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Verification of commercial weights

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Foreword

The International Organization of Legal Metrology (OIML) is a worldwide, intergovernmental organization whose primary aim is to harmonize the regulations and metrological controls applied by the national metrological services, or related organizations, of its Member States.

The two main categories of OIML publications are:

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VERIFICATION OF COMMERCIAL WEIGHTS

Introduction

The International Organization of Legal Metrology's Recommendation R 111 covers every aspect of the verification and calibration of weights of nominal values from 5000 kg to 1 mg and covering all classes of accuracy. Weights are classified in to nine classes, namely E_1, E_2, F_1, F_2, M_1, M_{1-2}, M_2, M_{2-3} and M_3 according to their maximum permissible errors (MPE). Weights of class E_1 have the smallest MPE. Normally, weights belonging to classes E_1, E_2, F_1, F_2 are used as standards maintained at different levels in a country while weights belonging to class M_1 and lower are used for trade and commerce. Commercial weights are tested only for their compliance to the specifications, including that of MPE. No mass value is assigned to these weights. Specially trained technical people, who are well versed with all the scientific aspects and needs of standard weights, maintain standard weights of classes E_1, E_2, F_1 and F_2, while on the other hand commercial weights are verified by comparatively less scientifically qualified people with many other administrative duties. This happens especially in developing and smaller countries where legal metrology departments are parts of bigger departments having various activities dealing with all other aspects of trade and commerce. Quite often legal metrology inspectors are taken from the administrative cadres, who come to the department for short periods, so they are not exposed to the detailed technical training required for the of verification of weights or for that matter any other weighing and measuring instruments covered by legal metrology. It is therefore imperative that step-by-step procedures are laid down for them, which do not concentrate too much on the technical and scientific aspects of the procedures. Such procedures will not only reduce the load on the legal metrology inspector, but will encourage global uniformity in the verification of all legal weights or measures.

1 Scope

Weights may be classified either according to their shape or according to the purpose they are used for, and are hence allocated suitable classes of accuracy.

According to shape:

1 Rectangular bar weights 50 kg to 5 kg according to OIML R 111 (Figures 1 & 2)
2 Cylindrical weights 20 kg to 1 g according to OIML R 111 (Figure 3)
3 Hexagonal weights 50 kg to 5 kg according to OIML R 52 (Figure 4)
4 Hexagonal weights 2 kg to 100 g according to OIML R 52 (Figure 5)
5 Cylindrical rolling weights of 5000 kg according to OIML R 47 (Figure 6)
6 Rectangular weights (stacking type) 1000 kg and 500 kg according to OIML R 47 (Figure 7)
7 Cylindrical weights (suitable for stacking and rolling) according to OIML R 47 (Figure 8)
8 Hexagonal weights 50 kg to 5 kg according to Indian regulations (Figure 9) [see *Note*]
9 Hexagonal weights (nesting type) 2 kg to 100 g according to Indian regulations (Figure 10) [see *Note*]
10 Flat cylindrical disc weights (Nesting type) for bullion trade according to Indian regulations (Figure 11) [see *Note*]
11 Fractional weights 500 mg to 1 mg according to Indian regulations (Figures 12A and 12B) [see *Note*]
12 Carat weights according to Indian regulations (Figures 13A and 13B) [see *Note*]

Note: The weights mentioned in 8 to 12 above are not only used in India but in other neighbouring countries as well.

According to purpose:

1 Carat weights for precious stones and diamonds (belong to class M_1 in India)
2 Bullion weights for gold, silver and precious metals (belong to class M_1 in India)
3 Weights for semi- precious household items like spices (belong to class M_2 in India)
4 Weights of ordinary accuracy for less costly items like food grains, wood, coal etc. (belong to class M_3 in India)

Such weights were assigned maximum permissible errors according to the OIML Recommendations existing at the time. As an example, the maximum permissible errors for weights used for different purposes in India are given in 2.1 below. It may be noted that the maximum permissible errors for non-bullion weights correspond to class M_2, and those for bullion and carat weights to class M_1 of OIML Recommendation R 111 (1994).

2 Maximum permissible errors

For any weight, weighing or measurement instrument, the maximum permissible error (MPE) indicates the extreme values of the error in excess or/and in deficiency permitted by its respective legal requirement. It is synonymous with the term "*tolerance*". For example, if the conventional mass of any weight of nominal value W, is allowed to have any value in between W – E1 and W+ E2, then, E1 is the maximum permissible error in deficiency and E2 is the maximum permissible error in excess. E1 and E2 may be equal or unequal; sometimes E1 is numerically equal to half the value of E2. In some special cases E1 may be zero.

1 There are number of countries which use weights manufactured in India according to Indian regulations. In quite a few countries the regulations for weights are those which existed in India at that those regulations were introduced. For this reason, errors permitted for commercial weights as used in India have been cited.

2 The MPEs according to OIML R 111 and those adopted in India are given below to give an overall view. This will help in deciding which of R 111's MPE classes to select, according to a particular country's needs. It is better that every reader is well versed about the MPE used for different type of weights, as well as those given by R 111.

3 The MPEs are given in the accuracy checking working sheets so that a legal metrology inspector in the field is not required to refer to regulations, Recommendations and other documents.

4 The MPEs according to the latest version of R 111 are given for countries which have adopted or are likely to adopt OIML R 111.

5 If the MPEs in a specific country differ from those of India or OIML R 111, these values may be substituted.

2.1 Maximum permissible errors according to Indian regulations

Nominal value	Non-Bullion weights			Bullion Weights	
	Hexagonal	Rectangular bar	Cylindrical	Cylindrical	Flat disc
50 kg	7500 mg	7500 mg	-	-	-
20 kg	3000 mg	3000 mg	-	-	-
10 kg	1500 mg	1500 mg	1500 mg	500 mg	-
5 kg	750 mg	750 mg	750 mg	250 mg	-
2 kg	300 mg	-	300 mg	100 mg	-
1 kg	150 mg	-	150 mg	50 mg	50 mg
500 g	75 mg	-	75 mg	25 mg	25 mg
200 g	30 mg	-	30 mg	10 mg	10 mg
100 g	15 mg	-	15 mg	5 mg	5 mg
50 g	10 mg	-	10 mg	3 mg	3 mg
20 g		-	8 mg	2.5 mg	2.5 mg
10 g		-	6 mg	2 mg	2 mg
5 g		-	5 mg	1.5 mg	1.5 mg
2 g		-	4 mg	1.2 mg	1.2 mg
1 g		-	3 mg	1 mg	1 mg

No negative errors are allowed at the time of verification. Equal negative or positive errors are allowed at the time of inspection.

Maximum permissible errors of all the classes of weights according to R 111 (1994) are given below to give a general idea about MPEs.

2.2 Maximum permissible errors according to OIML R 111 (5000 kg to 100 kg)

Nominal value	MPE according to class (g)								
	E_1	E_2	F_1	F_2	M_1	M_{1-2}	M_2	M_{2-3}	M_3
5000 kg	-	-	25	80	250	500	800	1600	2500
2000 kg	-	-	10	30	100	200	300	600	1000
1000 kg	-	1.6	5	16	50	100	160	300	500
500 kg	-	0.8	2.5	8	25	50	80	160	250
200 kg	-	0.3	1	3	10	20	30	60	100
100 kg	-	0.16	0.5	1.6	5	10	16	30	50

2.3 Maximum permissible errors according to OIML R 111 (50 kg to 1 mg)

Nominal value	MPE according to class (mg)								
	E_1	E_2	F_1	F_2	M_1	M_{1-2}	M_2	M_{2-3}	M_3
50 kg	25	80	250	800	2500	-	8000	-	25000
20 kg	10	30	100	300	1000	-	3000	-	10000
10 kg	5	16	50	160	500	-	1600	-	5000
5 kg	2.5	8	25	80	250	-	800	-	2500
2 kg	1	3	10	30	100	-	300	-	1000
1 kg	0.5	1.6	5	16	50	-	160	-	500
500 g	0.25	0.8	2.5	8	25	-	80	-	250
200 g	0.1	0.3	1	3	10	-	30	-	100
100 g	0.05	0.16	0.5	1.6	5	-	16	-	50
50 g	0.03	0.1	0.3	1	3	-	10	-	30
20 g	0.025	0.08	0.25	0.8	2.5	-	8	-	25
10 g	0.02	0.06	0.20	0.6	2	-	6	-	20
5 g	0.016	0.05	0.16	0.5	1.6	-	5	-	16
2 g	0.012	0.04	0.12	0.4	1.2	-	4	-	12
1 g	0.01	0.03	0.1	0.3	1	-	3	-	10
500 mg	0.008	0.025	0.08	0.25	0.8	-	2.5	-	-
200 mg	0.006	0.02	0.06	0.2	0.6	-	2	-	-
100 mg	0.005	0.016	0.05	0.16	0.5	-	1.6	-	-
50 mg	0.004	0.012	0.04	0.12	0.4	-	-	-	-
20 mg	0.003	0.01	0.03	0.1	0.3	-	-	-	-
10 mg	0.003	0.008	0.025	0.08	0.25	-	-	-	-
5 mg	0.003	0.006	0.02	0.06	0.2	-	-	-	-
2 mg	0.003	0.006	0.02	0.06	0.2	-	-	-	-
1 mg	0.003	0.006	0.02	0.06	0.2	-	-	-	-

It may be noticed that the MPE for weights of same nominal value in alternative classes increases by a factor of 10 and by a factor of √10 (with suitable approximations) for weights in consecutive classes.

3 Visual inspection

3.1 Material

The choice of material for different weights should be left to the law making authority of the department of legal metrology. Their density should be such that their conventional values lie within 1/4 of the maximum permissible errors, with a variation in air density of 10 %. Materials for different type of weights should therefore be mentioned in secondary legislation. The job of the inspector is to see if the weights are made of the specified material.

- Grey cast iron is normally specified for rectangular bar, hexagonal weights and cylindrical knob weights not meant for bullion purposes.
- Brass, bronze, or gunmetal is specified for flat cylindrical disc weights and cylindrical knob weights used for bullion purposes or weights belonging to class M_1.
- Brass, bronze, gunmetal, nickel chromium alloy or non-magnetic stainless steel is specified for carat weights or weights belonging to class M_1.
- Brass, bronze, gunmetal, nickel chromium alloy, non-magnetic stainless steel, cupro-nickel or aluminium, nickel silver sheet is specified for fractional weights from 500 mg to 1 mg.

3.2 Adjusting cavity

- An appropriate adjusting cavity, as prescribed in R 111 or in national legislation, shall be provided in all commercial weights except those of nominal values of 10 g or below.
- An adjusting cavity is optional for 20 g and 50 g weights.
- No adjusting cavity shall be provided in carat weights.
- The dimensions of the adjusting cavity are to be checked on the manufacturer's premises at the time of manufacture. However the accessible dimensions of the adjusting cavity may be checked at the same time as other dimensions on verification or inspection.
- Not more than half of the adjusting cavity's volume should be filled with lead or other adjusting materials. However the volume to be filled or kept empty may be specified in national legislation. In no case should the lead or other adjusting material overflow the cavity, and its surface should be a few millimetres below the bottom surface of the weight.

3.3 Finish

Weights of grey cast iron and similar materials belonging to class M_2 and lower classes:

- surface should be free from dross and blowholes, and should be smooth;
- there should be no broken or sharp edges; and
- weights should only be spray-painted.

Weights of other than grey cast iron belonging to class M_1:

- surface should be free from blowholes and tool marks and should be smooth;
- there should be no sharp edges;
- coating to protect from corrosion should be resistant to normal wear and tear; and
- no porosity should be visible to the naked eye.

Sheet metal or wire weights:

- the metal sheet should be cleanly sheared and free from burrs, with slightly rounded corners;

- the diameter of wire weights should of visibly uniform diameter and should be cut in such a way that the ends are square to the axis of the wire; and
- the stamping should be legible and deep enough to ensure indelibility, but not so deep as to crack the metal sheet.

Note: If proper visual inspection is carried out, it should meet the requirements of clauses 9, 10 and 11 of R 111.

