by manufacturers, the determination of physical constants and the testing of materials. The work of the Kew Observatory, at the Old Deer Park, Richmond, has also been placed under the direction of the N.P.L. (see III. *Commercial*).[1] The C.I.P.M. at Paris, the first metrological institution, also undertakes verifications for purely scientific purposes. A descriptive list of the verifying instruments of the Standards' Department, London, has been published.[2] In the measurement of woollen and other textile fabrics, as to quality, strength, number of threads, &c., there exists at Bradford a voluntary standardizing institution known as the Conditioning House (Bradford Corporation Act 1887), the work of which has been extended to a chemical analysis of fabrics.

8. *Ancient Standards of England and Scotland.*—A "troy pound" and a new standard yard, as well as secondary standards, were constructed by direction of parliament in 1758–1760, and were deposited with the Clerk of the House of Commons. When the Houses of Parliament were burned down in 1834, the pound was lost and the yard was injured. It may here be mentioned that the expression "imperial" first occurs in the Weights and Measures Act of 1824. The injured standard was then lost sight of, but it was in 1891 brought to light by the Clerk of the Journals, and has now been placed in the lobby of the residence of the Clerk of the House, together with a standard "stone" of 14 lb.[3]

In the measurement of liquids the old "wine gallon" (231 cub. in.) was in use in England until 1824, when the present imperial gallon (fig. 5) was legalized; and the wine gallon of 1707 is still referred to as a standard in the United States. Together with the more ancient standard of Henry VII. and of Queen Elizabeth, this standard is deposited in the Jewel Tower at Westminster. They are probably of the Norman period, and were kept in the Pyx Chapel at Westminster, now in the custody of the Commissioners of Works. A sketch of these measures is given in fig. 6.[4]

Besides these ancient standards of England (1495, 1588, 1601) there are at the council chambers of Edinburgh and


FIG. 6.—A, Winchester Bushel of Henry VII.; B, Standard Hundred-weight (112 lb) of Elizabeth; C, Ale Gallon of Henry VII.; D, the old Wine Gallon.

Linlithgow some of the interesting standards of Scotland, as the Stirling jug or Scots pint, 1618; the choppin or half-pint, 1555 (fig. 7); the Lanark troy and tron weights of the same periods (fig. 8).[5]

*English Weights and Measures Abolished.*—The yard and handful, or 40 in. ell, abolished in 1439. The yard and inch, or 37 in. ell (cloth measure), abolished after 1553; known later as the Scotch ell = 37·06. Cloth ell of 45 in., used till 1600. The yard of Henry VII. = 35·963 in. Saxon moneyers pound, or Tower pound, 5400 grains, abolished in 1527. Mark, ⅔ pound = 3600 grains. Troy pound in use in 1415, established as monetary pound 1527. Troy weight was abolished, from the 1st of January 1879, by the Weights and Measures Act 1878, with the exception only of the Troy ounce, its decimal parts and multiples, legalized in 1853, 16 Vict. c. 29, to be used for the sale of gold and silver articles, platinum and precious stones. Merchant's pound, in 1270 established for all except gold, silver and medicines = 6750 grains, generally superseded by avoirdupois in 1303. Merchant's pound of 7200 grains, from France and Germany, also superseded. ("Avoirdepois" occurs in 1336, and has been thence continued: the Elizabethan standard was probably 7002 grains.) Ale gallon of 1601 = 282 cub. in., and wine gallon of 1707 = 231 cub. in., both abolished in 1824. Winchester corn bushel of 8×268.8 cub. in. and gallon of 274¼ are the oldest examples known (Henry

FIG. 7.—The Scots Choppin or Half-Pint, 1555.

FIG. 8.—Lanark Stone Troy Weight, 1618.

VII.), gradually modified until fixed in 1826 at 277.274, or 10 pounds of water.

*French Weights and Measures Abolished.*—Often needed in reading older works.

| | | | | |
|---|---|---|---|---|
| ligne, | 12 = pouce, | 12 = pied, | 6 = toise, | 2000 = lieue de poste. |
| ·08883 in. | 1·0658 | 12·7892 | 76·735 | 2·42219 miles. |
| grain, | 72 = gros, | 8 = once, | 8 = marc, | 2 = poids de marc. |
| ·8197 gr. | 59·021 | 472·17 | 3777·33 | 1·0792 lb. |

Rhineland foot, much used in Germany, = 12·357 in. = the foot of the Scotch or English cloth ell of 37·06 in., or 3×12·353. (H. J. C.)

## II. ANCIENT HISTORICAL

Though no line can be drawn between ancient and modern metrology, yet, owing to neglect, and partly to the scarcity of materials, there is a gap of more than a thousand years over which the connexion of units* of measure is mostly guess-work. Hence, except in a few cases, we shall not here consider any units of the middle ages. A constant difficulty in studying works on metrology is the need of distinguishing the absolute facts of the case from the web of theory into which each writer has woven them—often the names used, and sometimes the very existence of the units in question, being entirely an assumption of the writer. Again, each writer has his own leaning: A. Böckh, to the study of water-volumes and weights, even deriving linear measures therefrom; V. Queipo, to the connexion with Arabic and Spanish measures; J. Brandis, to the basis of Assyrian standards; Mommsen, to coin weights; and P. Bortolotti to Egyptian units; but F. Hultsch is more general, and appears to give a more equal representation of all sides than do other authors. In this article the tendency will be to trust far more to actual measures and weights than to the statements of ancient writers; and this position seems to be justified by the great increase in materials, and their more accurate means of study. The usual arrangement by countries has been mainly abandoned in favour of following out each unit as a whole, without recurring to it separately for every locality.

The materials for study are of three kinds. (1) *Literary*, both in direct statements in works on measures (*e.g.* Elias of Nisibis), medicine (Galen) and cosmetics (Cleopatra), in ready-reckoners (Didymus), clerk's (kātib's) guides, and like handbooks, and in indirect explanations of the equivalents of measures mentioned by authors (*e.g.* Josephus). But all such sources are liable to the most confounding errors, and some passages relied on have in any case to submit to conjectural emendation. These authors are of great value for connecting the monumental information,

[1] Treasury Committee on National Physical Laboratory, Parliamentary Paper, 1898.
[2] Descriptive List of Standards and Instruments, Parliamentary Paper, 1892.
[3] Report on Standards deposited in House of Commons, 1st November 1891.
[4] S. Fisher, *The Art Journal*, August 1900.
[5] Buchanan, *Ancient Scotch Standards*.

* In the absence of the actual standards of ancient times the units of measure and of weight have to be inferred from the other remains; hence unit in this division is used for any more or less closely defined amount of length or weight in terms of which matter was measured.

but must yield more and more to the increasing evidence of actual weights and measures. Besides this, all their evidence is but approximate, often only stating quantities to a half or quarter of the amount, and seldom nearer than 5 or 10%; hence they are entirely worthless for all the closer questions of the approximation or original identity of standards in different countries; and it is just in this line that the imagination of writers has led them into the greatest speculations, unchecked by accurate evidence of the original standards. (2) *Weights and measures actually remaining.* These are the prime sources, and as they increase and are more fully studied, so the subject will be cleared and obtain a fixed basis. A difficulty has been in the paucity of examples, more due to the neglect of collectors than the rarity of specimens. The number of published weights did not exceed 600 of all standards in 1880; but the collections from Naucratis (28),[1] Defenneh (29) and Memphis (44) have supplied over six times this quantity, and of an earlier age than most other examples, while existing collections have been more thoroughly examined. It is above all desirable to make allowances for the changes which weights have undergone; and, as this has only been done for the above Egyptian collections and that of the British Museum, conclusions as to the accurate values of different standards will here be drawn from these rather than continental sources. (3) *Objects which have been made by measure or weight,* and from which the unit of construction can be deduced. Buildings will generally yield up their builder's foot or cubit when examined (*Inductive Metrology,* p. 9). Vases may also be found bearing such relations to one another as to show their unit of volume. And coins have long been recognized as one of the great sources of metrology—valuable for their wide and detailed range of information, though most unsatisfactory on account of the constant temptation to diminish their weight, a weakness which seldom allows us to reckon them as of the full standard. Another defect in the evidence of coins is that, when one variety of the unit of weight was once fixed on for the coinage, there was (barring the depreciation) no departure from it, because of the need of a fixed value, and hence coins do not show the range and character of the real variations of units as do buildings, or vases, or the actual commercial weights.

PRINCIPLE OF STUDY.—1. *Limits of Variation in Different Copies, Places and Times.*—Unfortunately, so very little is known of the ages of weights and measures that this datum—most essential in considering their history—has been scarcely considered. In measure, Egyptians of Dynasty IV. at Gizeh on an average varied 1 in 350 between different buildings (27). Buildings at Persepolis, all of nearly the same age, vary in unit 1 in 450 (25). Including a greater range of time and place, the Roman foot in Italy varied during two or three centuries on an average $\frac{1}{400}$ from the mean. Covering a longer time, we find an average variation of $\frac{1}{200}$ in the Attic foot (25), $\frac{1}{150}$ in the English foot (25), $\frac{1}{170}$ in the English itinerary foot (25). So we may say that an average variation of $\frac{1}{400}$ by toleration, extending to double that by change of place and time, is usual in ancient measures. In weights of the same place and age there is a far wider range; at Defenneh (29), within a century probably, the average variation of different units is $\frac{1}{36}$, $\frac{1}{60}$, and $\frac{1}{67}$, the range being just the same as in all times and places taken together. Even in a set of weights all found together, the average variation is only reduced to $\frac{1}{60}$, in place of $\frac{1}{36}$ (29). Taking a wider range of place and time, the Roman libra has an average variation of $\frac{1}{90}$ in the examples of better period (43), and in those of Byzantine age $\frac{1}{85}$ (44). Altogether, we see that weights have descended from original varieties with so little intercomparison that no rectification of their values has been made, and hence there is as much variety in any one place and time as in all together. Average variation may be said to range from $\frac{1}{40}$ to $\frac{1}{70}$ in different units, doubtless greatly due to defective balances.

2. *Rate of Variation.*—Though large differences may exist, the rate of general variation is but slow—excluding, of course, all monetary standards. In Egypt the cubit lengthened $\frac{1}{170}$ in some thousands of years (25, 44). The Italian mile has lengthened $\frac{1}{100}$ since Roman times (2); the English mile lengthened about $\frac{1}{300}$ in four centuries (31). The English foot has not appreciably varied in several centuries (25). Of weights there are scarce any dated, excepting coins, which nearly all decrease; the Attic tetradrachm, however, increased $\frac{1}{50}$ in three centuries (28), owing probably to its being below the average trade weight to begin with. Roughly dividing the Roman weights, there appears a decrease of $\frac{1}{40}$ from imperial to Byzantine times (43).

3. *Tendency of Variation.*—This is, in the above cases of lengths, to an increase in course of time. The Roman foot is also probably $\frac{1}{300}$ larger than the earlier form of it, and the later form in Britain and Africa perhaps another $\frac{1}{300}$ larger (25). Probably measures tend to increase and weights to decrease in transmission from time to time or place to place.

4. *Details of Variation.*—Having noticed variation in the gross, we must next observe its details. The only way of examining these is by drawing curves (28, 29), representing the frequency of occurrence of all the variations of a unit; for instance, in the Egyptian unit—the kat—counting in a large number how many occur between 140 and 141 grains, 141 and 142, and so on; such numbers represented by curves show at once where any particular varieties of the unit lie (see *Naukratis*, i. 83). This method is only applicable where there is a large number of examples; but there is no other way of studying the details. The results from such a study—of the Egyptian kat, for example—show that there are several distinct families or types of a unit, which originated in early times, have been perpetuated by copying, and reappear alike in each locality (see *Tanis*, ii. pl. l.). Hence we see that if one unit is derived from another it may be possible, by the similarity or difference of the forms of the curves, to discern whether it was derived by general consent and recognition from a standard in the same condition of distribution as that in which we know it, or whether it was derived from it in earlier times before it became so varied, or by some one action forming it from an individual example of the other standard without any variation being transmitted. As our knowledge of the age and locality of weights increases these criteria in curves will prove of greater value; but even now no consideration of the connexion of different units should be made without a graphic representation to compare their relative extent and nature of variation.

5. *Transfer of Units.*—The transfer of units from one people to another takes place almost always by trade. Hence the value of such evidence in pointing out the ancient course of trade and commercial connexions (17). The great spread of the Phoenician weight on the Mediterranean, of the Persian in Asia Minor and of the Assyrian in Egypt are evident cases; and that the decimal weights of the laws of Manu (43) are decidedly not Assyrian or Persian, but on exactly the Phoenician standard, is a curious evidence of trade by water and not overland. If, as seems probable, units of length may be traced in prehistoric remains, they are of great value; at Stonehenge, for instance, the earlier parts are laid out by the Phoenician foot, and the later by the Pelasgo-Roman foot (26). The earlier foot is continually to be traced in other megalithic remains, whereas the later very seldom occurs (25). This bears strongly on the Phoenician origin of our prehistoric civilization. Again, the Belgic foot of the Tungri is the basis of the present English land measures, which we thus see are neither Roman nor British in origin, but Belgic. Generally a unit is transferred from a higher to a less civilized people; but the near resemblance of measures in different countries should always be corroborated by historical considerations of a probable connexion by commerce or origin (Head, *Historia Numorum*, xxxvii.). It should be borne in mind that in early times the larger values, such as minae, would be transmitted by commerce, while after the introduction of coinage the lesser values of shekels and drachmae would be the units; and this needs notice, because usually a borrowed unit was multiplied or divided according to the ideas of the borrowers, and strange modifications thus arose.

[1] These figures refer to the authorities at the end of this section.

6. *Connexions of Lengths, Volumes and Weights.*—This is the most difficult branch of metrology, owing to the variety of connexions which can be suggested, to the vague information we have, especially on volumes, and to the liability of writers to rationalize connexions which were never intended. To illustrate how easy it is to go astray in this line, observe the continual reference in modern handbooks to the cubic foot as 1000 oz. of water; also the cubic inch is very nearly 250 grains, while the gallon has actually been fixed at 10 lb of water; the first two are certainly mere coincidences, as may very probably be the last also, and yet they offer quite as tempting a base for theorizing as any connexions in ancient metrology. No such theories can be counted as more than coincidences which have been adopted, unless we find a very exact connexion, or some positive statement of origination. The idea of connecting volume and weight has received an immense impetus through the metric system, but it is not very prominent in ancient times. The Egyptians report the weight of a measure of various articles, amongst others water (6), but lay no special stress on it, and the fact that there is no measure of water equal to a direct decimal multiple of the weight-unit, except very high in the scale, does not seem as if the volume was directly based upon weight. Again, there are many theories of the equivalence of different cubic cubits of water with various multiples of talents (2, 8, 18, 24, 33); but connexion by lesser units would be far more probable, as the primary use of weights is not to weigh large cubical vessels of liquid, but rather small portions of precious metals. The Roman amphora being equal to the cubic foot, and containing 80 librae of water, is one of the strongest cases of such relations, being often mentioned by ancient writers. Yet it appears to be only an approximate relation, and therefore probably accidental, as the volume by the examples is too large to agree to the cube of the length or to the weight, differing $\frac{1}{40}$, or sometimes even $\frac{1}{13}$.[1]

Another idea which has haunted the older metrologists, but is still less likely, is the connexion of various measures with degrees on the earth's surface. The lameness of the Greeks in angular measurement would alone show that they could not derive itinerary measures from long and accurately determined distances on the earth.

7. *Connexions with Coinage.*—From the 7th century B.C. onward, the relations of units of weight have been complicated by the need of the interrelations of gold, silver and copper coinage; and various standards have been derived theoretically from others through the weight of one metal equal in value to a unit of another. That this mode of originating standards was greatly promoted, if not started, by the use of coinage we may see by the rarity of the Persian silver weight (derived from the Assyrian standard), soon after the introduction of coinage, as shown in the weights of Defenneh (29). The relative value of gold and silver (17, 21) in Asia is agreed generally to have been 13⅓ to 1 in the early ages of coinage; at Athens in 434 B.C. it was 14:1; in Macedon, 350 B.C., 12½:1; in Sicily, 400 B.C., 15:1, and 300 B.C., 12:1; in Italy in 1st century, it was 12:1, in the later empire 13·9:1, and under Justinian 14·4:1. Silver stood to copper in Egypt as 80:1 (Brugsch), or 120:1 (Revillout); in early Italy and Sicily as 250:1 (Mommsen), or 120:1 (Soutzo), under the empire 120:1, and under Justinian 100:1. The distinction of the use of standards for trade in general, or for silver or gold in particular, should be noted. The early observance of the relative values may be inferred from Num. vii. 13, 14, where silver offerings are 13 and 7 times the weight of the gold, or of equal value and one-half value.

