Contents

1 Forces 1
1.1 Objectives 1
1.2 Concept of Force 1
1.3 Representation of Forces: Diagram of Forces 3
1.4 Resultant or Sum of Force Vectors 4
1.5 Addition of Vectors 4
1.5.1 Rule of Polygon 4
1.5.2 Rule of Parallelogram 5
1.5.3 Method of Components 5
1.5.4 Algebraic Method 6
1.6 Newton's Laws 8
1.6.1 Newton's First Law of Motion (Law of Inertia) 8
1.6.2 Newton's Second Law (Mass and Acceleration) 9
1.6.3 Newton's Third Law (Action and Reaction) 9
1.7 Some Specific Forces 10
1.7.1 Weight 10
1.7.2 Muscle Forces 11
1.7.3 Contact Force or of Reaction or Normal (Perpendicular) Force 12
1.7.4 Forces of Friction 15
1.8 Pressure 18
1.9 Answers to Exercises 21

2 Torques 23
2.1 Objectives 23
2.2 Concept of Torque 23
2.3 Binary or Couple 29
2.4 Torque Due to Two or More Nonparallel Forces 31
2.4.1 Resultant of Two Nonparallel Forces Applied on a Body and Its Line of Action 31

2.4.2 Resultant of Two or More Nonparallel Forces Applied on a Body and Its Line of Action: Method of Funicular Polygon 32
2.5 Rotational Equilibrium 35
2.6 Answers to Exercises 37

3 Center of Gravity 39
3.1 Objectives 39
3.2 Weight and Center of Gravity 39
3.3 Practical Method to Locate the Center of Gravity 42
3.4 Analytical Method to Locate the Center of Gravity 45
3.5 Stable, Unstable, and Neutral Equilibrium 52
3.6 Motion of the Center of Gravity 55
3.7 Answers to Exercises 56

4 Rotations 59
4.1 Objectives 59
4.2 Moment of Inertia 59
4.3 Moment of Inertia of Regularly Shaped Uniform Solids 63
4.3.1 Radius of Gyration 63
4.3.2 Parallel Axis Theorem 66
4.4 Moment of Inertia of the Human Body 68
4.5 Angular Momentum and Its Conservation 70
4.5.1 Angular Impulse 71
4.6 Variation of Angular Momentum 73
4.7 Answers to Exercises 74

5 Simple Machines 77
5.1 Objectives 77
5.2 Simple Machines 77
5.3 Work Done by a Force 78
5.4 Levers 78
5.4.1 First Class Levers 79
5.4.2 Second Class Levers 80
5.4.3 Third Class Levers 81
5.4.4 Mechanical Advantage 81
5.5 Levers in the Human Body 82
5.5.1 The Locomotion Equipment 82
5.5.2 Articulations and Joints 83
5.5.3 Muscle and Levers 84
5.5.4 Identification of Levers in the Human Body 84
5.6 Pulleys 88
5.6.1 Combination of Pulleys 89
5.6.2 Traction Systems 92
5.7 Inclined Plane 95
5.8 Answers to Exercises 97

6 Muscle Force 99
6.1 Objectives 99
6.2 Equilibrium Conditions of a Rigid Body 99
6.3 System of Parallel Forces 100
6.4 System of Nonparallel Forces 103
6.5 Forces on the Hip 106
6.6 Forces on the Spinal Column 108
6.6.1 Forces Involved in the Spinal Column When the Posture Is Incorrect 108
6.6.2 Forces Involved in the Spinal Column When the Posture Is Correct 112
6.7 Answers to Exercises 114

7 Bones 115
7.1 Objectives 115
7.2 Skeleton and Bones 115
7.2.1 Composition of Bones 116
7.3 Elastic Properties of Solids 116
7.3.1 Tensile Stress and Compressive Stress 117
7.4 Modulus of Elasticity 118
7.4.1 Young's Modulus Y 118
7.4.2 Shear Modulus S 120
7.5 Elastic Properties of Bones 122
7.6 Pressure or Stress on Intervertebral Discs 125
7.7 Pressure on the Vertebrae 127
7.8 Shear Stress in the Lumbosacral Intervertebral Disc 127
7.9 Bone Fractures in Collisions 129
7.10 Answers to Exercises 132

8 Experimental Activities 135
8.1 Objectives 135
8.2 Introduction 135
8.2.1 Significant Digits 135
8.2.2 Mathematical Operations with Significant Digits: Two Examples 137
8.3 Chapter 1: Forces 138
8.3.1 Objectives 138
8.3.2 Activity 1: Construction and Calibration of a Spring Scale (Dynamometer) 138
8.3.3 Activity 2: Conditions for the Static Equilibrium with Respect to Translation 141
8.4 Chapter 2: Torques 142
8.4.1 Objectives 142
8.4.2 Activity 3: Torque of a Force 142

8.5 Chapter 3: Center of Gravity 144
8.5.1 Objectives 144
8.5.2 Activity 4: Center of Gravity 144
8.6 Chapter 4: Rotations 145
8.6.1 Objectives 145
8.6.2 Activity 5: Moment of Inertia and Angular Momentum 145
8.7 Chapter 5: Simple Machines 146
8.7.1 Objectives 146
8.7.2 Activity 6: Levers 146
8.7.3 Activity 7: Inclined Plane 148
8.8 Chapter 6: Muscle Force 149
8.8.1 Objectives 149
8.8.2 Activity 8: Association of Springs 149
8.9 Chapter 7: Bones 152
8.9.1 Objectives 152
8.9.2 Activity 9: Strength of a Spring 152

Appendix 153

References 157

Abbreviations 159

Index 161

http://www.springer.com/978-1-4614-8575-9

Biomechanics of the Human Body

Okuno, E.; Fratin, L.

2014, XII, 164 p. 128 illus., Softcover
ISBN: 978-1-4614-8575-9