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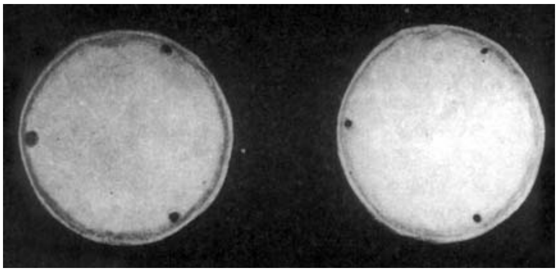
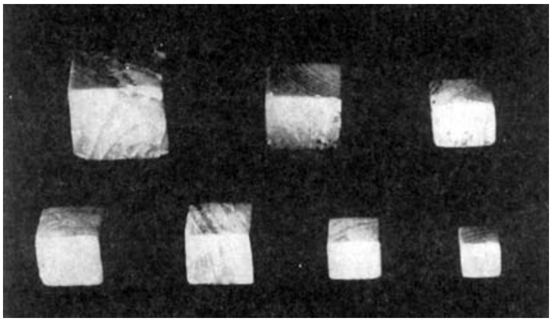


Weights and Measures in the Indus Valley. Fig. 1 Balance pans (photograph by the Maninichi Newspapers, 1961; used with permission).



Weights and Measures in the Indus Valley. Fig. 2 Weights (photograph by the Mainichi Newspapers, 1961; used with permission).

The measuring system used in the Indus valley was different from the Mesopotamian and Egyptian measuring systems, but the sensitivity of precision balances used in these regions is assumed to have been comparable. The weights excavated from Taxila (sixth century BCE to seventh century AD) descend from the system of weights used in the Indus civilization (Fig. 2).

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Weights and Measures in Islam

Ulrich Rebstock

In the sphere of Islamic influence the Quranic injunction "to give full measure and to weigh with the right scales" (*Qur'ān* 17:35), led - in the long run - to systems of measuring that were subjected to the authority and control of politics and law. But only a few measuring standards were substituted by new Islamic prescriptions. The most lasting novelty set off through the Quranic revelation affected the measure of time. It assumed a dual character. The natural solar year gave way to the ritual lunar year (29–30 days of the month), except in some fields of public administration and astronomical science. Within the sphere of the metrological systems of measures and weights, however, the *Qur'ān* remains vague. Among the terms most often mentioned, *kayl* or *mikyāl* (Sura 12:12 and *passim*, 'measure of capacity'), *mīzān* and *mithqāl* (Sura 6:152, 21:47 and *passim*, 'weight'), range first. Others, like *qinṭār* (3:75, 'hundredweight'), *darāhim* (3:75, pl. of *dirham*), *dīnār* (3:75) and *ḥabba min ḥardal* (21:47, 'grain of mustard'), are used in a metaphorical sense. A more systematic elaboration of metrical definitions and ratios, mainly for juridical purposes, was effectuated in the 'traditions of the Prophet' (*ḥadīth*, pl. *aḥādīth*). The characteristic aspects of the genesis of Islamic law – a cumulative development until the fourth and tenth century, geographically restricted proliferation of the various law schools (*madhāhib*), lack of normative authority – did, however, not allow for the introduction of uniform and ubiquitously accepted Islamic metric systems. Thus, the weights and measures which were used in Arabia and outside it, in the lands conquered by the Muslims, co-existed side by side, replaced each other, sometimes only by function, or by name, or intermingled. The striking feature of the metric systems that were in use in the early, medieval and pre-modern Islamic countries was their diversity. Neither in time, nor in space, could standard values develop that were accepted beyond their regional borders and their rulers' period. Although some names of units of measure, e.g. *dhirā'*, *dirham* or *raṭl*, were widely diffused throughout the Islamic world, their absolute values and use in practice differed considerably. Notwithstanding this bewildering array of measures, a few basic terms that have survived until modern times stand for the cultural continuity between the Ancient Orient and the Islamic world: *raṭl* (Greek litron, 'litre'), *irdabb* (Greek artabe, Persian 'measure of capacity'), *maṭar* (Greek metretes, 'measure of 40 L'), *ḳisṭ* (Greek xestes, Latin sextarius, 'jug'), *ḳinṭār* (Latin centenarius, 'hundredweight'), *ḳafīz* (Persian 'measuring cup'), *ḳīrāṭ* (Greek

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keratios, 'carat'), *istār* (Greek stater, 'weight of gold coin'), *dirham* (Greek drachme), *dīnār* (Latin denarius), *kayl* (Aramaic measure of capacity), *mann/mannā* (Babylonian unit of weight), *kurr* (Babylonian measure of capacity).

The development of systems of measure was influenced by the interplay between cultural tradition and the order of authorities. Until the tenth century, the spread of Islam brought about an intercontinental economic and cultural sphere which amalgamated measuring standards of Egyptian, Arabic, Greek, Roman-Byzantine, Mesopotamian and Persian origin. This resulted in a multiplicity of regional and functional systems of measurement, which were constantly modified by power politics, institutional reforms or, simply, by the rulers' autocratic order. Quite often, the advent of new dynasties brought about the introduction of new metrological standards, mainly in the field of the basic weight units of currency of gold (*mithqāl*) and silver (*dirham*), and the exchange rate of gold *dīnār* and silver *dirham,* which were fixed at a very early state by the canonical texts of the *Qur'ān* and the prophetic tradition (*ḥadīth*). Contrary to the more or less stable weight rate (10 weight *dirham*s equal 7 weight *mithqāl*), which everyday use polished into the handier ratio of 3:2, the prescribed rate of value (10 silver *dirham*s equal 1 gold *dīnār*) incessantly deteriorated over the course of time. Ratios of 12:1, 16 4/5:1, 20:1,

Alphabetic list of abbreviations used

ar	*aruzza,* pl. *aruzzāt*	grain of rice
ash	*ashl,* pl. *ashwāl, ushūl*	part of a 'rope'
az	*azla/azāla,* pl. *azāla, azālāt*	unit of capacity measure
ʿas	*ʿashīr,* pl. *ʿashīrāt, ʿushrān, aʿshur*	tenth
ba	*baṭṭa*	leather bottle
bā	*bāb,* pl. *abwāb*	portion
bāʿ	*bāʿ,* pl. *abwāʿ*	arms' span
da	*dāniḳ,* pl. *dawāniḳ, dawānīḳ*	1/6 of a dirham/dīnār
dh	*dhirāʿ,* pl. *dhirāʿāt, adhruʿ*	ell
dī	*dīnār,* pl. *danānīr*	Gold dīnār
dir	*dirham,* pl. *darāhim*	silver-dirham
dj	*djarīb,* pl. *djirbān, adjriba*	unit of square measure
djo	*djou*	barleycorn (Persian)
fa	*fals,* pl. *fulūs, aflus*	small coin
fad	*faddān,* pl. *fadādīn*	yoke of oxen
far	*farq*	unit of capacity measure
fā	*fātil*	small unit of weight
ghi	*ghirāra,* pl. *gharā'ir*	sack
ḥa	*ḥabba,* pl. *ḥubūb, ḥabbāt*	seed
ḥab	*ḥabl,* pl. *ḥibāl, ḥubūl*	rope, thread
ḥi	*ḥiml,* pl. *aḥmāl*	camel-load
ir	*irdabb,* pl. *arādibb*	unit of capacity measure
is	*istār,* pl. *asātir*	unit of weight measure (Greek)
iṣ	*iṣbaʿ,* pl. *aṣābiʿ*	width of middle finger
ka	*kaff,* pl. *kaffāt*	hand
kā	*kāra*	load carried on the back
kay	*kayl/kayla,* pl. *akyāl, akāyil*	unit of weight measure
kayl	*kayladja,* pl. *kayladjāt, kayālidj*	unit of capacity measure
ku	*kurr,* pl. *akrār*	unit of capacity measure
ḳa	*ḳafīz,* pl. *aḳfiza, ḳifzān*	unit of capacity weight
ḳab	*ḳab(a)ḍa,* pl. *ḳabaḍāt*	width of fist
ḳad	*ḳadaḥ,* pl. *aḳdāḥ*	unit of capacity measure
ḳal	*ḳalam,* pl. *aḳlām*	'strip'
ḳām	*ḳāma*	build, fathom
ḳaṣ	*ḳaṣaba,* pl. *ḳaṣabāt*	pole, rod
ḳin	*ḳinṭār,* pl. *ḳanāṭīr*	'hundredweight'
ḳis	*ḳisṭ,* pl. *aḳsāṭ*	'portion'
ḳī	*ḳīrāṭ,* pl. *ḳarārīṭ*	carat
ḳu	*ḳulla,* pl. *ḳulal, ḳilāl*	jug
ma	*mann/mannā,* pl. *amnān, amunnā'*	unit of weight measure
mak	*makkūk,* pl. *makākīk*	unit of capacity measure
mar	*marzbān*	unit of capacity measure (Persian)