3.4 Magnetic properties

If the prescribed material is used, it will meet the requirements for permanent magnetism and susceptibility, however if mild steel or brass weights have been made from rods formed from scrap, it is likely that the weights may show magnetism. It is not possible for a legal metrology inspector to test the permanent magnetism or susceptibility of the material in the field, so a small sensitive compass may be used by an inspector to see if the weights show magnetism. If the test is positive, then the whole lot should be suspended for the time being and a sample may be sent to an appropriate laboratory to test its compliance with the requirements of clause 9 of R 111.

3.5 Markings

Each weight should be correctly marked with the following information, as prescribed in R 111 or in national legislation:

- nominal value of the weight with name or symbol of the unit, such as kg, g or kilogram, etc.;
- name or trade mark of the maker or manufacturer;
- if necessary, a special mark and/or word(s) to identify the use of the weight. For example in India, the word "Bullion" within a diamond mark is to be marked on weights used for bullion purposes.

4 Shape and dimensions

At least 10 % of new weights must be checked for dimensions at the manufacturer's premises.

The permitted variation in dimensions is ± 5 % for weights of nominal values greater than 1 kg and ± 10 % for weights of nominal values of 1 kg and below.

4.1 Weights according to OIML Recommendation R 111

- Dimensions A, A′, B, B′, a, d′ and H are important for type 1 rectangular weights (Figure 1) and A, A′, B, B′, a, d and H are important for type 2 (Figure 2);
- Dimensions Φ, Φ′, Φ″ and H are important for cylindrical weights (Figure 3).

4.2 Weights according to OIML Recommendation R 52

- Dimensions A_1, A_2, B_1, B_2, a and H are important for hexagonal weights with handles (Figure 4);
- Dimensions A_1, A_2, d_1 and H are important for hexagonal weights (Figure 5).

4.3 Weights according to Indian regulations

- Dimensions A, B, C, D, T and E are important for hexagonal weights with handles (Figure 9);
- Dimensions A, B, C, D, H and Q are important for hexagonal nesting type weights (Figure 10);
- Dimensions A, B, C, E, and G are important for flat cylindrical disc nesting type weights (Figure 11);
- Dimensions A_1, A_2, A_3 and B I(as applicable) are important for non-bullion fractional weights (Figure 12A). Weights of 5 mg, 50 mg and 500 mg will be pentagonal, those of 2 mg, 20 mg and

200 mg will be rectangular and those of 1 mg, 10 mg and 100 mg will be triangular. Dimensions D, C and H are important for bullion fractional weights (Figure 12B). To distinguish bullion weights from other fractional weights these are circular in shape, and of diameter D;

- Dimensions A, D, E, G and H are important for carat weights (Figure 13A). Those of 500 ct to 5 ct will be single piece cylindrical knob weights, those of 2 ct to 0.005 ct will be in form of a square with an edge 'a' (Figure 13 B).

4.4 Working sheets for checking dimensions

Working sheets are provided in section 7 for checking the dimensions of each class of weight. They have been designed for easy working and for record keeping . Where values of important dimensions have been given for each weight, measure the dimension with a vernier calliper and put a tick (✓) in the table if it is found to be correct. If all dimensions are within the prescribed limits, there will be only ticks in the row, so the weight will be acceptable. For each nominal value, a few lines have been left blank for recording the dimensions of weights of that nominal value. If need be, each cell of the row may be sub-divided to accommodate more weights.

5 Verification of weights for accuracy

In many developing countries that adopted the metric system in the 1950s such as India, two pan freely swinging balances are used. Weighing on such balances is time consuming and laborious in comparison to electronic or single pan damped balances. The problem multiplies if the weights are manufactured in large numbers. Thus a little more space is taken to describe the verification method for two pan balances.

5.1 Preliminaries

1 While in the field, choose a site so that no direct sunlight falls on the balance and working standard weights.

2 The area should be reasonably dust- and draught-free.

3 The temperature should not change faster than ± 3 °C per hour and the total change in temperature in 12 hours should not be more than ± 5 °C.

4 The balance table should be robust and rigid and is so placed that undue vibrations, while moving around it, are avoided.

5 Level the balance by placing a spirit level along and perpendicular to the length of the balance.

6 Clean the pans and floor of the balance with a small paintbrush or chamois leather.

7 Keep the doors of the balance, if provided, open for some time.

8 Use a chamois leather or forceps for lifting the standard weights.

9 Place the weights on the pan centrally and never drag them on the pan.

10 Release the balance slowly such that there is no lateral motion of the pans.

11 Arrest the balance when the beam is almost in the horizontal position, i.e. when the pointer is almost in the centre.

12 Use only the correct power supply with electronic balances.

13 For electronic balances, allow the correct warming up time and follow the instruction manual.

14 Note the indication when stabilised. Give equal time intervals between two readings.

15 Remove all magnetic materials from the vicinity of the balance.

16 See that there is no high voltage or high frequency generating source in the vicinity of the balance.

17 Never use an electronic balance as a measuring instrument. Always use the method of substitution when verifying the weights. Take the local value of the acceleration due to gravity, g, if the balance was calibrated against a standard weight somewhere else.

18 Use always the method of substitution weighing with two pan balances.

19 Collect sufficient number of weights for efficient working.

5.2 Observations with a freely swinging balance

1 Take the extreme right of the scale as zero. By convention, the extreme left of the scale is taken as zero, but the use of this convention gives a different expression for correction than that obtained with single pan or electronic balances.

2 Leave at least one complete oscillation before noting the observations.

3 Take at least three observations of the moving pointer on the scale. Two (R_1 and R_3) when it starts moving from the extreme right and one sandwiched observation (R_2) at its left turning point.

4 The rest point, R, is then given by $R = (R_1 + R_3 + 2R_2) / 4$.

5 Find by experiment the sensitivity figure of the balance.

5.3 Verification of weights using a two pan balance

It may be noted that in India, no negative error is permitted at the time of verification.

1 Load the right hand pan (RHP) with a working standard weight of the required nominal value, plus weights equivalent to the maximum permissible error (MPE).

2 Load the left hand pan (LHP) with available dummy weights so that the pointer moves within the scale or can be brought to equilibrium by adding some weights on the right hand pan.

3 Add standard weights to the right hand pan until the pointer moves between the extreme left and centre of the scale. Let the mass of the total additional weights other than that of working standard weight be w1.

4 Take observations as stated above and calculate the rest point R_S.

5 Substitute the standard weight with the weight under test and release the balance. Either of the following will happen:

A The pointer moves beyond the scale to the right

Conclusion: The mass of the weight is less than its nominal value plus the MPE, so reject it.

B The pointer moves within the scale

Action: Take observations and calculate rest point R_U.

Conclusions: If $R_U - R_S < 0$, the mass of the weight is less than its nominal value plus the MPE so reject it.

If $0 < (R_U - R_S)S <$ MPE (where S is the sensitivity figure of the balance i.e. value of one scale division in mg), the excess in mass of the weight is within the MPE, so accept it.

If $(R_U - R_S)S >$ MPE, the mass of the weight is more than its nominal value plus the MPE, so reject it.

C The pointer moves beyond the scale to the left

Conclusion: The mass of the weight is more than its nominal value plus the MPE

Action: Remove standard weights equivalent to the MPE and observe the scale:

C1 The pointer still moves to the left of the centre

Conclusion: The mass of the weight is more than its nominal value plus the MPE, so reject it.

C2 The pointer moves to right

Conclusion: The excess in mass of the weight is within the MPE, so accept it.

Let us consider the sensitivity figures prescribed for inspector's balances in India and the MPE of commercial weights belonging to class M_1. The sensitivity figures (S) prescribed for such balances, the smallest nominal value of the weight to be verified on it and the MPE of the corresponding OIML class M_1 weight, together with the ratio of MPE to sensitivity figure (S) are given in the following table.

Capacity	S	Smallest weight	MPE	MPE/S
50 kg	100 mg	10 kg	500 mg	5
5 kg	10 mg	500 g	25 mg	2.5
200 g	1 mg	100 g	5 mg	5
50 g	0.4 mg	5 g	1.6 mg	3.1
2 g	0.05 mg	1 g	1 mg	20
1 g	0.05 mg	1 mg	0.2 mg	4

The ratios of MPE/S are quite high. These will be still higher for weights of higher nominal value to be verified on the same balance and for all weights of other categories, as class M_1 weights have the finest MPE among commercial weights. It may therefore be seen that in 90 % of cases, the pointer will overshoot the scale on either side and the situation stated in B above will not arise. Also note that the weight is within the prescribed limits of error if the pointer overshoots the left of the scale with MPE weights on the RHP and moves right of the centre of the scale when the MPE weights are removed from the RHP. An inspector may therefore carry out the verification of weights just by observing the movement of the pointer. Situation B arises when the ratio of the MPE to the sensitivity figure of the balance is less than 3.

This procedure is applicable for verification of:

- hexagonal weights and weights of class M_2 or lower;
- cylindrical knob weights of class M_1, however for 500 g and 5 g bullion weights, one has to be careful; and
- fractional weights.

Although weights of class M_1 (bullion and carat weights used in India) may be verified by this method, it is advisable that observations are taken, actual mass differences are calculated, and weights are judged accordingly.

To explain the above stated procedure, a sample table for observations and decisions is given below. Various entries are as follows:

At S. No. A: With the working standard S+MPE on the RHP, the rest point R_S has been obtained nearly midway between the extreme left and the centre of the scale.

At S. No. 1: W1, the weight under test, replaces the working standard weight, with the MPE weights still on the RHP. So we are comparing W1+MPE with S+MPE. The tick in column 1 indicates that the pointer moves to the right. It means that W1+MPE is lighter than S+MPE, i.e. that W1 is lighter than S, and hence there is an R, or a Reject sign, in column 2.

At S. No. 2: W2, the weight under test replaces the working standard weight, with the MPE weights still on the RHP. A tick in column 3 indicates that the pointer overshoots left of the scale; it means that W2 is heavier than the standard. The MPE is to be removed from the RHP. The tick in column 4 indicates that the action is completed. The tick in column 5 indicates that the pointer moves to the right. This shows that the weight is lighter than S+MPE, meaning thereby that W2 is heavier than S but is lighter than S+MPE, i.e. that the weight is within the prescribed limits. Hence there is an A, or an Accept sign, in column 6.

At S. No. 3: W3, the weight under test replaces the working standard weight, with the MPE weights still on the RHP. The ticks in columns 3 and 4 have the same meaning as above. A tick in column 7 indicates that the weight is still heavier than S+MPE, hence there is an R, or a Reject sign, in column 8.

In this way, five weights may be verified in quick succession with reference to the same rest point R_S. Observations with S+MPE are taken again. If the rest point remains practically the same, then ten weights may be verified in quick succession, otherwise only five weights should be verified with reference to one rest point of the standard.

Working sheets for checking the accuracy of all categories of weights, together with their MPEs, as given at the bottom of the page, may be prepared. It is recommended that only proper working sheets should be used for checking accuracy.

SAMPLE TABLE FOR OBSERVATIONS AND DECISIONS

Hexagonal weights (Indian regulations)

S. No.	**Weight on RHP**	**Observations**		**Means**		**Rest point**			
A	S+MPE	R_1	R_3	$M_1=(R_1+R_3)/2$		$R_s=(M_1+M_2)/2$			
		R_2		$M_2=R_2$					
	Weight under test + MPE	Movement of pointer, action and decision taken							
		Right 1	Reject 2	Left 3	Remove MPE 4	Right 5	Accept 6	Left 7	Reject 8
1	W1+MPE	✓	Reject						
2	W2+MPE	-	-	✓	✓	✓	Accept		
3	W3+MPE	-	-	✓	✓	-	-	✓	Reject

Maximum permissible errors weights in mg (Indian regulations)

Nominal Value	**50 kg**	**20 kg**	**10 kg**	**5 kg**	**2 kg**	**1 kg**	**500 g**	**200 g**	**100 g**	**50 g**
MPE	7500	3000	1500	750	300	150	75	30	18	10

A self-explanatory sample table for recording the observations, calculation of rest-points, calculation of mass differences and conclusions is given below.

