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Understandings of principle, structure and influence factors

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Weighing instrument

Measuring instrument that serves to determine the mass of a body by using the action of gravity on this body.

The instrument may also be used to determine other quantities, magnitudes, parameters or characteristic related to mass.

According to its method of operation, a weighing instrument is classified as an automatic or non-automatic instrument.

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Automatic weighing instrument

An instrument that weighs without the intervention of an operator and follows a predetermined program of automatic processes characteristic of the instrument.

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Non-automatic weighing instrument

Instrument that requires the intervention of an operator during the weighing process, for example to deposit on or remove from the receptor the load to be measured and also to obtain the result.

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What's Mechanical Weighing Scale ?

Mechanical weighing scales use mechanical principle such as spring and lever when weighing is measured.

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Various Mechanical Weighing Scale

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Measurement principle

Lever

Elasticity

Spring

Load cell (electronically)

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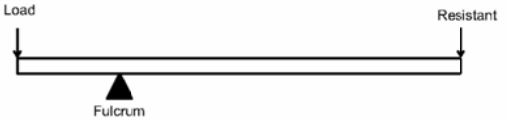
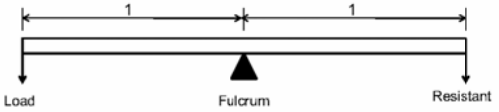
Levers in Mechanical Weighing Instruments

First order levers

The fulcrum is between the Load and Resistant. The resistant is usually either to the load or is less. In the case the lever has a mechanical advantage.



Simple beam (equal arm) Leverage 1 to 1



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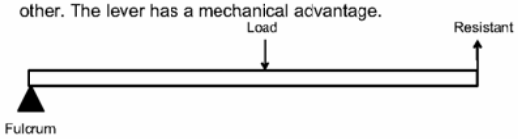
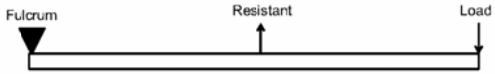
Second order levers

The fulcrum is at one end of the lever and the resistant is at the other. The lever has a mechanical advantage.



Third order levers

The fulcrum is at one end of the lever and the resistant is between the fulcrum and load. The lever has a mechanical advantage.



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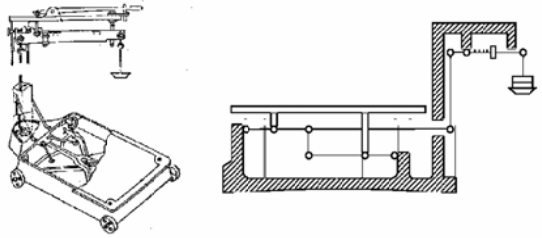
Combination of levers



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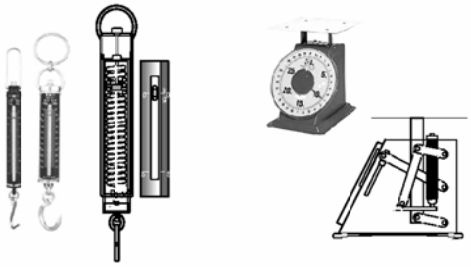
Spring type



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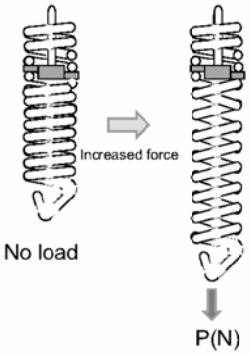
Elasticity : Spring



Hooke's law

Growth of the spring is in proportion to increased force

$$F = -kx$$

$$k = \frac{P}{\delta} = \frac{Gd^4}{8nd^3}$$

F : *Restoring force exerted by the spring*
k : *Spring constant* (N/mm)
x : *The distance by which the spring is elongated*
P : *Load* (N)
δ : *Displacement* (mm)
G : *Rigidity of spring materials* (N/mm²)
d : *Diameter of spring* (mm)
n : *Reel number*
D : *Diameter of the coil*

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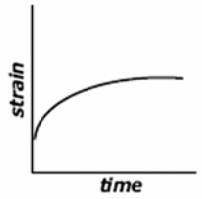
Spring -Creep and Hysteric's-

Creep



The strain by the outside power changes with the passage of time when the outside power is left while added.

Hystericis

The difference is caused in the relation between the stress and the strain in the increase and decrease of the stress.

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Spring -Temperature compensating-

The elastic coefficient changes with the temperature. The strain to constant outside power is different depending on the temperature.

Temperature compensating device

Bimetal

Compensated spring

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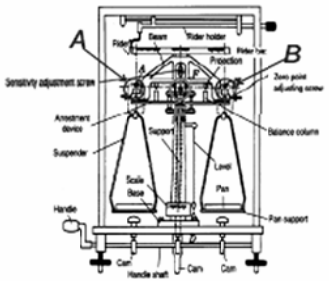
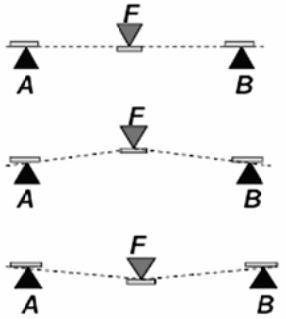
Equal arm balance - Sensitivity -





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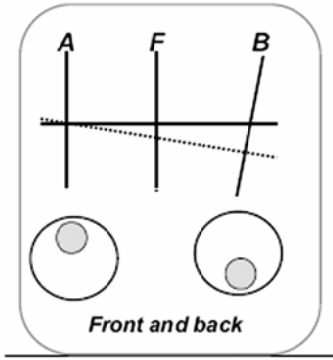
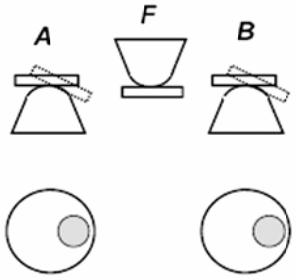
Equal arm balance - Eccentricity -





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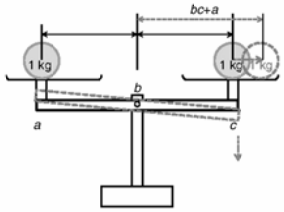
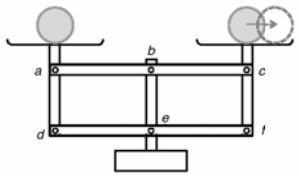
Roberval mechanism

Simple lever



Roberval mechanism



Same mass and same ratio of "*ab*" and "*bc*" ⇨ ***Equilibrium***

Same mass and difference ratio of "*ab*" and "*bc*" ⇨ ***Not Equilibrium***

It's form two parallelogram "*abde*", "*bcef*" which connected the joint of length and breadth with a pin, and move freely.
"*abc*" becomes level when it's put the same mass on a plate in the extension of "*ad*","*ef*".
"*abc*" becomes always level even if it's move a position of the mass then on a plate.

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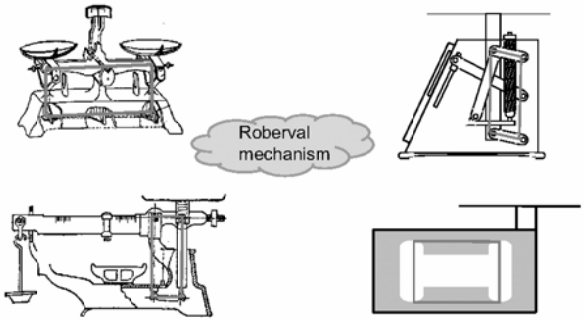
Use example of the Roberval mechanism



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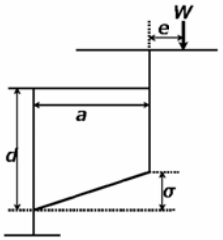
Robarval Eccentricity



Example:

a = 60 mm

d = 180 mm

σ = 1 mm

***W* = 2.5** kg

e = 50 mm

$$E = \frac{We\sigma}{ad}$$

E = ?

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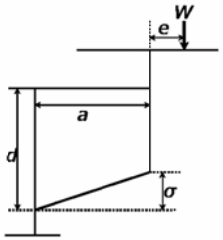
Robarval Eccentricity



Answer :

$$E = \frac{2\,500 \times 50 \times 1}{60 \times 180} = 11.6\ \mathrm{g}$$

$$E = \frac{We\sigma}{ad}$$

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Gravity compensation

All objects on the earth are subject to Earth's gravity all the time.
No measurements of force and mass can be free from the gravity effects, as the force and mass are measured by balancing the object's weight on a lever, or by converting it into modification of elastic body.
Gravity compensation is required because the gravity depends on the location on the earth (ex. latitude, longitude, altitude). 9.80665m/s^2 is used as the standard gravitational acceleration.
If a measuring instrument equipped with elastic bodies is calibrated at a place different from a place of use, the value of gravity compensation E_g is obtained in the following equation:

$$E_g = \frac{g_1 - g_2}{9.8} \cdot W$$

Where:
g_1: gravitational acceleration at the calibration site
g_2: gravitational acceleration at the place of use
W: mass, corresponding to inspection weight

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Gravity compensation

A range of the gravity in Japan

9.806 m/s^2 ~ 9.791 m/s^2

Hokkaido:9.806 m/s^2 ・・・ (g_2)

Tsukuba 9.800 m/s^2 ・・・ (g_1)

Okinawa 9.791 m/s^2

EX)
$I_1 \propto W$・(g_1=9.800 m/s^2)
$I_2 \propto W$・(g_2=9.800 m/s^2)
$I_1/I_2 = g_1/g_2$
$I_1 = I_1 \cdot g_2/g_1$
$= 5.000 \cdot 9.806/9.800 = 5.003_1 = 5.003$ (kg)

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Verification procedure for NAWIs

【 OIML R76 Edition 1992 】

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Contents of OIML R76 1992

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The related term of the mechanical weighing scale

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T.1.2 Non automatic weighing instrument

Instrument that requires the intervention of an operator during the weighing process, for example to deposit on or remove from the receptor the load to be measured and also to obtain the result.

The instrument permits direct observation of the weighing results either displayed or printed; both possibilities are covered by the word "indication".

Note: Terms such as "indicate", "indicating component" and their derivatives do not include printing.

