity) on water of arbitrary, but uniform, depth 214–21, 229–37, 243–4, 256–8, 264–71, 462–3, *IP*
group velocity of 243–5, 257, 262–3, 272–3, 283
initial-value problem for 282
'long-crested' 214, 238
'long' (on linear theory) 91–6, 100–1, 109–10, 122, 133, 136, 199–200, 217–18, 221, 243, 270, 428–31, 440–3, *GHJ*
'long' (on nonlinear theory) 140–1, 148–9, 175–83, 186, 189, 466–7, *FGH*
momentum of 279–80
near a coastline 211, 217–19, 258, 428–31, *HJ*
of maximum amplitude 453–4, *P*
of small wavelength (ripples) 221–9, 235–7, 245, 252, 261–4, 282–3, 393–4, *H*
particle motions in 211–12, 219–20, 225, 280, 429–30
stationary 260–70, 282–3, 452–4, *IP*
travelling over long distances 236, 238, *H*
waveforms of (on nonlinear theory) 454, 465, *PQ*
wave action 331–5, 456–9, *KP*
wave energy 14–16
acoustic 11–16, 22, 293, *CD*
conservation of 14–16, 106, 108, 293–4, 321–4, 357, 432, 458
dissipation of 76–85, 128–36, 154–65, 179–82, 229–37, 259–60, 263–5, 337–51, 359, 379–82, 443–6, *ABCDFHKM*
exchange, between wavenumbers in triad 469, *Q*
exchange with mean flow 328–37, *KL*
flow of, in tube or channel 106, 113–14, 121–7, 135, 191–3, 422
flux of 15–16, 21–2, 27, 78, 256–60, 282, 290, 294, 297–8, 313, 321–4, 330–1, 369–72, 402, 432, 452–3, 459
general properties of 254–6, 258–60, 316, 357, 369–70, 455–9, *HLMP*
in gravity waves 212–14, 220–1, 257, 263, 272
in inertial waves 440
in internal waves 287, 293
in ripples 227–9, 263, 282, *H*
loss per period 79, 135, 157, 231–2, 235, 339
maximum (for deep-water waves) 454, *P*
on nonlinear theories 452–9, *MP*
wave equation 4–5, 59
one-dimensional 4–5, 93
spherically symmetrical 17–18, 65
two-dimensional 384, 429
waveform distortion ('shearing') 150–6, 170–5, 183–94, *F*
condition for it to overcome small dispersion 464–6, *PQ*
waveforms of water waves (on nonlinear theory) 454, 465, *PQ*
wave group 239–43
waveguide 90, 418–31, 440–1, *JLM*
'one-sided' 418–19, 425–31
wavemaker 436, 460–1, *P*
wavemaking drag 263, 275–6, 286, 408–9, *IJ*
wavemaking power in general 370, 402–3
for water waves 263, 270, 275–6, 286, 408, *I*
on nonlinear theory 452–3, 459, *P*
wavenumber curve 363, 365–8, 376–80, 394–5, 400–17, 435, *IKL*
wavenumber surface 363, 365–76, 381–5, 400–1, 410–14, 432, 445–8, *LMO*
wavenumber vector 289–90, 352–8, 362–72, 400–2, 432–3, 438–9, 446–7
local 309–13, 317–20, 326–8
wave 'packets' 247
waves in solids 104, *B*

Cambridge University Press
978-0-521-01045-0 - Waves in Fluids
James Lighthill
Index
More information

wave speed 4–5, *B*
for Alfvén waves 445–9, *CMO*
for edge-waves 430, *IJ*
for gravity waves on deep water 210, 453
for gravity waves on water of uniform depth 215–18
for inertial waves 439, *MN*
for internal waves 314
for 'long' waves in channels 95
for one-dimensional waves in fluids 93
for ripples 223–7
for sound waves 5–10
for stationary waves 261–2
for waves in a distensible tube 96–9, *B*
in dispersive systems 204–5, 237–40, 242, 244
mean value along a tube 123
minimum (on deep water) 224, 245, 262–3
variation with amplitude, for water waves 453, 464–6, *PQ*
weak-bore theory 182–3, *DFGH*
weak-shock-wave theory 166–75, 190–9, 203, *DF*
well-mixed layer in ocean 302, *CJ*
'white horses' 180, 264, 454, *P*
Whitham's law (on positions and strengths of shock waves) 171–5, 190–9, 202, *DF*
Whitham theory for nonlinear dispersive systems 455–63, *MP*
wind (nonuniform), ray tracing in 325–37, 459, *KLP*
wind surge, enhancing tidal action 111, 442–3, *N*

Young's modulus 96–9, *B*

zone of silence 333