SAMPLE TABLE FOR OBSERVATIONS AND DECISIONS

Bullion and carat weights (class M_1)

S. No	Weights on RHP	Observations		Means	Rest point	Conclusions
1	$S + w_1$	R_1	R_3	$M_1 = (R_1+R_3)/2$	$R_S = (M_1+M_2)/2$	If $0 < (w_1-w_2) + (R_U–R_S)$, then $S < MPE$ Weight accepted, otherwise rejected
		R_2		$M_2 = R_2$		
2	$W + w_2$	R_1	R_3	$M_1 = (R_1+R_3)/2$	$R_U = (M_1+M_2)/2$	
		R_2		$M_2 = R_2$		
1	$S + w_1$					
2	$W1 + w_2$					
3	$W2 + w_2$					
4	$W3 + w_2$					
5	$W4 + w_2$					
6	$W5 + w_2$					
7	$S + w_1$					
8	$W6 + w_2$					
9	$W7 + w_2$					
10	$W8 + w_2$					
11	$W9 + w_2$					
12	$W10 + w_2$					

The mass of the weight under test, W, is then given by:

$$W = S + (w_1 – w_2) + (R_U – R_S)S$$

The condition for acceptance of the weight at the time of verification is:

$$0 < (w_1 – w_2) + S(R_U – R_S) < MPE$$

5.4 Verification of weights using electronic or single pan balances

1 Use the substitution method.

2 Place the working standard weight on the pan.

3 Note the indication I_S, after a stable reading is reached, but allow equal time intervals between placing the weight on the pan and noting the indication.

4 Replace the standard weight by the weight under test.

5 Note the indication I_U when a stable reading is reached, but allow equal time intervals between placing the weight on the pan and noting the indication.

If $0 < I_U - I_S < \text{MPE}$, accept the weight for stamping otherwise reject it.

Verify five weights in quick succession with same indication I_S. Place the working standard weight on the pan of the balance again and note the indication I_S. If it has not changed, another ten weights may be verified with the same I_S. Otherwise verify only five weights at a time.

6 Stamping

After verification, weights found to conform with the requirements (OIML Recommendations or national legislation) should be stamped as follows:

- Inspector's seal, for example identification, year and quarter are stamped on the lead pellet within the cavity if such a cavity is provided, otherwise on the bottom of the weight.
- No inspector's seal is stamped on weights of nominal values 10 mg, 5 mg, 2 mg and 1 mg.
- Inspector's seal for year only is stamped on weights of 20 mg and above.

7 Verification of dimensions

7.1 Rectangular bar weights of 50 kg to 5 kg according to OIML R 111 (type 1)

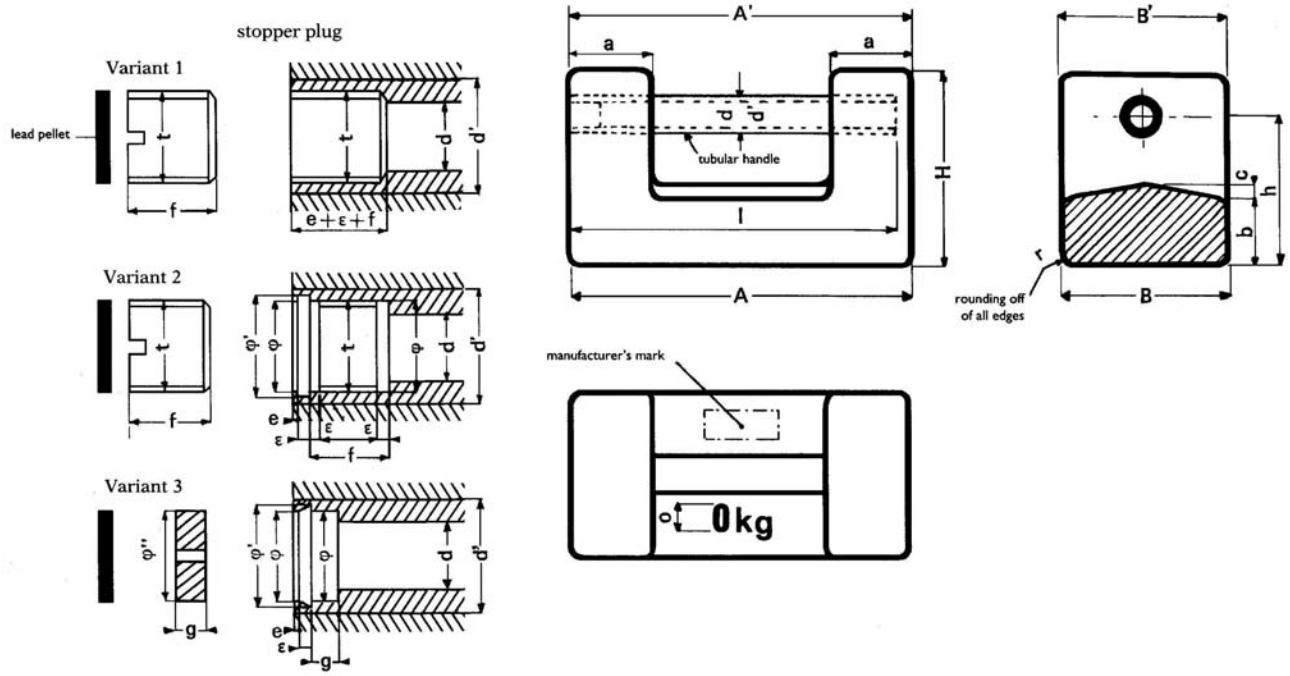


Figure 1

Dimensions of rectangular bar weights of 50 kg to 5 kg according to OIML R 111 (type 1)

Nominal value	A	A′	B	B′	H	a	b	c	h	d/d′	l	r	o	t	f	e	ε	ϕ	ϕ′	ϕ″	g
50 kg	310	314	155	157	192	83	74	16	152	24/32	300	10	25	M27x1.5	21	2	3	27.5	30	27	8
20 kg	230	234	115	117	139	61	52	12	109	24/32	220	8	20	M27x1.5	21	2	3	27.5	30	27	8
10 kg	190	193	95	97	109	46	38	8	84	12/20	185	6	16	M16x1.5	14	1	2	16.5	18	16	5
5 kg	150	152	75	77	84	36	30	6	66	12/20	145	5	12	M16x1.5	14	1	2	16.5	18	16	5

Note: All dimensions in millimetres

For accuracy check, use the working sheet given in 8.1 if using a two pan balance, or that in 9 if using a one pan / electronic balance.

Working sheet for checking dimensions – Rectangular bar weights of 50 kg to 5 kg according to OIML R 111 (type 1)			
Date:		Place:	
Name of inspector:		User's name:	

All dimensions are in millimetres

Nominal value	A	A′	B	B′	H	a	b	c	h	d/d′
50 kg	310	314	155	157	192	83	74	16	152	24/32
20 kg	230	234	115	117	139	61	52	12	109	24/32
10 kg	190	193	95	97	109	46	38	8	84	12/20
5 kg	150	152	75	77	84	36	30	6	66	12/20

7.2 Rectangular bar weights of 50 kg to 5 kg according to OIML R 111 (type 2)

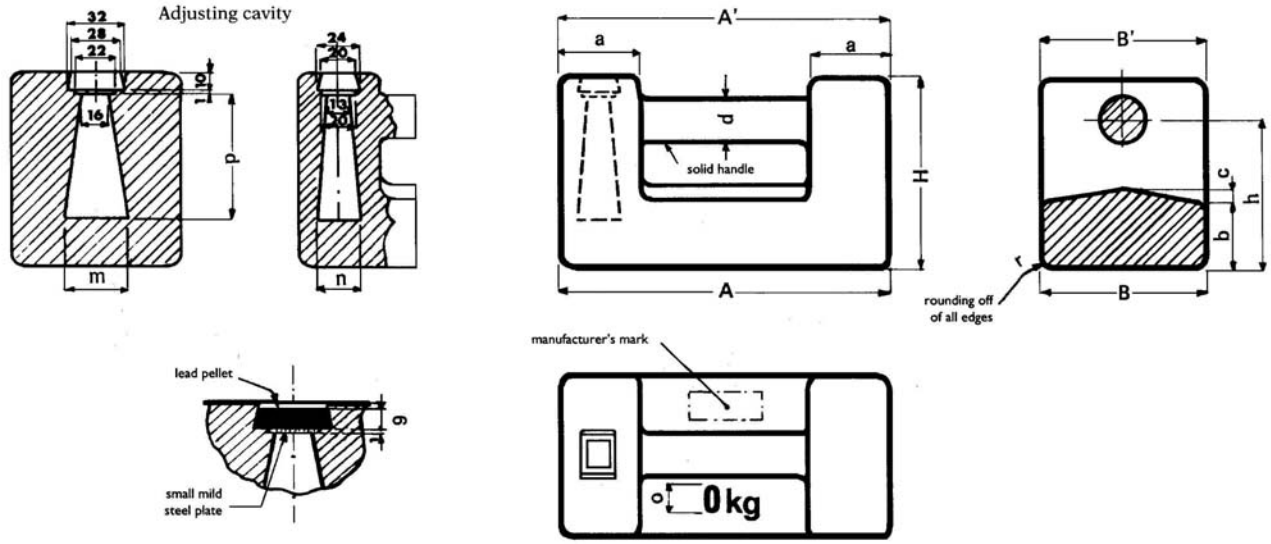


Figure 2

Dimensions of rectangular bar weights of 50 kg to 5 kg according to OIML R 111 (type 2)

Nominal value	A	A′	B	B′	H	a	b	c	H	d	r	o	m	n	p
50 kg	310	314	155	157	192	83	74	16	152	40	10	25	70	40	148
20 kg	230	234	115	117	139	61	52	12	109	29	8	20	50	30	95
10 kg	190	193	95	97	109	46	38	8	84	25	6	16	35	25	70
5 kg	150	152	75	77	84	36	30	6	66	19	5	12	16	13	55

Note: All dimensions in millimetres

For accuracy check, use the working sheet given in 8.1 if using a two pan balance, or that in 9 if using a one pan / electronic balance.

Working sheet for checking dimensions – Rectangular bar weights 50 kg to 5 kg according to OIML R 111 (type 2)			
Date:		Place:	
Name of inspector:		User's name:	

All dimensions are in millimetres

Nominal value	**A**	**A′**	**B**	**B′**	**H**	**a**	**b**	**c**	**h**	**d**
50 kg	310	314	155	157	192	83	74	16	152	40
20 kg	230	234	115	117	139	61	52	12	109	29
10 kg	190	193	95	97	109	46	38	8	84	25
5 kg	150	152	75	77	84	36	30	6	66	19