8. *Legal Regulations of Measures.*—Most states have preserved official standards, usually in temples under priestly custody. The Hebrew "shekel of the sanctuary" is familiar; the standard volume of the apet was secured in the dromus of Anubis at Memphis (35); in Athens, besides the standard weight, twelve copies for public comparison were kept in the city; also standard volume measures in several places (2); at Pompeii the block with standard volumes cut in it was found in the portico of the forum (33); other such standards are known in Greek cities (Gythium, Panidum and Trajanopolis) (11, 33); at Rome the standards were kept in the Capitol, and weights also in the temple of Hercules (2); the standard cubit of the Nilometer was before Constantine in the Serapaeum, but was removed by him to the church (2). In England the Saxon standards were kept at Winchester before A.D. 950 and copies were legally compared and stamped; the Normans removed them to Westminster to the custody of the king's chamberlains at the exchequer; and they were preserved in the crypt of Edward the Confessor, while remaining royal property (9). The oldest English standards remaining are those of Henry VII. Many weights have been found in the temenos of Demeter at Cnidus, the temple of Artemis at Ephesus, and in a temple of Aphrodite at Byblus (44); and the making or sale of weights may have been a business of the custodians of the temple standards.

9. *Names of Units.*—It is needful to observe that most names of measures are generic and not specific, and cover a great variety of units. Thus foot, digit, palm, cubit, stadium, mile, talent, mina, stater, drachm, obol, pound, ounce, grain, metretes, medimnus, modius, hin and many others mean nothing exact unless qualified by the name of their country or city. Also, it should be noted that some ethnic qualifications have been applied to different systems, and such names as Babylonian and Euboic are ambiguous; the normal value of a standard will therefore be used here rather than its name, in order to avoid confusion, unless specific names exist, such as *kat* and *uten*.

All quantities stated in this article without distinguishing names are in British units of inch, cubic inch or grain.

*Standards of Length.*—Most ancient measures have been derived from one of two great systems, that of the cubit of 20·63 in. or the digit of ·729 in.; and both these systems are found in the earliest remains.

20·63 in.—First known in Dynasty IV. in Egypt, most accurately 20·620 in the Great Pyramid, varying 20·51 to 20·71 in Dyn. IV. to VI. (27). Divided decimally in 100ths; but usually marked in Egypt into 7 palms of 28 digits, approximately; a mere juxtaposition (for convenience) of two incommensurate systems (25, 27). The average of several cubit rods remaining is 20·65, age in general about 1000 B.C. (33). At Philae, &c., in Roman times 20·76 on the Nilometers (44). This unit is also recorded by cubit lengths scratched on a tomb at Beni Hasan (44), and by dimensions of the tomb of Ramessu IV, and of Edfu temple (5) in papyri. From this cubit, *mahi*, was formed the *xylon* of 3 cubits, the usual length of a walking-staff; fathom, *nent*, of 4 cubits, and the *khet* of 40 cubits (18); also the *schoenus* of 12,000 cubits, actually found marked on the Memphis-Faium road (44).

Babylonia had this unit nearly as early as Egypt. The divided plotting scales lying on the drawing boards of the statues of Gudea (*Nature*, xxviii. 341) are of ½ 20·89, or a span of 10·44, which is divided in 16 digits of ·653, a fraction of the cubit also found in Egypt.

[1] Relative to the uncertain connexion of length, capacity and weight in the ancient metrological systems of the East, Sir Charles Warren, R.E., has obtained by deductive analysis a new equivalent of the original cubit (*Palestine Exploration Fund Quarterly*, April, July, October 1899). He shows that the length of the cubit arose through the weights; that is to say, the original cubit of Egypt was based on the cubic double-cubit of water—and from this the several nations branched off with their measures and weights. For the length of the building cubit Sir C. Warren has deduced a length equivalent to 20·6109 English inches, which compares with a mean Pyramid cubit of 20·6015 in. as hitherto found. By taking all the ancient cubits, there appears to be a remarkable coincidence throughout with 20·6109 in.

Sir C. Warren has derived a primitive unit from a proportion of the human body, by ascertaining the probable mean height of the ancient people in Egypt, and so thereby has derived a standard from the stature of man. The human body has furnished the earliest measure for many races (H. O. Arnold-Forster, *The Coming of the Kilogram*, 1898), as the foot, palm, hand, digit, nail, pace, ell (*ulna*), &c. It seems probable, therefore, that a royal cubit may have been derived from some kingly stature, and its length perpetuated in the ancient buildings of Egypt, as the Great Pyramid, &c.

So far this later research appears to confirm the opinion of Boeckh (2) that fundamental units of measure were at one time derived from weights and capacities. It is curious, however, to find that an ancient nation of the East, so wise in geometrical proportions, should have followed what by modern experience may be regarded as an inverse method, that of obtaining a unit of length by deducing it through weights and cubic measure, rather than by deriving cubic measure through the unit of length.

Buildings in Assyria and Babylonia show 20·5 to 20·6. The Babylonian system was sexagesimal, thus (18)—

uban, 5=qat, 6=ammat, 6=qanu, 60=sos, 30=parasang, 2=kaspu.
·69 inch 3·44 20·6 124 7430 223,000 446,000

Asia Minor had this unit in early times—in the temples of Ephesus 20·55, Samos 20·62; Hultsch also claims Priene 20·90, and the stadia of Aphrodisias 20·67 and Laodicea 20·94. Ten buildings in all give 20·63 mean (18, 25); but in Armenia it arose to 20·76 in late Roman times, like the late rise in Egypt (25). It was specially divided into ⅕th, the foot of ⅗ths being as important as the cubit.

12·45 in. ⅗×20·75. This was especially the Greek derivative of the 20·63 cubit. It originated in Babylonia as the foot of that system (24), in accordance with the sexary system applied to the early decimal division of the cubit. In Greece it is the most usual unit, occurring in the Propylaea at Athens 12·44, temple at Aegina 12·40, Miletus 12·51, the Olympic course 12·62, &c. (18); thirteen buildings giving an average of 12·45, mean variation ·06 (25), =⅗ of 20·75, m. var. ·10. The digit = ¼ palaeste, = 1/16 foot of 12·4; then the system is—

foot, {1½=cubit, 4=orguia ........................ 100= } stadion.
{10 ........................ =acaena, 10=plethron, 6= }
12·4 in. 18·7 74·7 124·5 1245 7470

In Etruria it probably appears in tombs as 12·45 (25); perhaps in Roman Britain; and in medieval England as 12·47 (25).

13·8 in. ⅔×20·7. This foot is scarcely known monumentally. On three Egyptian cubits there is a prominent mark at the 19th digit or 14 in., which shows the existence of such a measure (33). It became prominent when adopted by Philetaerus about 280 B.C. as the standard of Pergamum (42), and probably it had been shortly before adopted by the Ptolemies for Egypt. From that time it is one of the principal units in the literature (Didymus, &c.), and is said to occur in the temple of Augustus at Pergamum as 13·8 (18). Fixed by the Romans at 16 digits (13⅓=Roman foot), or its cubit at 1⅘ Roman feet, it was legally =13·94 at 123 B.C. (42); and 7½ Philetaerean stadia were=Roman mile (18). The multiples of the 20·63 cubit are in late times generally reckoned in these feet of ⅔ cubit. The name "Babylonian foot" used by Böckh (2) is only a theory of his, from which to derive volumes and weights; and no evidence for this name, or connexion with Babylon, is to be found. Much has been written (2, 3, 33) on supposed cubits of about 17-18 in. derived from 20·63—mainly in endeavouring to get a basis for the Greek and Roman feet; but these are really connected with the digit system, and the monumental or literary evidence for such a division of 20·63 will not bear examination.

17·30 ⅚×20·76. There is, however, fair evidence for units of 17·30 and 1·730 or 1/12 of 20·76 in Persian buildings (25); and the same is found in Asia Minor as 17·25 or ⅚ of 20·70. On the Egyptian cubits a small cubit is marked as about 17 in., which may well be this unit, as ⅚ of 20·6 is 17·2; and, as these marks are placed *before* the 23rd digit or 17·0, they cannot refer to 6 palms, or 17·7, which is the 24th digit, though they are usually attributed to that (33).

We now turn to the second great family based on the digit. This has been so usually confounded with the 20·63 family, owing to the juxtaposition of 28 digits with that cubit in Egypt, that it should be observed how the difficulty of their incommensurability has been felt. For instance, Lepsius (3) supposed two primitive cubits of 13·2 and 20·63, to account for 28 digits being only 20·4 when free from the cubit of 20·63—the first 24 digits being in some cases made shorter on the cubits to agree with the true digit standard, while the remaining 4 are lengthened to fill up to 20·6. In the

·727 in. Dynasties IV. and V. in Egypt the digit is found in tomb sculptures as ·727 (27); while from a dozen examples in the later remains we find the mean ·728 (25). A length of 10 digits is marked on all the inscribed Egyptian cubits as the "lesser span" (33). In Assyria the same digit appears as ·730, particularly at Nimrud (25); and in Persia buildings show the 10-digit length of 7·34 (25). In Syria it was about ·728, but variable; in eastern Asia Minor more like the Persian, being ·732 (25). In these cases the digit itself, or decimal multiples, seem to have been used.

18·23 25×·729. The pre-Greek examples of this cubit in Egypt, mentioned by Böckh (2), give 18·23 as a mean, which is 25 digits of ·729, and has no relation to the 20·63 cubit. This cubit, or one nearly equal, was used in Judaea in the times of the kings, as the Siloam inscription names a distance of 1758 ft. as roundly 1200 cubits, showing a cubit of about 17·6 in. This is also evidently the Olympic cubit; and, in pursuance of the decimal multiple of the digit found in Egypt and Persia, the cubit of 25 digits was ¼ of the orguia of 100 digits, the series being—

old digit, {25=cubit, 4= } orguia, 10=amma, 10=stadion.
{100 ...... = }
·729 inch 18·2 72·9 729 7296.

Then, taking ⅔ of the cubit, or ⅙ of the orguia, as a foot, the Greeks arrived at their foot of 12·14; this, though very well known in literature, is but rarely found, and then generally in the form of the cubit, in monumental measures. The Parthenon step, celebrated as 100 ft. wide, and apparently 225 ft. long, gives by Stuart 12·137, by Penrose 12·165, by Paccard 12·148, differences due to scale and not to slips in measuring. Probably 12·16 is the nearest value. There are but few buildings wrought on this foot in Asia Minor, Greece or Roman remains. The Greek system, however, adopted this foot as a basis for decimal multiplication, forming

foot, 10=acaena, 10=plethron,
12·16 inches 121·6 1216

which stand as ⅙th of the other decimal series based on the digit. This is the agrarian system, in contrast to the orguia system, which was the itinerary series (33).

Then a further modification took place, to avoid the inconvenience of dividing the foot in 16⅔ digits, and a new digit was formed—longer than any value of the old digit—of 1/16 of the foot, or ·760, so that the series ran

digit, {10=lichas
{96 ...... =orguia, 10=amma, 10=stadion.
·76 inch 7·6 72·9 729 7296.

This formation of the Greek system (25) is only an inference from the facts yet known, for we have not sufficient information to prove it, though it seems much the simplest and most likely history.

11·62 16×·726. Seeing the good reasons for this digit having been exported to the West from Egypt—from the presence of the 18·23 cubit in Egypt, and from the ·729 digit being the decimal base of the Greek long measures—it is not surprising to find it in use in Italy as a digit, and multiplied by 16 as a foot. The more so as the half of this foot, or 8 digits, is marked off as a measure on the Egyptian cubit rods (33). Though Queipo has opposed this connexion (not noticing the Greek link of the digit), he agrees that it is supported by the Egyptian square measure of the plethron, being equal to the Roman actus (33). The foot of 11·6 appears probably first in the prehistoric and early Greek remains, and is certainly found in Etrurian tomb dimensions as 11·59 (25). Dörpfeld considers this as the Attic foot, and states the foot of the Greek metrological relief at Oxford as 11·65 (or 11·61, Hultsch). Hence we see that it probably passed from the East through Greece to Etruria, and thence became the standard foot of Rome; there, though divided by the Italian duodecimal system into 12 unciae, it always maintained its original 16 digits, which are found marked on some of the foot-measures. The well-known ratio of 25:24 between the 12·16 foot and this we see to have arisen through one being ⅙ of 100 and the other 16 digits—16⅔ : 16 being as 25 : 24, the legal ratio. The mean of a dozen foot-measures (1) gives 11·616±·008, and of long lengths and buildings 11·607±·01. In Britain and Africa, however, the Romans used a rather longer form (25) of about 11·68, or a digit of ·730. Their series of measures was—

digitus, 4=palmus, 4=pes, 5=passus, 125=stadium, 8=milliare;
·726 inch 2·90 11·62 58·1 7262 58,100

also

uncia ·968=1/12 pes, palmipes 14·52=5 palmi, cubitus 17·43=6 palmi.

Either from its Pelasgic or Etrurian use or from Romans, this foot appears to have come into prehistoric remains, as the circle of Stonehenge (26) is 100 ft. of 11·68 across, and the same is found in one or two other cases. 11·60 also appears as the foot of some medieval English buildings (25).

We now pass to units between which we cannot state any connexion.

**25·1.**—The earliest sign of this cubit is in a chamber at Abydos (44) about 1400 B.C.; there, below the sculptures, the plain wall is marked out by red designing lines in spaces of 25·13±·03 in., which have no relation to the size of the chamber or to the sculpture. They must therefore have been marked by a workman using a cubit of 25·13. Apart from medieval and other very uncertain data, such as the Sabbath day's journey being 2000 middling paces for 2000 cubits, it appears that Josephus, using the Greek or Roman cubit, gives half as many more to each dimension of the temple than does the Talmud; this shows the cubit used in the Talmud for temple measures to be certainly not under 25 in. Evidence of the early period is given, moreover, by the statement in 1 Kings (vii. 26) that the brazen sea held 2000 baths; the bath being about 2300 cub. in., this would show a cubic of 25 in. The corrupt text in Chronicles of 3000 baths would need a still longer cubit; and, if a lesser cubit of 21·6 or 18 in. be taken, the result for the size of the bath would be impossibly small. For other Jewish cubits see 18·2 and 21·6. Oppert (24) concludes from inscriptions that there was in Assyria a royal cubit of 7/6 the U cubit, or 25·20; and four monuments show (25) a cubit averaging 25·28. For Persia Queipo (33) relies on, and develops, an Arab statement that the Arab *hashama* cubit was the royal Persian, thus fixing it at about 25 in.; and the Persian guerze at present is 25, the royal guerze being 1½ times this, or 37½ in. As a unit of 1·013, decimally multiplied, is most commonly to be deduced from the ancient Persian buildings, we may take 25·34 as the nearest approach to the ancient Persian unit.

**21·6.**—The circuit of the city wall of Khorsabad (24) is minutely stated on a tablet as 24,740 ft. (U), and from the actual size the U is therefore 10·806 in. Hence the recorded series of measures on the Senkereh tablet are valued (Oppert) as—

susi, {20=(palm), 3=U, 6=qanu, 2=sa, 5=(n), 12=us, 30=kasbu.
{60 ........... =U, 60 ................ =(n).
·18 inch 3·6 10·80 64·8 129·6 648 7776 223,280

Other units are the suklum or ½U=5·4, and cubit of 2U=21·6,

24 × 0.759 (24 Greek digits) × √2 → 25.784 28 digits 21.268

which are not named in this tablet. In Persia (24) the series on the same base was—

vitasti, 2=arasni, 360=asparasa, 30=parathaftha, 2=gav;
10·7 inches 21·4 7704 231,120 462,240

probably

yava, 6=angusta 10=vitasti; and gama=⅗ arasni; also bazu=2 arasni.
·18 inch 1·08 10·7 12·8 21·4 42·8 21·4

The values here given are from some Persian buildings (25), which indicate 21·4, or slightly less; Oppert's value, on less certain data, is 21·52. The Egyptian cubits have an arm at 15 digits or about 10·9 marked on them, which seems like this same unit (33).

This cubit was also much used by the Jews (33); and is so often referred to that it has eclipsed the 25·1 cubit in most writers. The Gemara names 3 Jewish cubits (2) of 5, 6 and 7 palms; and, as Oppert (24) shows that 25·2 was reckoned 7 palms, 21·6 being 6 palms, we may reasonably apply this scale to the Gemara list, and read it as 18, 21·6 and 25·2 in. There is also a great amount of medieval and other data showing this cubit of 21·6 to have been familiar to the Jews after their captivity; but there is no evidence for its earlier date, as there is for the 25-in. cubit (from the brazen sea) and for the 18-in. cubit from the Siloam inscription.

From Assyria also it passed into Asia Minor, being found on the city standard of Ushak in Phrygia (33), engraved as 21·8, divided into the Assyrian foot of 10·8, and half and quarter, 5·4 and 2·7. Apparently the same unit is found (18) at Heraclea in Lucania, 21·86; and, as the general foot of the South Italians, or Oscan foot (18), best defined by the 100 feet square being $\frac{1}{10}$ of the jugerum, and therefore=10·80 or half of 21·60. A cubit of 21·5 seems certainly to be indicated in prehistoric remains in Britain, and also in early Christian buildings in Ireland (25).

**22·2.**—Another unit not far different, but yet distinct, is found apparently in Punic remains at Carthage (25), about 11·16 (22·32), and probably also in Sardinia as 11·07 (22·14), where it would naturally be of Punic origin. In the Hauran 22·16 is shown by a basalt door (British Museum), and perhaps elsewhere in Syria (25). It is of some value to trace this measure, since it is indicated by some prehistoric English remains as 22·4.

