# CIRCULAR

OF THE

# BUREAU OF STANDARDS

S. W. STRATTON, DIRECTOR

## No. 43

# THE METRIC CARAT

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# Bureau of Standards
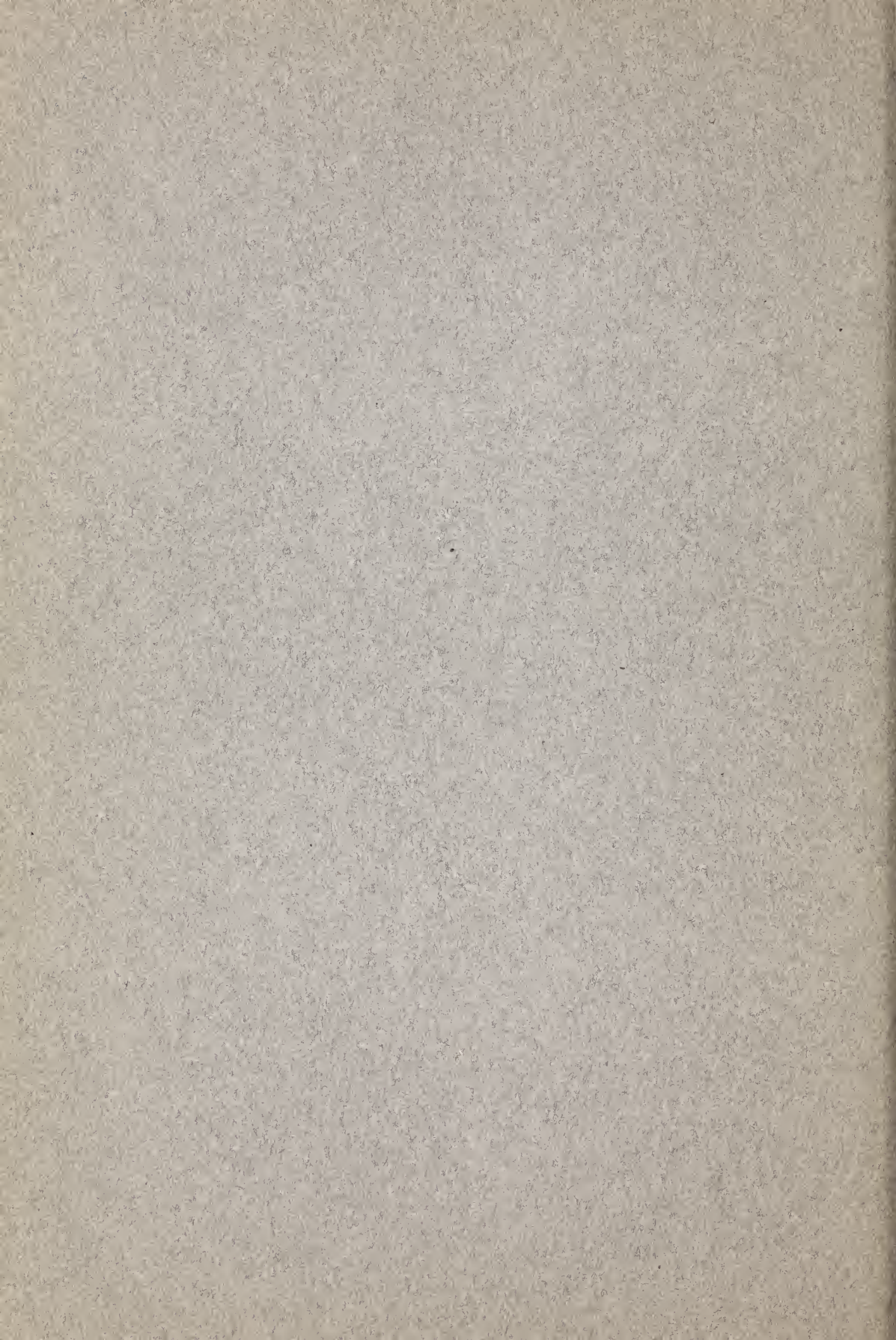
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# THE METRIC CARAT

