

**LABORATORY EXERCISES IN
ELEMENTARY PHYSICS: A
MANUAL FOR STUDENTS IN
ACADEMIES AND HIGH SCHOOLS**

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Laboratory Exercises in Elementary Physics: A Manual for Students in Academies and High Schools by Franklin H. Ayres

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AND HIGH SCHOOLS

BY

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P R E F A C E

THIS little work is, as its name implies, simply a manual of exercises in elementary physics. No claim is made that it embraces all the exercises suitable for work of this grade. It is believed, however, that the exercises as herein presented constitute a sound basis for a strong, rational, and flexible course in elementary laboratory physics.

There has been no attempt in this book to usurp the functions of the teacher. Much of the details of the work are most effective when they come directly from him. The inspiration must also come, in large measure, from the instructor; no book can take his place in this particular.

In handling laboratory work in physics of any grade, the instructor is confronted at all times with the serious problem of providing apparatus. This problem is all the more serious in view of the fact that good work, even in elementary physics, is quite impossible without reasonably good apparatus. Speaking to this very point, Professor Nichols has said: "The list of instruments essential to the carrying on of an effective course in laboratory physics is not a large one. It includes certain standard apparatus, such as the balance, the air-pump, the thermometer, the projecting lantern, the electrical machine, and the galvanometer; together with such accessories as are necessary to use with these instruments. Without such an equipment, no college or school should attempt to give instruction in physics."

The meaning of Professor Nichols's final observation, just

quoted, which is confirmed by my own experience, is that effective work in physics is impossible with odds and ends, with mere models to serve as apparatus. On the other hand, too great refinement of method and result should neither be attempted by students of high-school grade nor expected of them. Nevertheless, generally speaking, apparatus which is not accurate within five per cent, at least, should never be put into the hands of such students. Both the possibility and the probability of reasonably accurate results should always be present, not only for the reason that the very nature of the subject and the spirit of science-teaching demand it, but for the sake of the moral effect upon the student as well.

So, in selecting the exercises for this manual, I have endeavored to keep ideal conditions constantly in mind. Wherever possible, however, I have suggested alternative methods and apparatus in order to better adapt the book to laboratories having a limited equipment.

A shop is strongly recommended to all schools, and especially to those of small means. A comparatively small sum spent in fitting up such a shop will reduce the expense of maintaining a physical laboratory by more than one-half and make possible a vastly greater variety of work. These statements are verified by my own experience.

Acknowledgments are due Mr. E. M. Bainter, of the Department of Mathematics of Central High School, for valuable suggestions, and for reading the manuscript of the manual; and to Mr. Benjamin Lubschez, a recent student of this school, for the drawings from which the illustrations were made.

F. H. A.

KANSAS CITY, Mo., *July, 1901.*

CONTENTS

INTRODUCTORY

	PAGE
THE WORK OF THE LABORATORY	1
THE NOTE-BOOK	4
VARIAION	6
SOURCES OF ERROR	8
TRIGONOMETRICAL RELATIONS	9

CHAPTER I

INTRODUCTORY EXERCISES IN MEASUREMENTS

EXERCISE	
1. The common rule	11
2. Rule and caliper measurements of a sphere and a hollow cylinder	12
3. The diagonal scale	15
4. The micrometer caliper	18
5. The vernier rule	20
6. The spherometer ; thickness of a thin plate	23
7. The spherometer ; radius of a spherical surface	25
8. The beam balance. Weighing by the method of equal swings	26
9. Weight of one cubic centimeter of pure water near the temperature of maximum density	29
10. The beam balance : Double weighing and weighing by substitution	31
11. The beam balance : Weighing by the method of oscillations	32
12. Graphic representation of results : Relation of volume and weight of different masses of the same substance	35
13. Sensibility of a balance	38

CHAPTER II

ELASTICITY OF SOLIDS

<small>EXERCISES</small>	<small>PAGE</small>
14. Tenacity of wires	40
15. Elasticity of stretching	41
16. The Jolly balance	45
17. Elasticity of bending	47
18. Elasticity of torsion	51

CHAPTER III

MECHANICS OF SOLIDS

19. Composition of parallel forces	54
20. Resultant of three forces concurrent in one plane	57
21. On machines: Law of the lever	58
22. On machines: The practical lever	61
23. On machines: The pulley	63
24. On machines: The inclined plane	64
25. On machines: The wheel and axle	65
26. On machines: Starting and sliding friction	67
27. The gravity pendulum	70
28. Determination of the local value of g	73

CHAPTER IV

MECHANICS OF FLUIDS

29. Cohesion of water: Adhesion between glass and mercury, and between iron and mercury	75
30. Boyle's Law	77
31. Principle of Archimedes	81
32. Specific gravity of solids denser than, and insoluble in, water	82
33. Specific gravity of solids less dense than, and insoluble in, water	83
34. Specific gravity of a liquid by the method of weighing a solid in it	83
35. Specific gravity of a liquid by means of a specific-gravity bottle	84
36. Specific gravity of liquids by Hare's method	86
37. Specific gravity of liquids: By means of a densimeter	87

CONTENTS

vii

CHAPTER V

HEAT

EXERCISE	PAGE
38. Boiling and freezing points on a thermometer	89
39. Linear expansion coefficient for brass and iron	92
40. Expansion coefficient of a liquid	94
41. Expansion coefficient of volume of gases under constant pressure	98
42. Expansion coefficient of pressure in gases at constant volume	98
43. Melting-point of paraffin	101
44. Calorimetry: Method of mixtures	102
45. Calorimetry: Specific heat of iron	104
46. Calorimetry: Heat of fusion of ice	105
47. Calorimetry: Heat of Vaporization of water	106

CHAPTER VI

MAGNETISM AND ELECTRICITY

48. Permanent magnets and electromagnets	108
49. Lines of magnetic force	110
50. The simple voltaic cell, and fundamental ideas concerning the magnetic needle used as a galvanoscope	112
51. Law of the tangent galvanometer	113
52. Reduction factor of a tangent galvanometer by Ohm's Law	116
53. Reduction factor of a tangent galvanometer by means of a copper voltameter	118
54. Fall of potential	120
55. Verification of Ohm's Law	123
56. Measurement of resistance by the method of substitution	124
57. Measurement of resistance with the slide-wire bridge: Laws of length and cross-section	125
58. Joint resistance of branched circuits	128
59. Specific resistance	130
60. Temperature coefficient of resistance of copper	131
61. Resistance of a voltaic cell	132
62. Resistance of a voltaic cell by Mance's method	135
63. Electromotive force of a voltaic cell	136
64. Electromotive force of a voltaic cell in terms of a Daniell cell by the high-resistance method	138
65. Electromotive force of generators connected in different ways: Effect of method of connection upon current furnished when external conditions are constant	140