**20·0.**—This unit may be that of the pre-Semitic Mesopotamians, as it is found at the early temple of Mukayyir (Ur); and, with a few other cases (25), it averages 19·97. It is described by Oppert (24), from literary sources, as the great U of 222 susi or 39·96, double of 19·98; from which was formed a reed of 4 great U or 159·8. The same measure decimally divided is also indicated by buildings in Asia Minor and Syria (25).

**19·2.**—In Persia some buildings at Persepolis and other places (25) are constructed on a foot of 9·6, or cubit of 19·2; while the modern Persian arish is 38·27 or 2×19·13. The same is found very clearly in Asia Minor (25), averaging 19·3; and it is known in literature as the Pythic foot (18, 33) of 9·75, or ½ of 19·5, if Censorinus is rightly understood. It may be shown by a mark (33) on the 26th digit of Sharpe's Egyptian cubit=19·2 in.

**13·3.**—This measure does not seem to belong to very early times, and it may probably have originated in Asia Minor. It is found there as 13·35 in buildings. Hultsch gives it rather less, at 13·1, as the "small Asiatic foot." Thence it passed to Greece, where it is found (25) as 13·36. In Romano-African remains it is often found, rather higher, or 13·45 average (25). It lasted in Asia apparently till the building of the palace at Mashita (A.D. 620), where it is 13·22, according to the rough measures we have (25). And it may well be the origin of the dira' Stambuli of 26·6, twice 13·3. Found in Asia Minor and northern Greece, it does not appear unreasonable to connect it, as Hultsch does, with the Belgic foot of the Tungri, which was legalized (or perhaps introduced) by Drusus when governor, as ⅛ longer than the Roman foot, or 13·07; this statement was evidently an approximation by an increase of 2 digits, so that the small difference from 13·3 is not worth notice. Further, the pertica was 12 ft. of 18 digits, i.e. Drusian feet.

Turning now to England, we find (25) the commonest building foot up to the 15th century averaged 13·22. Here we see the Belgic foot passed over to England, and we can fill the gap to a considerable extent from the itinerary measures. It has been shown (31) that the old English mile, at least as far back as the 13th century, was of 10 and not 8 furlongs. It was therefore equal to 79,200 in., and divided decimally into 10 furlongs, 100 chains, or 1000 fathoms. For the existence of this fathom (half the Belgic pertica) we have the proof of its half, or yard, needing to be suppressed by statute (9) in 1439, as "the yard and full hand," or about 40 in.,—evidently the yard of the most usual old English foot of 13·22, which would be 39·66. We can restore then the old English system of long measure from the buildings, the statute-prohibition, the surviving chain and furlong, and the old English mile shown by maps and itineraries, thus:—

foot, 3=yard, 2=fathom, 10=chain, 10=furlong, 10=mile.
13·22 39·66 79·32 793 7932 79,320

Such a regular and extensive system could not have been put into use throughout the whole country suddenly in 1250, especially as it must have had to resist the legal foot now in use, which was enforced (9) as early as 950. We cannot suppose that such a system would be invented and become general in face of the laws enforcing the 12-in. foot. Therefore it must be dated some time before the 10th century, and this brings it as near as we can now hope to the Belgic foot, which lasted certainly to the 3rd or 4th century, and is exactly in the line of migration of the Belgic tribes into Britain. It is remarkable how near this early decimal system of Germany and Britain is the double of the modern decimal metric system. Had it not been unhappily driven out by the 12-in. foot, and repressed by statutes both against its yard and mile, we should need but a small change to place our measures in accord with the metre.

The Gallic leuga, or league, is a different unit, being 1·59 British miles by the very concordant itinerary of the Bordeaux pilgrim. This appears to be the great Celtic measure, as opposed to the old English, or Germanic, mile. In the north-west of England and in Wales this mile lasted as 1·56 British miles till 1500; and the perch of those parts was correspondingly longer till this century (31). The "old London mile" was 5000 ft., and probably this was the mile which was modified to 5280 ft., or 8 furlongs, and so became the British statute mile.

STANDARDS OF AREA.—We cannot here describe these in detail. Usually they were formed in each country on the squares of the long measures. The Greek system was—

foot, 36=hexapodes
100=..........acaena, 25=aroura, 4=plethron.
1.027 sq. ft. 36·96 102.68 2567 10,268

The Roman system was—

pes, 100=decempeda, 36=clima, 4=actus, 2=jugerum.
·94 sq. ft. 94 3384 13,536 27,072
jugerum, 2=heredium, 100=centuria, 4=saltus.
·6205 acre 1·241 124·1 496·4

STANDARDS OF VOLUME.—There is great uncertainty as to the exact values of all ancient standards of volume—the only precise data being those resulting from the theories of volumes derived from the cubes of feet and cubits. Such theories, as we have noticed, are extremely likely to be only approximations in ancient times, even if recognized then; and our data are quite inadequate for clearing the subject. If certain equivalences between volumes in different countries are stated here, it must be plainly understood that they are only known to be approximate results, and not to give a certain basis for any theories of derivation. All the actual monumental data that we have are alluded to here, with their amounts. The impossibility of safe correlation of units necessitates a division by countries.

*Egypt.*—The hon was the usual small standard; by 8 vases which have contents stated in hons (8, 12, 20, 22, 33, 40) the mean is 29·2 cub. in. ± ·6; by 9 unmarked pottery measures (30) 29·1 ± ·16, and divided by 20; by 18 vases, supposed multiples of hon (1), 32·1 ± ·2. These last are probably only rough, and we may take 29·2 cub. in. ± ·5. This was reckoned (6) to hold 5 utens of water (uten.·. 1470 grains), which agrees well to the weight; but this was probably an approximation, and not derivative, as there is (14) a weight called shet of 4·70 or 4·95 uten, and this was perhaps the actual weight of a hon. The variations of hon and uten, however, cover one another completely. From ratios stated before Greek times (35) the series of multiples was—

ro, 8=hon, 4=honnu, 10=apet or besha {..........10=(Theban), 10=sa. / 4=tama
3·65 cub. in. 29·2 116·8 1168 4672 11,680 116,800

(Theban) is the "great Theban measure."

In Ptolemaic times the artaba (2336·), modified from the Persian, was general in Egypt, a working equivalent to the Attic metretes—value 2 apet or ½ tama; medimnus=tama or 2 artabas, and fractions down to $\frac{1}{120}$ artaba (35). In Roman times the artaba remained (Didymus), but ⅗ was the usual unit (name unknown), and this was divided down to $\frac{1}{64}$ or $\frac{1}{120}$ artaba (35)—thus producing by $\frac{1}{64}$ artaba a working equivalent to the xestes and sextarius (35). Also a new Roman artaba (Didymus) of 1540 was brought in. Beside the equivalence of the hon to 5 utens weight of water, the mathematical papyrus (35) gives 5 besha=⅔ cubic cubit (Revillout's interpretation of this as 1 cubit² is impossible geometrically; see *Rev. Eg.* 1881, for data); this is very concordant, but it is very unlikely for 3 to be introduced in an Egyptian derivation, and probably therefore only a working equivalent. The other ratio of Revillout and Hultsch, 320 hons=cubit³, is certainly approximate.

*Syria, Palestine and Babylonia.*—Here there are no monumental data known; and the literary information does not distinguish the closely connected, perhaps identical, units of these lands. Moreover, none of the writers are before the Roman period, and many relied on are medieval rabbis. A large number of their statements are rough (2, 18, 33), being based on the working equivalence of the bath or epha with the Attic metretes, from which are sometimes drawn fractional statements which seem more accurate than they are. This, however, shows the bath to be about 2500 cub. in. There are two better data (2) of Epiphanius and Theodoret—Attic medimnus =1½ baths, and saton (⅓ bath)=1⅞ modii; these give about 2240 and 2260 cub. in. The best datum is in Josephus (*Ant.* iii. 15, 3), where 10 baths=41 Attic or 31 Sicilian medimni, for which it is agreed we must read modii (33); hence the bath=2300 cub. in. Thus these three different reckonings agree closely, but all equally depend on the Greek and Roman standards, which are not well fixed. The Sicilian modius here is $\frac{1}{11}$, or slightly under ⅒, of the bath, and so probably a

Punic variant of the $\frac{1}{3}$ bath or saton of Phoenicia. One close datum, if trustworthy, would be log of water = Assyrian mina ∴ bath about 2200 cub. in. The rabbinical statement of cub. cubit of 21·5 holding 320 logs puts the bath at about 2250 cub. in.; their log-measure, holding six hen's eggs, shows it to be over rather than under this amount; but their reckoning of bath = $\frac{1}{8}$ cubit cubed is but approximate; by 21·5 it is 1240, by 25·1 it is 1990 cubic in. The earliest Hebrew system was—

| | | | | | |
|---|---|---|---|---|---|
| (log, | 4 = kab) | 3 = hin, 6} / 'issarón ... 10} | = {bath, or epha} | | 10 = {homer—wet, or kor—dry. |
| 32 cub. in. | 128 | 230 / 283 | 2300 | | 23,000 |

'Issarón ("tenth-deal") is also called gomer. The log and kab are not found till the later writings; but the ratio of hin to 'issarón is practically fixed in early times by the proportions in Num. xv. 4-9. Epiphanius stating great hin = 18 xestes, and holy hin = 9, must refer to Syrian xestes, equal to 24 and 12 Roman; this makes holy hin as above, and great hin a double hin, *i.e.* seah or saton. His other statements of saton = 56 or 50 sextaria remain unexplained, unless this be an error for bath = 56 or 50 Syr. sext. and ∴ = 2290 or 2560 cub. in. The wholesale theory of Revillout (35) that all Hebrew and Syrian measures were doubled by the Ptolemaic revision, while retaining the same names, rests entirely on the resemblance of the names apet and epha, and of log to the Coptic and late measure lok. But there are other reasons against accepting this, besides the improbability of such a change.

The Phoenician and old Carthaginian system was (18)—

| | | | |
|---|---|---|---|
| log, | 4 = kab, | 6 = saton, | 30 = corus. |
| 31 cub. in. | 124 | 740 | 22,200 |

valuing them by 31 Sicilian = 41 Attic modii (Josephus, above).

The old Syrian system was (18)—

| | | | | |
|---|---|---|---|---|
| cotyle, | 2 = Syr. xestes, | 18 = sabitha or saton, | $1\frac{1}{2}$ = collathon, | 2 = bath-artaba; |
| 21 cub. in. | 42 | 740 | 1110 | 2220 |

also

| | | |
|---|---|---|
| Syr. xestes, | 45 = maris, | 2 = metretes or artaba. |
| 41 | 1850 | 3700 |

The later or Seleucidan system was (18)—

| | | |
|---|---|---|
| cotyle, | 2 = Syr. xestes, | 90 = Syr. metretes, |
| 22 | 44 | 4000 |

the Syrian being $1\frac{1}{3}$ Roman sextarii.

The Babylonian system was very similar (18)—

| | | | | | |
|---|---|---|---|---|---|
| (1), | 4 = capitha, | {15 = maris / 18 = ... epha, | | 10 = homer, | 6 = achane. |
| 33 cub. in. | 132 | 1980 | 2380 | 23,800 | 142,800 |

The approximate value from capitha = 2 Attic choenices (Xenophon) warrants us in taking the achane as fixed in the following system, which places it closely in accord with the preceding.

In Persia Hultsch states—

| | | | |
|---|---|---|---|
| capetis | ... 48 = artaba, 40} / maris ... 72} | | = achane, |
| 74·4 cub. in. | 1983 | 3570 | 142,800 |

the absolute values being fixed by artaba = 51 Attic choenices (Herod. i. 192). The maris of the Pontic system is $\frac{5}{6}$ of the above, and the Macedonian and Naxian maris $\frac{1}{10}$ of the Pontic (18). By the theory of maris = $\frac{1}{5}$ of $20·6^3$ it is 1755·; by maris = Assyrian talent, 1850, in place of 1850 or 1980 stated above; hence the more likely theory of weight, rather than cubit, connexion is nearer to the facts.

*Aeginetan System.*—This is so called from according with the Aeginetan weight. The absolute data are all dependent on the Attic and Roman systems, as there are no monumental data. The series of names is the same as in the Attic system (18). The values are $1\frac{1}{2}$ × the Attic (Athenaeus, Theophrastus, &c.) (2, 18), or more closely 11 to 12 times $\frac{1}{8}$ of Attic. Hence, the Attic cotyle being 17·5 cub. in., the Aeginetan is about 25·7. The Boeotian system (18) included the achane; if this = Persian, then cotyle = 24·7. Or, separately through the Roman system, the mnasis of Cyprus (18) = 170 sextarii; then the cotyle = 24·8. By the theory of the metretes being $1\frac{1}{2}$ talents Aeginetan, the cotyle would be 23·3 to 24·7 cub. in. by the actual weights, which have tended to decrease. Probably then 25·0 is the best approximation. By the theory (18) of 2 metretes = cube of the 18·67 cubit from the 12·45 foot, the cotyle would be about 25·4, within ·4; but then such a cubit is unknown among measures, and not likely to be formed, as 12·4 is $\frac{3}{5}$ of 20·6. The Aeginetan system then was—

| | | | | | |
|---|---|---|---|---|---|
| cotyle, | 4 = choenix, | {3 = chous ... | / 8 = ... hecteus, | 4 = metretes, | 16 / $1\frac{1}{2}$} = medimnus. |
| 25 cub. in. | 100 | 300 | 800 | 3200 | 4800 |

This was the system of Sparta, of Boeotia (where the aporryma = 4 choenices, the cophinus = 6 choenices, and saites or saton or hecteus = 2 aporrymae, while 30 medimni = achane, evidently Asiatic connexions throughout), and of Cyprus (where 2 choes = Cyprian medimnus, of which 5 = medimnus of Salamis, of which 2 = mnasis (18)).

*Attic or Usual Greek System.*—The absolute value of this system is far from certain. The best data are three stone slabs, each with several standard volumes cut in them (11, 18), and two named vases. The value of the cotyle from the Naxian slab is 15·4 (best, others 14·6–19·6); from a vase about 16·6; from the Panidum slab 17·1 (var. 16·2–18·2); from a Capuan vase 17·8; from the Ganus slab 17·8 (var. 17·–18·). From these we may take 17·5 as a fair approximation. It is supposed that the Panathenaic vases were intended as metretes; this would show a cotyle of 14·4–17·1. The theories of connexion give, for the value of the cotyle, metretes = Aeginetan talent, ∴ 15·4–16·6; metres $\frac{2}{3}$ of 12·16 cubed, ∴ 16·6; metretes = [illegible] of 12·16 cubed, ∴ 16·8; medimnus = 2 Attic talents, hecteus = 20 minae, choenix = $2\frac{1}{2}$ minae, ∴ 16·75; metretes = 3 cub. spithami ($\frac{1}{2}$ cubit = 9·12), ∴ 17·5; 6 metretes = 2 ft. of 12·45 cubed, ∴ 17·8 cub. in. for cotyle. But probably as good theories could be found for any other amount; and certainly the facts should not be set aside, as almost every author has done, in favour of some one of half a dozen theories. The system of multiples was for liquids—

| | | | | |
|---|---|---|---|---|
| cyathus, | $1\frac{1}{2}$ = oxybaphon, | 4 = cotyle, | 12 = chous, | 12 = metretes, |
| 2·9 cub. in. | 4·4 | 17·5 | 210 | 2520 |

with the tetarton (8·8), 2 = cotyle, 2 = xestes (35·), introduced from the Roman system. For dry measure—

| | | | | |
|---|---|---|---|---|
| cyathus, | 6 = cotyle, | 4 = choenix, | 8 = hecteus, | 6 = medimnus, |
| 2·9 cub. in. | 17·5 | 70 | 560 | 3360 |

with the xestes, and amphoreus (1680) = $\frac{1}{2}$ medimnus, from the Roman system. The various late provincial systems of division are beyond our present scope (18).

*System of Gythium.*—A system differing widely both in units and names from the preceding is found on the standard slab of Gythium in the southern Peloponnesus (*Rev. Arch.*, 1872). Writers have unified it with the Attic, but it is decidedly larger in its unit, giving 19·4 (var. 19·1–19·8) for the supposed cotyle. Its system is—

| | | | |
|---|---|---|---|
| cotyle, | 4 = hemihecton, | 4 = chous, | 3 = (*n*). |
| 58 cub. in. | 232 | 932 | 2796 |

And with this agrees a pottery cylindrical vessel, with official stamp on it (ΔΗΜΟΣΙΟΝ, &c.), and having a fine black line traced round the inside, near the top, to show its limit; this seems to be probably very accurate, and contains 58·5 cub. in., closely agreeing with the cotyle of Gythium. It has been described (*Rev. Arch.*, 1872) as an Attic choenix. Gythium being the southern port of Greece, it seems not too far to connect this 58 cub. in. with the double of the Egyptian hon = 58·4, as it is different from every other Greek system.