# THE METRIC CARAT.

Beginning July 1, 1913, the Bureau of Standards will recognize the international metric carat of 200 milligrams as the unit of weight for diamonds and other precious stones, and will use this unit for purposes of certification of all carat weights submitted to the Bureau for test. On the same date the Treasury Department of the United States Government will also begin the use of this unit in the customs service for the levying of import duties on precious stones. This unit will also be put into commercial use in the United States on this date by practically all the dealers in gems and precious stones through the efforts of a committee representing all the principal firms handling gems.

The Bureau therefore takes this opportunity of issuing a circular giving tables of the relations between the carat weight in former use in this country and the new international metric carat, together with such other information that may be of interest at this time in connection with the subject.

The carat weights in use in different countries have, in the past, differed greatly, scarcely any two of the important countries having the same standard. Even within the United States there has not been agreement in the standard used, the various makers of weights using slightly different standards. This has led to a great deal of confusion in the weighing of gems, and has been the more serious because of the great value of the article.

Recently the movement for the adoption of a uniform standard has met with increasing success, and the new carat of 200 milligrams has been adopted by Spain, Italy, Bulgaria, Denmark, Norway, Japan, Portugal, Roumania, Switzerland, Sweden, France, Germany, Holland, and Belgium, while considerable progress has been made toward its adoption in England.

The carat which has been in use heretofore in the United States, while varying, has been nearer the value 205.3 milligrams than any other. This value has therefore been taken in making up the tables of equivalents

given in this circular. The old carat has usually been subdivided on the binary system, the smallest subdivision used being usually one sixty-fourth of the carat. The equivalents in fractions of a carat in these tables are, therefore, given in sixty-fourths. One of the improvements introduced with the new carat is the subdivision of it on the decimal system. The fractions of the new carat in these tables are accordingly given to hundredths of a carat.

Tables 1 and 2 are for the conversion of quantities in the old unit to the equivalent weight in terms of the new metric carat, while Tables 3 and 4 are for the reverse process of converting quantities stated in the new system to old carats of 205.3 milligrams. Table 1 is used for the conversion of fractions of a carat, while Table 2 gives the equivalent of each unit or whole carat from 1 to 100 of the old system in metric carats and hundredths of a carat. If it is desired to convert whole carats and fractions of a carat of the old unit to the new, the two tables can be used in combination; that is, by adding the quantities obtained from each, thus: Suppose it is desired to obtain the equivalent of $28\frac{45}{64}$ old carats in terms of the metric carats.

$$
\begin{array}{llll}
\text{From Table 1} \ldots \ldots & & \tfrac{45}{64}\ \text{old carats} & = \ 0.72\ \text{metric carats}\\
\text{From Table 2} \ldots \ldots & 28 & \text{old carats} & = 28.74\ \text{metric carats}\\
\hline
\text{Adding} \ldots \ldots & 28\tfrac{45}{64}\ \text{old carats} & & = 29.46\ \text{metric carats}
\end{array}
$$

Or, if it is desired to convert a larger quantity involving several hundred or thousand carats, one uses the equivalents in the last column of Table 2 for each hundred and thousand of the old carats up to ten hundred and ten thousand—thus, to convert $3225\frac{3}{4}$ old carats to metric carats.

$$
\begin{array}{llll}
\text{From Table 1} \ldots \ldots & & \tfrac{3}{4}\ \text{old carats} = & 0.77\ \text{metric carats}\\
\text{From Table 2} \ldots \ldots & 25 & \text{old carats} = & 25.66\ \text{metric carats}\\
& 200 & \text{old carats} = & 205.30\ \text{metric carats}\\
& 3000 & \text{old carats} = & 3079.50\ \text{metric carats}\\
\hline
\text{Adding} \ldots \ldots & 3225\tfrac{3}{4}\ \text{old carats} = & 3311.23\ \text{metric carats}
\end{array}
$$