Alphabetic list of abbreviations used (Continued)

maṭ	*maṭar,* pl. *amṭār*	unit of liquid
mi	*mithḳāl,* pl. *mathāḳīl*	unit of weight measure
mish	*mishḳā‘*	drinking-vessel
mu	*mudd,* pl. *amdād*	unit of capacity measure
mud	*mudy,* pl. *amdā’*	unit of capacity measure
na	*naḳīr*	‘small spot’ (Arabic)
nu	*nügi,* pl. *nügiler*	unit of weight measure (Turkish)
oḳ	*oḳḳa,* pl. *oḳḳalar*	unit of weight measure (Turkish)
pe	*peymāne*	bowl
r	*raṭl,* pl. *arṭāl*	‘litre’
ru	*rub‘,* pl. *arbā‘*	fourth
sha	*sha‘īr,* pl. *sha‘īrāt*	grain of barley
shi	*shibr,* pl. *ashbār*	span of hand
si	*silsila,* pl. *salāsil*	chain
su	*sunbul,* pl. *sanābil*	ear of grain
ṣa	*ṣā‘,* pl. *aṣwu‘, aṣwā‘*	unit of capacity of weight
th	*thumn,* pl. *athmān*	eighth
ti	*tillīs*	unit of capacity measure
ṭa	*ṭassūdj,* pl. *ṭasāsīdj*	unit of weight measure
‘ush	*‘ushr,* pl. *a‘shār*	tenth
ūḳ	*ūḳīya,* pl. *awḳiyā, ūḳīyāt*	unit of weight measure
wa	*waiba*	unit of (dry) capacity measure
was	*wasḳ,* pl. *awsāḳ*	(camel’s) load
za	*zabīl*	basket made of palm-leaves

30:1 and even 50:1 are recorded. Nevertheless, modern Islamic jurists insist on referring to the canonical rates (10:7; 10:1) when, for example, fixing the minimum income (*niṣāb*) for the obligatory alms payment (*zakāt*) by Muslims of a determinate portion of their lawful property. The canonical ratio of the value of gold and silver (10:1) reflected the historical situation in the Mediterranean region and the Middle East after the Roman period (12:1). During the Il-Khānid period (thirteenth to fourteenth century), silver from Central Asia was massively imported to the West, the price of silver sank again, for a short period, to the Roman value. Gold, in contrast, remained remarkably stable over the millennium. Under the Persian king Darius the Great (522–486), mutton cost the same as in Anatolia in 1340: the equivalent of 1.9355 g pure gold.

The overall cultural diversity of the Islamic world corresponds to the diversity of the metric systems, which came into use between the Atlantic and the Indian sub-continent. Three geographical units can be differentiated: The Islamic Arab West, from Andalusia to Iraq, Persia and the adjacent areas under Persian influence, and India. The following comments omit the metric systems of India (see *EI* [2] VI, pp. 121a–122a, s.v. *makāyīl*, and VII, pp. 138a–140b, s.v. *misāḥa*) and concentrate on the development in the Arab West, in consideration of the situation in Persia. Emphasis is laid on the early Islamic and medieval period. The absolute equivalents in modern metric values stem back to archaeological evidence or observations of European travellers.

Measures of Length

Along with the basic unit of length, the *dhirā*ᶜ, several other units were used, some of them only for particular purposes (construction, geometry, etc.). In theory, i.e. without considering their actual common occurrence or precise values, these units could be arranged to the following equation:

1 *ash* = 1 *si* = 10 *bā* = 10 *ḳaṣ* = 15 *bā‘* (or *ḳām*) = 60 *dh* (= Persian *gaz*) = 360 *ḳab* = 1,440 *iṣ* = 3,600 *fa* = 8,640 *sha*.

The ‘black ell’ (*al-dhirā‘ al-sawdā’*), being ca. 54.04 cm, is said to refer to the length of the ell (from the elbow to the tip of the middle finger) of a slave of the Caliph al-Manṣūr (r. 754–775) or the Caliph al-Ma’mūn (r. 813–833). Another etymology links the measure to the unit by which the ‘Nilometer’ of the island of al-Rawḍa was operated. There are almost thirty variants of the ell, some varying 30-fold from the original. By the eleventh century, at least 11 different types of *dhirā’* can be differentiated:

- 1 *dhirā‘ sawdā’* = 1 + 1/7 + 2/3 ·1/7 *dh al-yad* (of the hand)
  = 1 + 1/8 +1/9 *dh al-ḥadīd* (iron ell)
- 1 *dh fiḍḍīya* (silver) = 1 – 1/7 *dh al-sawdā’*
- 1 *dh yūsufīya* (of Abū Yūsuf, d. 798) = 1− 2/3 ·1/7 *dh al-sawdā’*
- 1 *dh hāshimīya* (of the Banū Hāshim) = 1 + 1/8 + 1/10 *dh al-sawdā’*

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- 1 *dh bilālīya* (of Bilāl b. Abī Burda, d. 739) = 1 *dh al-sawdā'* + 2 + 2/3·1/7 *iṣ*
- 1 *dh fiḍḍīya* (al-misāḥa) = 7 or 8 *dh al-yad*
- 1 *dh ‹umarīya* (of ‹Umar b. ‹Abdal‹azīz, d. 720) = 1 + 1/2 *dh al-yad*
- 1 *dh mīzānīya* (surveyor's ell) = 3 *dh al-yad*
- 1 dh *mābahrāmī* = 1 + 1/2 *dh al-ḥadīd*

In addition to these different norms of the *dhirā*ʿ, a multitude of ells was used depending on the profession involved: carpenters, cloth-makers, constructors etc. Moreover, the ells used in different cities under the same name differed: the medieval cloth-ell of Damascus (ca. 63.035 cm), for example, was 1/12 longer than the cloth-ell of Cairo (58.187 cm).

Measures of Area

The calculation of the surface of (straight) areas operated with the conventional measures of length. The basic units, however, were the *ḳafīz* and the *djarīb*, two specific measures of surface area. Originally and throughout the Islamic period, both units also served as measures of capacity. One *djarīb* was conceived of as representing the surface area of agricultural land which could be sown with the amount of seed one *djarīb* contained.

Based on the ratio of the length units (1 *ash* = 10 *bā* = 60 *dh* = 360 *ḳab* = 1440 *iṣ*), the following ratio of units of surface area measurement can be generated:

$$1\ ash = 60\ dh \cdot 60\ dh = 3{,}600\ dh^{2} = 1\ dj$$

and:

$$1\ dj = 10\ ḳa = 10 \cdot 360\ dh^{2}$$
$$= \text{[in Persia] } 60\ ka = 600\ ‹as = 600 \cdot 6\ dh^{2}$$
$$= 100\ ‹as = 100 \cdot 36\ dh^{2}$$

This *djarīb* was called the 'small' *djarīb*, being 100 square *ḳabaḍa* (or *ḳaṣaba*; the units being often exchangeable) which renders: 100 · (399 cm · 399 cm)^2 = 1,592 m^2. The 'big' *djarīb* had 5,837 1/3 m^2, i.e. 3 2/3 'small' *djarīb*, and corresponded roughly to the predominantly Egyptian *faddān* which was calculated as 400 square *ḳaṣaba*, i.e. 6,368 m^2. During the nineteenth century, the *faddān* was reduced to 4,200.833 m^2.