*Roman System.*—The celebrated Farnesian standard congius of bronze of Vespasian, "mensurae exactae in Capitolio P. X.," contains 206·7 cub. in. (2), and hence the amphora 1654. By the sextarius of Dresden (2) the amphora is 1695; by the congius of Ste Geneviève (2) 1700 cub. in.; and by the ponderarium measures at Pompeii (33) 1540 to 1840, or about 1620 for a mean. So the Farnesian congius, or about 1650, may best be adopted. The system for liquid was—

| | | | | |
|---|---|---|---|---|
| quartarius, | 4 = sextarius, | 6 = congius, | 4 = urna, | 2 = amphora, |
| 8·6 cub. in. | 34·4 | 206 | 825 | 1650 |

for dry measure 16 sextarii = modius, 550 cub. in.; and to both systems were added from the Attic the cyathus (2·87), acetabulum (4·3) and hemina (17·2 cub. in.). The Roman theory of the amphora being the cubic foot makes it 1569 cub. in., or decidedly less than the actual measures; the other theory of its containing 80 librae of water would make it 1575 by the commercial or 1605 by the monetary libra—again too low for the measures. Both of these theories therefore are rather working equivalents than original derivations; or at least the interrelation was allowed to become far from exact.

*Indian and Chinese Systems.*—On the ancient Indian system see *Numismata Orientalia*, new ed., i. 24; on the ancient Chinese, *Nature*, xxx. 565, and xxxv. 318.

STANDARDS OF WEIGHT.—For these we have far more complete data than for volumes or even lengths, and can ascertain in many cases the nature of the variations, and their type in each place. The main series on which we shall rely here are those—(1) from Assyria (38) about 800 B.C.; (2) from the eastern Delta of Egypt (29) (Defenneh); (3) from western Delta (28) (Naucratis); (4) from Memphis (44)—all these about the 6th century B.C., and therefore before much interference from the decreasing coin standards; (5) from Cnidus; (6) from Athens; (7) from Corfu; and (8) from Italy (British Museum) (44). As other collections are but a fraction of the whole of these, and are much less completely examined, little if any good would be done by including them in the combined results, though for special types or inscriptions they will be mentioned.

**146 grains.**—The Egyptian unit was the kat, which varied between 138 and 155 grains (28, 29). There were several families or varieties within this range, at least in the Delta, probably five or six in all (29). The original places and dates of these cannot yet be fixed, except for the lowest type of 138–140 grains; this belonged to Heliopolis (7), as two weights (35) inscribed of "the treasury of An" show 139·9 and 140·4, while a plain one from there gives 138·8; the variety 147–149 may belong to Hermopolis (35), according to an inscribed weight. The names of the kat and tema are fixed by being found on weights, the uten by inscriptions; the series was—

| | | | |
|---|---|---|---|
| (*n*), | 10 = kat, | 10 = uten, | 10 = tema. |
| 14·6 grs. | 146 | 1460 | 14,600 |

The tema is the same name as the large wheat measure (35), which was worth 30,000 to 19,000 grains of copper, according to Ptolemaic receipts and accounts (*Rev. Eg.*, 1881, 150), and therefore very likely worth 10 utens of copper in earlier times when metals were scarcer. The kat was regularly divided into 10; but another division, for the sake of interrelation with another system, was in $\frac{1}{3}$ and $\frac{1}{6}$, scarcely found except in the eastern Delta, where it is common (29); and it is known from a papyrus (38) to be a Syrian weight. The uten is found ÷6=245, in Upper Egypt (rare) (44). Another division (in a papyrus) (38) is a silver weight of $\frac{1}{10}$ kat=about 88—perhaps the Babylonian siglus of 86. The uten was also binarily divided into 128 peks of gold in Ethiopia; this may refer to another standard (see 129) (33). The Ptolemaic copper coinage is on two bases—the uten, binarily divided, and the Ptolemaic five shekels (1050), also binarily divided. (This result is from a larger number than other students have used, and study by diagrams.) The theory (3) of the derivation of the uten from $\frac{1}{1500}$ cubic cubit of water would fix it at 1472, which is accordant; but there seems no authority either in volumes or weights for taking 1500 utens. Another theory (3) derives the uten from $\frac{1}{1000}$ of the cubic cubit of 24 digits, or better $\frac{8}{9}$ of 20·63; that, however, will only fit the very lowest variety of the uten, while there is no evidence of the existence of such a cubit. The kat is not unusual in Syria (44), and among the haematite weights of Troy (44) are nine examples, average 144, but not of extreme varieties.

**129 grs.; 258 grs. 7750; 15,500; 465,000.** The great standard of Babylonia became the parent of several other systems; and itself and its derivatives became more widely spread than any other standard. It was known in two forms—one system (24) of—

| um, | 60=sikhir, | 6=shekel, | 10=stone, | 6=maneh, | 60=talent; |
|---|---|---|---|---|---|
| ·36 grs. | 21·5 | 129 | 1290 | 7750 | 465,000 |

and the other system double of this in each stage except the talent. These two systems are distinctly named on the weights, and are known now as the light and heavy Assyrian systems (19, 24). (It is better to avoid the name Babylonian, as it has other meanings also.) There are no weights dated before the Assyrian bronze lion weights (9, 17, 19, 38) of the 11th to 8th centuries B.C. Thirteen of this class average 127·2 for the shekel; 9 haematite barrel-shaped weights (38) give 128·2; 16 stone duck-weights (38), 126·5. A heavier value is shown by the precious metals—the gold plates from Khorsabad (18) giving 129, and the gold daric coinage (21, 35) of Persia 129·2. Nine weights from Syria (44) average 128·8. This is the system of the "Babylonian" talent, by Herodotus=70 minae Euboic, by Pollux=70 minae Attic, by Aelian=72 minae Attic, and, therefore, about 470,000 grains. In Egypt this is found largely at Naucratis (28, 29), and less commonly at Defenneh (29). In both places the distribution, a high type of 129 and a lower of 127, is like the monetary and trade varieties above noticed; while a smaller number of examples are found, fewer and fewer, down to 118 grains. At Memphis (44) the shekel is scarcely known, and a $\frac{1}{2}$ mina weight was there converted into another standard (of 200). A few barrel weights are found at Karnak, and several egg-shaped shekel weights at Gebelen (44); also two cuboid weights from there (44) of 1 and 10 utens are marked as 6 and 60, which can hardly refer to any unit but the heavy shekel, giving 245. Hultsch refers to Egyptian gold rings of Dynasty XVIII. of 125 grains. That this unit penetrated far to the south in early times is shown by the tribute of Kush (34) in Dynasty XVIII.; this is of 801, 1443 and 23,741 kats, or 15 and 27 manehs and $7\frac{1}{2}$ talents when reduced to this system. And the later Ethiopic gold unit of the pek (7), or $\frac{1}{128}$ of the uten, was 10·8 or more, and may therefore be the $\frac{1}{2}$ sikhir or obolos of 21·5. But the fraction $\frac{1}{128}$, or a continued binary division repeated seven times, is such a likely mode of rude subdivision that little stress can be laid on this. In later times in Egypt a class of large glass scarabs for funerary purposes seem to be adjusted to the shekel (30). Whether this system or the Phoenician of 224 grains was that of the Hebrews is uncertain. There is no doubt but that in the Maccabean times and onward 218 was the shekel; but the use of the word darkemôn by Ezra and Nehemiah, and the probabilities of their case, point to the daragmaneh, $\frac{1}{60}$ maneh or shekel of Assyria; and the mention of $\frac{1}{3}$ shekel by Nehemiah as poll tax nearly proves that the 129 and not 218 grains is intended, as 218 is not divisible by 3. But the Maccabean use of 218 may have been a reversion to the older shekel; and this is strongly shown by the fraction $\frac{1}{4}$ shekel (1 Sam. ix. 8), the continual mention of large decimal numbers of shekels in the earlier books, and the certain fact of 100 shekels being=mina. This would all be against the 129 or 258 shekel, and for the 218 or 224. There is, however, one good datum if it can be trusted: 300 talents of silver (2 Kings xviii. 14) are 800 talents on Sennacherib's cylinder (34), while the 30 talents of gold is the same in both accounts. Eight hundred talents on the Assyrian silver standard would be 267—or roundly 300—talents on the heavy trade or gold system, which is therefore probably the Hebrew. Probably the 129 and 224 systems coexisted in the country; but on the whole it seems more likely that 129 or rather 258 grains was the Hebrew shekel before the Ptolemaic times—especially as the 100 shekels to the mina is paralleled by the following Persian system (Hultsch)—

shekel, { 50=mina ..... 60=talent of gold
shekel, { 60= ...... mina ................ 60=talent of trade,

| 129 grs. | 6450 7750 | 387,000 | 465,000 |
|---|---|---|---|

the Hebrew system being

| gerah, | 20=shekel, | 100=maneh, | 30=talent, |
|---|---|---|---|
| 12·9 grs. | 258 | 25,800 | 774,000 |

and, considering that the two Hebrew cubits are the Babylonian and Persian units, and the volumes are also Babylonian, it is the more likely that the weights should have come with these. From the east this unit passed to Asia Minor; and six multiples of 2 to 20 shekels (av. 127) are found among the haematite weights of Troy (44), including the oldest of them. On the Aegean coast it often occurs in early coinage (17)—at Lampsacus 131–129, Phocaea 256–254, Cyzicus 252–247, Methymna 124·6, &c. In later times it was a main unit of North Syria, and also on the Euxine, leaden weights of Antioch (3), Callatia and Tomis being known (38). The mean of these eastern weights is 7700 for the mina, or 128. But the leaden weights of the west (44) from Corfu, &c., average 7580, or 126·3; this standard was kept up at Cyzicus in trade long after it was lost in coinage. At Corinth the unit was evidently the Assyrian and not the Attic, being 129·6 at the earliest (17) (though modified to double Attic, or 133, later) and being ÷3, and not into 2 drachms. And this agrees with the mina being repeatedly found at Corcyra, and with the same standard passing to the Italian coinage (17) similar in weight, and in division into $\frac{1}{3}$—the heaviest coinages (17) down to 400 B.C. (Terina, Velia, Sybaris, Posidonia, Metapontum, Tarentum, &c.) being none over 126, while later on many were adjusted to the Attic, and rose to 134. Six disk weights from Carthage (44) show 126. It is usually the case that a unit lasts later in trade than in coinage; and the prominence of this standard in Italy may show how it is that this mina (18 unciae=7400) was known as the "Italic" in the days of Galen and Dioscorides (2).

**126 grs. 6300.** A variation on the main system was made by forming a mina of 50 shekels. This is one of the Persian series (gold), and the $\frac{1}{4}$ of the Hebrew series noted above. But it is most striking when it is found in the mina form which distinguishes it. Eleven weights from Syria and Cnidus (44) (of the curious type with two breasts on a rectangular block) show a mina of 6250 (125·0); and it is singular that this class is exactly like weights of the 224 system found with it, but yet quite distinct in standard. The same passed into Italy and Corfu (44), averaging 6000—divided in Italy into unciae ($\frac{1}{12}$), and scripulae ($\frac{1}{288}$), and called litra (in Corfu?). It is known in the coinage of Hatria (18) as 6320. And a strange division of the shekel in 10 (probably therefore connected with this decimal mina) is shown by a series of bronze weights (44) with four curved sides and marked with circles (British Museum, place unknown), which may be Romano-Gallic, averaging 125÷10. This whole class seems to cling to sites of Phoenician trade, and to keep clear of Greece and the north—perhaps a Phoenician form of the 129 system, avoiding the sexagesimal multiples.

If this unit have any connexion with the kat, it is that a kat of gold is worth 15 shekels or $\frac{1}{4}$ mina of silver; this agrees well with the range of both units, only it must be remembered that 129 was used as gold unit, and another silver unit deduced from it. More likely then the 147 and 129 units originated independently in Egypt and Babylonia.

**86 grs. 8600; 516,000.** From 129 grains of gold was adopted an equal value of silver=1720, on the proportion of 1:$13\frac{1}{3}$, and this was divided in 10=172—which was used either in this form, or its half, 86, best known as the siglus (17). Such a proportion is indicated in Num. vii., where the gold spoon of 10 shekels is equal in value to the bowl of 130 shekels, or double that of 70, *i.e.* the silver vessels were 200 and 100 sigli. The silver plates at Khorsabad (18) we find, to be 80 sigli of 84·6. The Persian silver coinage shows about 86·0; the danak was $\frac{1}{3}$ of this or 28·7. Xenophon and others state it at about 84. As a monetary weight it seems to have spread, perhaps entirely, in consequence of the Persian dominion; it varies from 174 downwards, usually 167, in Aradus, Cilicia and on to the Aegean coast, in Lydia and in Macedonia (17). The silver bars found at Troy averaging 2744, or $\frac{1}{3}$ mina of 8232, have been attributed to this unit (17); but no division of the mina in $\frac{1}{3}$ is to be expected, and the average is rather low. Two haematite weights from Troy (44) show 86 and 87·2. The mean from leaden weights of Chios, Tenedos (44), &c., is 8430. A duck-weight of Camirus, probably early, gives 8480; the same passed on to Greece and Italy (17), averaging 8610; but in Italy it was divided, like all other units, into unciae and scripulae (44). It is perhaps found in Etrurian coinage as 175–172 (17). By the Romans it was used on the Danube (18), two weights of the first legion there showing 8610; and this is the mina of 20 unciae (8400) named by Roman writers. The system was—

| obol, | 6=siglus, | 100=mina, | 60=talent. |
|---|---|---|---|
| 14·3 grs. | 86 | 8600 | 516,000 |

A derivation from this was the $\frac{1}{3}$ of 172, or 57·3, the so-called Phocaean drachma, equal in silver value to the $\frac{1}{60}$ of the gold 258 grains. It was used at Phocaea as 58·5, and passed to the colonies of Posidonia and Velia as 59 or 118. The colony of Massilia brought it into Gaul as 58·2–54·9.

**224 grs. 11,200; 672,000.** That this unit (commonly called Phoenician) is derived from the 129 system can hardly be doubted, both being so intimately associated in Syria and Asia Minor. The relation is 258 : 229 :: 9:8; but the exact form in which the descent took place is not settled: $\frac{1}{10}$ or 129 of gold is worth 57 of silver or a drachm, $\frac{1}{4}$ of 230 (or by trade weights 127 and 226); otherwise, deriving it from the silver weight of 86 already formed, the drachm is $\frac{1}{3}$ of the stater, 172, or double of the Persian danak of 28·7, and the sacred unit of Didyma in Ionia was this half-drachm, 27; or thirdly, what is indicated by the Lydian coinage (17). 86 of gold was equal to 1150 of silver, 5 shekels or $\frac{1}{10}$ mina. Other proposed derivations from the kat or pek are not satisfactory. In actual use this unit varied greatly: at Naucratis (29) there are groups of it at 231, 223 and others down to 208; this is the earliest form in which we can study it, and the corresponding values to these are 130 and 126, or the gold and trade varieties of the Babylonian, while the lower tail down to 208 corresponds to the shekel down to 118, which is just what is found. Hence the 224 unit seems to have been formed from the 129, after the main families or types of that had arisen. It is scarcer at Defenneh (29) and rare at Memphis (44). Under the Ptolemies, however, it became the great unit of Egypt, and is very prominent in the later literature in consequence (18, 35). The average of coins (21) of Ptolemy I. gives 219·6, and thence they gradually diminish to 210, the average (33) of the whole series of Ptolemies being 218. The "argenteus" (as Revillout transcribes a sign in the papyri) (35) was of 5 shekels, or 1090; it arose about 440 B.C., and became after 160 B.C. a weight unit for copper. In Syria, as early as the 15th century B.C., the tribute of the Rutennu, of Naharaina, Megiddo, Anaukasa, &c. (34), is on a basis of 454-484 kats, or 300 shekels ($\frac{1}{10}$ talent) of 226 grains. The commonest weight at Troy (44) is the shekel, averaging 224. In coinage it is one of the commonest units in early times; from Phoenicia, round the coast to Macedonia, it is predominant (17); at a maximum of 230 (Ialysus), it is in Macedonia 224, but seldom exceeds 220 elsewhere, the earliest Lydian of the 7th century being 219, and the general average of coins 218. The system was—

| (¼), | 8=drachm, | 4=shekel, | 25=mina, | 120=talent. |
|---|---|---|---|---|
| 7 grs. | 56 | 224 | 5600 | 672,000 |

From the Phoenician coinage it was adopted for the Maccabean. It is needless to give the continual evidences of this being the later Jewish shekel, both from coins (max. 223) and writers (2, 18, 33); the question of the early shekel we have noticed already under 129. In Phoenicia and Asia Minor the mina was specially made in the form with two breasts (44), 19 such weights averaging 5600 (=224); and thence it passed into Greece, more in a double value of 11,200 (=224). From Phoenicia this naturally became the main Punic unit; a bronze weight from Iol (18), marked 100, gives a drachma of 56 or 57 (224–228); and a Punic inscription (18) names 28 drachmae =25 Attic, and ∴ 57 to 59 grains (228–236); while a probably later series of 8 marble disks from Carthage (44) show 208, but vary from 197 to 234. In Spain it was 236 to 216 in different series (17), and it is a question whether the Massiliote drachmae of 58-55 are not Phoenician rather than Phocaic. In Italy this mina became naturalized, and formed the "Italic mina" of Hero, Priscian, &c.; also its double, the mina of 26 unciae or 10,800, =50 shekels of 216; the average of 42 weights gives 5390 (=215·6), and it was divided both into 100 drachmae, and also in the Italic mode of 12 unciae and 288 scripulae (44). The talent was of 120 minae of 5400, or 3000 shekels, shown by the talent from Herculaneum, TA, 660,000 and by the weight inscribed PONDO CXXV. (*i.e.* 125 librae) TALENTUM SICLORVM. iii., *i.e.* talent of 3000 shekels (2) (the M being omitted; just as Epiphanius describes this talent as 125 librae, or θ (=9) nomismata, for 9000). This gives the same approximate ratio 96: 100 to the libra as the usual drachma reckoning. The Alexandrian talent of Festus, 12,000 denarii, is the same talent again. It is believed that this mina ÷ 12 unciae by the Romans is the origin of the Arabic ratl of 12 ūkiyas, or 5500 grains (33), which is said to have been sent by Harun al-Rashid to Charlemagne, and so to have originated the French monetary pound of 5666 grains. But, as this is probably the same as the English monetary pound, or tower pound of 5400, which was in use earlier (see Saxon coins), it seems more likely that this pound (which is common in Roman weights) was directly inherited from the Roman civilization.