A non automatic weighing instrument may be:

-graduated or non-graduated,

- self-indicating, semi-self indicating or non-self-indicating.

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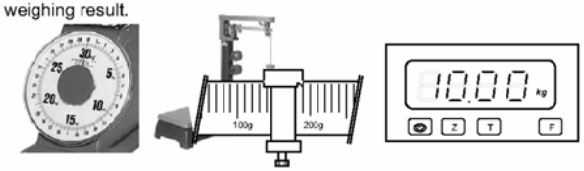
T.1.2.1 Graduated instrument

Instrument allowing the direct reading of the complete or partial weighing result.



T.1.2.2 Non graduated instrument

Instrument not fitted with a scale numbered in units of mass.

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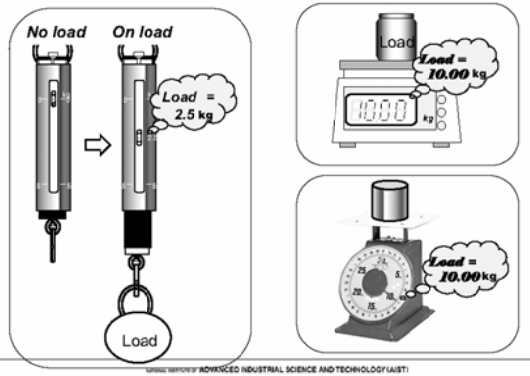
T.1.2.3 Self indicating instrument

Instrument in which the position of equilibrium is obtained without the interventes of an operator.



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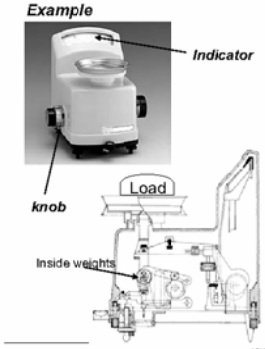
T.1.2.4 Semi self indicating instrument

Instrument with a self indication weighting range, in which the operator intervenes to alter the limits of this range.

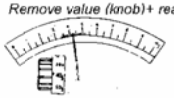
Example



Measurement procedure

1. *Load applies to load receptor*
2. *Remove inside weights by a knob*

3. *Repeat 2 till it is balanced in a weighing range*
4. *Load =*
   Remove value (knob)+ reading for indicator



Knob = 40g
Indicator = 4.3g
Load = 44.3g

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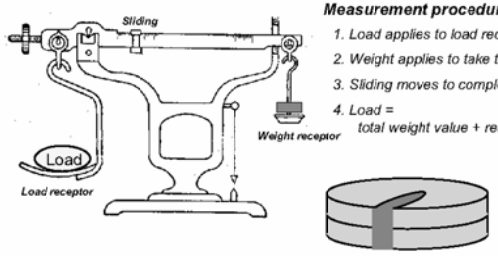
T.1.2.5 Non self indicating instrument

Instrument in which the position of equilibrium is obtained entirely by operator.

Example



Measurement procedure

1. *Load applies to load receptor*
2. *Weight applies to take the rough equilibrium.*
3. *Sliding moves to complete equilibrium*
4. *Load =*
   total weight value + reading of the sliding

AIST

T.2.1 Main device

T.2.1.1 Load receptor

Part of the instrument intended to receive the load.

T.2.1.2 Load-transmitting device

Part of the instrument for transmitting the force produced by the load acting on the load receptor, to the load measuring device.

T.2.1.3 Load measuring device

Part of the instrument for measuring the mass of the load by means of an equilibrium device for balancing the force coming from the load transmitting device, and an indicating or printing device.

T.2.4 Indicating device (of a weighing instrument)

Part of the load measuring device on which the direct reading of the result is obtained.

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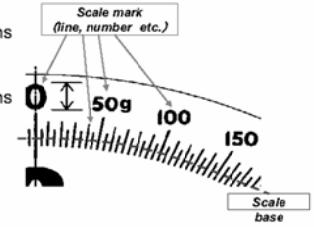
T.2.4.1 Indicating component

Component indicating the equilibrium and /or the result.
On an instrument with several positions of equilibrium it indicates only the equilibrium (so-called zero).
On an instrument with several positions of equilibrium it indicates both the equilibrium and the result. On an electronic instrument, this is the display.



T.2.4.2 Scale mark

A line or other mark on an indicating component corresponding to a specified value of mass.

T.2.4.3 Scale base

An imaginary line through the centers of all the shortest scale marks.

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T.2.7.2 Zero setting device

Device for setting the indication to zero when there is no load on the load receptor.

T.2.7.2.1 Non automatic zero setting device

Device for setting the indication to zero by an operator.

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T.2.7.4 Tare device

Device for setting the indication to zero when a load is on the load receptor:
Without altering the weighing range for net loads (additive tare device),
or
Reducing the weighing range for net loads (subtractive tare device).

It may function as;
- A non automatic device (load balanced by an operator),
- A semi automatic device (load balanced automatically following a single manual command),
- An automatic device (load balanced automatically without the intervention of an operator).

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T.3.2 Scale divisions

T.3.2.1 Scale spacing *(instrument with analogue indication)*

Distance between any two consecutive scale marks, measured along the scale base.

T.3.2.2 Actual scale interval (d)

Value expressed in units of mass of:

The difference between the values corresponding to two consecutive scale marks, for analogue indication, or

The difference between two consecutive indication values, for digital indication.

T.3.2.3 Verification scale interval (e)

Value, expressed in units of mass, used for the classification and verification of an instrument.

T.3.2.4 Scale interval of numbering

Value of the difference between two consecutive numbered scale marks.

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T.3.2.5 Number of verification scale intervals
(single-interval instrument)

Quotient of the maximum capacity and the verification scale interval:

$$n = Max / e$$

T.4 Metrological properties of an instrument

T.4.1 Sensitivity
(k)

For given value of the measured mass, the quotient of the change of the observed variable *l* and the corresponding change of the measured ***M***

$$k = \Delta l / \Delta M$$

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Verification procedure for NAWIs

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Verification Item
(8.3 initial verification)

- ☐ ***Visual inspection (8.3.2)***
- ☐ ***Tests (8.3.3)***
  - ***Error of indication*** **【 Weighing test】**
    - ◇ *Value of maximum permissible error*
    - ◇ *Maximum permissible errors for net values*
    - ◇ *Tare weighing device*
  - ***Accuracy of zero setting and tare devices***
  - ***Repeatability***
  - ***Eccentricity***
  - ***Discrimination***
  - ***Sensitivity of non self indication instruments***

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Visual inspection (8.3.2)

Before testing, the instrument shall be visual inspected

- ***Confirmation of markings:***
  Accuracy class, Max, Min, e, d
- ***Confirmation of condition of instrument***
- ***Confirmation of level of instrument***

**Results of the visual inspection should be recorded in the test report. including test date and observer, etc.*

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Tests (8.3.3)

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Value of maximum permissible error

Maximum permissible error for verification

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Accuracy classes for NAWI's (3.2)

Class 1 Special accuracy Ⓘ
ultra micro-, micro-, semi micro, macro-

Class 2 High accuracy Ⓘⓘ
precision balances

Class 3 Medium accuracy Ⓘⓘⓘ
NAWI's for trade use

Class 4 Ordinary accuracy Ⓘⓥ
NAWI's for lower accuracy

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Accuracy classes for NAWI's (3.2)

Accuracy class	Verification scale interval	Number of verification scale interval		Minimum capacity
		Minimum	Maximum	
Special (I)	0.001g≤ *e*	50 000	-	100 *e*
High (II)	0.001 g≤ *e* ≤0.05 g 0.1g≤ *e*	100 5 000	100 000 100 000	20 *e* 50 *e*
Medium (III)	0.1 g≤ *e* ≤2 g 5 g≤ *e*	100 500	10 000 10 000	20 *e* 20 *e*
Ordinary (IV)	5 g≤ *e*	100	1 000	10 *e*

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Verification scale interval (e)

Value, expressed in unit of mass, used for the classification and verification of an instrument.

Number of verification scale interval (n)

Quotient of the maximum capacity and the verification scale interval.

$$n = Max / e$$

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Maximum permissible error (3.5.1)

Verification

Maximum permissible errors	For loads, m expressed in verification scale intervals, e			
	Class 1	Class 2	Class 3	Class 4
±0.5 *e*	0≤ *m* ≤50 000	0≤ *m* ≤ 5 000	0≤ *m* ≤500	0≤ *m* ≤50
±1.0 *e*	50 000 < *m* ≤200 000	5 000 < *m* ≤20 000	500 < *m* ≤2 000	50 < *m* ≤200
±1.5 *e*	200 000≤ *m*	20 000 <*m*≤100 000	2 000 <*m*≤10 000	200 < *m* ≤1 000

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Exercise

Determine MPE and MPE change points.