7.3 Cylindrical weights of 20 kg to 1 g according to OIML R 111

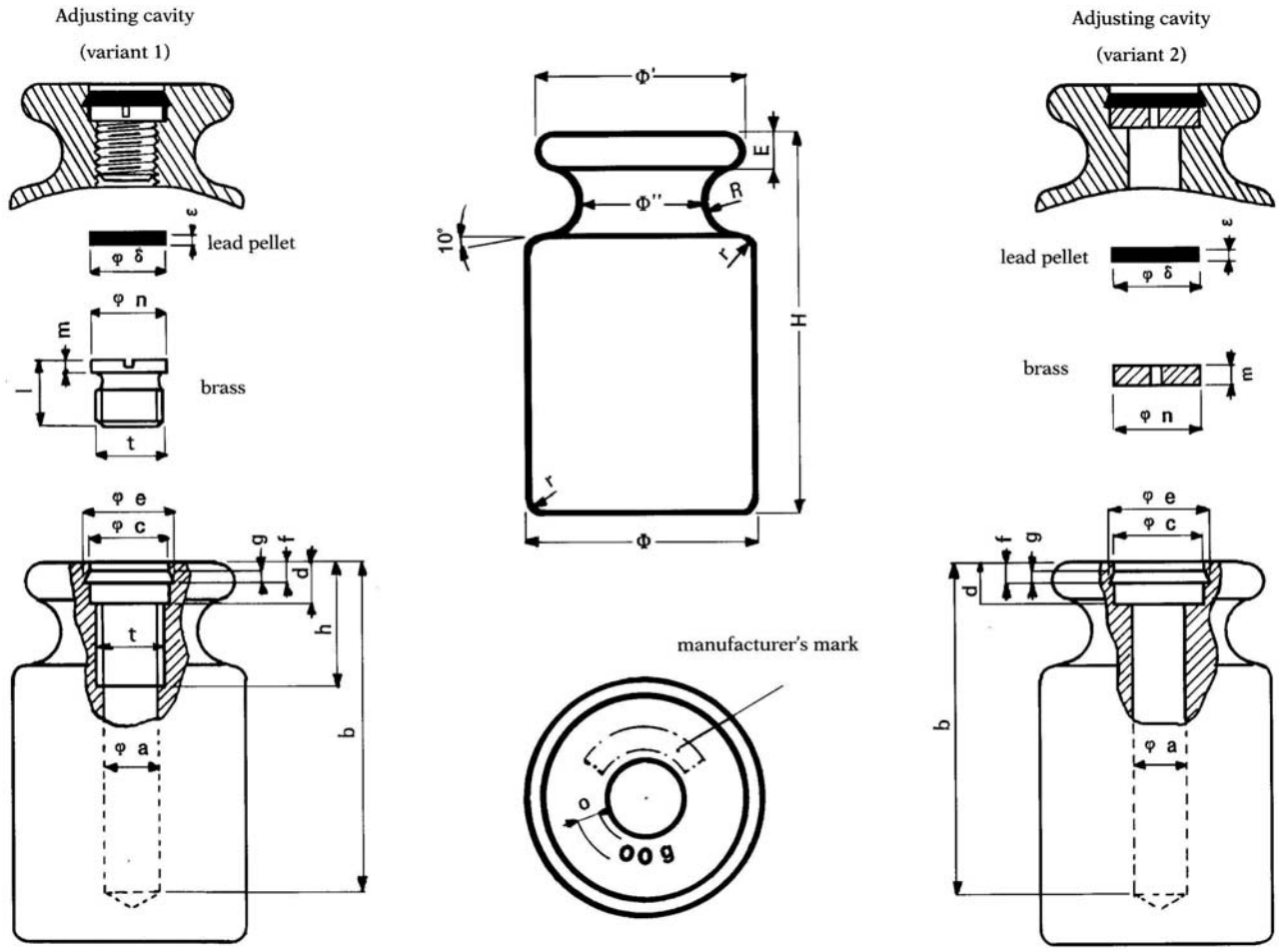


Figure 3

Dimensions of cylindrical weights of 20 kg to 1 g according to OIML R 111

Nominal value	Φ	Φ′	Φ″	E	R	r	o
20 kg	128	112	74	22	18	3	10
10 kg	100	90	58	17	15	3	10
5 kg	80	72	46	13	12	2	10
2 kg	60	54	36	10	9	2	5
1 kg	48	43	27	8	7	2	5
500 g	38	34	22	6	5.5	1.5	3.2
200 g	28	25	16	4.5	4	1.5	3.2
100 g	22	20	13	4	3.5	1	2
50 g	18	16	10	3	2.5	1	2
20 g	13	11.5	7.5	2	1.8	0.5	1.5
10 g	10	9	6	1.6	1.5	0.5	1
5 g	8	7	4.5	1.4	1.25	0.5	1
2 g	6	5.5	3	1	0.9	0.5	1
1 g	6	5.5	3	1	0.9	0.5	1

Note: All dimensions in millimetres

Dimensions of cavity for weights from 20 kg to 50 g in millimetres

Nominal value	a	b	c	d	e	f	g	H	t	l	m	N	δ	ε
20 kg	18	160	24.5	8	26.5	4	2.5	35	M20x1.5	18	4	24	24	3
10 kg	18	160	24.5	8	26.5	4	2.5	35	M20x1.5	18	4	24	24	3
5 kg	18	120	24.5	8	26.5	4	2.5	35	M20x1.5	18	4	24	24	3
2 kg	12	80	18.5	7	20	4	2.5	20	M14x1.5	13	3	18	18	3
1 kg	12	65	18.5	7	20	4	2.5	20	M14x1.5	13	3	18	18	3
500 g	7	50	10.5	4.5	12	2.5	1.5	15	M8x1	8	2	10	10	2
200 g	7	40	10.5	4.5	12	2.5	1.5	15	M8x1	8	2	10	10	2
100 g	4.5	30	7.5	3.5	9	2	1	10	M6x0.5	5	1.5	7	7	1.5
50 g	4.5	25	7.5	3.5	9	2	1	10	M6x0.5	5	1.5	7	7	1.5
20 g	3	18	5.5	2.5	6.5	1.5	1	9	M4x0.5	5	1	5	5	1

Note: All dimensions in millimetres

Note: The values of 'a' would depend upon the adjusting material used in variant 1

For accuracy check, use the working sheet given in 8.2 if using a two pan balance, or that in 9 if using a one pan / electronic balance.

Working sheet for checking dimensions – Cylindrical weights of 20 kg to 1 g according to OIML R 111			
Date:		Place:	
Name of inspector:		User's name:	

All dimensions are in millimetres

Nominal value	Φ	Φ′	Φ″	E	R	r	o
20 kg	128	112	74	22	18	3	10
10 kg	100	90	58	17	15	3	10
5 kg	80	72	46	13	12	2	10
2 kg	60	54	36	10	9	2	5
1 kg	48	43	27	8	7	2	5
500 g	38	34	22	6	5.5	1.5	3.2
200 g	28	25	16	4.5	4	1.5	3.2
100 g	22	20	13	4	3.5	1	2
50 g	18	16	10	3	2.5	1	2
20 g	13	11.5	7.5	2	1.8	0.5	1.5
10 g	10	9	6	1.6	1.5	0.5	1
							No Loading
							Hole
5 g	8	7	4.5	1.4	1.25	0.5	1
							No loading
							Hole
2 g	6	5.5	3	1	0.9	0.5	1
							No loading
							Hole
1 g	6	5.5	3	1	0.9	0.5	1
							No loading
							Hole

7.4 Hexagonal weights of 50 kg to 5 kg according to OIML R 52

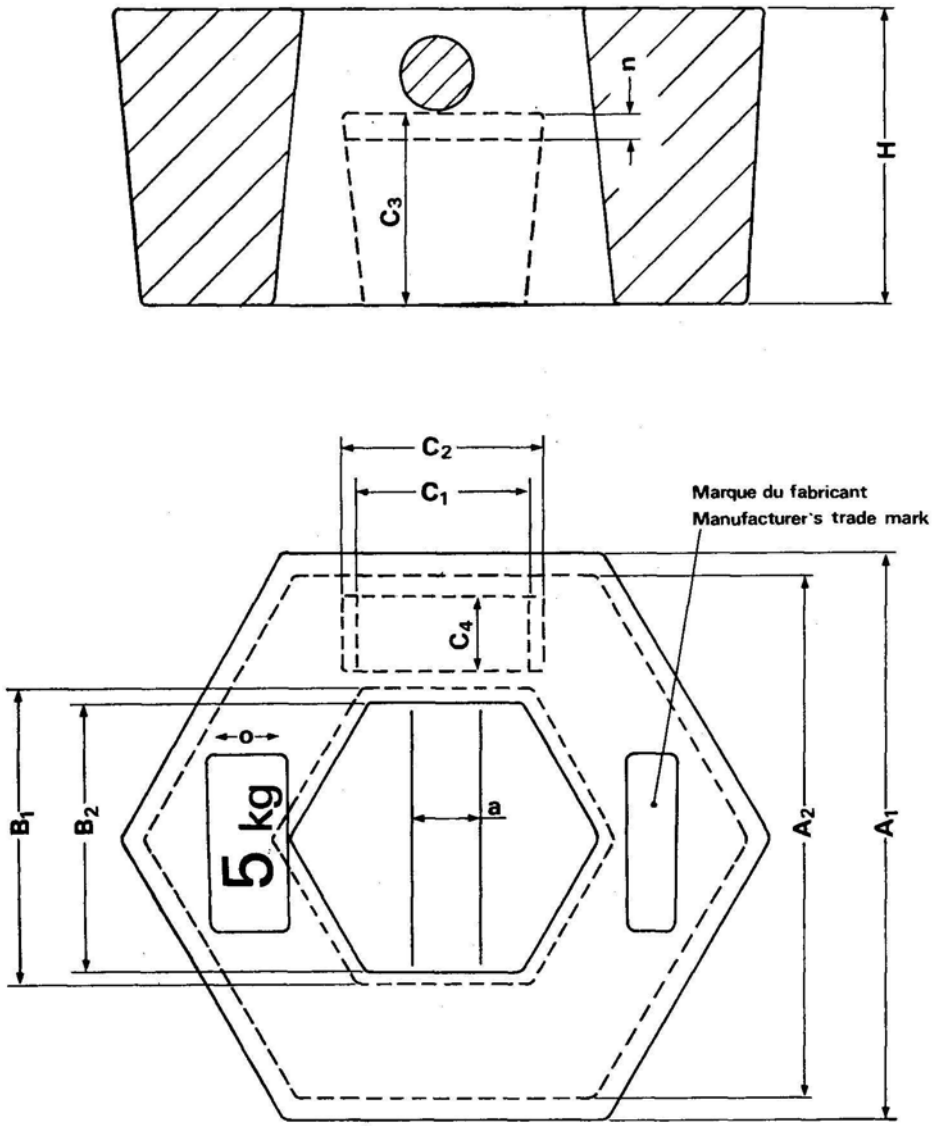


Figure 4

Dimensions of hexagonal weights of 50 kg to 5 kg according to R 52

Nominal value	A_1	A_2	B_1	B_2	H	a	O	C_1	C_2	C_3	C_4	n*
50 kg	283	266	150	135	150	40	14	105	135	110	30	5
20 kg	210	198	110	100	112	25	14	63	77	70	30	5
10 kg	165	155	90	80	96	20	10	53	66	60	22	5
5 kg	139	130	80	70	68	19	10	35	49	55	17	5

Note: All dimensions in millimetres

* The minimum value of n is given.

For accuracy check, use the working sheet given in 8.4 if using a two pan balance, or that in 9 if using a one pan / electronic balance.

Working sheet for checking dimensions – Hexagonal weights of 50 kg to 5 kg according to OIML R 52			
Date:		Place:	
Name of inspector:		User's name:	

All dimensions are in millimetres

Nominal value	A_1	A_2	B_1	B_2	H	a	C_2	C_4	O	n*
50 kg	283	266	150	135	150	40	135	30	14	5
20 kg	210	198	110	100	112	25	77	30	14	5
10 kg	165	155	90	80	96	20	66	22	10	5
5 kg	139	130	80	70	68	19	49	17	10	5

* The minimum value of n is given.

7.5 Hexagonal weights of 2 kg to 100 g according to OIML R 52

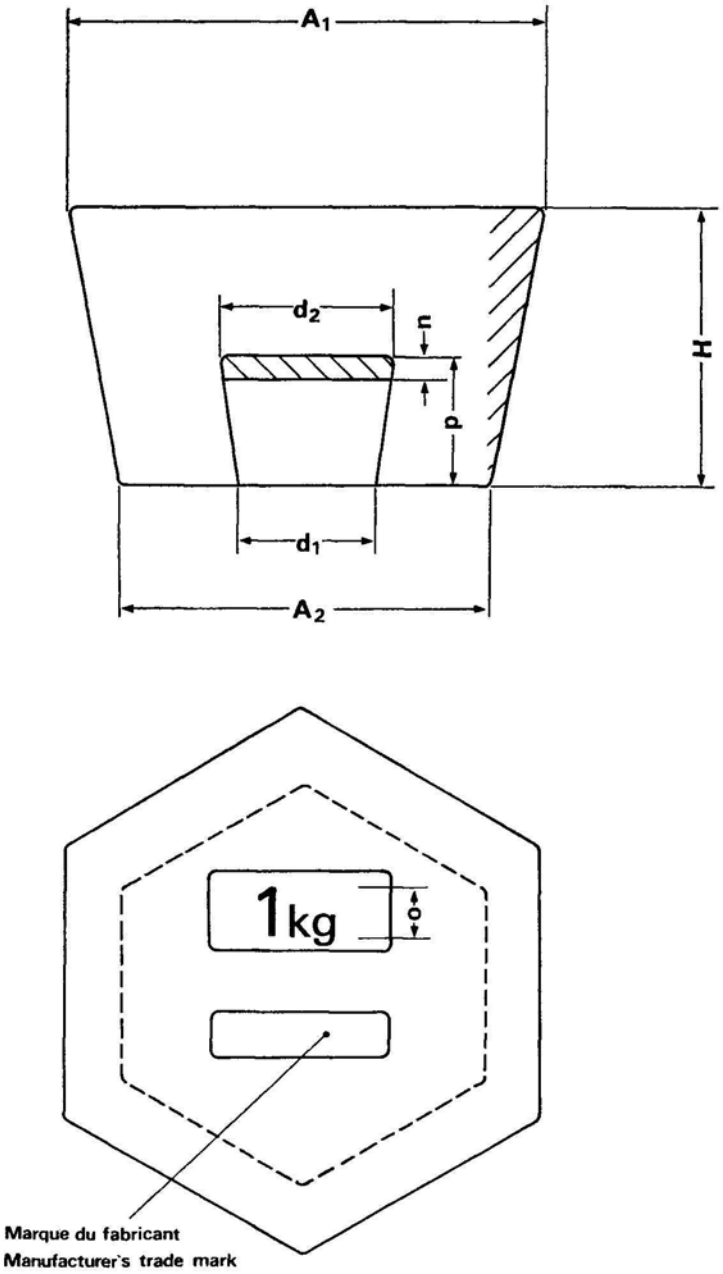


Figure 5

Dimensions of hexagonal weights of 2 kg to 100 g according to OIML R 52

Nominal value	A_1	A_2	H	O	d_1	d_2	p	n*
2 kg	89	69	55	5	33	42	30	4
1 kg	71	55	44	5	26	33	25	4
500 g	56	44	35	4	20	26	20	3
200 g	42	34	26	4	15	19	15	3
100 g	34	26	21	3	12	15	12	2

Note: All dimensions in millimetres

For accuracy check, use the working sheet given in 8.4 if using a two pan balance, or that in 9 if using a one pan / electronic balance.