80 grs. 4000; 400,000. Another unit, which has scarcely been recognized in metrology hitherto, is prominent in the weights from Egypt—some 50 weights from Naucratis and 15 from Defenneh plainly agreeing on this and on no other basis. Its value varies between 76·5 and 81·5—mean 79 at Naucratis (29) or 81 at Defenneh (29). It has been connected theoretically with a binary division of the 10 shekels or "stone" of the Assyrian systems (28), 1290 ÷ 16 being 80·6; this is suggested by the most usual multiples being 40 and 80=25 and 50 shekels of 129; it is thus akin to the mina of 50 shekels previously noticed. The tribute of the Asi, Rutennu, Khita, Assaru, &c., to Thothmes III. (34), though in uneven numbers of kats, comes out in round thousands of units when reduced to this standard. That this unit is quite distinct from the Persian 86 grains is clear in the Egyptian weights, which maintain a wide gap between the two systems. Next, in Syria three inscribed weights of Antioch and Berytus (18) show a mina of about 16,400, or 200×82. Then at Abydus, or more probably from Babylonia, there is the large bronze lion-weight, stated to have been originally 400,500 grains; this has been continually ÷ 60 by different writers, regardless of the fact (*Rev. arch.*, 1862, 30) that it bears the numeral 100; this therefore is certainly a talent of 100 minae of 4005; and as the mina is generally 50 shekels in Greek systems it points to a weight of 80·1. Farther west the same unit occurs in several Greek weights (44) which show a mina of 7800 to 8310, mean 8050 ÷ 100 = 80·5. Turning to coinage, we find this often, but usually overlooked as a degraded form of the Persian 86 grains siglos. But the earliest coinage in Cilicia, before the general Persian coinage (17) about 380 B.C., is Tarsus, 164 grains; Soli, 169, 163, 158; Nagidus, 158, 161-153 later; Issus, 166; Mallus, 163-154—all of which can only by straining be classed as Persian; but they agree to this standard, which, as we have seen, was used in Syria in earlier times by the Khita, &c. The Milesian or "native" system of Asia Minor (18) is fixed by Hultsch at 163 and 81·6 grains—the coins of Miletus (17) showing 160, 80 and 39. Coming down to literary evidence, this is abundant. Böckh decides that the "Alexandrian drachma" was $\frac{6}{5}$ of the Solonic 67, or = 80·5, and shows that it was not Ptolemaic, or Rhodian, or Aeginetan, being distinguished from these in inscriptions (2). Then the "Alexandrian mina" of Dioscorides and Galen (2) is 20 unciae = 8250; in the "Analecta" (2) it is 150 or 158 drachmae = 8100. Then Attic: Euboic or Aeginetan :: 18:25 in the metrologists (2), and the Euboic talent = 7000 "Alexandrian" drachmae; the drachma therefore is 80·0. The "Alexandrian" wood talent: Attic talent : : 6:5 (Hero, Didymus), and ∴ 480,000, which is 60 minae of 8000. Pliny states the Egyptian talent at 80 librae = 396,000; evidently = the Abydus lion talent, which is ÷ 100, and the mina is ∴ 3960, or 50×79·2. The largest weight is the "wood" talent of Syria (18) = 6 Roman talents, or 1,860,000, evidently 120 Antioch minae of 15,500 or 2×7750. This evidence is too distinct to be set aside; and, exactly confirming as it does the Egyptian weights and coin weights, and agreeing with the early Asiatic tribute, it cannot be overlooked in future. The system was

| drachm, | 2=stater, | 50=mina, | {50=talent. | 60=Greek talent. |
|---|---|---|---|---|
| 80 grs. | 160 | 8000 | 400,000 | 480,000 |

207 grs. to 190 9650; 579,000. This system, the Aeginetan, one of the most important to the Greek world, has been thought to be a degradation of the Phoenician (17, 21), supposing 220 grains to have been reduced in primitive Greek usage to 194. But we are now able to prove that it was an independent system—(1) by its not ranging usually over 200 grains in Egypt before it passed to Greece; (2) by its earliest example, perhaps before the 224 unit existed, not being over 208; and (3) by there being no intermediate linking on of this to the Phoenician unit in the large number of Egyptian weights, nor in the Ptolemaic coinage, in which both standards are used. The first example (30) is one with the name of Amenhotep I. (17th century B.C.) marked as "gold 5," which is 5×207·6. Two other marked weights are from Memphis (44), showing 201·8 and 196·4, and another Egyptian 191·4. The range of the (34) Naucratis weights is 186 to 199, divided in two groups averaging 190 and 196, equal to the Greek monetary and trade varieties. Ptolemy I. and II. also struck a series of coins (32) averaging 199. In Syria haematite weights are found (30) averaging 198·5, divided into 99·2, 49·6 and 24·8; and the same division is shown by gold rings from Egypt (38) of 24·9. In the medical papyrus (38) a weight of ⅔ kat is used, which is thought to be Syrian; now ⅔ kat = 92 to 101 grains, or just this weight which we have found in Syria; and the weights of ⅔ and ⅓ kat are very rare in Egypt except at Defenneh (29), on the Syrian road, where they abound. So we have thus a weight of 207-191 in Egypt on marked weights, joining therefore completely with the Aeginetan unit in Egypt of 199 to 186, and coinage of 199, and strongly connected with Syria, where a double mina of Sidon (18) is 10,460 or 50×209·2. Probably before any Greek coinage we find this among the haematite weights of Troy (44), ranging from 208 to 193·2 (or 104-96·6), *i.e.* just covering the range from the earliest Egyptian down to the early Aeginetan coinage. Turning now to the early coinage, we see the fuller weight kept up (17) at Samos (202), Miletus (201), Calymna (100, 50), Methymna and Scepsis (99, 49),[1] Ionia (197); while the coinage of Aegina, (17, 12), which by its wide diffusion made this unit best known, though a few of its earliest staters go up even to 207, yet is characteristically on the lower of the two groups which we recognize in Egypt, and thus started what has been considered the standard value of 194, or usually 190, decreasing afterwards to 184. In later times, in Asia, however, the fuller weight, or higher Egyptian group, which we have just noticed in the coinage, was kept up (17) into the series of cistophori (196-191), as in the Ptolemaic series of 199. At Athens the old mina was fixed by Solon at 150 of his drachmae (18) or 9800 grains, according to the earliest drachmae, showing a stater of 196; and this continued to be the trade mina in Athens, at least until 160 B.C., but in a reduced form, in which it equalled only 138 Attic drachmae, or 9200. The Greek mina weights show (44), on an average of 37, 9650 (= stater of 193), varying from 186 to 199. In the Hellenic coinage it varies (18) from a maximum of 200 at Pharae to 192, usual full weight; this unit occupied (17) all central Greece, Peloponnesus and most of the islands. The system was—

| obol, | 6=drachm, | 2=stater, | 50=mina, | 60=talent. |
|---|---|---|---|---|
| 16 grs. | 96 | 192 | 9600 | 576,000 |

[1] That this unit was used for gold in Egypt, one thousand years before becoming a silver coin weight in Asia Minor, need not be dwelt on, when we see in the coinage of Lydia (17) gold pieces and silver on the same standard, which was expressly formed for silver alone, *i.e.* 84 grains. The Attic and Assyrian standards were used indifferently for either gold or silver.

½ TOLA ↑

It also passed into Italy, but in a smaller multiple of 35 drachmae, or ½ of the Greek mina; 12 Italian weights (44) bearing value marks (which cannot therefore be differently attributed) show a libra of 2400 or ¼ of 9600, which was divided in unciae and sextulae, and the full-sized mina is known as the 24 uncia mina, or talent of 120 librae of Vitruvius and Isidore (18) = 9900. Hultsch states this to be the old Etruscan pound.

412 4950 grs. With the trade mina of 9650 in Greece, and recognized in Italy, we can hardly doubt that the Roman libra is the half of this mina. At Athens it was 2×4900, and on the average of all the Greek weights it is 2×4825, so that 4950—the libra—is as close as we need expect. The division by 12 does not affect the question, as every standard that came into Italy was similarly divided. In the libra, as in most other standards, the value which happened to be first at hand for the coinage was not the mean of the whole of the weights in the country; the Phoenician coin weight is below the trade average, the Assyrian is above, the Aeginetan is below, but the Roman coinage is above the average of trade weights, or the mean standard. Rejecting all weights of the lower empire, the average (44) of about 100 is 4956; while 42 later Greek weights (nomisma, &c.) average 4857, and 16 later Latin ones (solidus, &c.) show 4819. The coinage standard, however, was always higher (18); the oldest gold shows 5056, the Campanian Roman 5054, the consular gold 5037, the aurei 5037, the Constantine solidi 5053 and the Justinian gold 4996. Thus, though it fell in the later empire, like the trade weight, yet it was always above that. Though it has no exact relation to the congius or amphora, yet it is closely = 4977 grains, the $\frac{1}{80}$ of the cubic foot of water. If, however, the weight in a degraded form, and the foot in an undegraded form, come from the East, it is needless to look for an exact relation between them, but rather for a mere working equivalent, like the 1000 ounces to the cubit foot in England. Böckh has remarked the great diversity between weights of the same age—those marked "Ad Augusti Temp" ranging 4971 to 5535, those tested by the fussy praefect Q. Junius Rusticus vary 4362 to 5625, and a set in the British Museum (44) belonging together vary 4700 to 5168. The series was—

| | | | | |
|---|---|---|---|---|
| siliqua, | 6 = scripulum, | 4 = sextula, | 6 = uncia, | 12 = libra, |
| 2·8¼ grs. | 17·2 | 68·7 | 412 | 4950 |

the greater weight being the centumpondium of 495,000. Other weights were added to these from the Greek system—

| | | | |
|---|---|---|---|
| obolus, | 6 = drachma, | [illegible] = sicilicus, | 4 = uncia; |
| 8·6 grs. | 51·5 | 103 | 412 |

and the sextula after Constantine had the name of solidus as a coin weight, or nomisma in Greek, marked N on the weights. A beautiful set of multiples of the scripulum was found near Lyons (38); from 1 to 10×17·28 grains, showing a libra of 4976. In Bryzantine times in Egypt glass was used for coin-weights (30), averaging 68·0 for the solidus = 4896 for the libra. The Saxon and Norman ounce is said to average 416·5 (*Num. Chron.*, 1871, 42), apparently the Roman uncia inherited.

67 grs. 6700; 402,000. The system which is perhaps the best known, through its adoption by Solon in Athens, and is thence called Attic or Solonic, is nevertheless far older than its introduction into Greece, being found in full vigour in Egypt in the 6th century B.C. It has been usually reckoned as a rather heavier form of the 129 shekel, increased to 134 on its adoption by Solon. But the Egyptian weights render this view impossible. Among them (29) the two contiguous groups can be discriminated by the 129 being multiplied by 30 and 60, while the 67 or 134 is differently ×25, 40, 50 and 100. Hence, although the two groups overlap owing to their nearness, it is impossible to regard them as all one unit. The 129 range is up to 131·8, while the Attic range is 130 to 138 (65-69). Hultsch reckons on a ratio of 24:25 between them, and this is very near the true values; the full Attic being 67·3, the Assyrian should be 129·2, and this is just the full gold coinage weight. We may perhaps see the sense of this ratio through another system. The 80-grain system, as we have seen, was probably formed by binarily dividing the 10 shekels, or "stone"; and it had a talent (Abydus lion) of 5000 drachmae; this is practically identical with the talent of 6000 Attic drachmae. So the talent of the 80-grain system was sexagesimally divided for the mina which was afterwards adopted by Solon. Such seems the most likely history of it, and this is in exact accord with the full original weight of each system. In Egypt the mean value at Naucratis (29) was 66·7, while at Defenneh (29) and Memphis (44)—probably rather earlier—it was 67·0. The type of the grouping is not alike in different places, showing that no distinct families had arisen before the diffusion of this unit in Egypt; but the usual range is 65·5 to 69·0. Next it is found at Troy (44) in three cases, all high examples of 68·2 to 68·7; and these are very important, since they cannot be dissociated from the Greek Attic unit, and yet they are of a variety as far removed as may be from the half of the Assyrian, which ranges there from 123·5 to 131; thus the difference of unit between Assyrian and Attic in these earliest of all Greek weights is very strongly marked. At Athens a low variety of the unit was adopted for the coinage, true to the object of Solon in depreciating debts; and the first coinage is of only 65·2, or scarcely within the range of the trade weights (28); this seems to have been felt, as, contrary to all other states, Athens slowly increased its coin weight up to 66·6, or but little under the trade average. It gradually supplanted the Aeginetan standard in Greece and Italy as the power of Athens rose; and it was adopted by Philip and Alexander (17) for their great gold coinage of 133 and 66·5. This system is often known as the "Euboic," owing to its early use in Euboea, and its diffusion by trade from thence. The series was—

| | | | | |
|---|---|---|---|---|
| chalcous, | 8 = obolus, | 6 = drachma, | 100 = mina, | 60 = talenton. |
| 1·4 grs. | 11·17 | 67 | 6700 | 402,000 |

Turning now to its usual trade values in Greece (44), the mean of 113 gives 67·15; but they vary more than the Egyptian examples, having a sub-variety both above and below the main body, which itself exactly coincides with the Egyptian weights. The greater part of those weights which bear names indicate a mina of double the usual reckoning, so that there was a light and a heavy system, a mina of the drachma and a mina of the stater, as in the Phoenician and Assyrian weights. In trade both the minae were divided in ⅔, ½, ⅜, ⅓, and ⅙, regardless of the drachmae. This unit passed also into Italy; the libra of Picenum and the double of the Etrurian and Sicilian libra (17); it was there divided in unciae and scripulae (44), the mean of 6 from Italy and Sicily being 6600; one weight (bought in Smyrna) has the name "Leitra" on it. In literature it is constantly referred to; but we may notice the "general mina" (Cleopatra), in Egypt, 16 unciae = 6600; the Ptolemaic talent, equal to the Attic in weight and divisions (Hero, Didymus); the Antiochian talent, equal to the Attic (Hero); the treaty of the Romans with Antiochus, naming talents of 80 librae, *i.e.* mina of 16 unciae; the Roman mina in Egypt, of 15 unciae, probably the same diminished; and the Italic mina of 16 unciae. It seems even to have lasted in Egypt till the middle ages, as Jabarti and the "kātib's guide" both name the ratl misri (of Cairo) as 144 dirhems = 6760.

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(W. M. F. P.)

## III. COMMERCIAL

1. *Denominations.*—The denominations of trade weights and measures at present used in the United Kingdom are represented by "Board of Trade standards," by which are regulated the accuracy of the common weights and measures handled in shops, &c.:[1]

*Imperial Measures of Length.*—100 feet, 66 feet or a chain of 100 links, rod, pole, or perch, measures from 10 feet to 1 foot;

[1] Board of Trade Model Regulations, 1892; Weights and Measures Acts, 1878, 1889, 1892, 1893.

18 inches; yard of 36 inches, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$ yard, nail, inch, and duodecimal, decimal and binary parts of the inch.

*Imperial Measures of Capacity.*—Liquid measures from 32 gallons to 1 gallon, quart, pint, $\frac{1}{2}$ pint, gill, $\frac{1}{2}$ gill, $\frac{1}{4}$ gill. Dry measures of bushel, $\frac{1}{2}$ bushel, peck, gallon, quart, pint, $\frac{1}{2}$ pint.

*Apothecaries' Measures.*—40 fluid ounces to $\frac{1}{2}$ fl. oz., 16 fluid drachms to $\frac{1}{2}$ fl. dr., 60 minims to 1 minim.