If multiplied with one another these units render the matrix (see above).

There is substantial evidence that the professional surveyors during the Abbasid period used a specific system of calculation. They divided the biggest unit, the *azla*, into 100 *dh mīzānīya* which corresponded to 48 *iṣ ‹umarīya* (see above), hence:

$$1\ az = 100\ dh^2 = 100 \cdot 12^2\ ḳab^2 = 100 \cdot 12^2 \cdot 4^2\ iṣ^2$$

In the Turkish lands of the Ottoman Empire (Minor Asia, Iraq, Syria and Palestine) the *dönüm* (turn), Arabic *dūnam,* was – until recent times – the standard measure of area. Originally measuring 939 m^2, it has been adjusted in colonial times to 1,000 m^2 (in Iraq to 2,500 m^2).

Measures of Capacity

Most of the confusion about the system of the Islamic measures of capacity, both in primary medieval and in modern secondary texts, dates back to the Oriental practice to measure grain, pulse, and some liquids in capacity, but not in weight. The Arabic term *mīzān* does not clearly differentiate between the two. The transition from volume to weight needs the related quantity of the litre of water: the volume of approx. 75–77 kg of wheat and 60–72 kg of barley correspond to the volume of 100 kg/L of water.

From this economic and agricultural use of measures of capacity the proper mathematical and technical calculation of volumes must be set apart. This calculation is built on the calculation of the surface area multiplied by the third dimension. The names used for the cubic units of measure do not change. Related to the *dhirā‹ mīzānīya* and based on the ratio 1 *az* = 100 *dh* ^{3} = 100 *ku*, the following values are produced: (see matrix below)

Most of the units of measures of capacity are regarded as units of weights too. It is therefore impossible to separate the two systems properly. Depending on

	ashl	**bāb**	**dhirā‹**	**ḳabaḍa**	**iṣba‹**
ashl	1 *dj*	1 *ḳab*	5/3 *ash*	1/6 + 1/9 *ash*	1/24 + 1/36 *ash* = 2 1/2 *dh* ^{2}
bāb		1 *ash*	1 *ash* = 6 *dh* ^{2}	1/36 *ash* = 1 *dh* ^{2}	1/144 *iṣ* = ¼ *dh* ^{2}
dhirā‹			1/36 *ash* = 1 *dh* ^{2}	1/216 *ash* = 1/6 *dh* ^{2}	1/864 *ash* = 1/24 *dh* ^{2}
ḳabaḍa				1/1,296 *ash* = 1/144 *dh* ^{2}	1/5,841 *ash* = 1/576 *dh* ^{2}

	azla^3	**dhirā‹**^{3}	**ḳafīz**^{3}	**ḳabaḍa**^{3}	**iṣba‹**^{3}
azla^3	1	100	6,000	172,800 = 10^2 · (12 *ḳab*)^3	11,059,200 = 10^2 · (48 *iṣ*)^3
dhirā‹^{3}				1,728	110,592

the material measured, additionally different types of the same unit, e.g., a 'honey-*farḳ*' or a 'barley-*irdabb*', were used. The absolute values of these types differed considerably in different regions and periods. In order to allow a comparative overview, units that are related to each other by practical use are grouped together. Minor local variations and temporal changes are ignored.

Few of these units have a canonical background: 1 *was* = 60 *ṣāʿ* = 240 *mu* = ca. 252 L. Far bigger than this *mudd* (ca. 1.05 L) of Medina were the *mudd* of Egypt and Iraq (2.5 L), of Syria (3.67 L), of the Maghreb (4.32 L), and that of Jerusalem (100 L). The prophetic *ṣāʿ* was exactly 4.2125 L. Being the quantitative lower limit (*niṣāb*) for the liability for the *zakāt* (alms) taxes, the measure of 5 *wasḳ* of dates, for example, was equated in value with 5 *ūḳīya* (= 200 *dir* = 529.9 g), 20 *dī* (or *mithḳāl,* = 84.7 g, see later), 5 *dhawd* (camels), the *niṣāb* of cotton (5 *was* = 1,600 *dir ʿirāḳī* à 130 g), or 50 *kay.* Therefore, the values given for one *wasḳ* greatly differ. In the time of Hārūn al-Rashīd (around 800), a short-lived *wasḳ* (1 *was* = 2 1/2 prophetic *was*) was introduced.

Towards the end of the seventh century, the *ḳafīz* (usually corresponding to 1/10 *dj* = 1/60 *kurr*) was used instead of this prophetic *ṣāʿ* in Iraq. Another specific *ḳafīz* of capacity is recorded from Iraq around 990: 1 *ḳa* = 1 *ḳaffa* (basket) = 1/2 *zabīl* (basket made of palm leaves).

In Egypt grain, but in particular wheat, was measured by *irdabb*: 1 *ir* = 6 *wa* = 24 *ru* = 48 *ḳad* = 90 *ma* = 96 *ḳad* (small) = ca. 90 L. Different values extant for the *irdabb* (between 72.3 kg, modern 182 L) may be explained also by the difference of volume between, for example, wheat, barley and lentils (100:80:104).

Egyptian flour was measured in *tillīs*: 1 *ti* = 3/2 *wa* = 3 *ba* = 15 *ma* = 24 *ḳad* = 22.5 L. There, the *waiba* of rice (1 *wa* = 8 *ḳad* = 24 *r kabīr*), as observed around 1665, contained only 12.5 l. Three centuries before in Tunis, it was equal to 12 prophetic *mudd* (ca. 12.6 l).

In Medina and Iraq, honey but also wheat was measured in *farḳ* : 1 *fa* = 3 *ṣa* = 36 *r bagdādī* = 19 L. In Egypt and Syria, the *mudy* – not to be confused with the *mudd* - replaced the *ḳisṭ* when not oil but food was measured. It is sometimes called 'the Syrian *djarīb*', sometimes equated with the *ḳafīz*. The practice in Syria, however: 1 *ḳa* = 8 *mak* = 12 *ṣa*, the indication: 1 *mud* = 15 *mak* = 22 1/2 *ṣa* does not confirm this. In Palestine, a square *mudy* was known (1 mud^2 = 1 *ḥab* · 1 *ḥab*).

Olive oil was merchandised in *maṭar* (1 *maṭ* = 2 *ḳu* = ca. 17 kg) in the Maghreb, in *ḳulla* (1 *ḳu* = 12 *th* = 27 *r* = 13.6 kg) in Andalusia. In Egypt, the *thumn* corresponded to 1/8 *ḳad* (today 0.29 L), in Qayrawān to 6 prophetic *mu* = 6.32 L. Oil and other liquids were also measured in *ḳisṭ*: In Iraq, the 'small' *ḳisṭ* (1 *ḳi* = 3 *r* = 1.22 L) was half of the 'great' *ḳisṭ,* in Egypt it was half of a *ṣāʿ*: 211 L; elsewhere the *ḳisṭ* is given as: 1 *maṭ* = 4 *ḳi* = 21 1/3 *r djarwī* (see below) = 192 *ūḳ* (capacity) = 256 *ūḳ* (weight). In Andalusia, wine and vinegar were sold in *rubʿ* (1 *ru* = 1/4 *ḳad* = 18 *r* = 216 *ūḳ* = 1,728 *mi* = 8.16 L, in Persia the *peymāne* (bowl, 8.3 L) was in use for this purpose. In Iraq, wine, but also oil and honey, were measured by *makkūk* or *mishḳāʿ* (drinking-vessel): 1 *mak* = 48 *th* à 50 *dir* = 64 *mish* à 37 1/2 *dir* = 7.5 L.