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Exercise 1

Determine MPE and MPE change points for verification

Specification of NAWI is

Max : 3 kg,
Verification scale Interval (e): 1 g,
Accuracy class 3

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Maximum permissible errors	For loads, m expressed in verification scale intervals, e			
	Class 1	Class 2	Class 3	Class 4
±0.5 e	0 ⩽ m ⩽ 50 000	0 ⩽ m ⩽ 5 000	0 ⩽ m ⩽ 500	0 ⩽ m ⩽ 50
±1.0 e	50 000 < m ⩽ 200 000	5 000 < m ⩽ 20 000	500 < m ⩽ 2 000	50 < m ⩽ 200
±1.5 e	200 000 ⩽ m	20 000 < m ⩽ 100 000	2 000 < m ⩽ 10 000	200 < m ⩽ 1 000

MPE (e)	Class 3 For loads, m expressed in verification scale intervals, e	MPE (g)	Class 3 (mass)
±0.5 e	0 ⩽ m ⩽ 500	±0.5 × 1g = ±0.5 g	0 ⩽ m ⩽ 500 × 1 g (e) 0 g ⩽ m ⩽ 500 g
±1.0 e	500 < m ⩽ 2 000	±1.0 × 1g = ±1 g	500 × 1g(e) < m ⩽ 2 000 × 1 g(e) 500 g < m ⩽ 2 000 g
±1.5 e	2 000 < m ⩽ 10 000	±1.5 × 1g = ±1.5 g	2 000 × 1g(e) < m ⩽ 10000 × 1 g (e) 2 000 g < m ⩽ 10 000 g

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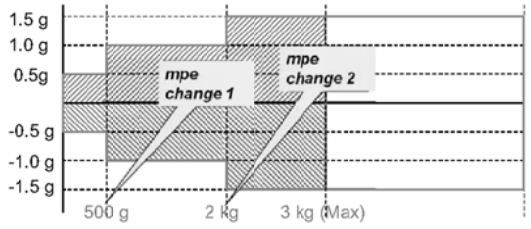
Answer

Max : 3 kg, Verification scale Interval (e): 1 g, Accuracy class 3

MPE (g)	Class 3 (mass)	Mpe change points
±0.5 g	0 g ⩽ m ⩽ 500 g	500 g (change point 1)
±1.0 g	500 g < m ⩽ 2 kg	2 kg (change point 2)
±1.5 g	2 kg < m ⩽ 3 kg (Max)	-



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Exercise 2

Determine MPE and MPE change points for verification

Specification of NAWI is

Max : 6 kg,
Verification scale Interval (e): 2 g,
Accuracy class 3

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Maximum permissible errors	For loads, m expressed in verification scale intervals, e			
	Class 1	Class 2	Class 3	Class 4
±0.5 *e*	0 ⩽ *m* ⩽ 50 000	0 ⩽ *m* ⩽ 5 000	0 ⩽ *m* ⩽ 500	0 ⩽ *m* ⩽ 50
±1.0 *e*	50 000 < *m* ⩽ 200 000	5 000 < *m* ⩽ 20 000	500 < *m* ⩽ 2 000	50 < *m* ⩽ 200
±1.5 *e*	200 000 ⩽ *m*	20 000 < *m* ⩽ 100 000	2 000 < *m* ⩽ 10 000	200 < *m* ⩽ 1 000

MPE (e)	Class 3 For loads, m expressed in verification scale intervals, e	MPE (g)	Class 3 (mass)
±0.5 *e*	0 ⩽ *m* ⩽ 500	±0.5×2g = ±1.0 g	0 ⩽ *m* ⩽ 500×2 g *(e)* 0 g ⩽ *m* ⩽ 1 000 g
±1.0 *e*	500 < *m* ⩽ 2 000	±1.0×2g = ±2.0 g	500×2g *(e)* < *m* ⩽ 2 000×2 g *(e)* 1 000 g < *m* ⩽ 4 000 g
±1.5 *e*	2 000 < *m* ⩽ 10 000	±1.5×2g = ±3.0 g	2 000×2g *(e)* < *m* ⩽ 10 000×2g *(e)* 4 000 g < *m* ⩽ 20 000 g

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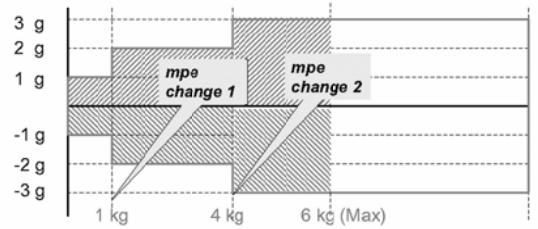
Answer

Max : 6 kg, Verification scale Interval (e): 2 g, Accuracy class 3

MPE (g)	Class 3 (mass)	Mpe change points
±1.0 g	0 g ⩽ *m* ⩽ 1 kg	1 kg (change point 1)
±2.0 g	1 kg < *m* ⩽ 4 kg	4 kg (change point 2)
±3.0 g	4 kg < *m* ⩽ 6 kg (Max)	-



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Exercise 3

Determine MPE and MPE change points for verification

Specification of NAWI is

Max : 5 kg,
Verification scale Interval (e): 10 g,
Accuracy class 3 or class 4

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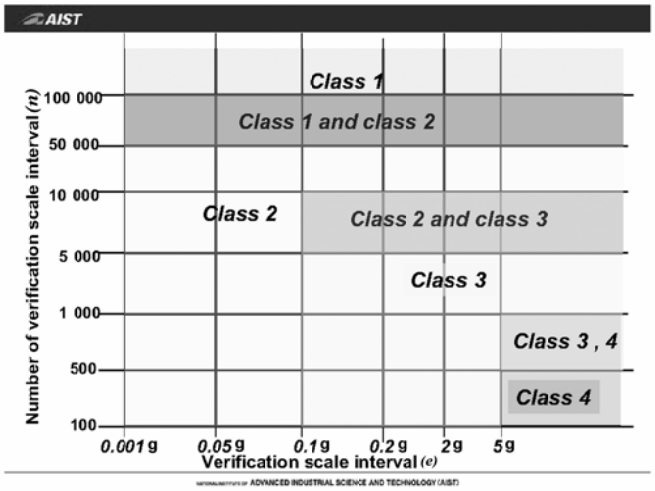
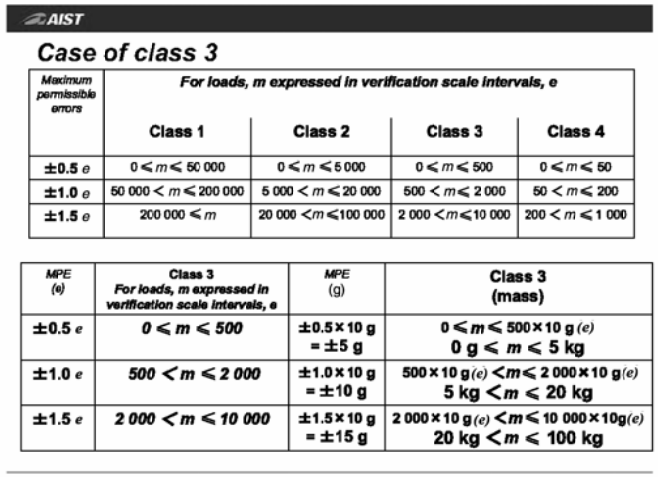
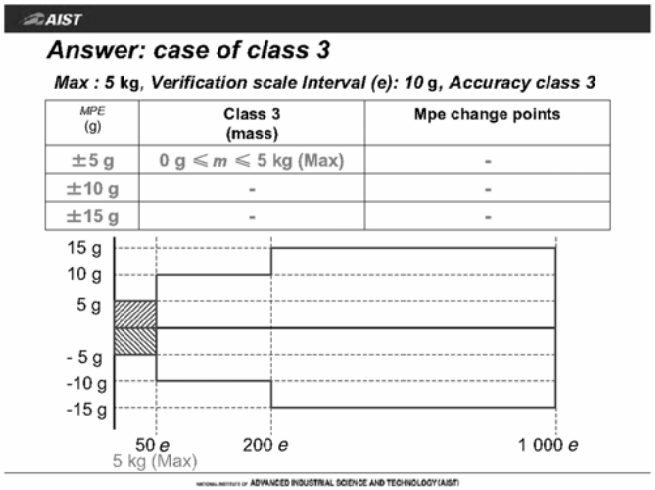
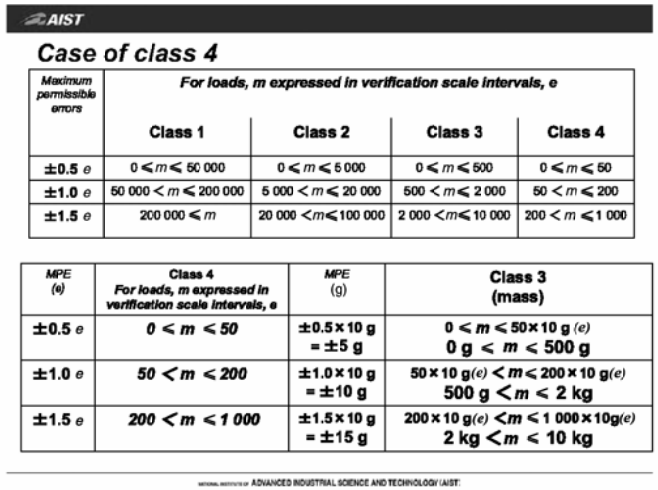
Accuracy classes for NAWI's (3.2)

Accuracy class	Verification scale interval	Number of verification scale interval		Minimum capacity
		Minimum	Maximum	
Special (I)	0.001g ⩽ *e*	50 000	-	100 *e*
High (II)	0.001 g ⩽ *e* ⩽ 0.05 g	100	100 000	20 *e*
	0.1g ⩽ *e*	5 000	100 000	50 *e*
Medium (III)	0.1 g ⩽ *e* ⩽ 2 g	100	10 000	20 *e*
	5 g ⩽ *e*	500	10 000	20 *e*
Ordinary (IV)	5 g ⩽ *e*	100	1 000	10 *e*


AIST
Class 1
Class 1 and class 2
Class 2
Class 2 and class 3
Class 3
Class 3 , 4
Class 4
Number of verification scale interval (n)
100 000
50 000
10 000
5 000
1 000
500
100
0.001 g
0.05 g
0.1 g
0.2 g
2 g
5 g
Verification scale interval (e)
ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)


AIST
Case of class 3
Maximum permissible errors
For loads, m expressed in verification scale intervals, e
Class 1
Class 2
Class 3
Class 4
±0.5 e
0 ⩽ m ⩽ 50 000
0 ⩽ m ⩽ 5 000
0 ⩽ m ⩽ 500
0 ⩽ m ⩽ 50
±1.0 e
50 000 < m ⩽ 200 000
5 000 < m ⩽ 20 000
500 < m ⩽ 2 000
50 < m ⩽ 200
±1.5 e
200 000 ⩽ m
20 000 < m ⩽ 100 000
2 000 < m ⩽ 10 000
200 < m ⩽ 1 000
MPE (e)
Class 3 For loads, m expressed in verification scale intervals, e
MPE (g)
Class 3 (mass)
±0.5 e
0 ⩽ m ⩽ 500
±0.5 × 10 g = ±5 g
0 ⩽ m ⩽ 500 × 10 g (e)
0 g ⩽ m ⩽ 5 kg
±1.0 e
500 < m ⩽ 2 000
±1.0 × 10 g = ±10 g
500 × 10 g (e) < m ⩽ 2 000 × 10 g (e)
5 kg < m ⩽ 20 kg
±1.5 e
2 000 < m ⩽ 10 000
±1.5 × 10 g = ±15 g
2 000 × 10 g (e) < m ⩽ 10 000 × 10g (e)
20 kg < m ⩽ 100 kg
ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)


