*not strongly*, the rest being about half *strongly* and half *violently* affected. This reagent is satisfactory even in warm solution, and still better in hot solution.

Unlike citric acid, it causes dolomite to effervesce in traces even in the cold, while calcite is made to effervesce freely. The distinction is therefore not quite so sharp as with citric acid.

### CONCLUSION.

Tartaric acid is the best of the four reagents; citric acid is a close second. Both give satisfactory results in every case tested, using lump or powder in hot solution. Oxalic acid also gives effervescence in every case, in hot solution, and is indeed a practicable reagent, but not so strong as the preceding. Potassium acid sulphate is satisfactory except in the cases of witherite and phosgenite; the rest average low, but the effervescence is sufficient to be easily observed. Bearing these exceptions in mind, it can be used if the other reagents are not at hand.

Some sulphides also effervesce with each of the reagents, giving off hydrogen sulphide, as with hydrochloric acid, and the odor of the gas coming off should therefore be tested, to make sure that the material is not a sulphide.

LEHIGH UNIVERSITY.
January 18, 1900.

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## REGULATIONS FOR THE TESTING OF THERMOMETERS.[1]

[As Adopted by the Physikalisch-Technische Reichsanstalt, April 1, 1898.]

### I. PRELIMINARY REMARKS.

1. Glass thermometers filled with mercury, alcohol, toluene, or any other suitable liquid will be accepted for testing. They will be distinguished as:

*a*. Standard normal thermometers [*Haupt-Normalthermometer*];

*b*. Thermometers for scientific purposes (laboratory thermometers);

*c*. Thermometers for meteorological purposes and for estimating altitudes by boiling-point determinations;

*d*. Thermometers for technical purposes (factory thermometers);

[1] Translated for the use of the Committee on Standards and for the Journal of the Society by C. E. Linebarger.

*e*. Thermometers for medical purposes (clinical thermometers);

*f*. Thermometers for household or domestic use (window-, room-, bath-thermometers, etc.).

The *standard normal thermometers* will be tested only at the Physikalisch-Technische Reichsanstalt, the thermometers for household use only at the testing bureau in Ilmenau.

The Physikalisch-Technische Reichsanstalt is to decide as to the acceptance of thermometers other than the above, unless this is provided for in what follows, although questions as to acceptance may be addressed to the testing bureau at Ilmenau.

Such faults in the construction of all thermometers sent in to be tested, as may give rise to inaccuracies or irregularities in their temperature indications or render their reading too difficult are to be avoided.

**2.** The testing is done in two stages—the preliminary testing [*Vorprüfung*] and the main testing [*Hauptprüfung*]. The former takes into account all the regulations given in paragraphs **4** to **10**, while the latter consists of a regular thermometric examination, beginning with observations, lasting for at least eight days, on the constancy of the indications of the thermometer (by means of determinations of the freezing-point and the like).

The type of the instrument determines whether the further tests shall involve:

*a*. A determination of the fundamental interval[1] by calibration and comparison with normal thermometers,

*b*. or only a comparison with normal thermometers in thermostats.

Whenever the divisions on the instrument permit, the amount of the depression of the freezing-point will always be determined and stated in the certificate.

In the testing of a maximum or minimum thermometer (for medical, meteorological, or other purposes), besides the comparison stated in *b*, experiments will be made to ascertain whether the instrument works properly. The errors in both series of tests for such thermometers should not differ when the divisions are

[1] [The fundamental interval is the scale interval between the normal boiling-point and the normal freezing-point, the latter being taken at the lowest position observed.]

$\frac{1}{10}°$ or $\frac{1}{5}°$ by more than 0.08° C.
$\frac{1}{1}°$ " $\frac{1}{2}°$ " " " 0.2° C.

The differences in the readings of maximum thermometers *at* a given temperature and *after* cooling, should not in the case of clinical thermometers amount to more than 0.15° C. In the case of maximum thermometers of other kinds the allowable differences are to be estimated from the length of the mercury column.

Tests will also be made to ascertain whether the device for recording the maximum temperature offers too great a resistance when the mercury is shaken down.