Working sheet for checking dimensions – Hexagonal weights of 2 kg to 100 g according to OIML R 52			
Date:		Place:	
Name of inspector:		User's name:	

All dimensions are in millimetres

Nominal value	A_1	A_2	H	O	d_1
2 kg	89	69	55	5	33
1 kg	71	55	44	5	26
500 g	56	44	35	4	20
200 g	42	34	268	4	15
100 g	34	26	21	3	12

7.6 Cylindrical weights of 5000 kg suitable for rolling according to OIML R 47

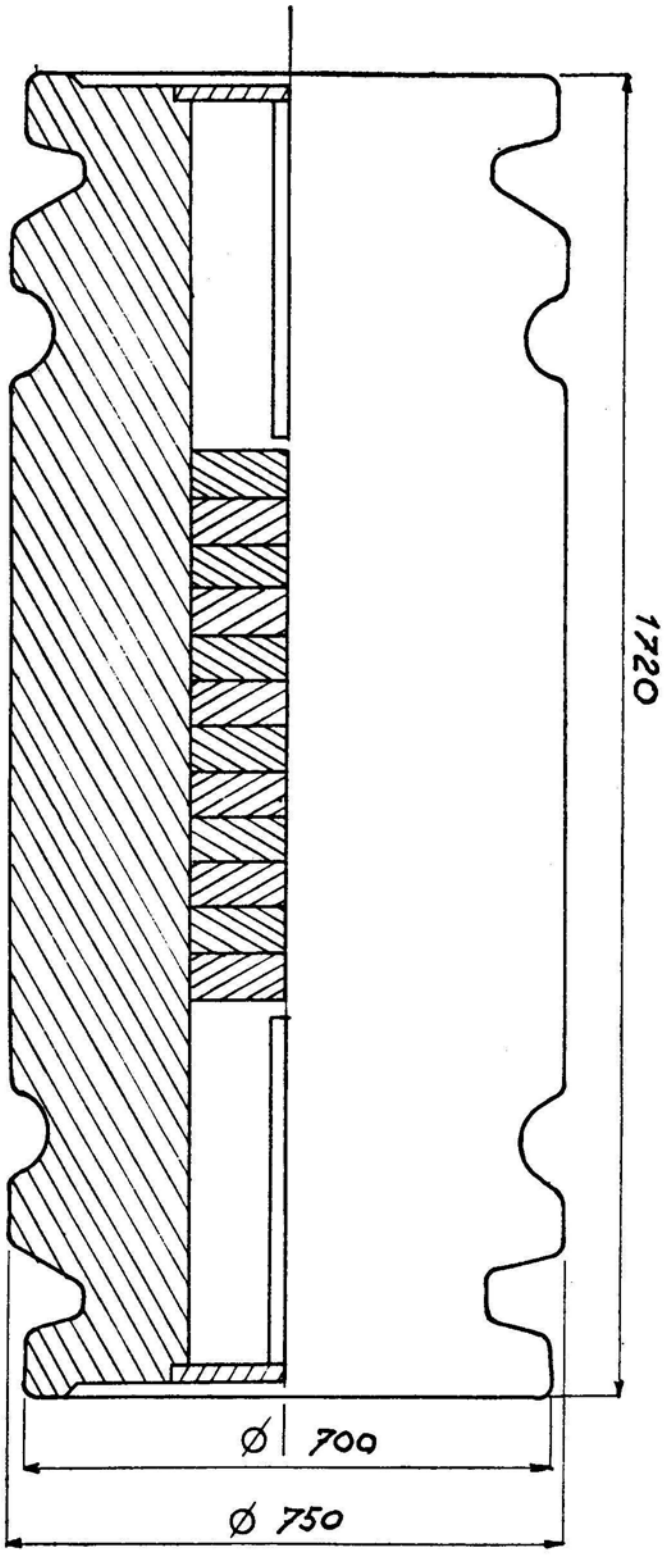


Figure 6

Dimensions of cylindrical weights of 5000 kg (suitable for rolling) according to OIML R 47

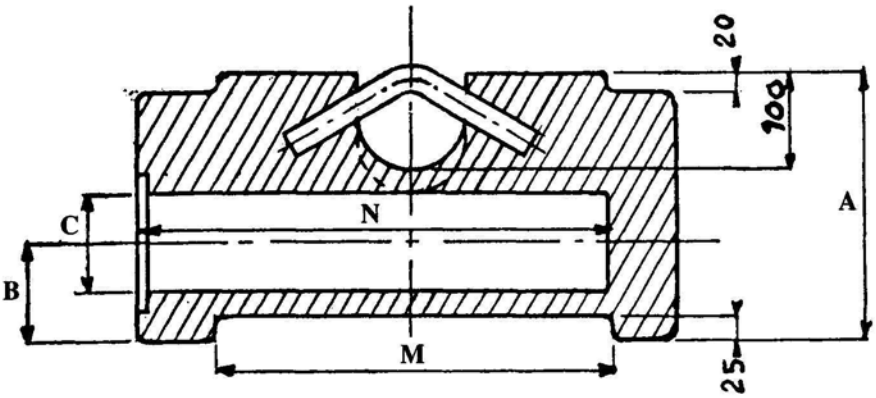
For accuracy check, use the working sheet given in 8.3 if using a two pan balance, or that in 9 if using a one pan / electronic balance.

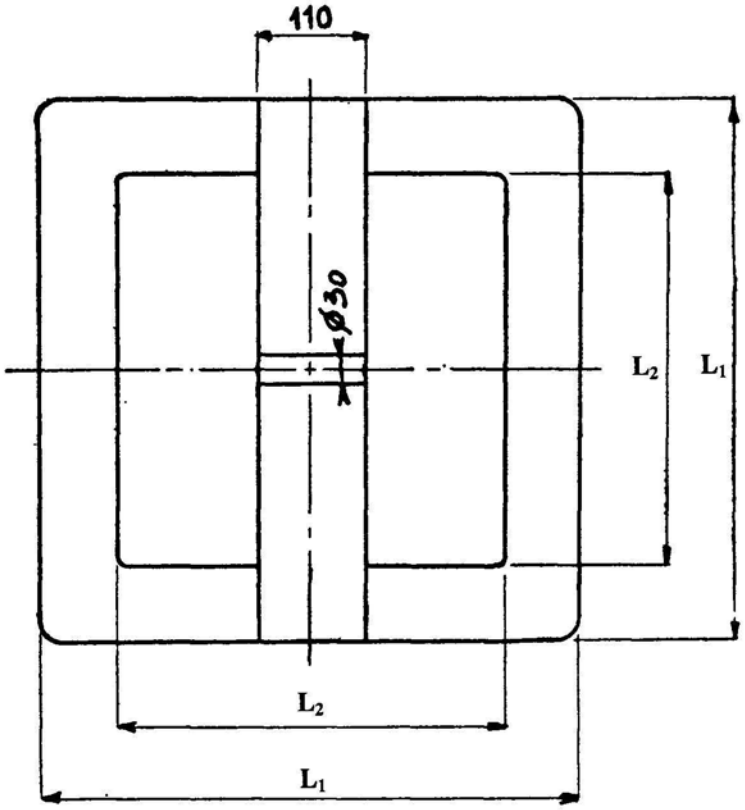
Working sheet for checking dimensions – Cylindrical weights of 5000 kg (suitable for rolling) according to OIML R 47			
Date:		Place:	
Name of inspector:		User's name:	

All dimensions are in millimetres

Nominal value	Length	Maximum diameter
5000 kg	1720	750

7.7 Rectangular weights of 500 kg and 1000 kg suitable for stacking according to OIML R 47





Note: All dimensions in millimetres

For accuracy check, use the working sheet given in 8.3 if using a two pan balance, or that in 9 if using a one pan / electronic balance.

Working sheet for checking dimensions – Rectangular weights of 500 kg and 1000 kg suitable for stacking according to OIML R 47			
Date:		Place:	
Name of inspector:		User's name:	

All dimensions are in millimetres

Nominal value	**A**	**B**	**CΦ**	**L_1**	**L_2**	**M**	**N**
1000 kg	504	120	140	560	400	410	480
500 kg	273	100	100	560	400	410	480

7.8 Cylindrical weights of 500 kg and 1000 kg suitable for stacking and rolling according to OIML R 47

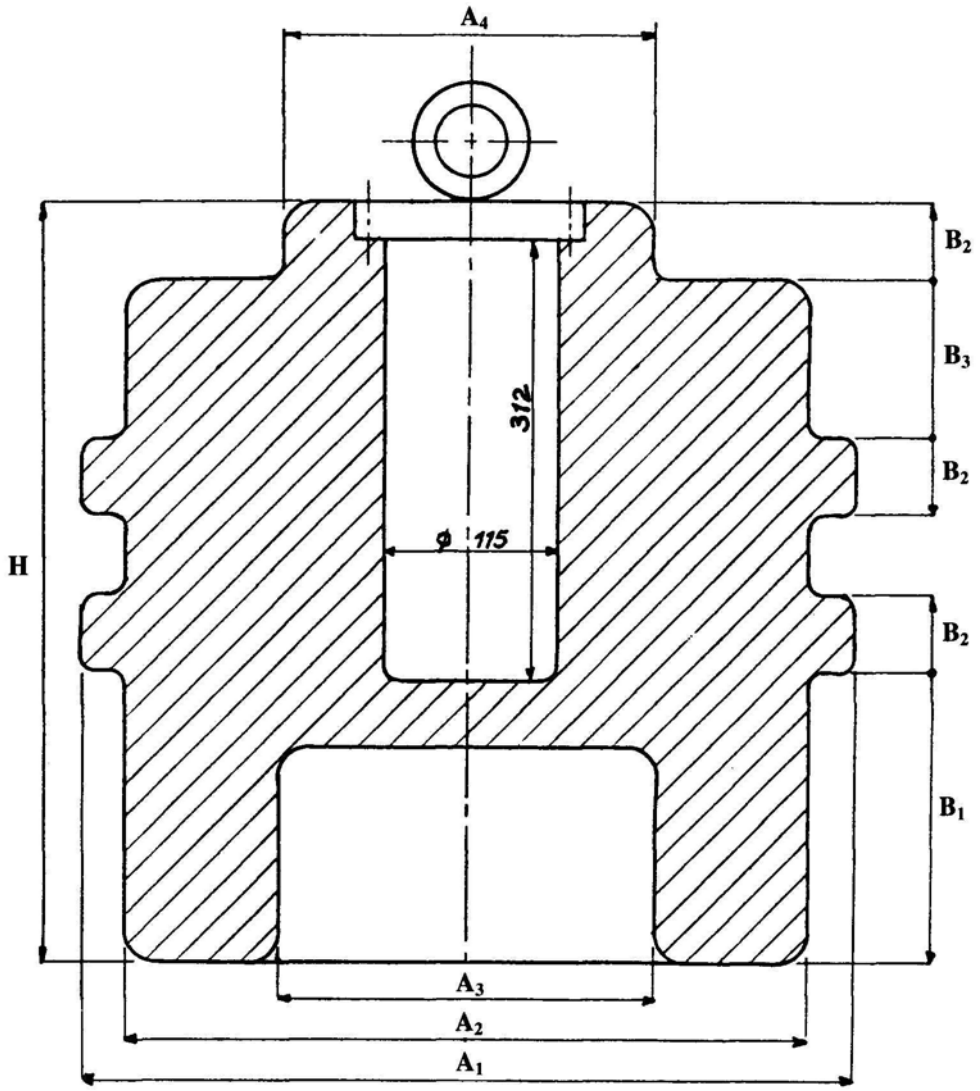


Figure 8

Cylindrical weights of 500 kg suitable for stacking and rolling according to OIML R 47

For accuracy check, use the working sheet given in 8.3 if using a two pan balance, or that in 9 if using a one pan / electronic balance.