Table 3, instead of giving the equivalent of each 0.01 metric carat in sixty-fourths of an old carat, gives the limits, shown by a brace, of the successive sixty-fourths of the old carat, so that any decimal fraction of a metric carat is equivalent to the sixty-fourth of the old carat shown opposite the limits between which it lies, the limits being given to thousandths of a metric carat. Thus, any fraction of a metric carat between 0.698 and 0.714 is equivalent to $\frac{44}{64}$ old carats, according to Table 3. In Table 4 the equivalent

of each whole metric carat from 1 to 100 is given in whole carats and sixty-fourths of the old unit. For example, to obtain the equivalent of 58.71 metric carats in old carats—

From Table 3 . . . . . . 0.71 metric carats = $\frac{44}{64}$ old carats
From Table 4 . . . . . . 58    metric carats = $56\frac{32}{64}$ old carats

Adding . . . . . . 58.71 metric carats = $56\frac{76}{64}$ old carats
= $57\frac{12}{64}$ old carats

Similarly, if it is desired to convert 3974.15 metric carats to old carats—

From Table 3 . . . . . . 0.15 metric carats = $\frac{9}{64}$ old carats
From Table 4 . . . . . . 74    metric carats = $72\frac{6}{64}$ old carats
900    metric carats = $876\frac{49}{64}$ old carats
3000    metric carats = $2922\frac{35}{64}$ old carats

Adding . . . . . . 3974.15 metric carats = $3870\frac{99}{64}$ old carats
= $3871\frac{35}{64}$ old carats

## TABLE 1

Equivalents of fractions of the old carat weight in new decimal metric carats.
Computed on the basis—
1 old carat = 205.3 milligrams
1 new metric carat = 200 milligrams

| Old carat | | | | | | New metric carats | Old carat | | | | | | | New metric carats |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/2's | 1/4's | 8ths | 16ths | 32nds | 64ths | | 1 carat | 1/2's | 1/4's | 8ths | 16ths | 32nds | 64ths | |
| | | | | | 1 | =0.02 | | | | | | | 33 | =0.53 |
| | | | | 1 | 2 | = .03 | | | | | | 17 | 34 | = .55 |
| | | | | | 3 | = .05 | | | | | | | 35 | = .56 |
| | | | 1 | 2 | 4 | = .06 | | | | | 9 | 18 | 36 | = .58 |
| | | | | | 5 | = .08 | | | | | | | 37 | = .59 |
| | | | | 3 | 6 | = .10 | | | | | | 19 | 38 | = .61 |
| | | | | | 7 | = .11 | | | | | | | 39 | = .63 |
| | | 1 | 2 | 4 | 8 | = .13 | | | | 5 | 10 | 20 | 40 | = .64 |
| | | | | | 9 | = .14 | | | | | | | 41 | = .66 |
| | | | | 5 | 10 | = .16 | | | | | | 21 | 42 | = .67 |
| | | | | | 11 | = .18 | | | | | | | 43 | = .69 |
| | | | 3 | 6 | 12 | = .19 | | | | | 11 | 22 | 44 | = .71 |
| | | | | | 13 | = .21 | | | | | | | 45 | = .72 |
| | | | | 7 | 14 | = .22 | | | | | | 23 | 46 | = .74 |
| | | | | | 15 | = .24 | | | | | | | 47 | = .75 |
| | 1 | 2 | 4 | 8 | 16 | = .26 | | | 3 | 6 | 12 | 24 | 48 | = .77 |
| | | | | | 17 | = .27 | | | | | | | 49 | = .79 |
| | | | | 9 | 18 | = .29 | | | | | | 25 | 50 | = .80 |
| | | | | | 19 | = .30 | | | | | | | 51 | = .82 |
| | | | 5 | 10 | 20 | = .32 | | | | | 13 | 26 | 52 | = .83 |
| | | | | | 21 | = .34 | | | | | | | 53 | = .85 |
| | | | | 11 | 22 | = .35 | | | | | | 27 | 54 | = .87 |
| | | | | | 23 | = .37 | | | | | | | 55 | = .88 |
| | | 3 | 6 | 12 | 24 | = .38 | | | | 7 | 14 | 28 | 56 | = .90 |
| | | | | | 25 | = .40 | | | | | | | 57 | = .91 |
| | | | | 13 | 26 | = .42 | | | | | | 29 | 58 | = .93 |
| | | | | | 27 | = .43 | | | | | | | 59 | = .95 |
| | | | 7 | 14 | 28 | = .45 | | | | | 15 | 30 | 60 | = .96 |
| | | | | | 29 | = .47 | | | | | | | 61 | = .98 |
| | | | | 15 | 30 | = .48 | | | | | | 31 | 62 | = .99 |
| | | | | | 31 | = .50 | | | | | | | 63 | =1.01 |
| 1 | 2 | 4 | 8 | 16 | 32 | = .51 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | =1.03 |