Another widespread unit of capacity was the *ghirāra*, mainly used for grain: 1 *ghi* = 3 *ir miṣrī* = 12 *kay* = 14 *mak* = 72 *mu dimashḳī* = 73 1/2 *mu miṣrī* = 265 L. In Egypt, the *kayla* = 8 *ḳad* was 7.5 L (modern 16.5 L).

This *kayla* is not identical with the *kayladja*, presumably an originally Persian unit of capacity measure: 1 *kayl* = ½ *ṣa* = 1/3 *mak* = 3/14 *ghi* = 1/6 *ḳa* wheat = 1/5 *ḳa* barley = ca. 1 7/8 *ma* = 2.5 L (or 2 L in East Iran).

The most basic of all grain measures, especially in the Islamic East, was the old Babylonian *kurr.*

> 1 *ku* = 30 *kā* = 60 *ḳa* = 480 *mak* = 600 '*ush*/'*as* = 1,440 *kayl* = 5,769 *ru* = 7,200 *r* = 11,520 *th* = 2,925 kg (wheat).

Smaller than this 'big' *kurr* of Baghdad was the *kurr* of Wāsiṭ and Baṣra (1 *ku* = 60 *ḳa* = 480 *mak* = 1,440 *kayl* à 600 *dir* of wheat = 2,700 kg); a 'reformed' *kurr* even amounted only to: 1 *ku* = 60 *ḳa* à 25 *r baghdādī* = 609.375 kg (wheat). Moreover, depending on the kind of grain measured, different *akrār* were used: In fourteenth century Baghdad, the *kurr* of wheat weighed 2,925 kg, that of barley 2,437.5 kg, and that of rice 3.656,25 kg. The common sub-units of the *kurr*, the *ḳafīz*, *makkūk*, *kayladja,* and *thumn* differed respectively, sometimes not only proportionally. Thus, in twelfth century Aleppo, a quite different *makkūk* existed: 1 *mak* = 19 *sun* = 28.5 *r* à 684 *dir* à 3.125 g = 60.92 kg. About the same time, the *ḳafīz* of Ḥamāh was 7/8 *ḳa* of that of Shayzar. In Aleppo, 4 *mak* made one *marzbān* (1 *mar* = 1/4 *mak* = 19/4 *sun* = 57/8 *r* = 4,873 1/2 *dir* = 15.23 kg).

Towards the end of the tenth century, the mathematician al-Būzdjānī compared the new 'reformed' (Arabic *muʿaddal*) *djarīb* - this *djarīb* was not measured with 10 but with 2 1/2 *ḳa* only – which was introduced after 978 by his Lord, the Būyid ʿAḍud al-Dawla, with four different common types of the *kurr.* His systematic treatment of the issue will throw some light on the complex variety of the units used and their specific relation when being transformed from one into another (see matrix below).

Besides *simsim* (sesame), *ḥinṭa* (wheat), *djahkandam* (mixture of 1/2 *ḥinṭa* + 1/2 *shaʿīr*), and *shaʿīr* (barley), a fifth category is formed to include all kinds of grain and dry goods that do not belong to one of the aforementioned categories: nuts, like almonds, pistachios and hazelnuts, dried pears, plums etc. From the

1. Ratio of *kurr*-Variants

Types of *kurr*	***mu‘addal***	***kāmil***	***fālidj***	***hāshimī***	***sulaymānī***
mu‘addal	1	2	2 1/2	3	3 1/2 + 1/4
kāmil	1/4	1	1 1/4	1 1/2	1 1/2 + 1/4 +1 1/8
fālidj	2/5	4/5	1	1 1/5	1 1/2
hāshimī	1/3	2/3	5/6	1	1 1/4
sulaymānī	1/6 + 1/10	1/3 + 1/5	2/3	4/5	1
[ratio]	60	30	24	20	16

2. Djarīb per *kurr*

Types of *kurr*	***mu‘addal***	***kāmil***	***fālidj***	***hāshimī***	***sulaymānī***
djarīb/kurr	24	12	9 3/5	8	6 2/5
fraction	1/3 · 1/8	1/2 · 1/6	1/2 · 1/6 + 1/6 · 1/8	1/8	1/8 + 1/4 · 1/8

3. Ratios Between sub-units (as indicated by Al-Būzdjānī)

	makkūk	***‘ushr***	***kayladja***	***rub‘***	***raṭl***	***thumn***
kurr	480	600	1,440	5,760	7,200	11,520
makkūk		1 1/4		12	15	24
‘ushr			1/4 + 1/6			
kayladja					5	8
ḥubūb	4	5			60	
rub‘		1/12 + 1/48			1 1/4	
thumn		1/20 + 1/60			1/2 + 1/8	

4. Ratio of Capacity Between Different Kinds of Grain

	simsim	***ḥinṭa***	***djahkandam***	***sha‘īr***
simsim	1	2	2 2/3	4
ḥinṭa	1/2	1	1 1/3	2
djahkandam	1/4 + 1/8	1/2 + 1/4	1	1 1/2
sha*‘īr*	1/4	1/2	2/3	1
[ratio]	8	4	3	2

matrixes 1–4, exactly 280 possible combinations result by which the transfer of one given quantity (and value) of one commodity into another can be calculated.

Example: If 24 *ku* of oats (*ḥurṭumān* = category of *sha‘īr*) should be transferred into *kurr sulaymānī* of pepper grass (*ḥabb al-rishād* = category of *ḥinṭa*), then the rule of seven is required, in short:

24 ku kāmil sha‘īr – 1/6 · 24 = 22
ku sulaymānī ḥinṭa + 30 *ḳa*.

Measures of Weight

The entire Islamic system of weights is based on the *dirham* and the *raṭl*. The *raṭl* is the most common smallest unit, or reference, of weight. The weight of the *dirham* is used for two different purposes. The two values differ correspondingly:

a) *dirham al-fiḍḍa* (silver *dirham*)

Calibration of the silver (*dirham*) and gold (*dīnār*) coins was done with the help of glass weights. The earliest preserved exemplars date back to the second half of the eighth century. The *dirham* weight defined the weight of the *dirham* coin, the *mithḳāl* weight the weight of the *dīnār*. The most precise glass weights of the *mithḳāl* have an average weight of 4.233 g (max. tolerance 1/3 mg). Archaeological finds affirm both the weight of the *dirham* in accordance to the canonical ratio of *dirham: mithḳāl* (= 10:7): 2.97 g, as to the ‘rounded’ ratio (= 3:2): 2.82 g. An exceptional *mithḳāl* weight was in use in Egypt under the Ayyubid dynasty and in the Maghreb under the Almohad dynasty (4.722 g).

The *mithḳāl* gold and the *dirham* silver were divided into *ḳīrāṭ* and *ḥabba*.

1 *mi* gold = 20 *ḳī* = 60 *ḥa*;
1 *dir silver* = 12 *ḳī* = 48 *ḥa* (Iraq)
1 *mi* gold = 24 *ḳī* = 60 *ḥa*;
1 *dir silver* = 16 *ḳī* = 60 *ḥ* (Arabia, Egypt, Syria)

Hence, the values (see matrix below).