AIST
Answer: case of class 3
Max : 5 kg, Verification scale Interval (e): 10 g, Accuracy class 3
MPE (g)
Class 3 (mass)
Mpe change points
±5 g
0 g ⩽ m ⩽ 5 kg (Max)
-
±10 g
-
-
±15 g
-
-
15 g
10 g
5 g
- 5 g
-10 g
-15 g
50 e
5 kg (Max)
200 e
1 000 e
ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)

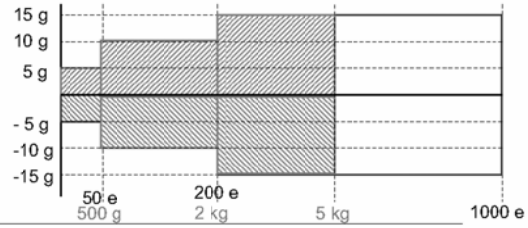

AIST
Case of class 4
Maximum permissible errors
For loads, m expressed in verification scale intervals, e
Class 1
Class 2
Class 3
Class 4
±0.5 e
0 ⩽ m ⩽ 50 000
0 ⩽ m ⩽ 5 000
0 ⩽ m ⩽ 500
0 ⩽ m ⩽ 50
±1.0 e
50 000 < m ⩽ 200 000
5 000 < m ⩽ 20 000
500 < m ⩽ 2 000
50 < m ⩽ 200
±1.5 e
200 000 ⩽ m
20 000 < m ⩽ 100 000
2 000 < m ⩽ 10 000
200 < m ⩽ 1 000
MPE (e)
Class 4 For loads, m expressed in verification scale intervals, e
MPE (g)
Class 3 (mass)
±0.5 e
0 < m < 50
±0.5 × 10 g = ±5 g
0 < m < 50 × 10 g (e)
0 g < m < 500 g
±1.0 e
50 < m < 200
±1.0 × 10 g = ±10 g
50 × 10 g (e) < m < 200 × 10 g (e)
500 g < m < 2 kg
±1.5 e
200 < m < 1 000
±1.5 × 10 g = ±15 g
200 × 10 g (e) < m < 1 000 × 10g (e)
2 kg < m < 10 kg
ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)

AIST

Answer: case of class 4

Max : 5 kg, Verification scale Interval (e): 10 g, Accuracy class 4

MPE (g)	Class 4 (mass)	Mpe change points
±5 g	0 g ⩽ *m* ⩽ 500 g	500 g
±10 g	500 g < *m* ⩽ 2 kg	2 kg
±15 g	2 kg < *m* ⩽ 5 kg (Max)	-



AIST

Exercise 4

Determine MPE and MPE change points for verification

Specification of NAWI is
Max : 6 kg,
e_1 : 1 g (0 – 3 kg)
e_2 : 2 g (3 – 6 kg)
Class 3
**** Multi interval instrument***

AIST

Max : 6 kg (e_1: 0 - 3 kg , e_2: 3 – 6 kg)

$n_1 = Max_1 / e_1$ = 3 kg / 1g = ***3 000***
$n_2 = Max / e_2$ = 6 kg / 2g = ***3 000***

Accuracy class	Verification scale interval	Number of verification scale interval		Minimum capacity
		Minimum	Maximum	
Special Class 1	**0.001g⩽*e***	**50 000**	**-**	**100 *e***
High Class 2	**0.001 g⩽ *e* ⩽0.05 g** **0.1g⩽*e***	**100** **5 000**	**100 000** **100 000**	**20 *e*** **50 *e***
Medium Class 3	0.1 g⩽ *e* ⩽2 g **5 g⩽ *e***	100 **500**	10 000 **10 000**	**20 *e*** **20 *e***
Ordinary Class 4	**5 g⩽ *e***	**100**	**1 000**	**10 *e***

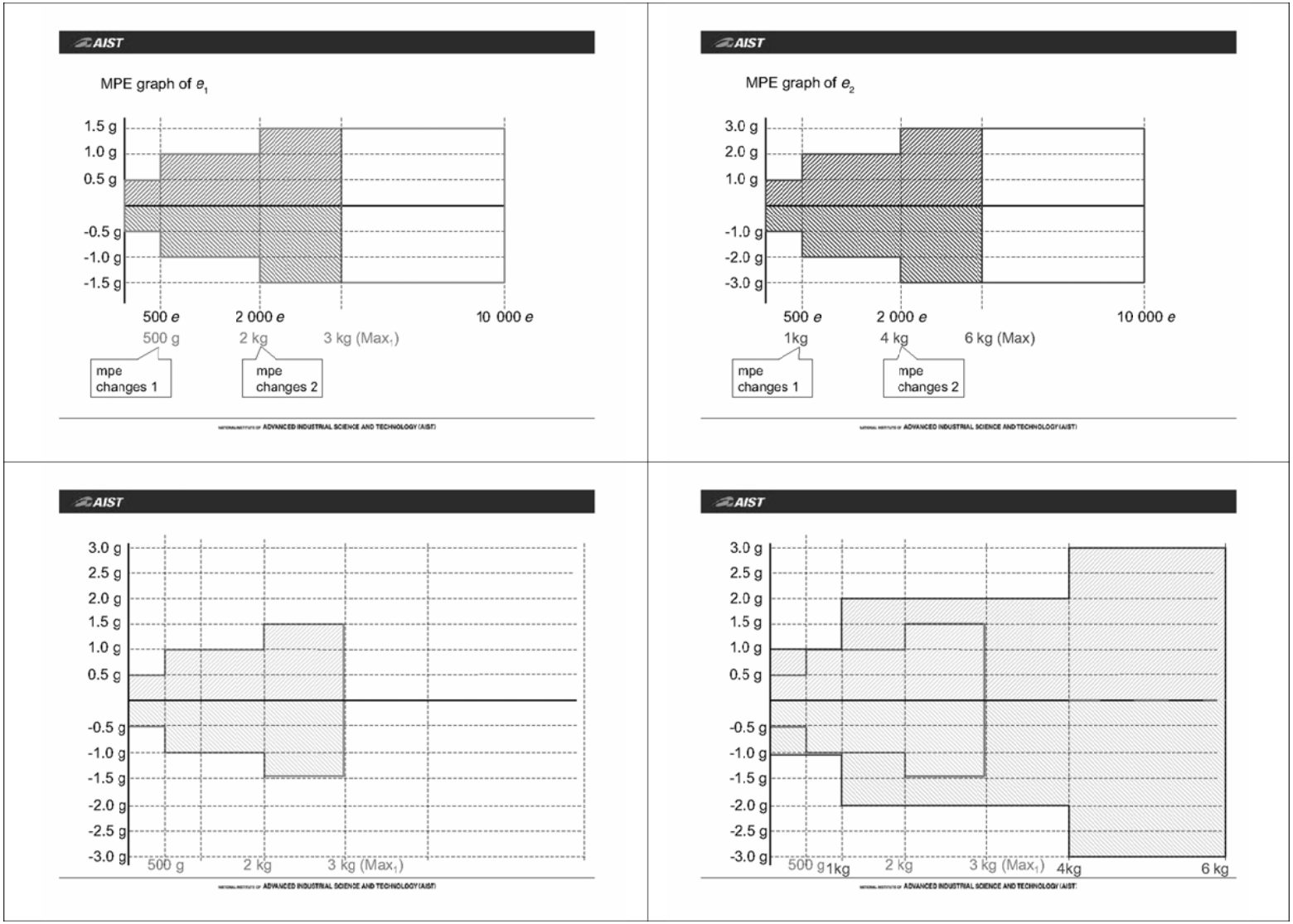
AIST

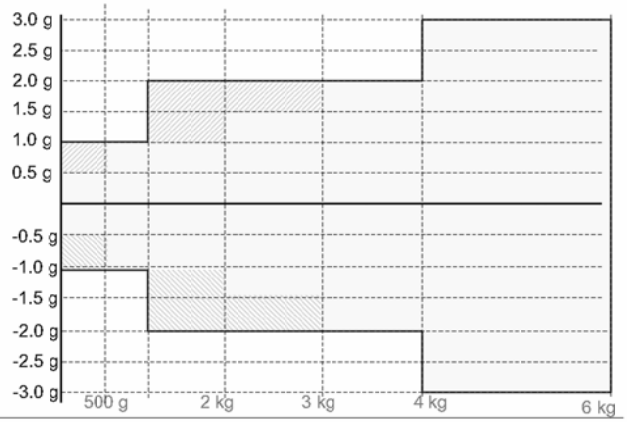
Applied e_1 (1 g)

MPE (e_1)	Class 3 *For loads, m expressed in verification scale intervals, e*	MPE (g)	Class 3 (mass)
±0.5 e_1	***0 ⩽ m ⩽500***	±0.5×1g = ±0.5 g	**0⩽m⩽500×1 g (e_1)** 0 g ⩽ m ⩽ 500 g
±1.0 e_1	***500 < m ⩽2 000***	±1.0×1g = ±1 g	**500×1 g (e_1) <m⩽2 000×1 g (e_1)** 500 g <m⩽ 2 000 g
±1.5 e_1	***2 000 < m <10 000***	±1.5×1g = ±1.5 g	**2 000×1 g (e_1) <m⩽10 000×1g(e_1)** 2 000 g <m ⩽10 000 g

Applied e_2 (2 g)

MPE (e_2)	Class 3 *For loads, m expressed in verification scale intervals, e*	MPE (g)	Class 3 (mass)
±0.5 e_2	***0 ⩽ m ⩽ 500***	±0.5×2g = ±1.0 g	**0⩽m⩽500×2g (e_2)** 0 g ⩽ m ⩽ 1 000 g
±1.0 e_2	***500 < m ⩽ 2 000***	±1.0×2g = ±2.0 g	**500×2 g (e_2) <m⩽2 000×2g(e_2)** 1 000 g <m ⩽ 4 000 g
±1.5 e_2	***2 000 < m <10 000***	±1.5×2g = ±3.0 g	**2 000×2 g (e_2) <m⩽10 000×2g(e_2)** 4 000 g <m ⩽ 20 000 g