*Avoirdupois Weights.*—Cental (100 lb), 56 lb ($\frac{1}{2}$ cwt.), 28 lb, 14 lb (stone), 7, 4, 2, 1 lb; 8, 4, 2, 1, $\frac{1}{2}$ ounce (8 drams); 4, 2, 1, $\frac{1}{2}$ drams.

*Troy Weights.*—The ounce (480 gr.) and multiples and decimal parts of the ounce troy from 500 ounces to 0·001 oz.

*Apothecaries' Weights.*—10 oz. to 1 oz. (480 gr.); 4 drachms to $\frac{1}{2}$ oz.; 2, 1 drachms; 2 scruples to $\frac{1}{2}$ scruple; and 6 grains to $\frac{1}{2}$ grain.

*Pennyweights.*—20 dwt. (480 grains), 10, 5, 3, 2, 1 dwts.

*Grain Weights.*—4000, 2000, 1000 gr. (making 7000 gr. or 1 lb), 500 to 0·01 gr.

2. The international trade metric weights and measures (1897) handled in shops, &c., of which there are also Board of Trade standards, are set out as follows:—

IMPERIAL TO METRIC

| | | |
|---|---|---|
| 1 yard | = | 0·914399 m. |
| 1 square yard | = | 0·836126 m². |
| 1 cubic inch | = | 16·387 c.c. |
| 1 gallon[2] | = | 4·5459631 l. |
| 1 pound (7000 grains) | = | 0·45359243 kg. |
| 1 ounce troy (480 gr.) | = | 31·1035 grammes. |
| 1 fluid drachm | = | 3·552 millilitres (ml.). |
| 1 fluid ounce | = | 2·84123 centilitres (cl.). |

METRIC TO IMPERIAL

| | | |
|---|---|---|
| 1 metre (m.) at 0° C. | = | 39·370113 inches at 62° F |
| 1 square metre (m².) | = | 10·7639 square feet. |
| 1 cubic decimetre (c.d.) or 1000 cubic centimetres (c.c.) | = | 61·024 cubic inches. |
| 1 litre (l.) | = | 1·7598 pints. |
| 1 kilogram (kg.) | = | 2·2046223 lb avoir. |
| 1 gramme (g.) | = | 15·4323564 grains or 0·7716 scruple. |

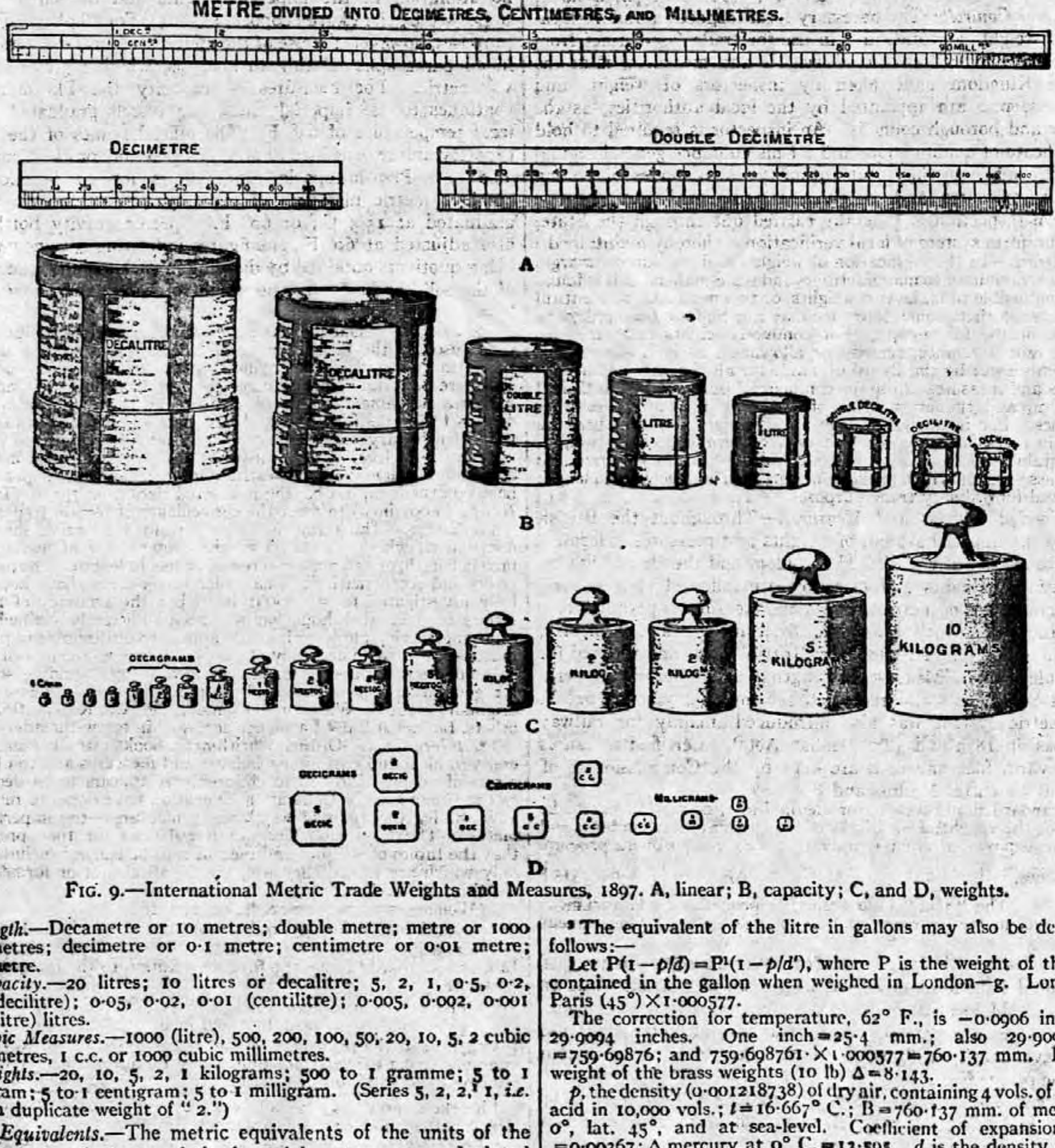


FIG. 9.—International Metric Trade Weights and Measures, 1897. A, linear; B, capacity; C, and D, weights.

*Length.*—Decametre or 10 metres; double metre; metre or 1000 millimetres; decimetre or 0·1 metre; centimetre or 0·01 metre; millimetre.

*Capacity.*—20 litres; 10 litres or decalitre; 5, 2, 1, 0·5, 0·2, 0·1 (decilitre); 0·05, 0·02, 0·01 (centilitre); 0·005, 0·002, 0·001 (millilitre) litres.

*Cubic Measures.*—1000 (litre), 500, 200, 100, 50, 20, 10, 5, 2 cubic centimetres, 1 c.c. or 1000 cubic millimetres.

*Weights.*—20, 10, 5, 2, 1 kilograms; 500 to 1 gramme; 5 to 1 decigram; 5 to 1 centigram; 5 to 1 milligram. (Series 5, 2, 2,[1] 1, *i.e.* with a duplicate weight of "2.")

3. *Equivalents.*—The metric equivalents of the units of the metric system in terms of the imperial system, as recalculated in 1897, are as follows:—[1]

[1] *Metric Equivalents*, King's Printers (1898).

[2] The equivalent of the litre in gallons may also be derived as follows:—

Let $P(1-p/d) = P^1(1-p/d')$, where P is the weight of the water contained in the gallon when weighed in London—g. London = g. Paris (45°) × 1·000577.

The correction for temperature, 62° F., is −0·0906 in.; hence 29·9094 inches. One inch = 25·4 mm.; also 29·9094 × 25·4 = 759·69876; and 759·69876 × 1·000577 = 760·137 mm. $P^1$ is the weight of the brass weights (10 lb) Δ = 8·143.

*p*, the density (0·001218738) of dry air, containing 4 vols. of carbonic acid in 10,000 vols.; $t$ = 16·667° C.; B = 760·137 mm. of mercury at 0°, lat. 45°, and at sea-level. Coefficient of expansion of air = 0·00367; Δ mercury at 0° C. = 13·595. *d* is the density of water at 62° F. (16·667° C.) = 0·9988611. *d'*, the density of the brass as above. 10 lb = 4·5359243 kg.

From the above it follows that P = 4·5407857 kg. Therefore—1 gallon = P/0·9988611 = 4·5459631 litres.

The equivalents of the Russian weights and measures, in terms also of the imperial and metric weights and measures, were re-calculated in 1897.[1] The following are the leading equivalents:

1 Russian pound = { 0·025 pood. / 96 zolotniks. / 9216 dolis.
= 0·40951240 kg.
= 0·90282018 lb avoir.

1 archinne = { 0·00066 verst. / 0·33 sagène. / 16 verchoks. / 280 liniias.
= 0·711200 mètre.
= 0·777778 yard.

1 vedro = { 10 schtoffs / = 100 tcharkas
= 12·299 litres
= 2·7056 gallons.

1 tchetverta = 8 tchetveriks
= 2·0991 hectolitres
= 5·7719 bushels.

4. *Local Control.*—The necessary local inspection and verification of weights and measures in use for trade (as distinct from the verbal and written use of weights and measures) is in the United Kingdom undertaken by inspectors of weights and measures, who are appointed by the local authorities, as the county and borough councils. An inspector is required to hold a certificate of qualification, and for his guidance general regulations are made by his local authority as to modes of testing weights, measures and weighing instruments.[2] In Europe the local inspection is generally carried out through the State, and a uniform system of local verification is thereby maintained.

5. *Errors.*—In the verification of weights and measures a margin of error is permitted to manufacturers and scale-makers, as it is found to be impossible to make two weights, or two measures, so identical that between them some difference may not be found either by the balance or the microscope. For common weights and measures this margin (tolerance, remedy or allowance, as it is also called) has been set out by the Board of Trade for all the various kinds of weights and measures in use for commercial purposes in the United Kingdom, and similar margins of error are recognized in other countries. For instance, on 1 lb avoir. weight made of brass, 2 grains in excess are allowed; on 1 oz. troy or apothecaries' weight, +0·2 grain is allowed; on 1 pint pot, 4 fluid drachms is permitted; on 1 brass yard, 0·05 inch in excess or 0·02 inch in deficiency in length is allowed for ordinary trade purposes.

6. *Foreign Weights and Measures.*—Throughout the British Empire the imperial system of weights and measures is legal.

In Russia, as in the United Kingdom and the United States, the national weights and measures are followed (§ 3 above), although the use of metric weights and measures is permissive.

In India the native weights, &c., ancient and arbitrary, are still followed. In 1889 the British yard was adopted for the whole of India (Measures of Length Act) at a normal temperature of 85° F. as standardized to the imperial yard at 62° F. The metric system was also introduced, mainly for railway purposes, in 1870 and 1871 (Indian Acts). Certified measures of the yard, foot and inch are kept by the Commissioners of Police at Calcutta, Madras and Bombay.

In standardizing a weight for use in India, correction has to be made for the weight of air displaced by the material standard, and for such purpose the normal temperature of 85°, atmospheric pressure 29·8 inches, latitude 22° 35′ 6·5″ (Calcutta), $g = \left\{ g'_{45^\circ}\, 0{\cdot}9982515 \right\}$ are taken. The "tola" (180 grains) is properly the Government unit of weight for currency; and 80 tolas make the "Government seer."

7. *Customary Weights and Measures.*—In some districts of the United Kingdom, as well as in provincial districts of other countries, old local and customary denominations of weights and measures are still found to be in use, although their use may have been prohibited by law. So powerful is custom with the people.[3]

8. *Legislation.*—In everyday transactions with reference to weights and measures, the British legislature also exercises control in industrial pursuits. For instance, in weighing live cattle, owners of markets are now required to provide adequate accommodation.[4] Useful statutes have also been passed to protect the working class, as in checking the weighing instruments used in mines in Great Britain, over which instruments wages are paid, and in the inspection of similar instruments used in factories and workshops. The Merchandise Marks Act 1887 makes it an offence also to apply in trade a false description, as to the number, quantity, measure, gauge or weight of goods sold; and this Act appears to reach offences that the Weights and Measures Acts may perhaps not reach.

9. *Pharmaceutical Weights and Measures.*—By the Medical Act of 1858, and the Act of 1862, the General Council of Medical Education and Registration of the United Kingdom are authorized to issue a "Pharmacopoeia" with reference to the weights and measures used in the preparation and dispensing of drugs, &c. The British Pharmacopoeia issued by the Council in 1898 makes no alteration in the imperial weights and measures required to be used by the Pharmacopoeia of 1864. For all pharmaceutical purposes, however, the use of the metric system alone is employed in all paragraphs relating to analysis, whether gravimetric or volumetric. For measures of capacity the Pharmacopoeia continues to use imperial measuring vessels graduated at the legal temperature of 62° F. The official names of the metric capacity units are defined at 4° C., as generally on the Continent. The new Pharmacopoeia also follows foreign practice, and employs metric measures of capacity and volumetric vessels graduated at 15·5 C., or 60° F. Specific gravity bottles are also adjusted at 60° F., the figures indicating specific gravities being quotients obtained by dividing in each instance the weight of the solid or liquid by the weight of an equal bulk of water, both taken at 60° F.[5]

10. *Gauges.*—"Gauges," as understood at one time, included only those used in the measurement of barrels, casks, &c., and hence the term "gauger." For engineering and manufacturing purposes the more important linear gauges are, however, now used, adjusted to some fundamental unit of measure as the inch; although in certain trades, as for wires and flat metals, gauges continue to be used of arbitrary scales and of merely numerical sizes, having no reference to a legal unit of measure; and such are rarely accurate. A standard gauge, however, exists (Order in Council, August 1883), based on the inch, but having numbered sizes from 7/0 (0·5 inch) to No. 50 (0·001 inch) to meet the convenience of certain trades.[6]

11. *Screws.*—The screw is an important productive measuring instrument, whether used as a micrometer-screw of less than an inch in length, or as a master-screw of 20 feet in length. The probable errors and eccentricities of small micrometer-screws have been carefully investigated to ±0·00001 inch; but the accuracy of leading screws used in workshops has not been sufficiently verified. For some engineering purposes it would appear to be desirable to produce master-screws to an accuracy of $\frac{1}{1000}$ of an inch to the foot of screw, so as to serve indirectly for the verification of "guiding screws" for general use in workshops.[7] Attempts in this direction were originally made by Whitworth, Clement, Donkin, Rogers, Bond and others, but we still need a higher accuracy in screw-threads.

12. *Educational.*—Ordinary arithmetic books often contain references to local and customary weights and measures and to obsolete terms of no practical use to children. It appears to be desirable, as the Committee of Council on Education have done, to recognize only the legal systems of weights and measures—the imperial and metric. The Education Code of Regulations for 1900 prescribes that the tables of weights and measures to be learned include those only which are in ordinary use, viz. in all classes or forms above the third the tables of

{ Weight—ton, cwt, stone, lb, oz. and dr.,
Length—mile, furlong, rod or pole, chain, yd., ft. and inch,
Capacity—quarter, bushel, pk., gall., qt. and pt.

In Code standards above the fifth, in addition to the foregoing, the tables of

{ Area—sq. mile, acre, rood, pole, yd., ft. and inch,
Volume—cubic yard, foot and inch.

Instruction in the principles of the metric system, and in the advantages to be gained from uniformity in the method of forming multiples and sub-multiples of the unit, are, under this Code, to be

[1] *C.I.P.M. Procès-verbaux* (1897), p. 155.
[2] Regulations, Birmingham, Glasgow, London, Manchester, &c.
[3] Report Select Committee (1892); *Merchant's Handbook*, W. A. Browne (1892); Reports H.M. Representatives Abroad, Foreign Office, 1900–1901.
[4] Markets and Fairs (Cattle) Acts 1887, 1891; Coal Mines Regulation Act 1887; Factory and Workshop Act 1878.
[5] *Pharmacopoeia* (1901); Calendar Pharmaceutical Society, 1902.
[6] Order in Council, 26th August 1881.
[7] *Systématique des vis horlogères*, Thury (Geneva, 1878). Bulletin Soc. d'Encouragement pour l'Industrie Nationale, Paris, 1894. Report of British Association on Screw-threads, 1900.

given to the scholars in Standards IV., V., VI. and VII. As a preparation for this it is stated in the Code that it will be useful to give in Standard III. (arithmetic) elementary lessons on the notation of decimal fractions. (See ARITHMETIC.)