In addition to these general systematic differences a variety of deviating systems from different regions, authors and periods are recorded (tenth to thirteenth century; indicated as I–V), that integrate sub-units like the *dāniḳ, ṭassūdj, ‘ashīr, fals, and aruzza* (which

	gold ḳīrāṭ	*gold ḥabba*	*silver ḳīrāṭ*	*silver ḥabba*
Iraq	0.212 g	0.0706 g	0.247 g	0.062 g
Egypt etc.	0.176 g	0.0706 g	0.186 g	0.0495 g

	dāniḳ	*ḳīrāṭ*	*ṭassūdj*	*ḥabba*	*ʿashīr*	*fals*	*aruzza*
I. Dīnār	12 1/2	20	24	60			
Dirham		12	24	48	60		
II. Dīnār	6	20 *baghdādī*		60 *baghdādī*	60		
		24 *baṣrī*		72 *ḫurās./shāmī*			
Dirham	6			48 *baghdādī/baṣrī*	60	96	
				36 *ḫurās./shāmī*			
III. Dīnār	[12]	[20]	24	60			240
IV. Dīnār		24/20	576	[72] 600/7		600	

elsewhere corresponds to 25 *ḥa ḫardal*, grains of mustard, i.e. ca. 0.0186 g); one author defines the ḥa *ḫardal* as 1/70 of a *ḥabba* (which is sometimes replaced by *'ḳamḥa'*, grain of wheat), 60 of which make one silver *dirham*, i.e. 1 *ḥa ḫardal* = 0.0007 g. From the vague comments of sources, it must be assumed that most of these different systems were in use as weight measures too (see matrix below).

According to the actual ratio of value between gold and silver currency, the moneychangers had to take several factors into consideration when transferring amounts of money from one currency into the other. This could result in thirteenth century Egypt, for example, when 16 4/5 *dir* were equivalent to 1 *dī*, in the following calculations:

1 *dī* = 1,440 *ḥa fiḍḍa* [10 · 60/7· 16 4/5 = 1,440]; and
1 *ḥa* gold = 1/5 + 2/25 ḳī = 16 4/5 *ḥa silver*; or
1 *fa* = 2 2/5 *ḥa silver* = 1/7 *ḥa gold* [2 2/5: 1/7 = 16 4/5].

b) *dirham al-kayl* (weight *dirham*)

In contrast to the homogeneous evidence of the weight of the 'silver *dirham*' the extant values of the weight of the 'weight *dirham*' deviate considerably from one another. They range from 3.086 g to 3.148 g. When not indicated otherwise, the following comments will be based on the established average standard value of 1 *dir* = 3,125 g with which the 'canonical' (ratio 10: 7) *mithḳāl* of 4.464 g is corresponding. From textual evidence some of which are included in the matrix above, different regional values of the *dirham/mithḳāl* weight can be deduced:

Egypt 3.125/4.68 g; Syria (Aleppo twelfth century) 3.14/4.427 g, (Aleppo nineteenth century) 1 *dir* = 3.167 g, Damascus 3.086/4.62 g; Anatolia (Ottoman period) 3.086/4.81 g; Iraq 3.125/4.46 g; Iran (fourteenth century) 1 *mī* = 4.3 g, (sixteenth century) [3.26]/4.639 g; Maghreb 3.3/4.722 g; East Africa (sixteenth century) 1 *mī* = 4.41 g.

With the exception of Persia, where the *mann* dominated the system of weight measures, the *raṭl* became the most common and widespread unit of weight measure in the Islamic world, comparable in size and function to the European 'pound' (Pfund, livre, libra, Italian loan word 'rotolo'). The *raṭl* was measured in *dirham*. Depending on what was measured, and where and when, the *raṭl* could take different numbers of *dirham* (values between 96 and 1.040 are recorded) of different *dirham* weights (standard value: 1 *dir* = 3.125 g).

If integrated into the early Meccan system:

1 *r* = 2 *ma* [à 130 *dir*] = 12 *ūḳ* = 480 *dir* = 1/100 *ḳin*,

the *mithḳāl* weights produce the following (fictitious) relation:

1 *mi* = 20 *ḳī* = 60 [or 100] *ḥa* = 10/7 *dir* = 1/336 *r* (for Iraq; 1 *ḳī* = 0.223 g)
1 *mi* = 24 *ḳī* = 96 *ḥa* = 3/2 *dir* = 1/320 *r* (for Mecca, Egypt etc.; 1 *ḳī* = 0.195 g).

From archaeological (glass weights) and textual evidence, several hundred *raṭl* weights are known. The following list enumerates (in order of size, with '[...]' values developed) some of the standard *raṭl* weights repeatedly recorded (see matrix below).

Besides the *raṭl*, the *mann* was an important unit of weight everywhere in the Islamic world, in particular in the Persian East, where it weighed between 260 *dir* (= 816.5 g) and 2,080 *dir* (= 6,656 g). A similar variety of *mann* weights was used In Asia Minor (twelfth century onwards). Until the fifteenth century it was used instead of one half of a *raṭl* à 130 *dirham*. Then a 'big' *mann* (ca. 3 to 3.25 kg), and a 'middle' *mann* of 1.920 g came into use. During the Safawid period (sixteenth century), a 'super' *mann*, later called the 'royal' *mann* (between 5.7 and 6 kg), was introduced. The Ottomans used the *oḳḳa* (1 *oḳ* = 2 *nu* = 400 *dir* à 3.207 g = 1.2828 kg) instead of the *raṭl*. Its stability was proverbial: *Okka her yerde dört yüz dirhem gelir* (... to be no different from anybody else).

Egypt (Abbasid period)	96 dir	300 g
Rūmī (Asia Minor) I	102 6/7 *dir*	321.43 g
Umayyad period	[110 *dir*]	340 g
Rūmī (Asia Minor) II	120 *dir*	375 g
Iraq (medieval)	128 4/7 *dir*	401.79 g
Abbasid period (Egypt, Baghdad)	130 *dir*	406.25 g
Maghreb	130 *dir*	406.25 g
Maghreb	137 1/7 *dir*	428.57 g
Umayyad period (Egypt)	[140 *dir*]	437.5 g
Maghreb (Fāṭimid period)	140 *dir*	437.5 g
Egypt (later Abbasid period)	144 *dir*	450 g
Fulfulī	150 *dir*	468.75 g
Maghreb (Ibn Baṭṭūṭa)	150 *dir*	468.75 g
'big' Egypt (Abbasid period)	160 *dir*	500 g
Maghreb (Ibn Baṭṭūṭa)	180 *dir*	562.5 g
Laithī	200 *dir*	625 g
Djarwī	312 *dir*	975 g
Turkestan (fourteenth century)	330 *dir*	1,031.25 g
Fes/Marrakesh (fourteenth century; = 16 ūḳ)	336 *dir*	1,050 g
Aleppo (twelfth and thirteenth century)	480 *dir*	1,500 g
Syria/Palestine (fourteenth century)	592 1/2 *dir*	1,851.56 g
Ḥimṣ (twelfth century)	684 *dir* [sic]	2,137.5 g
Aleppo (after thirteenth century)	[724 *dir*]	2,273 g
Jerusalem (medieval)	800 *dir*	2,500 g
Ḥimṣ (Syria, medieval)	864 *dir*	2,700 g
Constantinople (eighteenth century)	876 *dir*	2,800 kg
Jerusalem (nineteenth century)	900 *dir*	2,812.5 g
Iran (Shīrāz, Fārs; in *mann*)	1,040 *dir*	3,250 g

The biggest unit - besides the rather colloquial *ḥiml*, camel-load (1 *ḥi* = ca. 250 kg) -, was the *ḳinṭār*, the hundredweight (= 100 *r*). Depending on the type of *raṭl* it was based on, the *ḳinṭār* weights differed. In medieval Egypt, different *ḳinṭār* weights were common: *fulfulī* (pepper) = 100 *r* à 144 *dir* = 45 kg; *laithī* = 100 *r* à 200 *dir* = 62 kg; *djarwī* = 100 *r* à 312 *dir* = 96.7 kg; *mannī* = 100 *r* à 260 *dir* = 81.25 kg; 'big' = 24 *ru* = 240 *r* à 160 *dir* = 38,600 *dir* = 120 kg. In a treatise composed by a customs officer in the thirteenth century, additional *ḳinṭār* names, but no values, for specific goods are mentioned. While the *ḳinṭār* of Syria (Aleppo, Ḥimṣ, Ḥamāh) was always equivalent to 100 local *raṭl*, it was taken for 100 *mann* in late medieval Iraq. In Iran (fifteenth century) and Asia Minor (Ottoman period) 1 *ḳinṭār* weighed ca. 57 kg.