AIST
MPE graph of e_1
1.5 g
1.0 g
0.5 g
-0.5 g
-1.0 g
-1.5 g
500 e
2 000 e
10 000 e
500 g
2 kg
3 kg (Max.)
mpe changes 1
mpe changes 2
ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)
AIST
MPE graph of e_2
3.0 g
2.0 g
1.0 g
-1.0 g
-2.0 g
-3.0 g
500 e
2 000 e
10 000 e
1kg
4 kg
6 kg (Max)
mpe changes 1
mpe changes 2
ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)
AIST
3.0 g
2.5 g
2.0 g
1.5 g
1.0 g
0.5 g
-0.5 g
-1.0 g
-1.5 g
-2.0 g
-2.5 g
-3.0 g
500 g
2 kg
3 kg (Max$_1$)
ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)
AIST
3.0 g
2.5 g
2.0 g
1.5 g
1.0 g
0.5 g
-0.5 g
-1.0 g
-1.5 g
-2.0 g
-2.5 g
-3.0 g
500 g
1kg
2 kg
3 kg (Max$_1$)
4kg
6 kg
ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)



Answer

Specification of NAWI is

***Max : 6* kg, e_1 : *1* g *(0 – 3* kg) e_2 : *2* g *(3 – 6* kg)**

**** Multi interval instrument***

MPE (g)	Class 3 (Gram)	Mpe change points
±0.5 g	0 g ⩽ *m* ⩽ 500 g	500 g
±1.0 g	500 g < *m* ⩽ 2 kg	2 kg
±1.5 g	2 kg < *m* ⩽ 3 kg	3 kg
±2.0 g	3 kg < *m* ⩽ 4 kg	4 kg
±3.0 g	4 kg < *m* ⩽ 6 kg	

Exercise 5

Specification of NAWI is
***Max : 150* kg**
***e : 100* g**
Class 3

Exercise 6

Specification of NAWI is
***Max : 60* kg**
***e : 20* g**
Class 3

Exercise 7

Specification of NAWI is
***Max : 500* g**
***e : 5* g**
Class 4

Exercise 8

Specification of NAWI is
***Max : 3* kg**
***e : 0.1* g**
Class 2

AIST

Exercise 9

Specification of NAWI is

***Max : 1* kg**
***e : 0.2* g**
class 3

Exercise 10

Specification of NAWI is

***Max : 15* kg**
e_1 : 2 g (0 ~ 6 kg)
e_2 : 5 g (6 ~ 15 kg)
**** Multi interval instrument***

AIST

Verification Standards (3.7)

Weights 3.7.1

The standard weights or standard masses used for the verification of an instrument shall not have an error greater than 1/3 of the maximum permissible error of the instrument for the applied.

Max : 3 kg, Verification scale interval (*e*) : 1 g, Min : 20 g ,Class 3

Test points	Test load	MPE (*e*)	MPE(g)	MPE/3	Weights
Zero	0	0.5 *e*	0.5 g	0.17 g	-
Min	20 g	0.5 *e*	0.5 g	0.17 g	***M2 (3mg)***
500 *e*	500 g	0.5 *e*	0.5 g	0.17 g	***M2 (75mg)***
Any	1 000 g	1 *e*	1.0 g	0.33 g	***M2 (150mg)***
2 000 *e*	2 000 g	1 *e*	1.0 g	0.33 g	***M2 (300mg)***
Max	3 000 g	1.5 *e*	1.5 g	0.5 g	***M2 (450mg)***

AIST

OIML R 111 **Weights of classes E1, E2, F1, F2, M1, M1–2, M2, M2–3 and M3**

Minimum accuracy class of weights

The accuracy class for weights used as standards for the verification of weights or weighing instruments should be
in accordance with the requirements of the relevant OIML Recommendations.

The OIML weight classes are defined as follows:

Class E1: Weights intended to ensure traceability between national mass standards (with values derived from the International Prototype of the kilogram) and weights of class E2 and lower. Class E1 weights or weight sets shall be accompanied by a calibration certificate (see 15.2.2.1).

Class E2: Weights intended for use in the verification or calibration of class F1 weights and for use with weighing instruments of special accuracy class I. Class E2 weights or weight sets shall be accompanied by a calibration certificate (see 15.2.2.2). They may be used as class E1 weights if they comply with the requirements for surface roughness, magnetic susceptibility and magnetization for class E1 weights, and if their calibration certificate gives the appropriate data as specified in 15.2.2.1.

Class F1: Weights intended for use in the verification or calibration of class F2 weights and for use with weighing instruments of special accuracy class I and high accuracy class Ⅱ.

AIST

Class F2: Weights intended for use in the verification or calibration of class M1 and possibly class M2 weights. Also intended for use in important commercial transactions (e.g. precious metals and stones) on weighing instruments of high accuracy class Ⅱ.

Class M1: Weights intended for use in the verification or calibration of class M2 weights, and for use with weighing instruments of medium accuracy class Ⅲ.

Class M2: Weights intended for use in the verification or calibration of class M3 weights and for use in general commercial transactions and with weighing instruments of medium accuracy class Ⅲ.

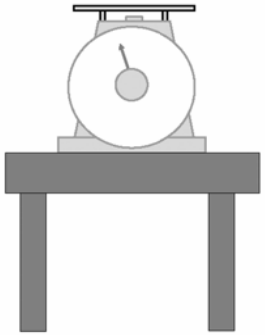
Class M3: Weights intended for use with weighing instruments of medium accuracy class Ⅲ and ordinary accuracy class Ⅳ.

Classes M1–2 and M2–3 : Weights from 50 kg to 5 000 kg of lower accuracy intended for use with weighing instruments of medium accuracy class Ⅲ.

Note: The error in a weight used for the verification of a weighing instrument shall not exceed 1/3 of the maximum permissible error for an instrument. These values are listed in section 3.7.1 of OIML R *76 Non-automatic Weighing Instruments (1992).*

AIST

Test set up



Inspection environment

Set up to solid table

Vibration

Influence by the wind

Preparations for ;

Weights

Report sheet

AIST

Test producer

Part 1: Self indicating instrument (analog indication)
Spring type

Part 2: Non-self indicating instrument
Lever type

AIST

Test producer - part 1

Self indicating instrument (analog indication)

Spring type

AIST

Value of maximum permissible error
【Weighing performance test】

Test loads (A4.4.1 and 8.3.3)

Apply test loads from zero up to and including Max, and similarly remove the test loads back to zero.

Determining the verification for weighing tests at least 5 shall be selected. The test loads selected shall include Max, and Min, and values at or near those at which the mpe changes.

AIST

Weighing Performance Test

Determine the test loads and mpe

Example : Max : 3 kg, *e : 10* g, *Min : 100* g, *class 4*

Test load		mpe
zero		
Min		
Mpe change 1		
Mpe change 2		
Max		
*Any load		

AIST

Weighing Performance Test

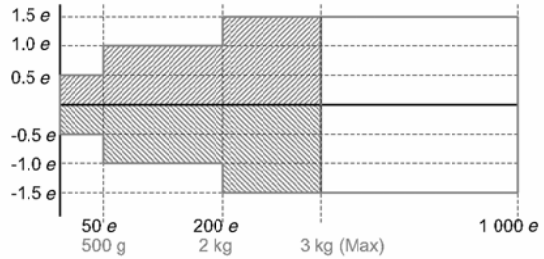
Determine the test loads and mpe

Example : Max : 3 kg, *e : 10* g, *Min : 100* g, *classes 4*

Test load		mpe
zero	0 g	????
Min	100 g	????
Mpe change 1	????	????
Mpe change 2	????	????
Max	3 kg	????
Any load	????	????

AIST

mpe	Class 4 *For loads, m expressed in verification scale intervals, e*	Class 4 (Gram)
±0.5 *e*	$0 \leqslant m \leqslant 50$	$0g \leqslant m \leqslant 500g$
±1.0 *e*	$50 < m \leqslant 200$	$500g < m \leqslant 2\,000g$
±1.5 *e*	$200 < m < 1\,000$	$2\,000g < m < 10\,000g$



AIST

Weighing Performance Test

Determine the test loads and mpe

Example : Max : 3 kg, *e : 10* g, *Min : 100* g, *class 4*

Test load		mpe
zero	0 g	5 g
Min	100 g	5 g
Mpe change 1	500 g	5 g
Mpe change 2	2 kg	10 g
Max	3 kg	15 g
Any load	????	????

Weighing Performance Test

Determine the test loads and mpe

Example : Max : 3 kg, e : 10 g, Min : 100 g, class 4

Test load		mpe
zero	0 g	5 g
Min	100 g	5 g
Mpe change 1	500 g	5 g
Any load	1 kg	10 g
Mpe change 2	2 kg	10 g
Max	3 kg	15 g

Weighing Performance Test

Test loads and MPE are recorded in the test report.