Working sheet for checking dimensions – Cylindrical weights of 500 kg and 1000 kg suitable for stacking and rolling according to OIML R 47			
Date:		Place:	
Name of inspector:		User's name:	

All dimensions are in millimetres

Nominal value	**A_1**	**A_2**	**A_3**	**A_4**	**B_1**	**B_2**	**B_3**	**H**
500 kg	510	450	251	249	190	50	105	495

7.9 Hexagonal weights of 50 kg to 5 kg (with cast handle) according to Indian regulations

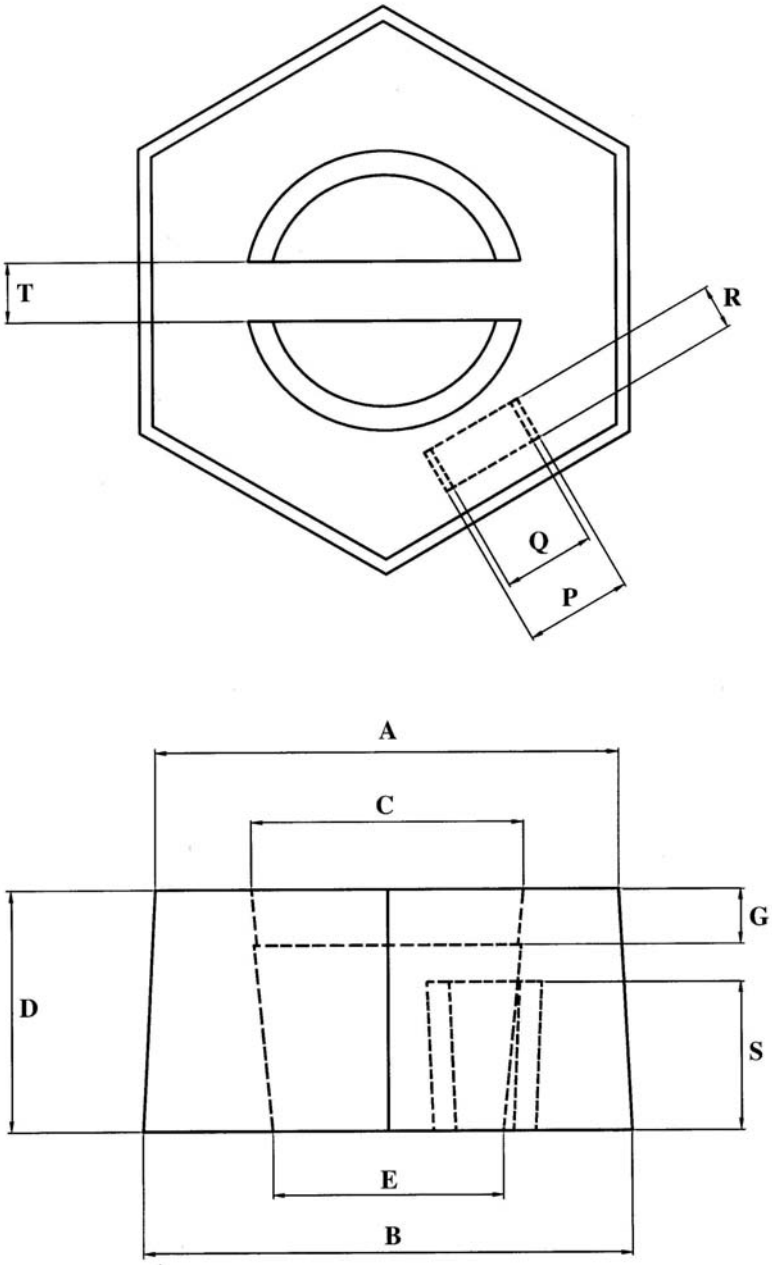


Figure 9

Dimensions of hexagonal weights of 50 kg to 5 kg (with cast handle) according to Indian regulations

Nominal value	A	B	C	D	E	G	P	Q	R	S	T
50 kg	236	253	134	170	100	27	58	48	24	102	32
20 kg	188	200	112	113	90	21	44	38	19	66	22
10 kg	152	161	92	88	74	18	36	30	15	54	19
5 kg	125	132	75	65	62	15	29	25	12	40	16

Note: All dimensions in millimetres

For accuracy check, use the working sheet given in 8.4 if using a two pan balance, or that in 9 if using a one pan / electronic balance.

Working sheet for checking dimensions – Hexagonal weights of 50 kg to 5 kg (with cast handle) according to Indian regulations			
Date:		Place:	
Name of inspector:		User's name:	

All dimensions are in millimetres

Nominal value	A	B	C	D	E	G	P	Q	R	S	T
50 kg	236	253	134	170	100	27	58	48	24	102	32
20 kg	188	200	112	113	90	21	44	38	19	66	22
10 kg	152	161	92	88	74	18	36	30	15	54	19
5 kg	125	132	75	65	62	15	29	25	12	40	16

7.10 Hexagonal weights of 2 kg to 50 g (nesting type) according to Indian regulations

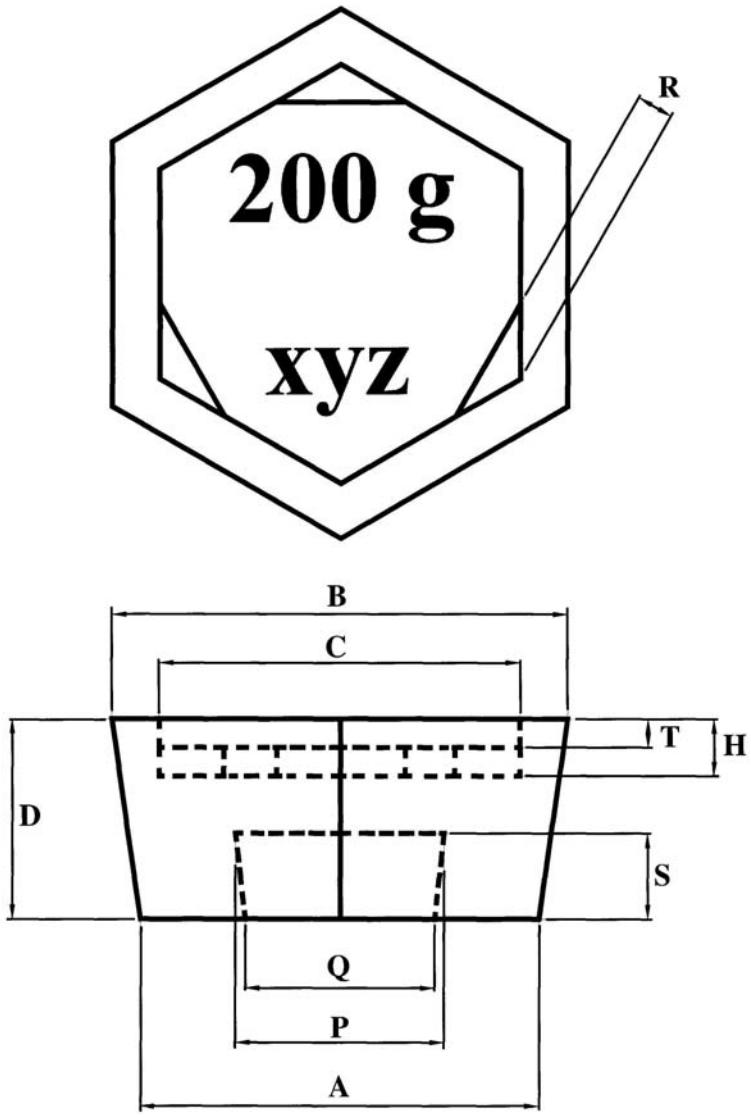


Figure 10

Dimensions of hexagonal weights of 2 kg to 50 g (nesting type) according to Indian regulations

Nominal value	A	B	C	D	H	P	Q	R	S	T
2 kg	94	101	78	41	10	34	30	9	18	4
1 kg	73	79	62	34	8	32	28	8	16	4
500 g	57	62	47	27	6	23	20	6	13	3
200 g	42	48	38	21	6	22	20	4	9	3
100 g	33	38	31	17	5	18	16	3	7	2.5
50 g	27	31	24	12	3	16	14	3	5	2

Note: All dimensions in millimetres

For accuracy check, use the working sheet given in 8.4 if using a two pan balance, or that in 9 if using a one pan / electronic balance.

Working sheet for checking dimensions – Hexagonal weights of 2 kg to 50 g (nesting type) according to Indian regulations			
Date:		Place:	
Name of inspector:		User's name:	

All dimensions are in millimetres

Nominal value	A	B	C	D	H	P	Q	R	S	T
2 kg	94	101	78	41	10	34	30	9	18	4
1 kg	73	79	62	34	8	32	28	8	16	4
500 g	57	62	47	27	6	23	20	6	13	3
200 g	42	48	38	21	6	22	20	4	9	3
100 g	33	38	31	17	5	18	16	3	7	2.5
50 g	27	31	24	12	3	16	14	3	5	2

7.11 Flat cylindrical disc weights of 1 kg to 1 g (nesting type) according to Indian regulations

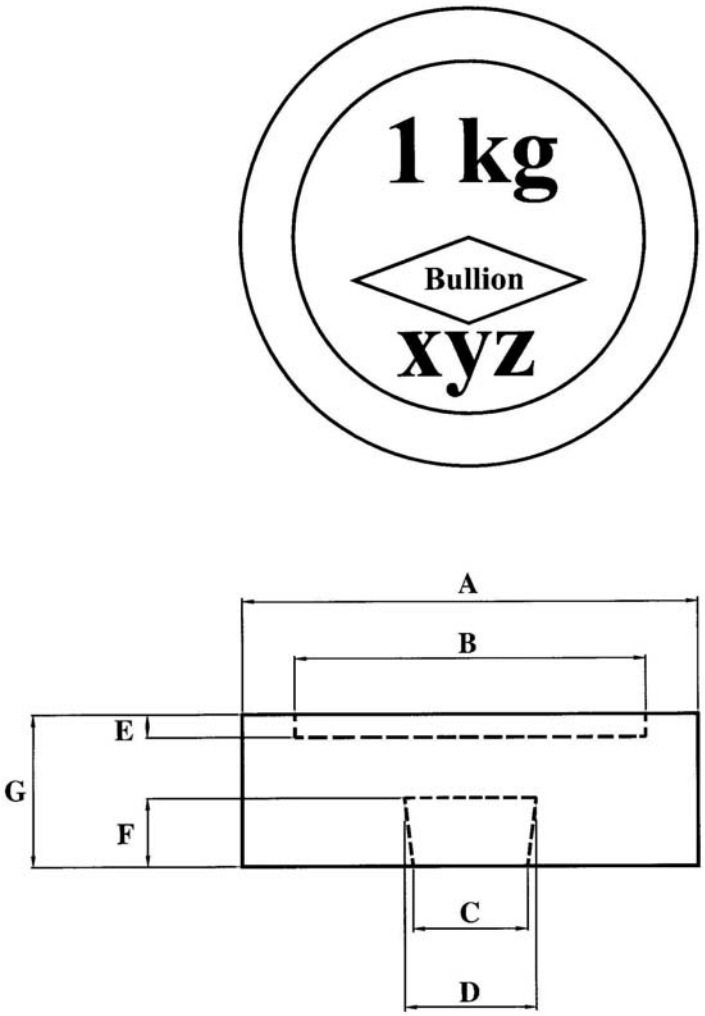


Figure 11

Dimensions of flat cylinder disc weights of 1 kg to 1 g (nesting type) according to Indian regulations

Nominal value	A	B	C	D	E	F	G
1 kg	80	61.5	20	23	4.0	12	26.6
500 g	61	48.5	16	19	2.5	10	22.5
200 g	48	37.5	14	16	2.0	7	14.8
100 g	37	28.5	12	14	2.0	6	12.7
50 g	28	21.5	10	11	1.5	3	11.0
20 g	21	16.5	9	10	1.5	3	8.4
10 g	16	12.5	-	-	1.5	-	6.9
5 g	12	9.5	-	-	1.0	-	5.9
2 g	9	7.0	-	-	1.0	-	4.4
1 g	6.5	-	-	-	-	-	3.6

Note: All dimensions in millimetres

For accuracy check, use the working sheet given in 8.4 for non-bullion weights and the working sheet given in 8.6 for bullion weights if using a two pan balance, or in either case, that in 9 if using a one pan / electronic balance.

