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INDUSTRIAL PHYSICS

MECHANICS

BY

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PREFACE

The present trend in education has created a demand for a series of textbooks in which the material presented is more closely connected with the every-day life of the student. This volume is the result of an attempt to provide a textbook in elementary, practical mechanics,—a textbook suitable for use in technical, industrial, vocational and evening schools.

The chief difficulty encountered in writing an educational book is the choice of material. The material presented here consists largely of notes used in class by the author. It has been tried out and has proven successful. Certain time-honored topics, usually included in similar books, have been omitted; there has been no sacrifice, however, of fundamental principles. The order of presentation has been found satisfactory. It may be changed, if desired, without impairing the value of the course. An attempt has been made throughout to keep the diction simple and understandable.

Attention is directed to the questions and problems at the end of each chapter or division. The questions depend upon the subject-matter preceding and are invaluable both for study and review. The problems are not difficult and, it is hoped, sufficiently generous in number. Experience has proven that problems are an excellent medium for clarifying misunderstandings on the part of the student. Arithmetic is sufficient for most solutions, although a knowledge of algebra and trigonometry will be helpful. A special chapter dealing with elementary trigonometry has been included.

The author makes no particular claim to originality. He has consulted various standard works freely and acknowledges his indebtedness to many of them. Care has been exercised to keep the book free from errors. In case errors have crept in, the author will be glad to have his attention called to them.

Criticism of scope and content will also be welcomed.

Certain chapters have been made possible through the hearty coöperation of various firms and manufacturing plants in furnishing information, photographs, electrotypes, etc. Grateful acknowledgment is made to the following: Brown and Sharpe Mfg. Co.; Central Scientific Co.; Cole Motor Car Co.; Curtiss Aeroplane and Motor Corp.; Dodge Sales and Engineering Co.; Edw. R. Ladew Co.; Fafnir Bearing Co.; Ford Motor Co.; Goodell-Pratt Co.; Goodyear Rubber Co.; Goulds Mfg. Co.; Hyatt Roller Bearing Co.; Keuffel and Esser Co.; L. E. Knott and Co.; Link-Belt Co.; L. S. Starrett Co.; Skinner Engine Co.; Timken Roller Bearing Co.; Whitney Mfg. Co.; Worthington Pump and Machinery Corp.; Yale and Towne Mfg. Co.

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L. R. SMITH.

JERSEY CITY, N. J.,
June, 1922.

CHAPTER II

MEASUREMENT AND MEASURING INSTRUMENTS

SECTION I. MEASURES AND WEIGHTS

16. The English System.—In the United States we still employ the so-called *English system* of measurement for everyday work. The *yard* is taken as the standard of length, the *pound* as the standard of mass (weight) and the *second* as the standard of time. In applied physics the *foot* (*1/3 of a yard*), the *pound* and the *second* are often used as fundamental units. A system of measurement employing the three latter units is called the *foot-pound-second system*. It is usually spoken of as the *f.p.s. system*. The English system is inconvenient and has given way almost entirely to the *metric system* for purely scientific work. At present there seems to be a tendency toward the adoption of the metric system in this country for all purposes. The coming generation should thoroughly master the metric system, so that there will be as little confusion as possible when the change occurs.

17. The Metric System.—About the time of the French Revolution, the government of France appointed a commission to devise a system of weights and measures to replace the awkward system then in use. This resulted in the establishment of the metric system in France. It has since been made compulsory in most civilized countries, England and the United States being exceptions. The metric system is extremely easy to use on account of its simplicity and decimal scale. In scientific work the *centimeter*, *gram* and *second* are used as fundamental units. A system of measurement employing the three latter units is called the *centimeter-gram-second system*. It is usually referred to as the *c.g.s. system*.

The *meter* (*m.*) was adopted as the standard of length in the metric system. It was intended to be $\frac{1}{10,000,000}$ of the distance from the Equator to the North Pole, measured on the meridian of Paris. This distance was computed incorrectly, however, and the standard meter to-day is the distance between two transverse scratches on a bar of platinum-iridium at a temperature of 0°C. This bar is preserved in the archives of France and replicas have been sent to all civilized countries. The meter is 39.37 inches long. Our yard is officially defined as $\frac{3,600}{3,937}$ of a meter. The meter is divided into 10 equal parts or *decimeters;* 100 equal parts or *centimeters;* and 1,000 equal parts or *millimeters.* The centimeter, due to its more convenient size, is universally used

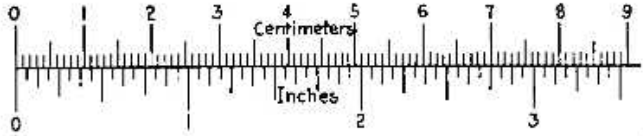

FIG. 1.—Comparison of the centimeter and inch.

in scientific work. Figure 1 shows the relation of the centimeter and inch.

The metric standard of mass (weight) is the *kilogram* (*Kg.*). It was intended to be *the mass of one cubic decimeter* ($dm.^3$) *of pure water at a temperature of* 4°*C.* Due to a very slight error, this relation is not exactly true. It is close enough, however, for all practical purposes. The prototype kilogram is a cylinder of platinum-iridium kept in the archives of France, copies of which have been furnished to all civilized countries. The *gram* (*g.*) or one thousandth of a kilogram is taken as the fundamental unit. The gram is divided into 10 equal parts or *decigrams;* 100 equal parts or *centigrams;* and 1,000 equal parts or *milligrams.* Our pound avoirdupois is equivalent to 453.5924277 grams. For practical work, 454 grams is used. The kilogram is equivalent to about 2.2 pounds. Figure 2 shows the practical relation of the pound and kilogram.