The smaller weight unit of *istār* (1 *is* = 4 1/2 *mi* = 6 3/7 *dir* = 20.07 g), only known from Egypt, was used there to weigh silk: 1 *s-ḳ-ṭ* [?] = 3 *ru* = 90 *man* = 180 *is*.

The Quranic '*ḥabba min ḫardal*' (the 'grain of mustard', see above), being 1/70 ḥa of 1/60 *dir* each (= ca. 0.0007 g), seems to have remained the smallest unit of weight in use in the Islamic world. If calculated properly, the fictitious *naḳīr* (1*djo* = 6 [*ḥa*] *ḫardal* = 72 *fa* = 432 *fāl* = 2,592 *na* = 1/96 *mi* = 0.045 g) would correspond to ca. 5 ng.

al-Ḳurashī

The research of the history of weights and measures and their use in the Islamic world is based on a variety of sources. Unfortunately, no particular literary type of text developed that could claim to be called 'professional'. The information available is scattered over texts on law, social and economic history, administration and geography. They generally lack a systematic character, i.e. ignore comparative and proportionate references. The most recent endeavor to collect all information available in the historical sources was undertaken by Maḥmūá Fākhūrī and Ṣalāḥ al-Dīn knawwām in: *Madjmūᶜat waḥdāt al-qiyās al-ᶜarabīya*

Aleppo: Weights

1 *dir* = 60 *ḥa*
1 *ḳī* = 4 *ḥa* = 2/45 *dī*
1 *ḥa/dī* = (6/7 + 2/21) *ḥa/dī* (Egypt)
1 *ḳī* = (1 + 1/4) *ḳī* (Iraq)
1 *r* = 7,560 *ḳī*
1 *dī* = (22 + 1/2) *ḳī* = 90 *ḥa*
1 *dī* = 3/2 *dī* (Iraq)
1 *ḥa* = [(1 + 3/25) *ḥa* (Syria)]
1 *ḳī* = (1 + 1/8) *ḳī* (Iraq)

Anṭāḳiya: Weights

1 *r* = [16/17 *r sulaymānī*]
1 *r* = [4/5 *r ẓāhirī*]
1 *r* = 384 *dir* = [12 *ūḳ*] = [17 1/7 *mi*] = (268 4/5) *mi*
1 *ūḳ* = 32 *dir* (22 2/5) *mi*
1 *r* = (3/5 + 1/25) *r* (Syria) = (2 + 1/2 + 1/20 + 1/100) *r fulfulī* = 4/5 *r ẓāhirī* = (2/3 + 1/4 + 1/100) *r ḥaythamī*

Ardabīl: Weights

1 *r* = [9/5 *r sulaymānī*]
1 *ūḳ* = 90 *dir*
1 *r* = 1 4/5 *r sulaymānī* = 8 2/5 *r* (Iraq)
1 *r* = 1.080 *r* = [12 *ūḳ*] = 756 *mi*
1 *mi* = 63 *dir*

Asyūṭ (Egypt): Weights

1 *r* = [5/3 *r sulaymānī*] = *r* (Ṭaḥāwī, ʿAkkā)
1 *r* = 1,000 *dir* = 700 *mi* = [12 *ūḳ*]
1 *r* = 1 2/3 *r* (Syria) = 31/3 *r djarwī* = 6 2/3 *r fulfulī* = (7 + 2/3 + 1/9) *r* (Iraq)
1 *r* = 720 *dir* = 1/5 *ḳis*
1 *ūḳ* = 83 1/3 *dir* = 58 1/3 *mi*

Baghdad: Measures of capacity

1 *r* = [3/16 *ṣa* (Ḥidjāz) = [2 *ma*] = [1/4 *mu* (Damascus)] = 3/14 *r* (Syria)

Bardhaʿa (Azarbaydjan): Weights

1 *r* = [7/5 r *sulaymānī*]
1 *ūḳ* = 588 *mi*
1 *r* = 1 2/3 *r sulaymānī*
= (6 + 1/3 + 1/5) *r sulaymānī*
1 *r* = 840 *dir* = [14 *ūḳ*]
1 *ūḳ/mi* = 49 *dir*

Damascus: Measures of capacity

1 *mu* = 1 4/7 *mu* (Ḥidjāz) = 4 *r* (Baghdad)

Weights

1*r* = 12 *ūḳ* = 600 *dir* = 1 *r sulaymānī*
1 r = 420 *mi* = 3,600 *da* = 14,400 *ḳī* = 36,000 *ḥa*
1 *ūḳ* = 35 *mi* = 300 *da* 1,200 *ḳī* = 3,000 *ḥa*
1 *ḥa* = (6/7 + 1/28) *ḥa* (Aleppo)
1 *ūḳ* (small, silk) = 10 *dir* = 1/50 *r* = 1/20 *is*
1 *ūḳ* = 50 *dir*
1 *ḳī* = 1 3/8 *da* (Iraq)
1 *ḳī* = [15/16 *ḳī* (Aleppo)]

Diyār Bakr (N-Syria)

1 *dir* = 60 *ḥa*
1 *ḳī* = 4 *ḥa* = 2/45 *dī*
1 *dī* = 22 1/2 *ḳī* = 90 *ḥa*
1 *ḥa* = 1/4 *ḳī* = 1/90 *dī*

Diyār Muḍar (N-Syria)

1 *dir* = 60 *ḥa*
1 *ḳī* = 4 *ḥa* = 2/45 *dī*
1 *dī* = 22 1/2 *ḳī* = 90 *ḥa*
1 *ḥa* = 1/4 *ḳī* = 1/90 *dī*

Djarwī: Weights

1 *r* = [6/7 *ma* (Syria, general)]
1 *r* = [1/2 *r sulaymānī*]
1 *r* = 300 *dir* = 1/2 *r* (Syria) = (1/5 + 1/10) *r* (Ṭaḥāwī)] = 1 1/6 *ma* = 210 *mi*
= 2 1/3 *r* (Iraq) = [3/10 *r* (Asyūṭī)]

Djazīra: Weights

1 *dir* = 60 *ḥa*
1 *ḳī* = 4 *ḥa* = 2/45 *dī*
1 *dī* = 22 1/2 *ḳī* = 2/45 *dī*
1 *ḥa* = 1/4 *ḳī* = 1/90 *dī*

Egypt: Measures of area

1 *fad* = 100 *dh* · 100 *dh* = 20 *ḳab*

Measures of capacity

1 *ku* = 1 *ḳin fulfulī* = 1/4 *ḳin* (Syria)

Weights

1 *dir* = 60 *ḥa*
1 *dir* = (1/2 + 1/5) *dī* = 16 4/5 *ḳī*
1 *dī* = 10/7 *dir* = 24 *ḳī* = 85 5/7 *ḥa/dir*
1 *ḳī* = (1/7 + 1/14) *da* [sic]
1 *dī* = 600/7 *ḥa*
1 *ḥa* = (1/5 + 2/25) *ḳī*
1 *ḥa/dī* = [(1 + 1/21) *ḥa/dī* (Aleppo)]
1 *ḳī* = [21/25 *ḳī* (Iraq)]
1 *r* = 1 *ḳin fulfulī* = 1/4 *ḳin* (Syria)
1 *da* = 6 *ḥa*
1 *ḳī* = 3 4/7 *ḥa*
1 *da/dī* = 8 4/7 *ḥa/dir*
1 *da* = 2 2/5 *ḳī*
1 *ḳī* = 25/7 *ḥa* = (1/24 + 1/42) *dir*
1 *ḥa/dī* = (1/100 + 1/600) *dī*
1 *ḳī* = [15/16 *ḳī* (Aleppo)]
1 *ḳī/dir* = [3/8 *da* (Iraq)]