*Table of the Principal Foreign Weights and Measures now in use, and of their Equivalents in Imperial or in Metric Weights and Measures.*

| | | |
|---|---|---|
| Almude | Portugal | 16·8 litres. |
| Anoman (Ammomam, Amomam) | Ceylon | 0·699 quarter (dry measure), 5·60 bushels. |
| Ara | Italy | 1 metric are, 119.6 sq. yds. |
| Archin, or Arshin | Turkey | 1 new archin (Law 1881) = 1 mètre (39·37 inches) = 10 parmaks (decimetres) = 100 khats (centimetres), 1 mill = 1000 archins (kilometre). Pharoagh = 10 mills. Another pharoagh = 2 hours' journey. |
| Archin | Bulgaria | 0·758 metre (masons). 0·680 metre (tailors). |
| Archine, or Archinne | Russia | 28 inches, or 0·7112 metre. |
| Ardeb | Egypt | 5·447 bushels (Customs). 5 bushels (old measure). |
| Are | | = 100 sq. metres = 119·6 sq. yds. |
| Area | Spain | 1 metric are. |
| Arpent | France, Canada | Legal arpent was equal to 100 sq. perches = 51·07 metric ares in Quebec = 180 French feet. |
| Arroba | Portugal | 14·68 to 15 kilogrammes. |
| | Spain | Mayor = 3·55 gallons, or 1 cantara. |
| Artaba | Persia | 1·809 bushel. Menor = 2·76 gallons (liquids). |
| Aune | Belgium | 1 metre. Formerly 1·312 yard. |
| | France | 1·885 metre (1812). |
| | Jersey | 4 feet. |
| Barilo | Rome | 12·834 gallons. |
| Bat, or Tical | Siam | 234 grains. |
| Batman | Persia | 6½ lb av.; varies locally. |
| | Turkey | = 10 ocks. |
| Behär | Arabia | 439·45 lb av., nearly. |
| Berri | Turkey | 1·084 mile (old measure). |
| Boisseau | Belgium | 15 litres. |
| Boutylka | Russia | 1·353 pint (wine bottle). |
| Braça | Portugal | 2·22 metres. |
| Braccio | Spain | 0·670 metre (commercial). |
| | Rome | Braccio d'ara = 29·528 inches. |
| Brasse | France | 5·328 feet. |
| Braza | Argentina | 5·682 feet. |
| Bu, or tsubo | Japan | 3·0306 square metres. |
| Bushel | U. States, Canada | 2150·42 cubic inches, about 0·96944 imperial bushel. 1 bushel = 8 gallons = 32 quarts = 64 pints. |
| Bunder | Netherlands | 2·471 acres (old hectare). |
| Cabot | Jersey | 10 pots, or 4 gallons, 1 quart 3 gills imperial measure. |
| Candy | Bombay | 560 lb av. |
| | Madras | 493·7 lb av. |
| Cantar | Turkey | 124·7 lb av. (old weight). |
| Cantara piccolo | Italy | 74·771 lb av. |
| Capicha | Persia | 0·58 gallon. |
| Catty | China | 1⅓ lb av. See *Tael*. |
| | N. Borneo | 1⅓ lb av. |
| | Siam | 2·675 lb av., or $\frac{1}{50}$ hap. |
| Cawnie | Madras | 1·322 acre. |
| Cental | U. States, Canada | 100 lb av. (As in Great Britain.) |
| Centigramme | | = $\frac{1}{100}$ grm. = 0·154 grain. |
| Centilitre | | = $\frac{1}{100}$ litre = 0·07 gill. |
| Centimetre | | = 0·394 inch = $\frac{1}{100}$ m. |
| Centimetre, cubic (c.c.) | | = 0·061 cubic inch, or 1 c.c. |
| Centimetre, square | | = 0·155 square inch. |
| Centner | Austria | 50 kilogrammes = 110·231 lb. av. |
| | Denmark | 50 kilogrammes = 110·231 lb. av. |
| | Switzerland | 50 kilogrammes = 110·231 lb. |
| Chain | Canada | 66 feet. |
| | Cyprus | 0·33 pic. |
| Chang | China | 10 ch'ih = 11 ft. 9 inches (Treaty). |
| | Siam | 2·675 lb. |
| Chapah | N. Borneo | 1⅓ lb av. |
| Chee. See *Tahil*. | | |
| Chek | Hong Kong | 14⅝ inches. |
| Chenica | Persia | 0·289 gallon. |
| Ch'ien | China | 58⅓ grains (silver weight). |
| Ch'ih | China | Varies throughout China from 11 to 15·8 inches. For Customs purposes the Treaty ch'ih = 14·1 inches, and 5 ch'ih = 1 pu. |
| Ch'ih | Peking | = 12·3, = 12·5 public works. |
| | | = 12·4 statistics. |
| | | = 12·6 architects. |
| | | = 12·7 common. |
| | | = 13·1 tribunal of mathematics. |
| | Shanghai | = 13·2 Board of Revenue. |
| | | = 14·1 Customs. |
| Chilogramme | Italy | 1 kilogramme. |
| Chin or Catty | China | 1⅓ lb av. (Treaty). |
| Ching | China | 121 sq. feet (Treaty). |
| Ch'ing | China | 72,600 sq. feet (Treaty). |
| Chittack | Bengal | 5 tolas, or 900 grains. |
| Ch'ok | Corea | 7⅞ in. (linear); 12⅜ in. (building). |
| Chüo | China | 1815 sq. feet (Treaty). |
| Chupah | Singapore | 1·66 lb av. of water at 62° F., as a measure of capacity. |
| | Malacca | 144 oz. av. of water. |
| Chupak | Straits Settlements | 1 quart. |
| Collothun | Persia | 1·809 gallon. |
| Coss | Bengal | 1·136 metre. |
| Covado | Portugal | 0·66 metre. |
| Covid, or Cubit | Madras | 18 to 21 inches. |
| | Bombay | 18 inches. |
| | Siam | 18 inches. |
| Covido | Arabia | 18 inches approximately. |
| Covido (Great) | | 27 inches. |
| Cuartillo | Spain | 1·16 litre (dry); 0·504 litre liquid. |
| Daktylon (Royal) | Greece | 1 centimetre. |
| Daribah | Egypt | 43·58 bushels (Customs). |
| Decagramme | | = 10 grms. = 5·64 drams av. |
| Decalitre | | = 10 litres = 2·2 gallons. |
| Decametre | | = 10·936 yards. |
| Déçiatina | Russia | = 2400 square sagènes = 2·7 acres. |
| Decigramme | | = $\frac{1}{10}$ grm. = 1·54 grain. |
| Decilitre | | = $\frac{1}{10}$ litre = 0·176 pint. |
| Decimetre | | = 3·937 inches = 0·1 metre. |
| Decimetre, cubic | | = 1000 c.c. = 61·024 cub. in. |
| Decimetre, square | | = 100 sq. centm. = 15·5 sq. in. |
| Denaro | Rome | 18·17 grains (old weight). |
| Deunam | Turkey | 1 metric are. |
| Diraa, or Draa, or Pic | Egypt | 27 inches usually. 21·3 inches Nile measure. |
| | Turkey | 27 inches (old measure of pike). |
| Dirhem | Egypt | 1·761 dram av. (Customs). 3·0884 grammes (Cairo). |
| Djerib | Turkey | 1 hectare. |
| Dolia, or Dola | Russia | 0·686 grain. 96 doli = 1 zolotnick. |
| Drachma | Netherlands | 3·906 grammes. |
| | Turkey | 154·324 grains. |
| Drachmé (Royal) | Greece | 1 gramme (gold weight). |
| | Constantinople | = 57·871 grains. See *Ock*. |
| Dram. See *Oke*. | | |
| Ducat | Vienna | 53·873 grains. |
| Duim | Netherlands | 1 centimetre. |
| Eimer | Austria | 12·448 gallons. |
| El | Netherlands | 1 metre. (Old ell = 27·08 inches). |
| Ell | Jersey | 4 feet. |
| Ella | N. Borneo | 1 yard. |
| Elle | Switzerland | 0·6561 yard. |
| Endaseh, or Hindâzi | Egypt | Usually 25 inches. |
| Faltche | Moldavia | 1 hectare, 43 ares, 22 centiares. |
| Fanega | Argentina | 3·773 bushels. |
| | Portugal | 55·364 litres. |
| | Spain | 1·526 bushel. |
| | Peru | 1⅓ bushel. |
| | | 1·615 acre, but varies locally. |
| Fass | Germany | 1 hectolitre. |
| Feddan | Egypt | 1·038 acre (Masri). Also 1·127 acre locally. |
| | | 1.266 acre (old). |
| Fen | China | 5·83 grains (silver weight). |
| Fjerdingkar | Denmark | 0·9564 bushel. |
| Fod | Denmark | 1·0297 foot. |
| | Norway | 0·3137 metre. |
| Foglietto | Rome | 0·8 pint. |
| Foot | U. States | 12 inches. |
| | Canada | French foot = 12·8 inches. |
| | Amsterdam, South Africa | 11·147 in. old measure. |
| | Old Rhenish | 12·356 in. old measure. |

| | | |
|---|---|---|
| Fot | Sweden | 11·689 in. 10 fot = 1 stöng. 1 ref = 10 stänger. 1 mil = 360 ref. |
| Founte, or Funt or Livre | Russia | 0·90282 lb av. |
| Foute, or Pied | Russia | 1 English foot. |
| Frasco | Argentina | $2\frac{3}{8}$ litres. |
| Fuss | Vienna | 12 zolls = 1·037 foot. |
| | Switzerland | $3\frac{1}{3}$ fuss = 1 metre. See *Stab.* |
| Gallon | U. States, Canada | 231 cubic inches = 8·3389 lb av. of water at t. 39·8° Fahr. At 62° Fahr. = 0·8325 imp. gallon. |
| Gantang | Straits Settlements | 32 gallons. |
| | N. Borneo | 144 oz. av. weight of water as measure of capacity. |
| Garnetz | Russia | 0·3607 peck. |
| Gin. See *Kati.* | | |
| Gisla | Zanzibar | Measure of 360 lb av. of rice. |
| Go | Japan | 180·39 cubic centimetres. |
| Grain | Russia | 0·960 grain (apothecaries). |
| Gramme (gr.) | | = 15·4323564 grains av. troy. = 0·2572 drachm, 0·7716 scruple. = 0·03215 oz. troy. |
| Grammé (Royal) | Greece | 1 millimetre. |
| Gramo | Spain | 1 gramme. |
| Grano | Rome | 0·757 grain. |
| Grao | Portugal | 0·768 grain; also measure 0·18 in. |
| Grein | Netherlands | = 0·065 gramme. |
| Guz, or Gudge | India: Bengal | 36 inches. |
| | „ Bombay | 27 inches. |
| | „ Madras | 33 inches, Government Survey. |
| | Persia | The guz, gueza or zer varies from 24 to 44 inches. A guz of 40·95 inches (Guz, Azerbáiján) is common. Government standard guz = $36\frac{1}{3}$ inches. There is a guz for retail trade of 25 inches. |
| | Arabia | 25 inches to 37 inches (Bassorah). |
| Hat'h, or Moolum, or Cubit | Bengal | 18 inches. |
| | Bombay | 18 inches, or cubit. |
| Hectare | | = 100 ares, or 2·471 acres. |
| Hectogramme | | 100 grm. = 3·53 oz. av. |
| Hectolitre | | 100 litres = 2·75 bushels. |
| Hectometre | | = 109·36 yards. |
| Hiyaka-me | Japan | 5797·198 grains. |
| Hiyak-kin | Japan | $132\frac{1}{3}$ lb av. |
| Hoon. See *Tahil.* | | |
| Hu | China | $12\frac{1}{2}$ gallons, nearly. |
| Immi | Switzerland | 1·5 litre. |
| Joch | Austria-Hungary | 1·422 acre. |
| Kaima | Sweden | 0·576 gallon. |
| Kan | Netherlands | 1 litre. |
| | Hong Kong | $1\frac{1}{3}$ lb av. |
| Kanne or Kanna | Germany | 1 litre, or formerly 1·762 pint. |
| | Sweden | 0·576 pint. |
| Kantar, or Cantaro | Egypt | 99·0492 lb av. = 100 rotls (Customs). 45 kilogrammes of cotton. 44·5 kilogrammes other produce. |
| Karwar | Persia | 100 batman. |
| Kassabah | Egypt | 3·8824 yards (Customs). |
| Kati, Catty or Gin | China, Straits Settlements | $1\frac{1}{3}$ lb av. |
| Keila, or Pishi | Zanzibar | Measure of 6 lb av. of rice. |
| Ken | Japan | 5·965 ft., 1·81 metre. |
| Kerât | Turkey | $1\frac{1}{8}$ inch measure (old). 3·09 grains weight (old) |
| Kette, or Chain | Germany | 14·994 ellen, or 10·936 yards. |
| Keu | Siam | 40 inches. |
| Khat (New) | Turkey | 1 centimetre. |
| Kile | Cyprus | 8 gallons. |
| Killow | Turkey | 0·97 bushel. |
| Kilogramme | | = 1000 grm. = 2·2046223 lb av. |
| Kilometre | | = 0·6214 mile. |
| Kin | Japan, China | 0·601 kilogramme = 1·325 lb. |
| Klafter | Austria | = 2·0740 yards. |
| | Switzerland | 1·9685 yard. |
| Kòddi | Arabia | 1·67 gallon. |
| Koilon (Royal) | Greece | 1 hectolitre. Old koilon = 33·16 litra. |
| Koku | Japan | = 39·7033 galls. = 4·9629 bushels. |
| Kon | Corea | $1\frac{1}{3}$ lb av. |
| Korn-tonde | Norway | 138·97 litres. |
| Korn-tonde | Sweden | 3·821 bushels. |
| Korn-top Maal | Norway | 160 litres. |
| Korrel | Netherlands | 1 decigramme. |
| Kotyle (Royal) | Greece | 1 decilitre. |
| Kouza | Cyprus | 9 quarts. |
| Koyan | Straits Setts. | $5333\frac{1}{3}$ lb av. |
| Krina | Bulgaria | 12·8 litres. |
| Kung | China | 78·96 inches (Treaty). |
| Kup | Siam | 10 inches. |
| Kwan or Kuwan | Japan | 8·281 lb = 3·75652 kilogrammes. |
| Kyat | Burma | 100 kyats = 3·652 lb av. |
| Lak't | Bulgaria | 0·650 metre. |
| Last | Netherlands | 30 hectolitres. |
| Leang | China | $583\frac{1}{3}$ grains (silver weight). |
| Lèkha | Bulgaria | 229·83 sq. metres. |
| Li | China | about $\frac{1}{3}$ mile = 360 pu. Varies with length of ch'ih. A small weight 0·583 grain. |
| Liang | China | $1\frac{1}{3}$ oz. 16 liang = 1 chin = $1\frac{1}{3}$ lb av. |
| Libbra | Italy | 0·7477 lb av. |
| Libra | Argentina | 1·0127 lb av. |
| Libra (Castilian) | Spain, Mexico | 1·014 lb. |
| Libra, or Arratel | Portugal | 1·012 lb av. |
| Line or Ligne | Paris | $\frac{1}{12}$ point, or 0·089 inch. |
| Liniia | Russia | 0·1 inch. 1 archine = 280 liniias. |
| Litra (Royal) | Greece | 1 litre = 100 mystra. |
| Litre | Cyprus | $2\frac{1}{4}$ quarts. |
| Litre (metric) | | = 1·7598 pint. |
| Litro | Spain, Italy | 1 litre. |
| Livre (lb) | Russia | 0·90282 lb av. Apoth. livre = 11·5204 oz. troy. |
| | Belgium | Kilogramme. |
| Livre-poids | France | 0·4895 kilogramme. |
| Loth | Germany | New loth = 1 decagramme. Old loth, nearly $\frac{1}{2}$ oz. av. |
| | Switzerland | 15·625 grammes. |
| | Vienna | 270·1 grains. Postal loth, 257·2 grains. |
| Maass | Austria | 1·245 quart. |
| | Switzerland | 2·64 gallons. |
| Maatze | Netherlands | 1 decilitre. |
| Mace | China | $58\frac{1}{3}$ grains. |
| | N. Borneo | $93\frac{1}{3}$ lb av. |
| Mahud | Arabia | 2·04 lb av. |
| Maik | Burmah | 3 maik = cubit = $19\frac{1}{2}$ inches. |
| Marc, or Mark | France | 0·2448 kilogramme (old weight). |
| | Sweden | 0·4645 lb av. |
| | Vienna | 4331·37 grains = 24 karato. |
| Marco | Portugal | = 8 oncas = 229·5 grammes. |
| | Spain | 3550·54 grains. |
| Maund | India | 82·286 lb av., Government. $72\frac{1}{2}$ lb (old bazaar). 74·67 lb av., factory. 28 lb nearly, Bombay. 25 lb nearly, Madras. 37 to 44 lb, Juggerat. Local maunds vary on either side of 80 lb. |
| Megametre (astronomy) | | 1,000,000 metres. |
| Metre (m.) | U. States | 39·37 inches. |
| | Great Britain | 39·370113 inches = 1 m. |
| Metre, cubic | | = 1000 c.d. = 35·315 cubic feet. |
| Metre, square | | = 100 square decimetres = 10·764 square feet. |
| Metro | Spain, Italy | 1 metre. |
| Metz. | Austria | 1·691 bushel. |
| Micron (μ) | | = $\frac{1}{1000}$ millimetre. |
| Miglio | Rome | 0·925 mile. |
| Mijle | Netherlands | 1 kilometre. |
| Mil, or Mill | Turkey | 1000 archins (new mil). |
| | Denmark | 4·680 miles. |
| Mile | France, Germany | Nautical mile = 1852 metres. |
| Mile (postal) | Austria | 4·714 miles. |
| Milha | Portugal | 1·296 mile. |
| Mille | France | 1·949 kilometre. |
| Milligramme | | = $\frac{1}{1000}$ gramme = 0·015 grain. |
| Millilitre. | | = $\frac{1}{1000}$ litre. |
| Millimetre | | = 0·03937 inch = $\frac{1}{1000}$ m. |
| Miscal | Persia | 71 grains. |
| Mkono | East Africa | 45·72 centimetres. |
| Mna | Greece | $1\frac{1}{2}$ kilogramme = 1·172 oka. |
| Momme | Japan | $\frac{1}{1000}$ kwan. |
| Morgen | Denmark, Norway, Prussia | 0·631 acre. |