## TABLE 2

Equivalents of the old carats in new decimal metric carats.

Computed on the basis—

1 old carat = 205.3 milligrams

1 new metric carat = 200 milligrams

| Old carats | New metric carats | Old carats | New metric carats | Old carats | New metric carats | Old carats | New metric carats | Old carats | New metric carats |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.03 | 26 | 26.69 | 51 | 52.35 | 76 | 78.01 | 200 | 205.30 |
| 2 | 2.05 | 27 | 27.72 | 52 | 53.38 | 77 | 79.04 | 300 | 307.95 |
| 3 | 3.08 | 28 | 28.74 | 53 | 54.40 | 78 | 80.07 | 400 | 410.60 |
| 4 | 4.11 | 29 | 29.77 | 54 | 55.43 | 79 | 81.09 | 500 | 513.25 |
| 5 | 5.13 | 30 | 30.80 | 55 | 56.46 | 80 | 82.12 | 600 | 615.90 |
| 6 | 6.16 | 31 | 31.82 | 56 | 57.48 | 81 | 83.15 | 700 | 718.55 |
| 7 | 7.19 | 32 | 32.85 | 57 | 58.51 | 82 | 84.17 | 800 | 821.20 |
| 8 | 8.21 | 33 | 33.87 | 58 | 59.54 | 83 | 85.20 | 900 | 923.85 |
| 9 | 9.24 | 34 | 34.90 | 59 | 60.56 | 84 | 86.23 | 1000 | 1026.50 |
| 10 | 10.26 | 35 | 35.93 | 60 | 61.59 | 85 | 87.25 | 2000 | 2053.00 |
| 11 | 11.29 | 36 | 36.95 | 61 | 62.62 | 86 | 88.28 | 3000 | 3079.50 |
| 12 | 12.32 | 37 | 37.98 | 62 | 63.64 | 87 | 89.31 | 4000 | 4106.00 |
| 13 | 13.34 | 38 | 39.01 | 63 | 64.67 | 88 | 90.33 | 5000 | 5132.50 |
| 14 | 14.37 | 39 | 40.03 | 64 | 65.70 | 89 | 91.36 | 6000 | 6159.00 |
| 15 | 15.40 | 40 | 41.06 | 65 | 66.72 | 90 | 92.38 | 7000 | 7185.50 |
| 16 | 16.42 | 41 | 42.09 | 66 | 67.75 | 91 | 93.41 | 8000 | 8212.00 |
| 17 | 17.45 | 42 | 43.11 | 67 | 68.78 | 92 | 94.44 | 9000 | 9238.50 |
| 18 | 18.48 | 43 | 44.14 | 68 | 69.80 | 93 | 95.46 | 10000 | 10265.00 |
| 19 | 19.50 | 44 | 45.17 | 69 | 70.83 | 94 | 96.49 | | |
| 20 | 20.53 | 45 | 46.19 | 70 | 71.86 | 95 | 97.52 | | |
| 21 | 21.56 | 46 | 47.22 | 71 | 72.88 | 96 | 98.54 | | |
| 22 | 22.58 | 47 | 48.25 | 72 | 73.91 | 97 | 99.57 | | |
| 23 | 23.61 | 48 | 49.27 | 73 | 74.93 | 98 | 100.60 | | |
| 24 | 24.64 | 49 | 50.30 | 74 | 75.96 | 99 | 101.62 | | |
| 25 | 25.66 | 50 | 51.32 | 75 | 76.99 | 100 | 102.65 | | |