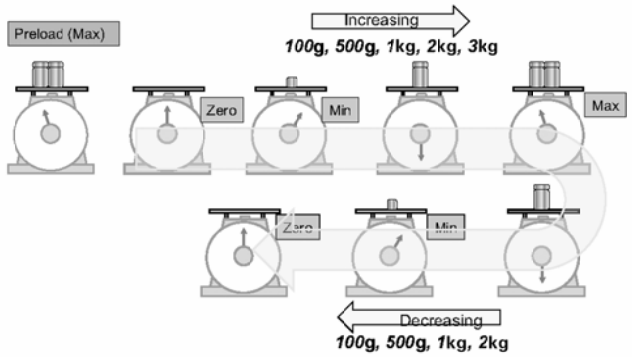
Example : Max : 3 kg, e : 10 g, Min : 100 g, class 4

Load	Indication		Error		Corrected error		Mpe
0							5 g
100 g							5 g
500 g							5 g
1 kg							10 g
2 kg							10 g
3 kg							15 g

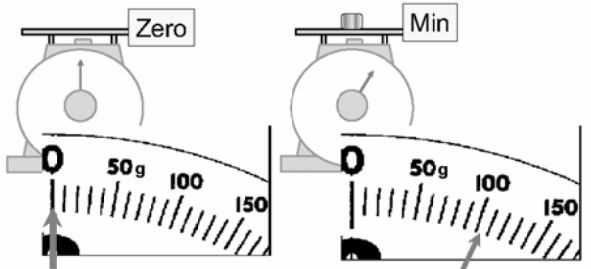
Initial zero error

Weighing Performance Test

Self indication instruments



Weighing Performance Test



Test load (L) = 0 g
Indication (I) = 0 g

Test load (L) = 100 g
Indication (I) = 101 g

If it's possible, read of 0.1e

AIST

Record these the indication value of the instrument when put on the test load

Load	Indication		Error		Corrected error		Mpe
0	0	1					5 g
100 g	101	101					5 g
500 g	503	503					5 g
1 kg	1 005	1 003					10 g
2 kg	2 005	2 010					10 g
3 kg	3 010						15 g

Initial zero error

AIST

Weighing Performance Test

Calculate of Error

$$Error\ (E) = I - L$$

I = Indication L = Load

$$Corrected\ error\ (Ec) = E - E_0$$

E = Error of each test load

E_0 = initial zero error

** If initial zero error is not zero, this formula shall be applied.*

AIST

Record these the indication value of the instrument when put on the test load

Load	Indication		Error		Corrected error		Mpe
0	0	1					5 g
100 g	101	101					5 g
500 g	503	503					5 g
1 kg	1 005	1 003					10 g
2 kg	2 005	2 010					10 g
3 kg	3 010						15 g

Initial zero error

Pass or Fail

AIST

Record these the indication value of the instrument when put on the test load

Load	Indication		Error		Corrected error		Mpe
0	0	1	0	1	0	1	5 g
100 g	101	101	1	1	1	1	5 g
500 g	503	503	3	3	3	3	5 g
1 kg	1 005	1 003	5	3	5	3	10 g
2 kg	2 005	2 010	5	10	5	10	10 g
3 kg	3 010		10		10		15 g

Initial zero error

Pass

AIST

Example

Corrected error shall be applied in the case of the following results

Load	Indication		Error		Corrected error		mpe
0	*5*	*5*					*5* g
100 g	*105*	*105*					*5* g
500 g	*505*	*505*					*5* g
1 kg	*1 010*	*1 010*					*10* g
2 kg	*2 015*	*2 015*					*10* g
3 kg	*3 015*						*15* g

Pass or Fail Initial zero error

AIST

Example

Corrected error shall be applied in the case of the following results

Load	Indication		Error		Corrected error		mpe
0	*5*	*5*	*5*	*5*	*0*	*0*	*5* g
100 g	*105*	*105*	*5*	*5*	*0*	*0*	*5* g
500 g	*505*	*505*	*5*	*5*	*0*	*0*	*5* g
1 kg	*1 010*	*1 010*	*10*	*10*	*5*	*5*	*10* g
2 kg	*2 015*	*2 015*	*15*	*15*	*10*	*10*	*10* g
3 kg	*3 015*		*15*		*10*		*15* g

Pass Initial zero error

AIST

Repeatability (A.4.10)

The difference between the results of several weighings of the same load shall not be greater than the absolute value of the maximum permissible error of the instruments.

Two series of weighings shall be performed ,one with a load of about 50% and one with a load close to 100% of Max. Normally no more than 3 weighings on class 3 and 4 or 6 weighings on classes 1 and 2 are necessary.

AIST

Repeatability test

Self indication instruments : analogue indication

Example : ***Max : 3 kg, e : 10 g, Min : 100 g, class 4***

➢Determining test load and mpe:

1/2 Max = 1.5 kg, mpe is ☐ g
Max = 3 kg, mpe is ☐ g

➢Record in test report

No.	Load	Indication	Load	Indication
1	1.5 kg		3 kg	
2	1.5 kg		3 kg	
3	1.5 kg		3 kg	
	Max-Min		Max−Min	

AIST

Repeatability test

Self indication instruments : analogue indication

Example : ***Max : 3 kg, e : 10 g, Min : 100 g, class 4***

➢Determining test load and mpe:

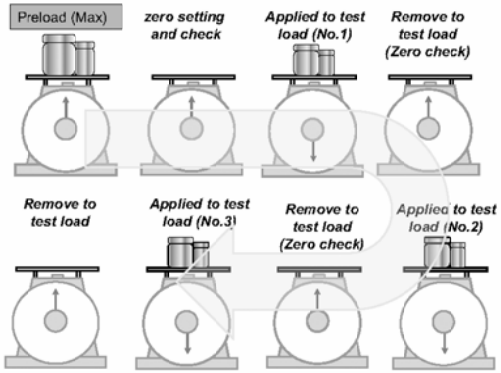
1/2 Max = 1.5 kg, mpe is 10 g
Max = 3 kg, mpe is 15 g

➢Record in test report

No.	Load	Indication	Load	Indication
1	1.5 kg		3 kg	
2	1.5 kg		3 kg	
3	1.5 kg		3 kg	
	Max-Min		Max-Min	

AIST

Repeatability test



AIST

Repeatability test

No.	Load	Indication	Load	Indication
1	**1.5 kg**	1500 g	**3 kg**	2990
2	**1.5 kg**	1505 g	**3 kg**	2990
3	**1.5 kg**	1500 g	**3 kg**	3000
	Max-Min		**Max-Min**	

Pass or Fail

AIST

Repeatability test

No.	Load	Indication	Load	Indication
1	**1.5 kg**	1500 g	**3 kg**	2990
2	**1.5 kg**	1505 g	**3 kg**	2990
3	**1.5 kg**	1500 g	**3 kg**	3000
	Max-Min	*5 g*	**Max-Min**	*10 g*

Pass

AIST

Discrimination test (A3.8)

Self indication instruments : analogue indication

An extra load equivalent to the absolute value of the maximum permissible error for the applied load when gently placed on or withdrawn from the instrument at equilibrium shall cause a permanent displacement of the indicating element corresponding to not less than 0.7 times extra load.

This test shall be performed with three different loads.

Min, 1/2Max, Max

AIST

Discrimination test

Self indication instruments : analogue indication

Example : ***Max : 3 kg, e : 10 g, Min : 100 g, class 4***

➢Determine test load and extra load :

Min = 100 g extra load: ☐ g
1/2Max = 1.5 kg extra load: ☐ g
Max = 3 kg extra load: ☐ g

➢Record in test report

Load	Indication I1	Extra load = mpe	Indication I2	I2-I1
100 g				
1.5 kg				
3 kg				

AIST

Discrimination test

Self indication instruments : analogue indication

Example : ***Max : 3 kg, e : 10 g, Min : 100 g, class 4***

➢Determine test load and extra load :

Min = 100 g ; extra load: 5 g
1/2Max = 1.5 kg ; extra load: 10 g
Max = 3 kg ; extra load: 15 g

➢Record in test report

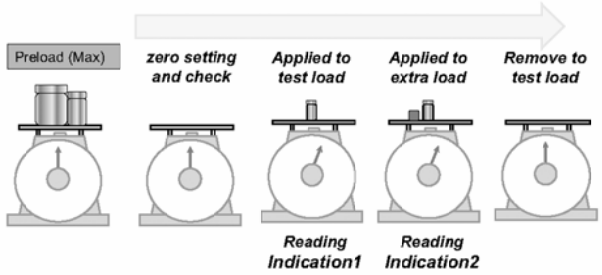
Load	Indication I1	Extra load = mpe	Indication I2	I2-I1
100 g		5 g		
1.5 kg		10 g		
3 kg		15 g		

AIST

Discrimination test

Self indication instruments : analogue indication

Example : ***Max : 3 kg, e : 10 g, Min : 100 g, class 4***

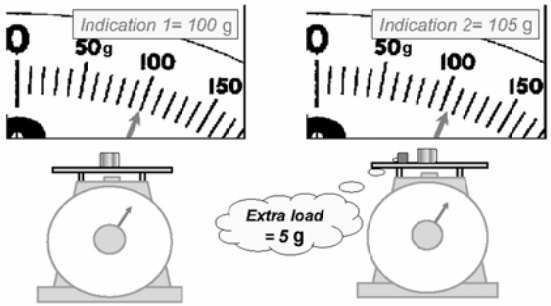


AIST

Discrimination test

Self indication instruments : analogue indication

Example : ***Max : 3*** **kg**, ***e : 10*** **g**, ***Min : 100*** **g**, ***class 4***



AIST

Discrimination test

Self indication instruments : analogue indication

Example : ***Max : 3*** **kg**, ***e : 10*** **g**, ***Min : 100*** **g**, ***class 4***

Load	Indication I1	Extra load = mpe	Indication I2	I2-I1
100 g	100 g	5 g	105 g	5 g
1.5 kg	1500 g	10 g	1510 g	10 g
3 kg	3000 g	15 g	3012 g	12 g

Check if I2-I1 ⩾0.7 mpe

Pass or Fail

AIST

Discrimination test

Self indication instruments : analogue indication

Example : ***Max : 3*** **kg**, ***e : 10*** **g**, ***Min : 100*** **g**, ***class 4***

Load	Indication I1	Extra load = mpe	Indication I2	I2-I1
100 g	100 g	5 g	105 g	5 g
1.5 kg	1500 g	10 g	1510 g	10 g
3 kg	3000 g	15 g	3012 g	12 g

Check if I2-I1 ⩾0.7 mpe

Pass

AIST

Eccentricity tests (A4.7)

The Indications for different positions of a load shall meet the maximum permissible errors, when the is tested according to following.