Working sheet for checking dimensions – Flat cylindrical disc weights of 1 kg to 1 g (nesting type) according to Indian regulations			
Date:		Place:	
Name of inspector:		User's name:	

All dimensions are in millimetres

Nominal value	A	B	G	C	D	F	E
1 kg	80	61.5	26.6	20	23	12	4.0
500 g	61	48.5	22.5	16	19	10	2.5
200 g	48	37.5	14.8	14	16	7	2.0
100 g	37	28.5	12.7	12	14	6	2.0
50 g	28	21.5	11.0	10	11	5	1.5
20 g	21	16.5	8.4	9	10	3	1.5
10 g	16	12.5	6.9	-	-	-	1.5
5 g	12	9.5	5.9	-	-	-	1.0
2 g	9	7.0	4.4	-	-	-	1.0
1 g	6.5	-	3.6	-	-	-	-

7.12 Bullion and non-bullion fractional weights according to Indian regulations

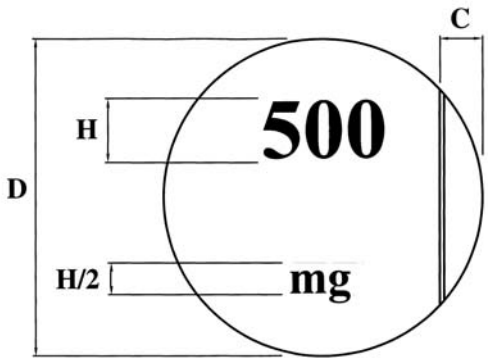


Figure 12 A

Sheet metal bullion weights

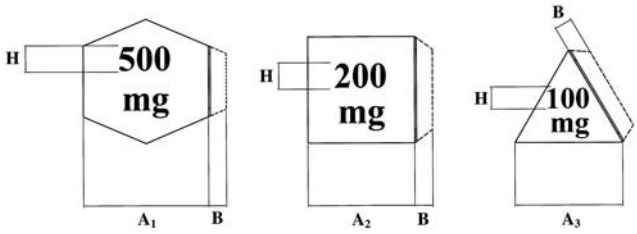


Figure 12 B

Sheet metal non-bullion weights

Nominal value	D Φ	C	H
500 mg	15.0	2.0	3.0
200 mg	13.0	2.0	3.0
100 mg	11.0	2.0	2.5
50 mg	9.0	1.5	2.5
20 mg	8.0	1.5	2.5
10 mg	7.0	1.5	2.5
5 mg	6.0	1.0	2.0
2 mg	5.0	1.0	2.0
1 mg	4.0	1.0	2.0

Nominal value	A_1	A_2	A_3	B	H
500 mg	14.0			2.0	3.0
200 mg		12.0		2.0	3.0
100 mg			12.0	2.0	2.5
50 mg	8.0			1.5	2.5
20 mg		7.0		1.5	2.5
10 mg			7.0	1.5	2.5
5 mg	4.5			1.0	2.0
2 mg		4.0		1.0	2.0
1 mg			4.0	1.0	2.0

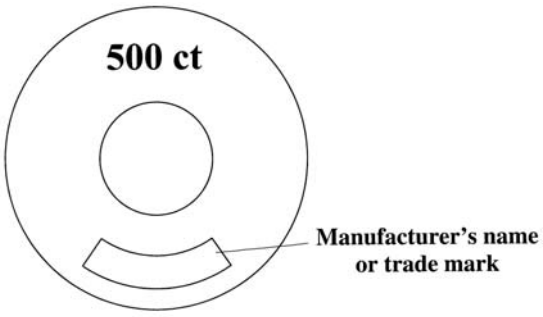
For accuracy check, use the working sheet given in 8.5 for non-bullion weights and the working sheet given in 8.7 for bullion weights if using a two pan balance, or in either case, that in 9 if using a one pan / electronic balance.

Working sheet for checking dimensions – Bullion and non-bullion fractional weights according to Indian regulations			
Date:		Place:	
Name of inspector:		User's name:	

All dimensions are in millimetres

Nominal value	Non-bullion weights				Bullion weights		
	A_1	A_2	A_3	B	D Φ	C	H
500 mg	14.0			2.0	15.0	2.0	3.0
200 mg		12.0		2.0	13.0	2.0	3.0
100 mg			12.0	2.0	11.0	2.0	2.5
50 mg	8.0			1.5	9.0	1.5	2.5
20 mg		7.0		1.5	8.0	1.5	2.5
10 mg			7.0	1.5	7.0	1.5	2.5
5 mg	4.5			1.0	6.0	1.0	2.0
2 mg		4.0		1.0	5.0	1.0	2.0
1 mg			4.0	1.0	4.0	1.0	2.0

7.13 Carat weights from 500 ct to 0.005 ct according to Indian regulations



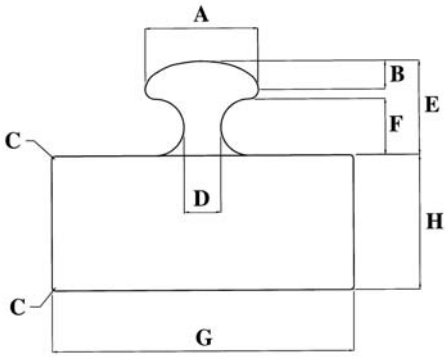


Figure 13 A

Carat weights 500 ct to 5 ct

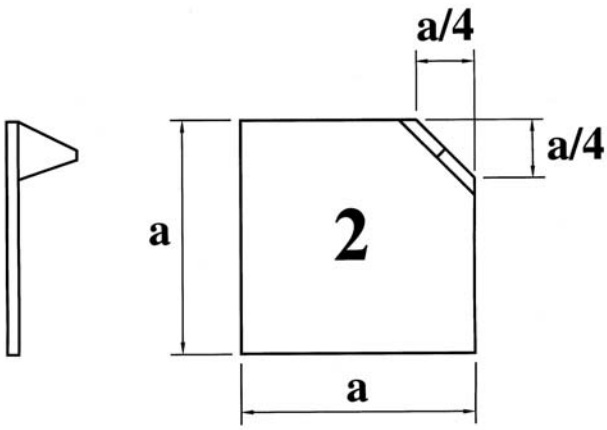


Figure 13 B

Sheet metal carat weights 2 ct to 0.005 ct

Dimensions of carat weights from 500 ct to 5 ct according to Indian regulations

Nominal value	A*	C**	D	E	F	G	H
500 ct	12	0.4	4.0	10	6	32	14.2
200 ct	10	0.4	3.0	8.5	5	23	10.8
100 ct	8	0.4	2.5	7	4	19	7.9
50 ct	6	0.3	2.0	5.5	3.0	15	6.4
20 ct	5	0.3	2.0	4.0	2.0	11	4.6
10 ct	4	0.3	1.5	3	1.5	9	3.5
5 ct	3	0.3	1.5	2.5	1.5	7	2.9

Note: All dimensions in millimetres

* The cross-section of the top of the knob is elliptical. For all weights, the major axis is twice the minor axis, i.e. B = A / 4.

** This is a recommended dimension only.

Dimensions of sheet metal carat weights from 2 ct to 0.005 ct according to Indian regulations

Nominal value	2 ct	1 ct	0.5 ct	0.2 ct	0.1 ct	0.05 ct	0.02 ct	0.01 ct	0.005 ct
a	12	10	9	8	7	6	5	4	3

Note: All dimensions in millimetres

For accuracy check, use the working sheet given in 8.8 if using a two pan balance, or that in 9 if using a one pan / electronic balance.

Working sheet for checking dimensions – Carat weights from 500 ct to 5 ct according to Indian regulations			
Date:		Place:	
Name of inspector:		User's name:	

All dimensions are in millimetres

Nominal value	A	D	E	G	H
500 ct	12.0	4.0	10.0	32.0	14.2
200 ct	10.0	3.0	8.5	23.0	10.8
100 ct	8.0	2.5	7.0	19.0	7.9
50 ct	6.0	2.0	5.5	15.0	6.4
20 ct	5.0	2.0	4.0	11.0	4.6
10 ct	4.0	1.5	3.0	9.0	3.5
5 ct	3.0	1.5	2.5	7.0	2.9

8 Working sheets for accuracy checks

8.1 Working sheet for accuracy check – Rectangular bar weights of class M_2 and lower

Date:		Place:			
Name of inspector:		User's name:			
No. of working standard:		Balance used:		Sensitivity figure:	

S. no.	Weight on RHP	Observations		Means		Rest point			
A	S + w_1	R_1	R_3	$M_1 = (R_1+R_3)/2$		$R_S = (M_1+M_2)/2$			
		R_2		$M_2 = R_2$					
	Weight under test + MPE	Movement of pointer, action and decisions							
		Right 1	Reject 2	Left 3	Remove MPE 4	Right 5	Accept 6	Left 7	Reject 8
1	W1+MPE								
2	W2+MPE								
3	W3+MPE								
4	W4+MPE								
5	W5+MPE								
B	S+MPE	R_1	R_3	$M_1 = (R_1+R_3)/2$		$R_S = (M_1+M_2)/2$			
		R_2		$M_2 = R_2$					
	Weight under test + MPE	Movement of pointer, action and decisions							
		Right	Reject	Left	Remove MPE	Right	Accept	Left	Reject
6	W1+MPE								
7	W2+MPE								
8	W3+MPE								
9	W4+MPE								
10	W5+MPE								
C	S+MPE	R_1	R_3	$M_1 = (R_1+R_3)/2$		$R_S = (M_1+M_2)/2$			
		R_2		$M_2 = R_2$					
	Weight under test + MPE	Movement of pointer, action and decisions							
		Right	Reject	Left	Remove MPE	Right	Accept	Left	Reject
11	W1+MPE								
12	W2+MPE								
13	W3+MPE								
14	W4+MPE								
15	W5+MPE								

Maximum permissible errors for rectangular bar weights

Nominal value	50 kg	20 kg	10 kg	5 kg
MPE (mg)	8000	3000	1600	800

8.2 Working sheet for accuracy check – OIML cylindrical knob weights of class M_2 and lower

Date:		Place:			
Name of inspector:		User's name:			
No. of working standard:		Balance used:		Sensitivity figure:	

S. no.	Weight onRHP	Observations		Means		Rest point			
A	$S+w_1$	R_1	R_3	$M_1 = (R_1+R_3)/2$		$R_S = (M_1+M_2)/2$			
		R_2		$M_2 = R_2$					
	Weight under test + MPE	Movement of pointer, action and decisions							
		Right 1	Reject 2	Left 3	Remove MPE 4	Right 5	Accept 6	Left 7	Reject 8
1	W1+MPE								
2	W2+MPE								
3	W3+MPE								
4	W4+MPE								
5	W5+MPE								
B	S+MPE	R_1	R_3	$M_1 = (R_1+R_3)/2$		$R_S = (M_1+M_2)/2$			
		R_2		$M_2 = R_2$					
	Weight under test + MPE	Movement of pointer, action and decisions							
		Right	Reject	Left	Remove MPE	Right	Accept	Left	Reject
6	W1+MPE								
7	W2+MPE								
8	W3+MPE								
9	W4+MPE								
10	W5+MPE								
C	S+MPE	R_1	R_3	$M_1 = (R_1+R_3)/2$		$R_S = (M_1+M_2)/2$			
		R_2		$M_2 = R_2$					
	Weight under test +MPE	Movement of pointer, action and decisions							
		Right	Reject	Left	Remove MPE	Right	Accept	Left	Reject
11	W1+MPE								
12	W2+MPE								
13	W3+MPE								
14	W4+MPE								
15	W5+MPE								