## TABLE 3

### Equivalents of decimals of the new metric carat in 64ths of the old carat

Computed on the basis—

1 new metric carat = 200 milligrams
1 old carat = 205.3 milligrams

[All the values between the two connected by each brace are equivalent to the number of 64ths of an old carat given opposite the brace.]

| New metric carats | Old carats | New metric carats | Old carats | New metric carats | Old carats | New metric carats | Old carats |
|---|---|---|---|---|---|---|---|
| $0.00_8$ | 1/64 | $0.26_5$ | 17/64 | $0.52_1$ | 33/64 | $0.77_8$ | 49/64 |
| $0.02_4$ | 2/64 | $0.28_1$ | 18/64 | $0.53_7$ | 34/64 | $0.79_4$ | 50/64 |
| $0.04_0$ | 3/64 | $0.29_7$ | 19/64 | $0.55_3$ | 35/64 | $0.81_0$ | 51/64 |
| $0.05_6$ | 4/64 | $0.31_3$ | 20/64 | $0.56_9$ | 36/64 | $0.82_6$ | 52/64 |
| $0.07_2$ | 5/64 | $0.32_9$ | 21/64 | $0.58_5$ | 37/64 | $0.84_2$ | 53/64 |
| $0.08_8$ | 6/64 | $0.34_5$ | 22/64 | $0.60_1$ | 38/64 | $0.85_8$ | 54/64 |
| $0.10_4$ | 7/64 | $0.36_1$ | 23/64 | $0.61_8$ | 39/64 | $0.87_4$ | 55/64 |
| $0.12_0$ | 8/64 | $0.37_7$ | 24/64 | $0.63_4$ | 40/64 | $0.89_0$ | 56/64 |
| $0.13_6$ | 9/64 | $0.39_3$ | 25/64 | $0.65_0$ | 41/64 | $0.90_6$ | 57/64 |
| $0.15_2$ | 10/64 | $0.40_9$ | 26/64 | $0.66_6$ | 42/64 | $0.92_2$ | 58/64 |
| $0.16_8$ | 11/64 | $0.42_5$ | 27/64 | $0.68_2$ | 43/64 | $0.93_8$ | 59/64 |
| $0.18_4$ | 12/64 | $0.44_1$ | 28/64 | $0.69_8$ | 44/64 | $0.95_4$ | 60/64 |
| $0.20_0$ | 13/64 | $0.45_7$ | 29/64 | $0.71_4$ | 45/64 | $0.97_0$ | 61/64 |
| $0.21_7$ | 14/64 | $0.47_3$ | 30/64 | $0.73_0$ | 46/64 | $0.98_6$ | 62/64 |
| $0.23_3$ | 15/64 | $0.48_9$ | 31/64 | $0.74_6$ | 47/64 | $1.00_2$ | 63/64 |
| $0.24_9$ | 16/64 | $0.50_5$ | 32/64 | $0.76_2$ | 48/64 | $1.01_8$ | 64/64 |
| $0.26_5$ | | $0.52_1$ | | $0.77_8$ | | $1.03_5$ | |

## TABLE 4

Equivalents of the new metric carats in old metric carats.