Filasṭīn (Palestine, incl. Tiberias): Measures of length and area

1 *ḥab* = 40 *dh*
1 *mudy* = 1 *ḥab* · 1 *ḥab*

Weights

1 *ra* = 420 *mi* = 3,600 *da* = 14,400 *ḳī* = 36,000 *ḥa*
1 *ūḳ* = 35 *mi* = 300 *da* = 1,200 *ḳī* = 3,000 *ḥa*

Fulfulī: Measures of capacity

1 *ra* = [7/32 *ṣa* (Ḥidjāz)] = [7/8 prophetic *mu*]

Weights

1 *r* = [7/12 *r* (Syria, general)]
1 *r* = 2 r *djarwī*
1 *r* = [1/4 r *sulaymānī*]
1*ḳin* = 1 *r* (Egypt) =1/4 *ḳin* (Syria)
1 *r*/*ūḳ* = 12 1/2 *dir* = (8 1/2 + 1/4) *mi* = 1/4 *r* (Syria) =(1/3 + 1/4) *ma*
1 *r* = [6/7 *r* (Iraq)] = [3/8 *r ḥaythamī* = [5/16 *r ẓāhirī*] =[3/2 *r* (Asyūṭī)]
= [3/2 *r* (Ṭaḥāwī)] =[25/64 *r* (Anṭākiya]
1 *r* = 150 *dir* = 105 *mi*

Ghaylānī, see Yemen

Ḥaithamī: Weights

1 *r* = 400 *dir* = [12 *ūḳ*]   1 *ūḳ* = 33 1/3 *dir*
1 *r* = 2/3 *r* (Syria) = 2 *r laythī* = 2 2/3 *r fulfulī* = 3 1/9 *r* (Iraq) = 1 5/9 *ma* (Iraq) = 1 5/6 *r ẓāhirī*
= 1 11/150 *ra* (Anṭākiya)

Ḥidjāz: Measures of capacity

1 *was* = 60 *ṣa* = 240 *mu*
1 *ṣa* = 5 1/3 *r* (Baghdad) = 1 1/7 *r* (Syria) = 4 4/7 *r fulfulī* = 2 2/3 *ma* = 8 *r* (Abū Ḥanīfa: Baghdad)
1 *mu* = 1 3/4 *mu* (Damascus)

Weights

1 *dī* = 24 *ḳī*
1 *r* = 3/601 r *sulaymānī*

Iraq: Measures of length and area

1 *dj* = 60 *dh* · 60 *dh* = [3,600 *dh* ^{2}] = 10 *ḳa* = 100 ‹*as*
1 *ḳaṣ* = 6 *dh* = 1 *bā* = 1/10 *ash*
1 ‹*as* = 1 *bā* · 1 *bā*
1 *ḳa* = 7 1/2 *dh* = 1/4 (or 1/3) *si*
1 *dj* = 1 *ash* · 1 *ash*
1 *mud* = 30 *ḳal* ^{2} = 1687 1/2 *dh* ^{2}

Measures of capacity

1 *ku* = 60 *ḳa*
1 *mu* = 3/4 prophetic *mu*

Weights

1 *dī* = 6 *da* = 60 *ḥa* = 20 *ḳī*
1 *dir* = 48 *ṭa* = 48 *ḥa* = 6 *da*
1 *dir* = (1/2 + 1/5) *dī*
1 *ṭa* = 4/5 *ḥa* (Syria)
1 *ḳī* = [4/5 *ḳī* (Aleppo)]
1 *da* = 2 2/3 *ḳī*/*dir* (Dam., Egypt)
1 *ḳī* = 8/9 *ḳī* (Aleppo, weight)
1 *ūḳ* = [1/1,200 *ḳin* (Syria)]
1 *r* = 128 4/7 *dir* = 90 *mi*
1 *ūḳ* = 10 5/7 *dir* = 7 1/2 *mi*
1 *r* = 1,800 *ḳī* = 6,171 3/7 *ḥa*/*dī* = 5,400 *ḥa*/*dir* = 3/14 *r* (Syria)
= 6/7 *r fulfulī* = 1/2 *ma* = [9/14 *r laythī*]
1 *r* = [9/28 *r ḥaythamī*] = [9/35 *r* (Asyūṭī)] = [5/42 *r* (Ardabīl)]
1 *ḳī* = 3 *ḥa*
1 *da*/*dir* = 8 *ḥa*/*dir*
1 *ḥa*/*dir* = 1/48 *dir*
1 *dī* = 2/3 *dī* (Aleppo)
1 *ḳī* = 1 1/7 + 1/21 *ḳī* (Damascus, Egypt)
1 *da* = 2 1/3 *ḳī*
1 *r* = [3/14 r *sulaymānī*]
1 *r* = 1/2 *r* (Syria, general)
1 *r* = [12 *ūḳ*]

Laythī: Weights

1 *r* = [1/3 *r sulaymānī*]
1 *r* = 100 *dir* = [6 3/33 *ūḳ*]
1 *ūḳ* = 16 1/2 *dir* = 140 *mi* = 11 2/3 *mi sulaymānī*
1 *r* = 1 1/4 *r fulfulī* = 6/7 *ma* = 1 5/9 *r* (Iraq)
1 *r* = [7/9 *ma* (Syria, general)]
1 *r* = [1/2 *r ḥaythamī*]

Makāyīl al-nabīy (prophetic measures)

1 *mu* = 1 1/3 *r* (Iraq) = 171 3/7 *dir* = 3 3/7 *ūḳ* (Syria) = 1 1/7 *r fulfulī* = 120 *mi*

Sulaymānī: Weights

1 *r* = 1 *r* (Damascus) = 200 1/3 *r* (Ḥidjāz) = 4 *r fulfulī* = 4 1/3 *r* (Iraq) = 3 *r laythī* = 2 *r djarwī* = 2 4/19 *r* (Ghaylānī)
= 1 1/2 *r ḥaythamī* = 1 1/4 *r ẓāhirī* = 5/4 *r* (Bardha‹ī) = 5/9 *r* (Ardabīl) = 3/5 *r* (Asyūṭī) = 1 1/16 *r* (Anṭākiya)
1 *r* = [2 2/15 *ma* (Syria, general)] = [7/3 *ma* (Syria, general)] = [5/7 *r* (Bardha‹ī)] = [5/9 *r* (Ardabīl)]

Syria: Measures of capacity

1 *ghi* = 3 *ḳa* (Iraq) = 12 *ru* = 72 *mu*
1 *r* = [7/8 *ṣa* (Ḥidjāz)] = [4 2/3 *r* (Baghdad)]
1 *ūḳ* = [7/24 prophetic *mu*]

Weights

1 *dir* = 60 *ḥa*
1 *da* = 10 *ḥa*
1 *ḳī* = 3 4/7 *ḥa*
1 *da*/*dī* = 8 4/7 *ḥa*/*dī*
1 *da* = 1 4/5 *ḳī*
1 *ḥa* = (1/5 + 2/25) *ḳī*
1 *ḥa* = 6 *da*
1 *dir* = (1/2 + 1/5) *dī* = 16 4/5 *ḳī*/*dī*
1 *dī* = 1 3/7 *dir* = 24 *ḳī* = 85 5/7 *ḥa*
1 *ḳī* = (1/7 + 1/14) *ḥa*
1 *dī* = 600/7 *ḥa*
1 *ḥa* = 4/5 *ṭa* (Iraq)