3. The fundamental temperature scale shall be that of the hydrogen thermometer as adopted for the international system of weights and measures according to a resolution of the *Bureau international des Poids et Mesures*, on October 15, 1887.

## II. GENERAL REGULATIONS.

4. The glass used in the construction of the thermometers should have the least possible thermal hysteresis [*thermische Nachwirkung*]. When glass is employed whose hysteresis is not sufficiently known or which is found to be too great, the thermometers must be allowed to stand from one to four months, the sender being notified of such action.

Thermometers which are to be tested at temperatures above 100° C., as well as all finer thermometers such as listed in paragraph 1, under *a*, *b*, and *c*, must be subjected to an artificial aging process before they are sent in. This consists in heating them for ten to thirty hours, according to the temperatures they are intended to indicate, to the highest temperature they register, and then cooling them slowly. Notice must therefore be given when the thermometers are sent in as to whether this heating has been done or not.

Thermometers reading to 550° C. should be made of Jena borosilicate glass $59^{III}$ or some similar difficultly fusible glass; those reading to 420° may also be made of Jena normal thermometer glass $16^{I}{}_{II}$ (with red-violet stripe) or of Greiner and Friedrichs' resistance glass (with blue stripe).

5. The capillary tube must be clean and of uniform bore. Thermometers of the types *a*, *b*, *c*, and *d*, in paragraph 1, are to have a pear-shaped bulb blown in their upper end. Bulbs blown

in the capillary tube itself must be there for a purpose and must not occasion a narrowing of the adjacent parts of the tube (unless, indeed, such constrictions are meant to serve a special object), which might cause a separation of the mercury during transportation or use. The upper end of the capillary must be in plain sight and not covered by the cap.

6. The mercury must be pure and dry and threads of it must not break off when it is retreating into the bulb. The mercury column should not separate at any place when the thermometer is inverted without jarring. Exceptions to this may be allowed in the case of thermometers with very long stems or large bores or with especially large bulbs.

Any other liquids used to fill the thermometers must be of such a nature that, when the column of liquid is retreating into the bulb, visible drops do not remain behind, and the coloring-matter that may be employed does not separate out.

The use of liquids with too low boiling-points is to be avoided as there is danger of their distilling over into the end of the capillary.

Thermometers designed to measure temperatures over 280° C. must be filled above the mercury with some dry gas (nitrogen, carbon dioxide, and the like) under proper pressure.

7. The scale-divisions must be durable and without any easily apparent errors. In the case of enclosed thermometers[1] [*Einschluss-thermometer*] the scale-divisions must be as close as possible to the capillary so as to insure definite and accurate readings at all positions.

The length of the shortest scale-division on a stem thermometer[2] [*Stab-thermometer*] should in general be at least $\frac{1}{6}$ of the circumference of the tube.

The nature of the division must be designated by the words *hunderttheilig* ["hundred-degreed"], Celsius, etc., and the divisions must be plainly numbered. Division marks must not be placed on widened parts of the capillary.

Division marks should not extend *unnecessarily far* above the temperature interval to be employed. Still a few divisions must

[1] Enclosed thermometers are such as have a small capillary tube lying against a scale and all enclosed in a larger tube.

[2] In stem thermometers the scale-divisions are cut or etched directly on the capillary tube.

always be marked above the highest and below the lowest of the parts of the scale to be tested.

Thermometers with Réaumur scales will not be tested. Exception to this rule will be made until the end of 1900 in the case of thermometers for technical use (*cf.* paragraph 1, *d*).

8. The scales of enclosed thermometers must be fastened securely and firmly, but must permit of free expansion without bending in one direction with reference to the enclosing tube. Thermometers with paper scales will be tested only up to 60° C.

The position of the scales with reference to the capillary or the enclosing tube is to be controlled by means of a mark which, when possible, will be placed on the *right-hand* side of the thermometer and is in no wise to interfere with the reading at that point.

The enclosing tube of enclosed thermometers should, unless exceptions be allowed according to the special regulations (paragraphs 11 to 16), be fused together at the upper end or be provided with a second mark in the vicinity of the end of the scale.

9. Only thermometers of the types *d* and *f* (technical and household thermometers) may have detachable scales. The tubes of such thermometers must be firmly fastened, must lie close to the scale, and must bear marks to control their position. The fastenings must be so arranged that they may be removed for testing and marking.

