
Contents

Foreword	ix
Preface	xi
Introduction	xiii
Chapter 1. Homogeneity of Relationships and Conversion of Units	1
1.1. Introduction.	1
1.2. Definitions of the basic SI units	2
1.2.1. Definition of the meter as adopted in 1983.	2
1.2.2. Definition of the kilogram.	2
1.2.3. Definition of the second adopted in 1967.	3
1.2.4. Definition of the ampere adopted in 1948	4
1.2.5. Definition of Kelvin adopted in 1967	4
1.2.6. Definition of a mole	5
1.2.7. Definition of the candela adopted in 1979	5
1.3. Additional quantities and SI derived quantities.	5
1.4. Rules for the use of units	7
1.4.1. Unit name	7
1.4.2. Unit symbols.	8
1.4.3. Compound symbols	8
1.5. Exercises	9
1.5.1. Exercise 1: calculation of dimensions	9

1.5.2. Exercise 2: homogeneity of relationships	15
1.5.3. Exercise 3: dimension of the constants of an equation	22
1.5.4. Exercise 4: equation for perfect gases	23
1.5.5. Exercise 5: unit conversions	24
Chapter 2. Dimensional Analysis: Rayleigh Method and Vaschy-Buckingham Method	29
2.1. Introduction	29
2.2. Definition of dimensional analysis	30
2.3. The Rayleigh method	31
2.3.1. Example of application: the period of the swinging of a pendulum	31
2.4. Vaschy-Buckingham method or method of π	34
2.4.1. The Vaschy-Buckingham theorem	35
2.4.2. Formation of terms in π	36
2.4.3. Application example: linear pressure drop calculation	37
2.5. Exercises: homogeneity method or Rayleigh method	41
2.5.1. Exercise 1: Reynolds number	41
2.5.2. Exercise 2: the Weber number	44
2.5.3. Exercise 3: capillary number	46
2.5.4. Exercise 4: power of a propeller	47
2.5.5. Exercise 5: flow through an orifice with thin walls	50
2.5.6. Exercise 6: a linear pressure drop along a horizontal pipe	52
2.5.7. Exercise 7: force exerted by a fluid on a body	57
2.5.8. Exercise 8: oscillation of a liquid in a U-shaped tube	59
2.5.9. Exercise 9: a falling ball	61
2.5.10. Exercise 10: implosion time of an air bubble	66
2.5.11. Exercise 11: vibration of a drop of water	68
2.5.12. Exercise 12: drag force of water on a ship	70
2.6. Exercises: Vaschy-Buckingham method or method of π	72
2.6.1. Exercise 13: pressure drop in a pipe of circular cross-section	72
2.6.2. Exercise 14: friction forces on a flat plate	75
2.6.3. Exercise 15: drag force exerted on a sphere	79
2.6.4. Exercise 16: hydraulic jump	84
2.6.5. Exercise 17: flow through a thin-walled spillway with a horizontal crested	86
2.6.6. Exercise 18: flow through a triangular weir	89
2.6.7. Exercise 19: volume of a bubble	92
2.6.8. Exercise 20: flow through an orifice	94
2.6.9. Exercise 21: sudden narrowing of a section	98

2.6.10. Exercise 22: capillary tube	102
2.6.11. Exercise 23: deformation of a bubble	106
2.6.12. Exercise 24: laminar dynamic boundary layer on a flat plate	108
2.6.13. Exercise 25: power of a stirrer	115
Chapter 3. Similarity of Flows	119
3.1. Definition and principle of similarity	119
3.1.1. Geometric similarity	119
3.1.2. Kinematic similarity	120
3.1.3. Dynamic similarity	121
3.1.4. Similarity conditions for viscous, incompressible, non-heavy fluids (Reynolds similarity)	124
3.1.5. Similarity conditions for non-viscous, incompressible, heavy fluids (Reech-Froude similarity)	124
3.1.6. Similarity requirements for non-viscous, non-compressible, heavy fluids	125
3.1.7. Conditions of similarity of turbulent flows	126
3.1.8. Distortion of the model	127
3.2. Exercises: similarity of flows	127
3.2.1. Exercise 1: similarity between ships	127
3.2.2. Exercise 2: similarity of centrifugal pumps	130
3.2.3. Exercise 3: volumetric pumps with small dimensions	136
3.2.4. Exercise 4: characteristics of a centrifugal pump	138
3.2.5. Exercise 5: test of an automobile in a wind tunnel	140
3.2.6. Exercise 6: power ratios (p model / p prototype) of a pump	142
3.2.7. Exercise 7: flow in a pipe	145
3.2.8. Exercise 8: viscous force on a rotating disk	146
3.2.9. Exercise 9: development study of a hydroelectric gallery	151
3.2.10. Exercise 10: movement of solid matter by a water current	155
3.2.11. Exercise 11: a tapered body	159
3.2.12. Exercise 12: model of a seaplane	162
3.2.13. Exercise 13: tide study	164
3.2.14. Exercise 14: transient gas flow	168
3.2.15. Exercise 15: model of a torpedo	170
3.2.16. Exercise 16: movement of a ball in a fluid	174
3.2.17. Exercise 17: similarity of the movement of an airship	177
3.2.18. Exercise 18: resistance to the movement of a ship	180
3.2.19. Exercise 19: mixing tank	185
3.2.20. Exercise 20: friction on a prototype probe	192

Appendices	195
Appendix 1. Some Dimensionless Numbers Used in Fluid Mechanics	197
Appendix 2. Coefficients of Conversion to the International System or to the English System	201
References	205
Index	207