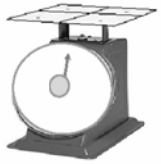
- Instrument with a load receptor having ***n*** points of support, with ***n ⩽ 4***
  Test load : (Max + Additive tare effect) / 3
- Instrument with a load receptor having ***n*** points of support, with ***n > 4***
  Test load : (Max + Additive tare effect) / (*n*-1)
- Instrument with a load receptor subject to minimal off-center loading
  Test load : 0.1Max + Additive tare effect
- Instrument used for weighing rolling loads
  Test load : usual rolling load, the heaviest and the most concentrated one which may be weighed, but not exceeding 0.8 times the sum of the Max and Additive tare effect

AIST

Eccentricity test

Self indication instruments : analogue indication

Example : ***Max : 3*** kg, ***e : 10*** g,
Min : 100 g, ***class 4***



➢***Determine type of load receptor , test load and mpe***

This instrument has 2 points of support

n points of support with ***n ⩽ 4***

Test load = *(Max + Additive tare effect) / 3 =* ? kg

mpe = ? g

AIST

Eccentricity test

Self indication instruments : analogue indication

Example : ***Max : 3*** kg, ***e : 10*** g,
Min : 100 g, ***class 4***

➢***Determine type of load receptor , test load and mpe***

This Instrument has 2 points of support

n points of support with ***n ⩽ 4***

Test load = *(Max + Additive tare effect) / 3 =3* kg */ 3 = 1* kg

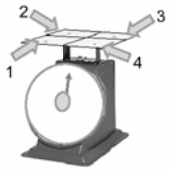
mpe = 10 g

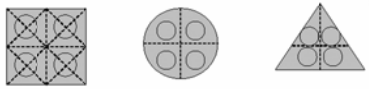
AIST

Eccentricity test

➢***Determine of different position***

Surface of the loading receptor is evenly divided into four





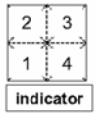
○ Load positions

AIST

Eccentricity test

➢***Record in test report***

Location	L	I	E	Ec	mpe
1	0				
1	1 kg				10 g
2	0				
2	1 kg				10 g
3	0				
3	1 kg				10 g
4	0				
4	1 kg				10 g

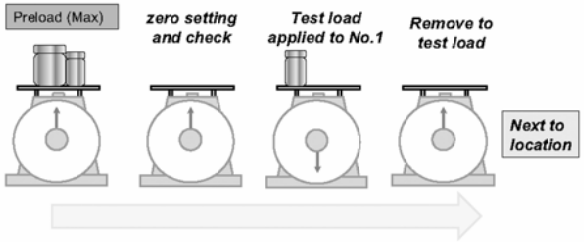


AIST

Eccentricity test

Self indication instruments : analogue indication

Example : ***Max : 3*** kg, ***e : 10*** g, ***Min : 100*** g, ***class 4***



AIST

Eccentricity test

Self indication instruments : analogue indication

Spring type: Example : ***Max : 3*** kg, ***e : 10*** g, ***Min : 100*** g, ***class 4***

Location	L	I	E	Ec	mpe
1	0	0 g			
1	1 kg	1000 g			10 g
2	0	0 g			
2	1 kg	1005 g			10 g
3	0	0 g			
3	1 kg	1005 g			10 g
4	0	5 g			
4	1 kg	1010 g			10 g

Pass or Fail

AIST

Eccentricity test

Self indication instruments : analogue indication

Spring type: Example : ***Max : 3*** kg, ***e : 10*** g, ***Min : 100*** g, ***class 4***

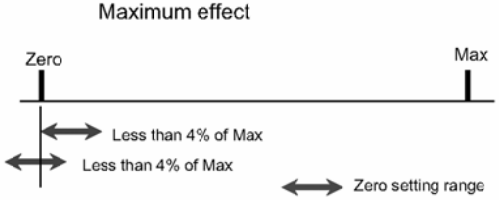
Location	L	I	E	Ec	mpe
1	0	0 g	0 g		
1	1 kg	1000 g	0 g	0 g	10 g
2	0	0 g	0 g		
2	1 kg	1005 g	5 g	5 g	10 g
3	0	0 g	0 g		
3	1 kg	1005 g	5 g	5 g	10 g
4	0	5 g	5 g		
4	1 kg	1010 g	10 g	5 g	10 g

Pass

AIST

Zero-setting device

- The effect does not alter Max
- The accuracy is 0.25 *e* or 0.5 *d* on a auxiliary indicating device
- The range is 4 % of Max for zero-setting



AIST

Zero setting accuracy

After zero setting the effect of zero deviation on the result of the weighing shall not be more than 0.25e; however, on an instrument with auxiliary indicating devices this effect shall be not more than 0.5d

AIST

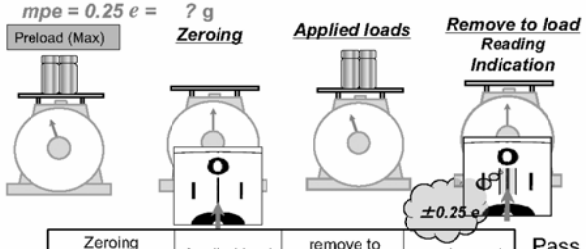
Self indicating instruments : analogue indication

Spring type: Example : ***Max : 3 kg, e : 10 g, Min : 100 g, class 4***

➢***Determine of mpe***

e = 10 g

mpe = 0.25 e = ***?*** g



Zeroing indication	Applied load	remove to load indication	requirement
0 g	150 kg	2 g	

Pass or Fail

AIST

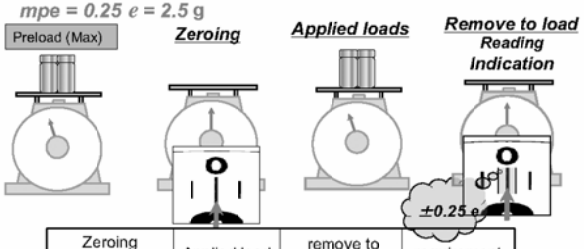
Self indicating instruments : analogue indication

Spring type: Example : ***Max : 3 kg, e : 10 g, Min : 100 g, class 4***

➢***Determine of mpe***

e = 10 g

mpe = 0.25 e = 2.5 g



Zeroing indication	Applied load	remove to load indication	requirement
0 g	150 kg	2 g	2.5 g

Pass

AIST

Test producer - part 2

Non-self indicating instrument

Platform instrument
Lever type

AIST

Value of maximum permissible error
【Weighing performance test】

Test loads

Apply test loads from zero up to and including Max, and similarly remove the test loads back to zero.

Determining the verification for weighing tests at least 5 shall be selected. The test loads selected shall include Max, and Min, and values at or near those at which the mpe changes.

AIST

Weighing Performance Test

Determine the test loads and mpe

Example : Max : 150 kg, e : 50 g, Min : 1 kg, class 3

Test load		mpe
zero		
Min		
Mpe change 1		
Mpe change 2		
Max		
*Any load		

AIST

Weighing Performance Test

Determine the test loads and mpe

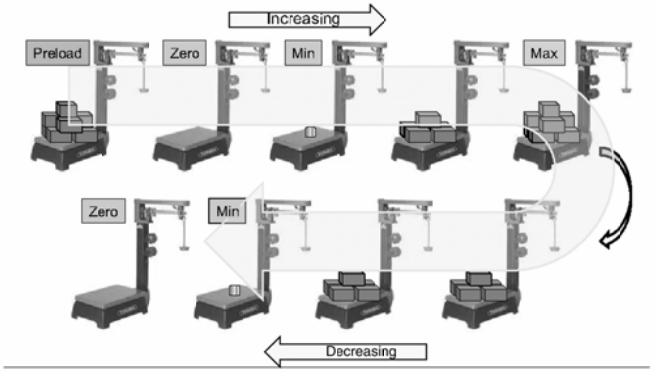
Example : Max : 150 kg, e : 50 g, Min : 1 kg, class 3

Test load		mpe
zero	0	25 g
Min	1 kg	25 g
Mpe change 1	25 kg	25 g
Mpe change 2	100 kg	50 g
Max	150 kg	75 g
*Any load	50 kg	50 g

AIST

Weighing Performance Test

Non self indication instruments Platform instrument



AIST

Weighing Performance Test

Test loads and MPE are recorded in the test report.

Example : Max : 150 kg, e : 50 g, Min : 1 kg, classes 3

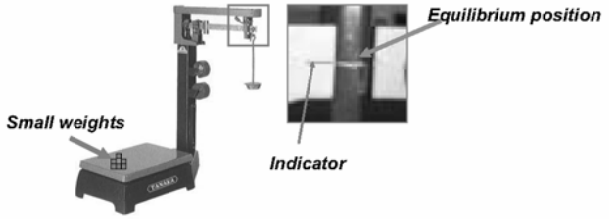
Load	Indication		Small weights		Error		Mpe
0							*25 g*
1 kg							*25 g*
25 kg							*25 g*
50 kg							*50 g*
100 kg							*50 g*
150 kg							*75 g*

AIST

Weighing Performance Test

Zeroing

1. *Small Weights put on the load receptor of no-load after preload.*
2. *Zero setting device to equilibrium position.*



AIST

Weighing Performance Test

Test loads and MPE are recorded in the test report.

Example : Max : 150 kg, e : 50 g, Min : 1 kg, classes 3

Load	Indication		Small weights		Error		Mpe
0	*0*				*0*		*25 g*
1 kg							*25 g*
25 kg							*25 g*
50 kg							*50 g*
100 kg							*50 g*
150 kg							*75 g*

AIST

Weighing Performance Test

Test load (Min)

1. *Min weight put on load receptor.*
2. *Confirm to position of indicator.*
   - *If indicator is an accord with equilibrium position, the error is 0.*
   - *If indicator balanced above equilibrium position,*

     Small weights shall be removed until equilibrium position comes to the indicator. (-)
   - *If indicator balanced below equilibrium position,*

     Small weights shall be put on until equilibrium position comes to the indicator. (+)

AIST

Weighing Performance Test

Test loads and MPE are recorded in the test report.

Example : Max : 150 kg, e : 50 g, Min : 1 kg, classes 3

Load	Indication		Small weights		Error		Mpe
0	*0*	*0*	*0*	*-10 g*			*25 g*
1 kg	*1 000*	*1 000*	*+15 g*	*-10 g*			*25 g*
25 kg	*25 000*	*25 000*	*+15 g*	*-10 g*			*25 g*
50 kg	*50 000*	*50 000*	*+5 g*	*-10 g*			*50 g*
100 kg	*100 000*	*100 000*	*-25 g*	*-40 g*			*50 g*
150 kg	*150 000*		*-50 g*				*75 g*

AIST

Weighing Performance Test

Calculate of Error

Non self indicating instruments

$$Error\ (E) = I - L + SI$$

I = Indication L = Load SI= small load

AIST

Weighing Performance Test

Test loads and MPE are recorded in the test report.