Thermometers with detachable scales will have both tube and scale marked (*cf.* paragraph 17).

10. Thermometers may bear the maker's number, trade-mark, etc., but nonsensical marks and such as are contrary to the results of the testing will not be permitted.

Maximum and minimum thermometers must be specially marked as such.

There must be on every thermometer sufficient room to place the official mark or stencil (*cf.* paragraph 17), and any other needed marks (*cf.* paragraph 18).

### III. SPECIAL REGULATIONS.

In what follows are given the requirements for testing and the allowable limits of error for the different types of thermometers listed in paragraph 1.

11. *Standard normal thermometers* must be mercury-in-glass thermometers, bearing the points 0 and 100 on their scale and must permit of direct calibration. They will be tested exclusively by the Physikalisch-Technische Reichsanstalt.

The divisions of these thermometers must be uniform and made without regard to the errors of calibration. The errors of division should not exceed $\frac{1}{20}$, and the width of a mark $\frac{1}{10}$. of the smallest interval.

The capillary tube must have a pear-shaped widening at its upper end and must be free from air. The examination of these thermometers will be made between the temperature-limits,—30° to + 100° C. and for every 10° at least.

The limits of error are:

1. For the fundamental interval, 0.10° C.;

2. For the error of calibration as the difference of the greatest deviations, 0.25° C.;

3. The depression of the freezing-point after a half-hour's heating to 100° C. and subsequent imbedding of the thermometer in ice for five minutes should not amount to more than 0.10° C.

The certificate will give in 0.001° the corrections for calibration, fundamental interval, freezing-point, and reduction to the gas-thermometer and also the aggregate error rounded off to 0.01.°

12. *Laboratory thermometers* are such as are employed in scientific and technical investigations in the laboratory for the measurement of temperatures from —80° to + 550° C.[1]

The limits of error are:

| For the temperature interval | When the scale is divided into integral degrees or multiples thereof. | fractions of a degree. |
|---|---|---|
| from — 80° to — 30° | 2° C. | 1.° C. |
| " — 30° " 0° | 1 | 0.5 |
| " 0° " 100° | 0.5 | 0.25 |
| " 100° " 200° | 1 | 0.5 |
| " 200° " 300° | 2 | 1 |
| " 300° " 400° | 3 | 2 |
| " 400° " 550° | 5 | 4 |

[1] Until further notice the scale of the air thermometer shall be standard for temperatures over 100° C., as the international agreement (*cf.* paragraph 3) has reference only to the interval between 0° and 100°, the comparison with the hydrogen thermometer having not yet been finished.

Tests are made when the divisions are in

$\frac{1}{10}$° C. for at least every 10°,

$\frac{1}{5}$° C. for at least every 15°,

$\frac{1}{2}$ or $\frac{1}{1}$° C. for at least every 20°, when the length of 10° is more than 40 mm.

$\frac{1}{2}$ or $\frac{1}{1}$° C. for at least every 25°, when the length of 10° is more than 20 mm. and less than 40 mm.

$\frac{1}{2}$ or $\frac{1}{1}$° C. for at least every 50°, when the length of 10° is more than 8 mm. and less than 20 mm.

$\frac{1}{2}$ or $\frac{1}{1}$° C. for at least every 100°, when the length of 10° is less than 8 mm.

13. (1) By *meteorological thermometers* are meant those used in finding the temperature of the air, of natural waters, of the earth's crust, of the sun's radiation, of the dew-point, etc. The scale may embrace any interval between —70° and + 100° C.

Tests are made

| When the divisions are in | | Limits of error. |
|---|---|---|
| $\frac{1}{5}$ or $\frac{1}{10}$° C. | For every 10°, at least. | Same as given in |
| $\frac{1}{2}$ " $\frac{1}{1}$° " | " " 20°, " " | paragraph 12. |

(2) Thermometers for the measurement of altitudes by boiling-point determinations may be divided either in centigrade degrees or in millimeters of tension of water-vapor under various pressures and may embrace the interval + 70 to 102° C.; they may also have an auxiliary scale near the zero-point. To prevent as much as possible any changes in these thermometers when used for some time on scientific expeditions, they should be subjected to an artificial aging process (*cf.* paragraph 4) before they are sent in.