Maximum permissible errors for class M_2 weights according to OIML R 111

Nominal value	20 kg	10 kg	5 kg	2 kg	1 kg	500 g	200 g	100 g	50 g	20 g	10 g	5 g	2 g	1 g
MPE (mg)	3000	1600	800	300	160	80	30	16	10	8	6	5	4	3

8.3 Working sheet for accuracy check – OIML weights of 500 kg and above, of class M_2 and lower

Date:		Place:	
Name of inspector:		User's name:	

No. of working standard:		Balance used:		Sensitivity figure:	

S. no.	Weight onRHP	Observations		Means		Rest point			
A	$S+w_1$	R_1	R_3	$M_1 = (R_1+R_3)/2$		$R_S = (M_1+M_2)/2$			
		R_2		$M_2 = R_2$					
	Weight under test + MPE	Movement of pointer, action and decisions							
		Right 1	Reject 2	Left 3	Remove MPE 4	Right 5	Accept 6	Left 7	Reject 8
1	W1+MPE								
2	W2+MPE								
3	W3+MPE								
4	W4+MPE								
5	W5+MPE								
B	S+MPE	R_1	R_3	$M_1 = (R_1+R_3)/2$		$R_S = (M_1+M_2)/2$			
		R_2		$M_2 = R_2$					
	Weight under test + MPE	Movement of pointer, action and decisions							
		Right	Reject	Left	Remove MPE	Right	Accept	Left	Reject
6	W1+MPE								
7	W2+MPE								
8	W3+MPE								
9	W4+MPE								
10	W5+MPE								
C	S+MPE	R_1	R_3	$M_1 = (R_1+R_3)/2$		$R_S = (M_1+M_2)/2$			
		R_2		$M_2 = R_2$					
	Weight under test +MPE	Movement of pointer, action and decisions							
		Right	Reject	Left	Remove MPE	Right	Accept	Left	Reject
11	W1+MPE								
12	W2+MPE								
13	W3+MPE								
14	W4+MPE								
15	W5+MPE								

Maximum permissible errors for weights of 5000 kg to 500 kg according to OIML R 47

Nominal value	Accuracy class		
	M_2	M_{2-3}	M_3
5000 kg	800 g	1600 g	2500 g
1000 kg	160 g	300 g	500 g
500 kg	80 g	160 g	250 g

8.4 Working sheet for accuracy check – Hexagonal weights of class M_2 and lower

Date:		Place:			
Name of inspector:		User's name:			
No. of working standard:		Balance used:		Sensitivity figure:	

S. no.	Weight onRHP	Observations		Means		Rest point			
A	$S+w_1$	R_1	R_3	$M_1 = (R_1+R_3)/2$		$R_S = (M_1+M_2)/2$			
		R_2		$M_2 = R_2$					
	Weight under test + MPE	Movement of pointer, action and decisions							
		Right 1	Reject 2	Left 3	Remove MPE 4	Right 5	Accept 6	Left 7	Reject 8
1	W1+MPE								
2	W2+MPE								
3	W3+MPE								
4	W4+MPE								
5	W5+MPE								
B	S+MPE	R_1	R_3	$M_1 = (R_1+R_3)/2$		$R_S = (M_1+M_2)/2$			
		R_2		$M_2 = R_2$					
	Weight under test + MPE	Movement of pointer, action and decisions							
		Right	Reject	Left	Remove MPE	Right	Accept	Left	Reject
6	W1+MPE								
7	W2+MPE								
8	W3+MPE								
9	W4+MPE								
10	W5+MPE								
C	S+MPE	R_1	R_3	$M_1 = (R_1+R_3)/2$		$R_S = (M_1+M_2)/2$			
		R_2		$M_2 = R_2$					
	Weight under test + MPE	Movement of pointer, action and decisions							
		Right	Reject	Left	Remove MPE	Right	Accept	Left	Reject
11	W1+MPE								
12	W2+MPE								
13	W3+MPE								
14	W4+MPE								
15	W5+MPE								

Maximum permissible errors for hexagonal weights according to R 52

Nominal value	50 kg	20 kg	10 kg	5 kg	2 kg	1 kg	500 g	200 g	100 g
MPE (mg)	8000	3000	1600	800	300	160	80	30	16

Maximum permissible errors for hexagonal weights according to Indian regulations

Nominal value	50 kg	20 kg	10 kg	5 kg	2 kg	1 kg	500 g	200 g	100 g	50 g
MPE (mg)	7500	3000	1500	750	300	150	75	30	15	10

8.5 Working sheet for accuracy check – Fractional non-bullion weights of class M_2 and lower

Date:		Place:			
Name of inspector:		User's name:			
No. of working standard:		Balance used:		Sensitivity figure:	

S. no.	Weight onRHP	Observations		Means		Rest point			
A	$S+w_1$	R_1	R_3	$M_1 = (R_1+R_3)/2$		$R_S = (M_1+M_2)/2$			
		R_2		$M_2 = R_2$					
	Weight under test + MPE	Movement of pointer, action and decisions							
		Right 1	Reject 2	Left 3	Remove MPE 4	Right 5	Accept 6	Left 7	Reject 8
1	W1+MPE								
2	W2+MPE								
3	W3+MPE								
4	W4+MPE								
5	W5+MPE								
B	S+MPE	R_1	R_3	$M_1 = (R_1+R_3)/2$		$R_S = (M_1+M_2)/2$			
		R_2		$M_2 = R_2$					
	Weight under test + MPE	Movement of pointer, action and decisions							
		Right	Reject	Left	Remove MPE	Right	Accept	Left	Reject
6	W1+MPE								
7	W2+MPE								
8	W3+MPE								
9	W4+MPE								
10	W5+MPE								
C	S+MPE	R_1	R_3	$M_1 = (R_1+R_3)/2$		$R_S = (M_1+M_2)/2$			
		R_2		$M_2 = R_2$					
	Weight under test + MPE	Movement of pointer, action and decisions							
		Right	Reject	Left	Remove MPE	Right	Accept	Left	Reject
11	W1+MPE								
12	W2+MPE								
13	W3+MPE								
14	W4+MPE								
15	W5+MPE								

Maximum permissible errors for fractional non-bullion weights of class M_2

Nominal value	500 mg	200 mg	100 mg	50 mg	20 mg	10 mg	5 mg	2 mg	1 mg
MPE (mg)	2.5	2.0	1.6	1.2	1.0	0.8	0.6	0.6	0.6

8.6 Working sheet for accuracy check – Bullion weights of class M_1

Date:		Place:	
Name of inspector:		User's name:	
No. of working standard:		Balance used:	Sensitivity figure:

S. no.	Weights on RHP	Observations		Means	Rest Point	Conclusions
1	$S+w_1$	R_1	R_3	$M_1 = (R_1+R_3)/2$	$R_S = (M_1+M_2)/2$	If $0 < w_1–w_2 + (R_U–R_S)S <$ MPE Weight accepted If $R_U–R_S < 0$ Weight rejected
		R_2		$M_2 = R_2$		
2	$W+w_2$	R_1	R_3	$M_1 = (R_1+R_3)/2$	$R_U = (M_1+M_2)/2$	
		R_2		$M_2 = R_2$		
1	$S+w_1$					
2	$W1+w_2$					
3	$W2+w_2$					
4	$W3+w_2$					
5	$W4+w_2$					
6	$W5+w_2$					
7	$S+w_1$					
8	$W6+w_2$					
9	$W7+w_2$					
10	$W8+w_2$					
11	$W9+w_2$					
12	$W10+w_2$					

Mass of weight under test, W, is then given by:

$$W = S + (w_1 – w_2) + (R_U–R_S)S$$

Condition for acceptance of the weight at the time of verification is:

$$0 < (w_1–w_2) + S(R_U–R_S) < \text{MPE}$$

Maximum permissible errors for bullion weights of class M_1

Nominal value	20 kg	10 kg	5 kg	2 kg	1 kg	500 g	200 g
MPE (mg)	1000	500	250	100	50	25	10

Nominal value	100 g	50 g	20 g	10 g	5 g	2 g	1 g
MPE (mg)	5	3	2.5	2	1.6	1.2	1

8.7 Working sheet for accuracy check – Fractional bullion weights of class M_1

Date:		Place:	
Name of inspector:		User's name:	

No. of working standard:		Balance used:		Sensitivity figure:	

S. no.	Weights on RHP	Observations		Means	Rest Point	Conclusions
1	$S+w_1$	R_1	R_3	$M_1 = (R_1+R_3)/2$	$R_S = (M_1+M_2)/2$	If $0 < w_1–w_2 + (R_U–R_S)S <$ MPE Weight accepted If $R_U–R_S < 0$ Weight rejected
		R_2		$M_2 = R_2$		
2	$W+w_2$	R_1	R_3	$M_1 = (R_1+R_3)/2$	$R_U = (M_1+M_2)/2$	
		R_2		$M_2 = R_2$		
1	$S+w_1$					
2	$W1+w_2$					
3	$W2+w_2$					
4	$W3+w_2$					
5	$W4+w_2$					
6	$W5+w_2$					
7	$S+w_1$					
8	$W6+w_2$					
9	$W7+w_2$					
10	$W8+w_2$					
11	$W9+w_2$					
12	$W10+w_2$					

Mass of weight under test, W, is then given by:

$$W = S + (w_1 – w_2) + (R_U–R_S)S$$

Condition for acceptance of the weight at the time of verification is:

$$0 < (w_1–w_2) + S(R_U–R_S) < \text{MPE}$$

Maximum permissible errors for fractional bullion weights of class M_1

Nominal value	500 mg	200 mg	100 mg	50 mg	20 mg	10 mg	5 mg	2 mg	1 mg
MPE (mg)	0.8	0.6	0.5	0.4	0.3	0.25	0.2	0.2	0.2

8.8 Working sheet for accuracy check – Carat weights according to Indian regulations

Date:		Place:	
Name of inspector:		User's name:	
No. of working standard:		Balance used:	Sensitivity figure:

S. no.	Weightson RHP	Observations	Means	Rest Point	Conclusions
1	$S+w_1$	R_1 R_3	$M_1 = (R_1+R_3)/2$	$R_S = (M_1+M_2)/2$	If $0 < w_1–w_2 + (R_U–R_S)S < MPE$ weight accepted If $R_U–R_S < 0$ weight rejected
		R_2	$M_2 = R_2$		
2	$W+w_2$	R_1 R_3	$M_1 = (R_1+R_3)/2$	$R_U = (M_1+M_2)/2$	
		R_2	$M_2 = R_2$		
1	$S+w_1$				
2	$W1+w_2$				
3	$W2+w_2$				
4	$W3+w_2$				
5	$W4+w_2$				
6	$W5+w_2$				
7	$S+w_1$				
8	$W6+w_2$				
9	$W7+w_2$				
10	$W8+w_2$				
11	$W9+w_2$				
12	$W10+w_2$				

The mass of the weight under test, W, is then given by:

$$W = S + (w_1–w_2) + (R_U–R_S)S$$

The condition for acceptance of the weight at the time of verification is:

$$0 < (w_1–w_2) + S(R_U–R_S) < MPE$$

Maximum permissible errors for weights of 500 carat to 0.005 carat

Nominal value (c)	**500**	**200**	**100**	**50**	**20**	**10**	**5**	**2**
MPE (mg)	5	3	2.5	2	1.6	1.2	1	0.8

Nominal value (c)	**1**	**0.5**	**0.2**	**0.1**	**0.05**	**0.02**	**0.01**	**0.005**
MPE (mg)	0.6	0.5	0.4	0.3	0.25	0.2	0.2	0.2

9 Working sheet for accuracy check with electronic or single pan balances

Date:			Place:		
Name of inspector:			User's name:		
No. of working standard:		Balance used:		Sensitivity figure:	

Nominal value	**MPE (mg)**	**S. no.**	**Weight on pan**	**Indication**	**I_U-I_S < 0 or > MPE**	**0 < I_U -I_S < MPE**
		1	S	I_S	Reject	Accept
		2	W	I_U		