1 *ḥa/dī* = (1/100 + 1/600) *dī*
1 *ḳī* = 25/7 *ḥa* = (1/28 + 1/42) *dir* = 1/24 *dī*
1 *ḥa* = (6/7 + 1/28) *ḥa* (Aleppo)

Weights (Syria, specific)

1 *r* = 420 *mi* = 3,600 *da* = 14,400 *ḳī* = 36,000 *ḥa*
1 *ūḳ* = 35 *mi* = 300 *da* = 1,200 *ḳī* = 3,000 *ḥa*
1 *ḳin* = [4 *ḳin fulfulī*] = [4 *r* (Egypt)] = 42,000 *mi* = 60,000 *dir*
1 *r* = [4 *r/ūḳ fulfulī*] = [2 *r djarwī*] = [14/3 *r* (Iraq)]
1 *r* = [3/2 *r ḥaythamī*] = [3/5 *r* (Asyūṭī)] = [16/25 *r* (Anṭākiya)]

Weights (Syria, unspecified)

1 *ḳin* = 100 *r* = 233 1/3 *ma* = 466 2/3 *r* [sic] = 1,200 *ūḳ* (Iraq)
1 *ma* = 260 *dir* ≈ 257 1/7 *dir* = 180 *mi* = 2 *r* (Iraq) = 1 5/7 *r fulfulī* = 13/30 *r sulaymānī*
1 *ma* = 1 2/7 *r laythī* = 6/7 *r djarwī* = 3/7 *r sulaymānī*
1 *r/ūḳ* = 5 1/7 ūḳ = 1/4 *ma* = 3 3/4 *mi*

Ṭaḥāwī: Weights

1 *r* = [3/10 *r djarwī*]
1 *r* = 1 *r* (Asyūṭī)

Yemen (Ghaylānī): Weights

1 *r* = [19/42 *r sulaymānī*]
1 *r* = [271 2/3 + 2/7] *dir sulaymānī* = 190 *mi sulaymānī*
1 *ūḳ* = (15 1/2 + 1/3) *mi sulaymānī*

Ẓāhirī (Fāṭimid): Weights

1 *r* = 480 *dir* = [12 *ūḳ*] = 336 *mi*
1 *r* = 4/5 *r* (Syria) = 1 1/5 *r ḥaythamī* = 3 1/5 *r fulfulī* = 1 1/4 *r* (Anṭākiya)
= (3 2/3 + 2/30) *r* (Iraq)
1 *ūḳ* = 40 *dir* = 28 *mi*

Ells (*adhruʿ*, unspecified):

dhirāʿ al-yad
1 *dh* = 2 *shi* (cloth) = 18 *iṣ* (medium) = 24 *iṣ* (without thumb) = [3/4 *dh* (*ḳāsimī*)]

dhirāʿ ḳāsimī (= hāshimī)
1 *dh* = 1 1/3 *dh* (*yad*) = 24 *iṣ* = 6 *ḳab*
1 *Iṣ* = 1/4 *ḳab* = 1/24 *dh*
1 *ḳab* = 1/6 *dh*

dhirāʿ hāshimī (mālikī)
1 *dh* = 8 *ḳab* = [3/5 *dh* (*mābahrāmī*)]

dhirāʿ mābahrāmī (sūd)
1 *dh* = 1 2/3 *dh* (*hāshimī*) = 60 *fa* = 1/3 (or 1/6) *ḳab*
1 *dj* = 36 *dh* · 36 *dh*

al-islāmīya, Beirut: Maktabat Lubnān Nāshirūn, 2002. Only occasionally, external sources, records of both European and Oriental travellers, allow the fixation of absolute values. With regard to their geographical and chronological diversity, the reconstruction of entire systems of measurement and of their relation to each other has just begun.

During the tenth century, mathematicians became aware of the complexity of the metric systems in use. Their particular perspective on the issue differed from what their legal and other colleagues had been noting down hitherto. They not only tried to present a systemized enumeration of all units related, but also endeavoured, for pedagogical reasons, to systematize the usage of measuring units in popular treatises. They sometimes even expressed efforts to standardise and facilitate the conversions customs, market and tax officers had to enact. Thus, stimulated by theoretical manuals, mathematically standardised methods of measuring and of converting quantities from one system into another became popularised. To some extent, these devices even had retroactive effects on the practice of Islamic laws.

Among these manuals, the “Book on the Basis of Arithmetic and the Division of Inheritances” (*Kitāb* *al-Tadhkira bi-uṣūl al-ḥisab wa l-farā'iḍ*), written by the Damascene mathematician ʿAlī b. al-Khiḍr al-ʿUthmānī al-urashī (1030–1067 AD) contains the most coherent information on the metric systems that were in use in the Islamic Middle East up to the lifetime of the author. The following list of units of weight, currency, capacity and length, together with the localities they refer to arranged in alphabetical order, is extracted and, if indicated by '[…]', concluded from different chapters of this *Kitāb al-Tadhkira*.

See also: ►Nilometer

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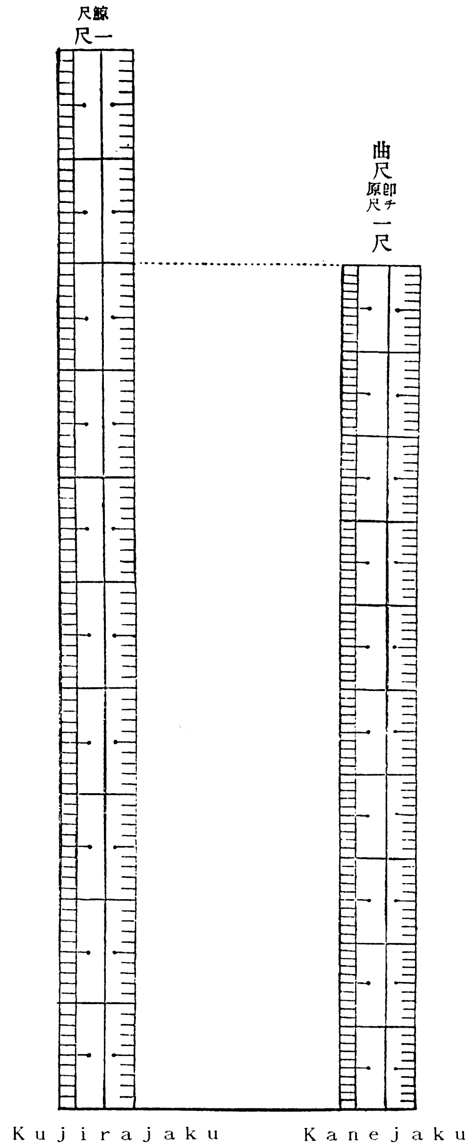
Weights and Measures in Japan

Shigeo Iwata

Japan used the 17.3 cm-long linear measure unit that was common to all the regions in East Asia for a period of 25,000 years. Under the influence of China, the Japanese measuring unit gradually lengthened during the period from the end of the eleventh century BCE to the middle of the third century BCE. Then, the length of the Japanese measure *shaku* was stabilized at 23 cm and remained unchanged until the end of the second century AD. Various civil disturbances in China had the effect of lengthening the linear measure substantially to 29 cm until the middle of the seventh century, and no more significant variation has since been observed (Fig. 1).



Weights and Measures in Japan. Fig. 1 Linear Measure. Drawing by The Ministry of Finance. *Doryoko Shurui Hyo* (The Classification Table of Weights and Measures) Genbei Kinokuniya, 1875. Chos 1, 4–6, 9–11.

Length

Under the Chinese Tang dynasty, a law was enacted mandating the use of two methods based on large and small linear measures. The large scale was 1.2 times as long as the small scale, which we refer to as the ancient linear measure. The small scale was used for music, astronomy, and ceremonial items.

Japan introduced this Chinese measuring system in 701. The large scale later became known as *kanejaku*, which refers to an L-shaped ruler used by architects. The small scale gradually dropped out of use. Linear measurement tools were mainly made of wood, though