Tests will be made for every 4°, at least, or in case a millimeter scale is used, for every 50 mm. The errors should not exceed 0.1° C. or 3 mm. respectively. If an auxiliary scale be attached at 0°, the depression of the freezing-point will be determined after the thermometer has been heated for half an hour to 100°; it should not amount to more than 0.1° C. If, however, an auxiliary scale is not attached, the depression of one of the lowest points of the scale will be determined.

14. The testing of *thermometers for technical purposes*, because of the multiplicity of their forms and the unusually large

dimensions of some of them, can be undertaken only as the facilities at hand permit.

The limits of error for these thermometers may be double those given in paragraph 12.

Thermometers made of glass free from thermal hysteresis up to 100° C. whose errors are all less than 0.05° C. are termed free from error. The number of points on the scale that will be tested is fixed according to the regulations given in the same paragraph, unless the thermometers be uncommonly long.

In the case of long technical thermometers the capillary connecting the bulb and scale must be so fine that the indications of the thermometer will not be appreciably affected by the temperature of the neck, due regard being given to the degree of accuracy required of such thermometers. If tests are to be made at higher temperatures on factory thermometers having long necks whose volume cannot otherwise be reliably ascertained, they must be sent in before they are filled under pressure so that the volume of the connecting capillary can be determined.

15. *Has to do with the limits of error, etc., of clinical thermometers.*

16. *Treats of limits of error, etc., of household thermometers.*

## IV. CERTIFICATES, CHARGES AND TIME REQUIRED FOR TESTING.

17. Thermometers with which certificates are given will be marked to show that they have been tested by the Physikalisch-Technische Reichsanstalt with the Imperial Eagle (*Reichsadler*) and P T R, and to show that the testing has been done at Ilmenau, with the Imperial Eagle and G S.

They are also marked with a number, with which *all* thermometers with the exception of such clinical thermometers as have been found unsuitable for testing are provided.

In addition, the year is given for all thermometers listed in paragraph 1, under *a*, *b*, *c*, and *d*.

Besides the thermometric errors, the certificate contains indications, when necessary, as to the kind and application of the thermometer in question.

The rounding-off of the thermometric errors found by the tests depends upon the nature of the scale and the results of the

testing, except where a special procedure is prescribed for the individual classes of thermometers in the foregoing regulations.

As a rule the errors observed are given for the thermometers in a vertical position and with the *whole* of the liquid column immersed in the bath.

If the use of the thermometer requires the liquid column to emerge from the bath whose temperature is to be measured, information must be given when the thermometer is sent in, as to how deep the thermometer must dip into the bath and what the temperature of the emergent column may be assumed to be.

18. *Charges for testing.*

19. Thermometers will be tested in the order of their receipt as shown by the post-mark; the preliminary tests will be made at once upon the receipt of the thermometer. The tests will be finished in from three to four weeks according to their nature and the amount of work on hand.

APPENDIX.

20. *Recommendations as to the packing and sending of thermometers.*

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[CONTRIBUTIONS FROM THE HAVEMEYER LABORATORIES OF COLUMBIA UNIVERSITY, NO. 19.]

## A NEW SYNTHESIS IN THE QUINAZOLINE GROUP.[1]

(PRELIMINARY ANNOUNCEMENT.)

BY MARSTON TAYLOR BOGERT AND AUGUST HENRY GOTTHELF.

Received February 15, 1900.

IN the course of some researches carried on in this laboratory by J. A. Mathews on "The Action of Nitriles upon Aromatic Acids,"[2] it was discovered that when anthranilic acid and acetonitrile were heated together in a sealed tube for five hours at 220°–230° C., instead of obtaining orthoamidobenzonitrile as expected, there resulted a crystalline product melting at 232°. This body was boiled with strong hydrochloric acid, and the solution on cooling deposited long needles which sublimed at about 280° without melting. Not enough of the substance, however, was secured for an analysis, and hence its nature could not be determined.

[1] Read before the New York Section, February 9, 1900.

[2] This Journal, 20, 654.