Computed on the basis

1 new metric carat = 200 milligrams

1 old carat = 205.3 milligrams

| New metric carats | Old carats | New metric carats | Old carats | New metric carats | Old carats | New metric carats | Old carats | New metric carats | Old carats |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 62/64 | 21 | 20 29/64 | 41 | 39 60/64 | 61 | 59 27/64 | 81 | 78 58/64 |
| 2 | 1 61/64 | 22 | 21 28/64 | 42 | 40 59/64 | 62 | 60 26/64 | 82 | 79 57/64 |
| 3 | 2 59/64 | 23 | 22 26/64 | 43 | 41 57/64 | 63 | 61 24/64 | 83 | 80 55/64 |
| 4 | 3 57/64 | 24 | 23 24/64 | 44 | 42 55/64 | 64 | 62 22/64 | 84 | 81 53/64 |
| 5 | 4 56/64 | 25 | 24 23/64 | 45 | 43 54/64 | 65 | 63 21/64 | 85 | 82 52/64 |
| 6 | 5 54/64 | 26 | 25 21/64 | 46 | 44 52/64 | 66 | 64 19/64 | 86 | 83 50/64 |
| 7 | 6 52/64 | 27 | 26 19/64 | 47 | 45 50/64 | 67 | 65 17/64 | 87 | 84 48/64 |
| 8 | 7 51/64 | 28 | 27 18/64 | 48 | 46 49/64 | 68 | 66 16/64 | 88 | 85 47/64 |
| 9 | 8 49/64 | 29 | 28 16/64 | 49 | 47 47/64 | 69 | 67 14/64 | 89 | 86 45/64 |
| 10 | 9 47/64 | 30 | 29 14/64 | 50 | 48 45/64 | 70 | 68 12/64 | 90 | 87 43/64 |
| 11 | 10 46/64 | 31 | 30 13/64 | 51 | 49 44/64 | 71 | 69 11/64 | 91 | 88 42/64 |
| 12 | 11 44/64 | 32 | 31 11/64 | 52 | 50 42/64 | 72 | 70 9/64 | 92 | 89 40/64 |
| 13 | 12 43/64 | 33 | 32 9/64 | 53 | 51 40/64 | 73 | 71 7/64 | 93 | 90 38/64 |
| 14 | 13 41/64 | 34 | 33 8/64 | 54 | 52 39/64 | 74 | 72 6/64 | 94 | 91 37/64 |
| 15 | 14 39/64 | 35 | 34 6/64 | 55 | 53 37/64 | 75 | 73 4/64 | 95 | 92 35/64 |
| 16 | 15 38/64 | 36 | 35 5/64 | 56 | 54 35/64 | 76 | 74 2/64 | 96 | 93 33/64 |
| 17 | 16 36/64 | 37 | 36 3/64 | 57 | 55 34/64 | 77 | 75 1/64 | 97 | 94 32/64 |
| 18 | 17 34/64 | 38 | 37 1/64 | 58 | 56 32/64 | 78 | 75 63/64 | 98 | 95 30/64 |
| 19 | 18 33/64 | 39 | 38 | 59 | 57 31/64 | 79 | 76 61/64 | 99 | 96 28/64 |
| 20 | 19 31/64 | 40 | 38 62/64 | 60 | 58 29/64 | 80 | 77 60/64 | 100 | 97 27/64 |

| New metric carats | Old carats | New metric carats | Old carats |
|---|---|---|---|
| 200 | 194 54/64 | 2000 | 1948 24/64 |
| 300 | 292 16/64 | 3000 | 2922 35/64 |
| 400 | 389 43/64 | 4000 | 3896 47/64 |
| 500 | 487 6/64 | 5000 | 4870 59/64 |
| 600 | 584 33/64 | 6000 | 5845 7/64 |
| 700 | 681 59/64 | 7000 | 6819 18/64 |
| 800 | 779 22/64 | 8000 | 7793 30/64 |
| 900 | 876 49/64 | 9000 | 8767 42/64 |
| 1000 | 974 12/64 | 10000 | 9741 54/64 |