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|---|---|---|
| Mou | China | Commonly 806·65 sq. yds. Varies locally. Shanghai = 6600 sq. ft. (Municipal Council). By Customs Treaty = 920·417 sq. yds., based on ch'ih of 14·1 inches. |
| Mud | Netherlands | 1 hectolitre. |
| Myriagramme | | = 10 kilogrammes = 22·046 lb av. |
| Ngoma | East Africa | 7½ keilas. |
| Nin | Siam | 1½ inch. |
| Obolos | Greece | 1 decigramme. |
| Ock | Turkey | Legal ock (1881) = 100 drachmas. New batman = 10 ocks, and kantar = 10 batmans ock = 1 kilogramme. |
| Octavillo | Spain | 0·29 litre. |
| Oitavo | Portugal | 1·730 litre. |
| Oke | Bulgaria | 1·28 litre (for liquids). 1·282 kilogramme (old). |
| | Cyprus | 2¾ lb. av. = 400 drams (Cyprus). |
| | Egypt | 2·751 lb av. (Customs). 2·805 lb (Alexandria). |
| | Greece | 2·80 lb = 1·282 kilogramme. 1·33 litre. |
| | Turkey | 1·1518 pint. 2·834 lb av. (old weight). |
| Onça | Portugal | 28·688 grammes. |
| Once | France | 30·59 grammes (old). |
| Oncia | Rome | 436·165 grains. |
| Onze | Netherlands | 1 hectogramme. 10 onzen = pond. |
| Ounce | U. States | Av. ounce = 437·5 grains. |
| Packen | Russia | 1083·382 lb av. |
| Palamé (Royal) | Greece | 1 decimetre. |
| Palm | Holland | 1 decimetre. |
| Palmo | Portugal | 0·22 metre. |
| | Spain | 8·346 inches. |
| Para | N. Borneo | 90 lb av. |
| Parah | Ceylon | 5·59 pints. |
| Parasang. See *Persakh*. | | |
| Parmak. See *Archin*. | | |
| Passeree | Bengal | 5 seers. |
| Pé | Portugal | ⅓ metre (old). |
| Pecheus (Royal) | Greece | 1 metre = 1·543 old pecheuse. |
| Pecul | China | 133⅓ lb av. |
| Perche | France | 22 square pieds de roi. In Quebec 18 French feet. |
| | Canada | |
| Persakh, or Parasang | Persia | Probably 3·88 miles = 6000 guz. |
| Pfund | Germany | = 16 unzen = 32 loth, 1·01 to 1·23 lb av. } old weight. Zoll. pfund (1872) = 500 grammes. |
| | Prussia | Old zoll. lb = 1·1023 lb av. |
| | Switzerland | 500 grammes = 16 unze. Apoth. pf. = 375 grammes. |
| | Vienna | Pfund = 560·06 grammes. Zoll. pfund (1871) = 500 grammes. |
| Pharoagh. See *Archin*. | | |
| Pic | Cyprus | 2 feet. |
| Picul | Japan; Straits Settlements, Hong Kong | 133⅓ lb av. |
| | North Borneo | A measure of 180 lb weight of water. |
| Picki | Greece | 0·648 metre. |
| | China | 25 gallons (dry measure). |
| Pie | Rome | 11·73 inches. |
| Pie de Burgos | Spain | 11·13 inches. |
| Pied | Belgium | 11·81 inches = 10 pounces. |
| | Canada | 12·79 inches. |
| Pied de Roi | Paris | 0·3248 metre. |
| Pike | Turkey | See *Dir'aa*. |
| Pint | U. States | 0·8325 imperial pint. |
| Pinte | France | 0·931 litre. |
| Pipa | Portugal | 534 litres (Oporto). 420 litres (Lisbon). 500 litres (officially). |
| Pipe | Gibraltar | 105 to 126 gallons. |
| Pital. See *Keila*. | | |
| Polde de Marc | France | 0·2448 kilo = 8 onces. |
| Polegada | Portugal | 27·77 millimetres. |
| Pond | Netherlands | 1 kilogramme. Apothecaries pond = 375 grammes. |
| Pot | Denmark | 1·7 pint = 4 paegle. |
| | Switzerland | 2·64 pints or 1·5 litre. |
| | Belgium | 1½ litre (dry). ½ litre (liquid) |
| | Norway | 0·965 litre. |
| Pouce | France | 1·066 inch (old measure). |
| | Russia | 1 inch. |
| Pond, or Pood | Russia | 0·016122 ton = 36 lb. |
| Pound | U. States | Standard troy lb = 5760 grains. Avoir. lb = 7000 grains. |
| | Russia | 0·90282 lb av. (0·4095 kilogramme). |
| | Jersey | 7561 grains = 16 oz. Jersey = 1 livre. |
| Pu | China | 70·5 inches = 5 ch'ih. |
| Puddee | Madras | 2·89 pints. 100 cubic inches = Government puddee. |
| Pulgada | Spain | 0·927 inch. |
| Pund | Denmark | 1·1023 lb av., or 500 grammes. |
| | Norway | 0·4981 kilogramme. |
| | Sweden | = 6560 grains. Varies locally. 5500·5 grains (apoth.). |
| Quart | U. States | See *Bushel*. |
| Quarto | Rome | 2·024 bushels. |
| | Portugal | 3·46 litres. |
| Quintal | Spain | 100 libras (Castilian) = 101·4 lb. |
| | Portugal | 58·752 kilogrammes, or 129½ lb av. |
| | Argentina | 100 libras, or 101·27 lb av. |
| Quintal (metric) | France | = 100 kilogrammes = 1·968 cwt. |
| Quintale | Italy | 1 metric quintal. |
| Ratel | Persia | 1·014 lb av. |
| Rattel, or Rottle | Arabia | 1·02 lb av., nearly (dry measure). 17·219 lb av. weight. |
| Ri | Japan | 2·440 miles (itinerary). 2·118 miles (natural). |
| Rode | Denmark | 3·762 metres. |
| Roede | Netherlands | 1 dekametre. |
| Rotl, or Rottolo | Egypt | 0·9905 lb av. (Customs). 0·9805 lb av. (Govt.). |
| | Cairo | 2·206 lb great rottolo. 0·715 lb less rottolo. |
| | Alexandria | 2·124 lb great rottolo. Rottolo mina = ⅝ oka. |
| Rottol | Turkey | 2·513 pints (old measure). |
| Rubbio | Spain | 1·012 quarter (dry measure). |
| Sagène | Russia | 7 feet. |
| Scheffel | Germany | 50 litres, formerly 14·56 metzen (Prussia). |
| Schepel | Netherlands | 1 decalitre. |
| Schoppen | Germany | ½ litre, formerly 0·11 gallon. |
| | Switzerland | 0·375 litre. |
| Se | Japan | 118·615 square yards (·9918 are). |
| Seer | India | Government seer = 2 2/35 lb av. Bengal, 80 tolas weight of rice (heaped measure), about 60 cubic inches (struck measure). Southern India = weight of 24 current rupees. Madras, 25 lb nearly. Juggerat, weight of 40 local rupees. Bombay, old seer, about 28 lb. |
| | Ceylon | Measure of 1·86 pint. |
| | Persia | 16 miscals, or 1136 grains weight (Sihr). |
| | *Note.*—In India the seer, like the maund, varies considerably; usually 40 seers go to a maund. | |
| Seidel | Austria | 0·6224 pint. |
| Sen | Siam | 44·4 miles, nearly. |
| Ser | India | 1 litre (Indian Law, 1871). |
| Shaku | Japan | 0·30 metre, also 9·18273 square decimetres; also 18·039 cubic centimetres. |
| Sheng | China | 1·813 pint. |
| Shih | China | 160 lb. |
| Shoô | Japan | 1·804 litre. |
| Skaal-pund | Sweden | 435·076 grammes, or 0·959 lb av. |
| | Norway | 0·4981 kilogramme, or officially ½ kilogramme. |
| Skeppe | Denmark | 17·39 litres. |
| Skjeppe | Norway | 17·37 litres. |
| Stab | Germany | 1 metre, or 3·⅛ old fuss, but varied. |
| Stadron (Royal) | Greece | 1 kilometre. |
| Stere (metric) | | 1 cubic metre. |
| Stero | Italy | 1 metric stere. |
| Streepe | Holland | 1 millimetre. |
| Stremma | Greece | 1 metric are. 238·1 square pecheus (Constantinople). |
| Strich | Germany | 1 millimetre. |
| Striche | Switzerland | 3⅓ strich = 1 millimetre. |
| Stunde | Germany | Old itinerary measure, 2·3 to 3·4 miles. |

| | | |
|---|---|---|
| Stunde | Switzerland | 4·8 kilometres. Stunder = 5 stunden, or 24 kilometres. |
| Sultchek | Turkey | Cubic measure (1881) whose sides equal a parmak (decimetre). |
| Sung | Corea | 4 lb av., nearly. |
| Tael | Siam | $936\frac{1}{4}$ grains. |
| | Hong Kong | $1\frac{1}{3}$ oz. av. |
| | China | Silver weight, $1\frac{1}{3}$ oz. av. |
| | Japan | 10 momme. |
| | (No current *coin* of the tael.) | |
| Tabil | Straits Settlements | $1\frac{1}{3}$ oz. av. = 10 chee = 100 hoon. |
| Tam | Hong Kong | $133\frac{1}{3}$ lb av. |
| Tan | China | = 25 gallons. Also $133\frac{1}{3}$ lb weight. |
| Tang | Burma | 2 miles, nearly. |
| Tang-sun | China | About $3\frac{1}{3}$ miles = 10 li. |
| Tank | Bombay | $17\frac{1}{7}$ grains, or 72 tanks = 30 pice. |
| Tcharka | Russia | 0·866 gill = 0·218 pint. |
| Tchetverte | Russia | 5·772 bushels = 8 tchetveriks, or 2·099 hectolitres. |
| Teng | Burma | Burmese measures of capacity depend on the teng or basket. Officially a basket is 2218·2 cubic inches, but the teng varies locally:—<br>Akyab = 23 lb of rice.<br>Bassein = 51 lb of rice.<br>Moulmein = 48 lb of rice.<br>Rangoon = 48 to 50 lb of rice. |
| Thanan | Siam | 1·5 pint. |
| Thangsat | Siam | 4·688 gallons. |
| To | Japan | 18·0391 litres = 3·9703 galls. = 1·98 pecks. |
| Toise | France | 2·1315 yards. |
| Tola | India | 180 grains. Legal weight of rupee. |
| Tomand | Arabia | 187·17 lb av. of rice. |
| Ton | U. States | 2240 lb av., also a net ton of 2000 lb. |
| Tönde | Denmark | 131·392 litres (liquid measure).<br>139·121 litres (dry measure). |
| Tonne, or Millier | France<br>Germany | 1000 kilogrammes. |
| Tonne (metric) | | 1000 kilogrammes = 0·9842 ton. |
| Tonnelada | Portugal | 793·15 kilogrammes. |
| Tonos | Greece | 29·526 cwt. |
| Tou | China | 18 pints approximately. |
| Tovar | Bulgaria | 128·2 kilogrammes. |
| T'sun | China | 1·41 inch (Treaty measure). |
| Tu | China | 100·142 miles = 25 li, based on the ch'ih of 14·1 inches. |
| Vara | Peru | 33 inches. |
| | Spain | 2·782 feet. |
| | Argentina | 2·841 feet. |
| | Portugal | 1·11 metre. |
| Vat | Holland | 1 hectolitre. |
| Vedro | Russia | 2·7056 gallons = 10 schtoffs, or 12·3 litres. |
| | Bulgaria | 12·8 litres. |
| Verchok | Russia | 1·75 inch. |
| Versta, or Verst | Russia | 0·66288 mile. |
| Vierkanteroede | Holland | 1 metric are. |
| Viertel | Denmark | 1·7 gallon. |
| | Switzerland | 15 litres. |
| Viss | Rangoon | $3\frac{21}{40}$ lb av. |
| Wa | Siam | 80 inches. |
| Wigtje | Netherlands | 1 gramme. |
| Wisse | Netherlands | 1 metric stere. |
| Yard | U. States | 36 inches. |
| | Mexico | 838 centimetres. |
| Zak | Netherlands | 1 hectolitre. |
| Zer (Persia). See *Gaz.* | | |
| Zoll | Switzerland | $3\frac{1}{3}$ zoll = 1 decimetre. Old zoll nearly one inch. (See also *Pfund.*) |
| Zolotnik | Russia | 65·8306 grains, or 96 doli. |

(H. J. C.)

**WEIGHT-THROWING**, the athletic sport of hurling heavy weights either for distance or height. Lifting and throwing weights of different kinds have always been popular in Great Britain, especially Scotland and Ireland, and on the continent of Europe, particularly in Germany, Switzerland and Austria-Hungary. No form of throwing weights is included in the British athletic championship programme, although "putting the shot" (*q.v.*) and "hammer-throwing" (*q.v.*) are recognized championship events. In America throwing the 56-lb weight for distance belongs to the championship programme. It was once a common event in Great Britain at all important athletic meetings, the ordinary slightly conical half-hundredweight being used and thrown by the ring attached to the top; the ring, however, was awkward to grip, and a triangular handle was afterwards substituted. In America the 56-lb weight is a ball of iron or lead with a triangular or pear-shaped handle. The weight used to be thrown standing, but since 1888 it has been thrown from a 7-ft. circle with a raised edge, like that used for the hammer and shot in America.

In throwing the athlete stands slightly stooping, with his feet about 18 in. apart and grasping the handle with both hands opposite his thighs. The weight is swung round and back past the right leg as far as possible, then up, over and round the head, as in the hammer-throw. One complete swing round the head is usually enough, as too much momentum is apt to throw the athlete off his balance. The weight is then swung round together with the whole body as rapidly as possible, as in hammer-throwing. The athlete works himself to the front of the circle just before the moment of delivery and begins the final heave with his back towards the direction in which he wishes to throw the weight. This heave is accomplished by completing the final spin of the body, giving the legs, back and arms a vigorous upward movement at the same time, and following the weight through with the uplifted arms as it leaves the hands, but taking care not to overstep the circle. With one hand a smoother swing can be made but much less power applied. In throwing for height the athlete stands beside the high-jump uprights and casts the weight over the cross-piece, making the swing and spin in a more vertical direction with a heave upward at the moment of delivery. Throwing for height and with one hand were formerly events in the American championship programme, but have been discontinued. The record for throwing the 56-lb weight for height is 15 ft. 6½ in., made by the American-Irishman J. S. Mitchell. The record for distance, 38 ft. 8 in., was made in 1907 by the American-Irishman John Flanagan. In throwing weights large and heavy men have an advantage over small, brute strength being the chief requisite, while a heavy body makes a better fulcrum while revolving than a light one.

**WEI-HAI-WEI**, a British naval and coaling station, on the N.E. coast of the Shan-tung peninsula, China, about 40 m. E. of the treaty port of Chi-fu and 115 m. from Port Arthur. It was formerly a Chinese naval station strongly fortified, but was captured by the Japanese in February 1895, and occupied by their troops until May 1898, pending the payment of the indemnity. Port Arthur having in the spring of that year been acquired by the Russian government under a lease from China, a similar lease was granted of Wei-hai-wei to the British government, and on the withdrawal of the Japanese troops the British fleet took possession, the flag being hoisted on the 24th of May 1898. No period was fixed for the termination of the lease, but it was stipulated that it should continue so long as Russia continued to hold Port Arthur. The lease of Port Arthur having been ceded to Japan in September 1905, the British lease of Wei-hai-wei was made to run for as long as Japan held Port Arthur.

The harbour is formed by an island named Liu-kung-tao running east and west across the mouth of a small bay, leaving an entrance at each end. Towards the mainland the water shoals, and the best anchorage is under the lee of the island. The native city is walled, and has a population of about 2000. The chief port is named Port Edward; it has good anchorage with a depth of 45 ft. of water. The leased area comprises, besides the harbour and island, a belt of the mainland, 10 English miles wide, skirting the whole length of the bay. The coast line of the bay is some 10 m., and the area thus leased extends to 285 sq. m. Within this area Great Britain has exclusive jurisdiction, and is represented by a commissioner under the colonial office; and has, besides, the right to erect fortifications, station troops and take any other measures necessary for defensive purposes at any points on or near the coast in that part of the peninsula east of 121° 40′ E. Within that zone, which covers 1505 sq. m., Chinese administration is not interfered with, but no troops other than Chinese and British are allowed there. The territory consists of rugged hills rising to 1600 ft. and well-cultivated valleys. The hills also, as far as possible,