THE CALCULATIONS OF GENERAL CHEMISTRY

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649507795

The Calculations of General Chemistry by William J. Hale

Except for use in any review, the reproduction or utilisation of this work in whole or in part in any form by any electronic, mechanical or other means, now known or hereafter invented, including xerography, photocopying and recording, or in any information storage or retrieval system, is forbidden without the permission of the publisher, Trieste Publishing Pty Ltd, PO Box 1576 Collingwood, Victoria 3066 Australia.

All rights reserved.

Edited by Trieste Publishing Pty Ltd.
Cover @ 2017

This book is sold subject to the condition that it shall not, by way of trade or otherwise, be lent, re-sold, hired out, or otherwise circulated without the publisher's prior consent in any form or binding or cover other than that in which it is published and without a similar condition including this condition being imposed on the subsequent purchaser.

www.triestepublishing.com

WILLIAM J. HALE

THE CALCULATIONS OF GENERAL CHEMISTRY

Trieste

H16
1920

To the Memory of

Henry Barker Hill

LATE PROFESSOR OF ORGANIC CHEMISTRY IN

HARVARD UNIVERSITY

IN APPRECIATION OF HIS MOST INSPIRING INFLUENCE

THIS BOOK

IS GRATEFULLY DEDICATED

80345

CONTENTS.

CHEMICAL CALCULATIONS.

CHAPTER I.

UNITS OF MEASUREMENT.

THE fundamental units employed in chemical calculations will be defined at the outset to insure their clear and consistent use.

Time. — As the unit of time we have adopted the second, $\frac{1}{86400}$ part of the mean solar day, or that period elapsing between the successive daily transits of the sun across a meridian.

Distance or Length. — The meter as the standard of length is fixed as that distance between two marks on a platinum-iridium bar preserved in Paris when this bar is at the temperature of 0° C. It is approximately one forty-millionth of a meridian, or one ten-millionth of the earth's quadrant from pole to equator. Larger values in multiples of the meter by ten, one hundred and one thousand are named by use of the Greek prefixes, — decameter, hectometer and kilometer (km.), — while submultiples by the same values receive names from the Latin prefixes, — decimeter (dcm.), centimeter (cm.) and millimeter (mm.). The one one-hundredth part of the meter, the centimeter, is usually defined as the unit of length. As still smaller values we employ the micron (μ), the one one-thousandth of a millimeter, and the millimicron ($\mu\mu$), the one one-thousandth of a micron.

Volume and Mass. — The cubic decimeter or liter is the standard of volume. The standard of mass is the kilogram, or a mass of platinum-iridium in block form, preserved in Paris, and originally intended to have the same mass as a cubic decimeter of water at its greatest density, 4° C. It is, however, slightly less than a cubic decimeter of water which at 4° C. weighs 1.000013 kilograms. Both the liter and kilogram are somewhat large for general scientific purposes. It is customary, therefore, to use the one one-thousandth part of each, — the cubic centimeter ($cm.^3$ or c.c.) as the unit of volume and the gram (g.) as the unit of mass. The mass of 1 c.c. of water at 4° C. is considered as 1 gram. The slight discrepancy between this value and the true one need be considered only in the most exact calculations.

Through a combination of the fundamental units just mentioned we arrive at a standard system in terms of which so many of our important units of measurement may be defined. This system of units, known as the centimeter-gram-second (C.G.S.) system, has met with universal adoption throughout the scientific world. Its applications may be noted in the following paragraph.

Force and Energy. — When a body moves at a uniform rate through a unit of distance, the centimeter, in a unit of time, the second, it is said to have a unit of velocity (abbreviated cm./sec.). When the change in velocity during one second is one centimeter per second we have a unit of acceleration. That force which will give to unit mass unit acceleration is called the unit of force or *dyne*. Now the same force operating upon different bodies does not produce in each the same acceleration. When, however, the same acceleration is attained in the several cases the bodies must have equal masses. The work done by the force of one dyne in producing a displacement in its own direction of one centimeter is called the unit of work or *erg*. When a body gains or loses energy the amount of energy may be measured in units of work, and when the work done upon a body imparts to it a certain velocity, the body, by virtue of this, is said to possess kinetic energy. The amount of energy so possessed may be expressed by the formula, $E = \frac{MV^2}{2}$, in which E represents the energy, M the mass and V the velocity. Mass, then, is in itself but a "measure of the kinetic energy which a body possesses when it has a definite velocity." — Ostwald.

Standards of Temperature and Pressure.

The accuracy with which measurements are conducted requires certain definite and constant conditions of temperature and pressure, the effect of changes in which will be studied in a later chapter. The standards adopted with these factors will receive only brief mention at this point.

Temperature. — The freezing-point of pure water is taken as the normal temperature and made 0° upon the Celsius or centigrade thermometer. The boiling-point of pure water at 760 mm. pressure is registered at 100° on this scale, and the intervening range of temperature between the freezing- and boiling-points of water is divided into one hundred equal parts or degrees centigrade. As pressure exerts a considerable influence upon the boiling-points of liquids, all temperatures are referred to the normal condition of pressure.

Pressure. — The standard condition of pressure, the normal pressure, is taken as that pressure which the atmosphere exerts at sea level in a latitude of 45°. This pressure is sufficient to sustain a column of mercury, at 0° C., 76 cm. (760 mm.) in height. In a column of this height and 1 sq. cm. cross section there are exactly 76 c.c. of mercury, and since, volume for volume, mercury is 13.596 times as heavy as water and 1 c.c. of it therefore weighs this number of grams, we have at once the value $76 \times 13.596 = 1033.2$ grams as the weight of the atmosphere per square centimeter. By reference to a barometer the actual weight of the atmosphere in millimeters of mercury is observed under the various conditions. These barometric readings are usually made at other temperatures than 0° C.; the correct readings, therefore, for millimeters of mercury at 0° C. must be calculated by use of a proper table showing the expansion of mercury with temperature (Appendix I). Gases measured in vessels inverted over a liquid will of course have the same pressure as the atmosphere (recorded by the barometer) when the levels of the liquid in the vessel and outside of it are equal. The temperature of the gases and liquid should of course be alike.