### EQUIPMENT FOR WEIGHING—ITS CARE AND USE.

With the inauguration of the use of this new standard of weight for gems in this country it is very desirable that there should be an improvement in the quality of the weights and balances used for weighing precious stones and in their care and use. The balances should be well made, should be of the equal-arm type preferably, with fine bearings and of a sensibility sufficiently great to determine at least 0.01 carat on any load for which the balance is designed. The equality of the arms should be ascertained and if they are unequal the method of weighing used should be such as to eliminate the error due to this cause. The balance should be mounted level on a firm base and in such a location that it will be as free from jars and sudden temperature changes as possible. The case should be kept closed when not in use, and when making a weighing the case should be closed to protect the pans from drafts. The pans should be kept clean and free from dust, and should hang free, clear from any supports, during a weighing. The arresting mechanism should always be lowered and raised carefully to avoid unnecessary injury and wear of the knife edges.

As much or greater care should be taken of the weights. They should never be touched with the fingers, being transferred to and from the balance with German silver or ivory-tipped lifters which should, in turn, be carefully made, with the edges well rounded and free from sharp corners which might injure the weights. The weights should always be kept under cover when not in use, preferably on a polished glass plate under a glass cover or in a special box with velvet or plush lined holes for the larger weights and polished wood holes for the flat weights.

In order to maintain the integrity of the weights as standard weights the weights themselves should, preferably, be made from one piece of metal, having no removable parts such as screw knobs, should not have any adjusting hole in the bottom, and should not, in general, have any feature of construction by which the adjustment of the weight can be changed intentionally or accidentally without the change being readily apparent. The larger weights of the set, above 5 carats, may be made of brass or some similarly resistant material. They may be adjusted by means of an adjusting plug of the same material driven tightly into a hole in the top of the weight (of the details of which as to design, size, etc., further information may be had upon application to this Bureau). Brass weights should be protected from oxidation by some suitable protective plating or lacquer.

The smaller weights should preferably be made of platinum or, in case of those less than 0.1 carat, of aluminum, and should conform to the requirements of class C weights, as established by the Bureau of Standards. It is recommended that a small letter "c," without a period, be used as the abbreviation for the metric carat, the abbreviation "car." having been used heretofore for the old carat. All weights should be marked with their designation.

All weights should be adjusted within at least the tolerances given in the table below, the Bureau of Standards class C tolerances:

| Designation | Tolerance |
|---|---|
| c | mg |
| 2500 | ±70 |
| 2000 | ±60 |
| 1000 | ±40 |
| 500 | ±30 |
| 200 | ±20 |
| 100 | ±10 |
| 50 | ± 7 |
| 20 | ± 5 |
| 10 | ± 3 |
| 5 | ± 2 |
| 2 | ± 1 |
| 1 | ± 0.7 |
| 0.5 | ± 0.5 |
| 0.2 | ± 0.3 |
| 0.1 | ± 0.2 |
| 0.05 | ± 0.15 |
| 0.02 | ± 0.10 |
| 0.01 | ± 0.05 |

It is recommended that sets of weights be made up in the 5, 2, 2, 1 series or the 5, 2, 1, 1, 1 series, preferably the first.

The better grades of weights may be submitted to the Bureau of Standards for test and certification. Sets of weights which are found to be within the tolerances given in the table above will be certified as within these tolerances at a fee of 30 cents per weight, or single weights will be verified at 50 cents per weight. The fees charged for the determination of the actual correction of each weight or for the verification of weights of other classes than class C will be given upon application. Weights sent

for test should be carefully packed and should be addressed to the "Bureau of Standards, Washington, D. C." Transportation charges both ways must be paid by the party submitting the weights for test. They should be accompanied by a letter requesting the test and indicating the kind of certificate desired. There will often be a saving of time in the return of the weights if the request for test is accompanied by a remittance covering the cost of the test in the form of money order, draft, or check, as it is required that all fees for tests shall be paid before the articles are returned.

S. W. STRATTON,
*Director.*

Approved:
EDWIN F. SWEET,
*Acting Secretary.*