Example : Max : 150 kg, e : 50 g, Min : 1 kg, classes 3

Load	Indication		Small weights		Error		Mpe
0	*0*	*0*	*0*	*-10 g*			*25 g*
1 kg	*1000*	*1000*	*+15 g*	*-10 g*			*25 g*
25 kg	*25000*	*25000*	*+15 g*	*-10 g*			*25 g*
50 kg	*50000*	*50000*	*+5 g*	*-10 g*			*50 g*
100 kg	*100000*	*100000*	*-25 g*	*-40 g*			*50 g*
150 kg	*150000*		*-50 g*				*75 g*

Pass or Fail

AIST

Weighing Performance Test

Test loads and MPE are recorded in the test report.

Example : Max : 150 kg, e : 50 g, Min : 1 kg, classes 3

Load	Indication		Small weights		Error		Mpe
0	*0*	*0*	*0*	*-10 g*	*0*	*-10 g*	*25 g*
1 kg	*1000*	*1000*	*+15 g*	*-10 g*	*15 g*	*-10 g*	*25 g*
25 kg	*25000*	*25000*	*+15 g*	*-10 g*	*15 g*	*-10 g*	*25 g*
50 kg	*50000*	*50000*	*+5 g*	*-10 g*	*5 g*	*-10 g*	*50 g*
100 kg	*100000*	*100000*	*-25 g*	*-40 g*	*-25 g*	*-40 g*	*50 g*
150 kg	*150000*		*-50 g*		*-50 g*		*75 g*

Pass

AIST

Weighing Performance Test

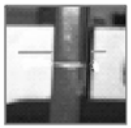
Simple method

Evaluation method; error cannot be determined

Non self indicating instruments

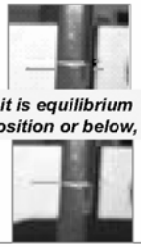
◆ *If indicator balanced above equilibrium position,*

Applied load



Indicator

Remove weights of the value mpe



If it is equilibrium position or below, PASS

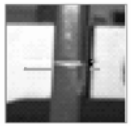
AIST

Weighing Performance Test

Simple method

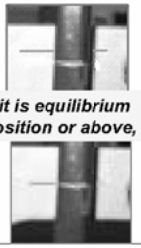
◆ *If indicator balanced below equilibrium position,*

Applied load



Indicator

Apply weights of the value of mpe



If it is equilibrium position or above, PASS

AIST

Repeatability

The difference between the results several weighings of the same load shall not be greater than the absolute value of the maximum permissible error of the instruments.

Two series of weighings shall be performed ,one with a load of about 50% and one with a load close to 100% of Max. Normally no more than 3 weighings on class 3 and 4 or 6 weighings on classes 1 and 2 are necessary.

AIST

Repeatability Test

Non self indication instruments

Example : ***Max : 150*** **kg,** ***e : 50*** **g,** ***Min : 1*** **kg,** ***class 3***

➢Determining test load and mpe:

1/2 Max = 75 kg, mpe : ? g
Max = 150 kg, mpe : ? g

➢Record in test report

No	Load	Indication	Small weights	Load	Indication	Small weights
1	75 kg			150 kg		
2	75 kg			150 kg		
3	75 kg			150 kg		
	Max-Min			Max-Min		

AIST

Repeatability Test

Non self indication instruments

Example : ***Max : 150*** **kg,** ***e : 50*** **g,** ***Min : 1*** **kg,** ***class 3***

➢Determining test load and mpe:

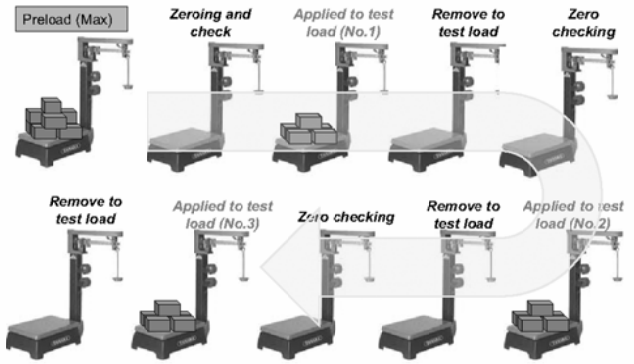
1/2 Max : 75 kg, mpe : 50 g
Max : 150 kg, mpe : 75 g

➢Record in test report

No	Load	Indication	Small weights	Load	Indication	Small weights
1	75 kg			150 kg		
2	75 kg			150 kg		
3	75 kg			150 kg		
	Max-Min			Max-Min		

AIST

Repeatability test



AIST

Repeatability test

No	Load	Indication	Small weights	Load	Indication	Small weights
1	75 kg	75.000 kg	+10 g	150 kg	150.000 kg	-50 g
2	75 kg	75.000 kg	+ 50 g	150 kg	150.000 kg	-50 g
3	75 kg	75.000 kg	+ 50 g	150 kg	150.000 kg	-40 g
	Max-Min			Max-Min		

Pass or Fail

AIST

Repeatability test

No	Load	Indication	Small weights	Load	Indication	Small weights
1	75 kg	75.000 kg	+10 g	150 kg	150.000 kg	-50 g
2	75 kg	75.000 kg	+ 50 g	150 kg	150.000 kg	-50 g
3	75 kg	75.000 kg	+ 50 g	150 kg	150.000 kg	-40 g
	Max-Min		40 g	Max-Min		*10* g

Pass

AIST

Discrimination test

Non self indicating instruments

An extra load equivalent to 0.4 times the absolute value of the maximum permissible error for the appiied load when gently placed cn or withdrawn from the instrument at equilibrium shall produce a visible cause a permanent displacement of the indicating element movement element .

This test shall be performed with three different loads.

Min, 1/2Max, Max

AIST

Discrimination test

Non self indication instruments

Example : ***Max : 150*** **kg,** ***e : 50*** **g,** ***Min : 1*** **kg,** ***class 3***

➢Determine test load and extra load :

Min = 1 kg : Extra load = ? g
1/2Max = 75 kg : Extra load = ? g
Max = 150 kg : Extra load = ? g

➢**Record in test report**

Load	Indication I	Extra load =0.4 mpe	Movement
1 kg			
75 kg			
150 kg			

AIST

Discrimination test

Non self indication instruments

Example : ***Max : 150*** **kg,** ***e : 50*** **g,** ***Min : 1*** **kg,** ***class 3***

➢Determine test load and extra load :

Min = 1 kg : Extra load 25 g ×0.4 = 10 g
1/2Max = 75 kg : Extra load 50 g ×0.4 = 20 g
Max = 150 kg : Extra load 75 g ×0.4 = 30 g

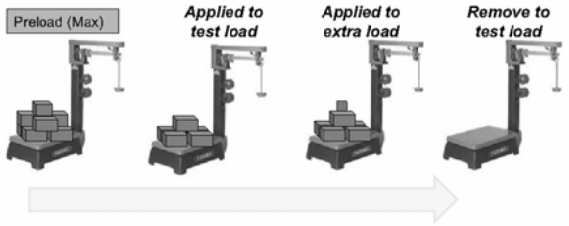
➢**Record in test report**

Load	Indication I	Extra load =0.4 mpe	Movement
1 kg		10 g	
75 kg		20 g	
150 kg		30 g	

AIST

Discrimination test

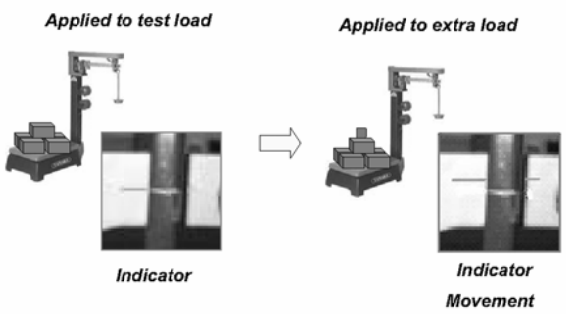
Non self indication instruments



AIST

Discrimination test

Non self indication instruments



AIST

Discrimination test

Non self indication instruments

Example : ***Max : 150*** **kg**, ***e : 50*** **g**, ***Min : 1*** **kg**, ***class 3***

Load	Indication I	Extra load =0.4 mpe	Movement (*)
1 kg	1.000 kg	10 g	+
75 kg	75.000 kg	20 g	+
150 kg	150.000 kg	30 g	+

(*) Mark visible movement by "+"

Pass or Fail

AIST

Discrimination test

Non self indication instruments

Example : ***Max : 150*** **kg**, ***e : 50*** **g**, ***Min : 1*** **kg**, ***class 3***

Load	Indication I	Extra load =0.4 mpe	Movement (*)
1 kg	1.000 kg	10 g	+
75 kg	75.000 kg	20 g	+
150 kg	150.000 kg	30 g	+

(*) Mark visible movement by "+"

Pass

AIST

Eccentricity

The Indications for different positions of a load shall meet the maximum permissible errors, when the is tested according to following.

- Instrument with a load receptor having ***n*** points of support, with ***n ⩽ 4***
  Test load : (Max + Additive tare effect) / 3
- Instrument with a load receptor having ***n*** points of support, with ***n > 4***
  Test load : (Max + Additive tare effect) / (n-1)
- Instrument with a load receptor subject to minimal off-center loading
  Test load : 0.1Max + Additive tare effect
- Instrument used for weighing rolling loads
  Test load : usual rolling load, the heaviest and the most concentrated one which may be weighed, but not exceeding 0.8 times the sum of the Max and Additive tare effect

AIST

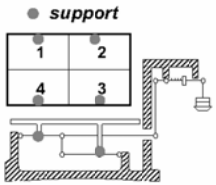
Eccentricity

Non self indication instruments :

Example : ***Max : 150*** kg, ***e : 50*** g ,
Min : 1 kg, ***class 3***

➢***Determine type of load receptor , test load and mpe***

This Instrument has 4 points of support



n points of support with ***n ⩽ 4***

Test load = (Max + Additive tare effect) / 3

= ☐ kg

mpe = ☐ g

AIST

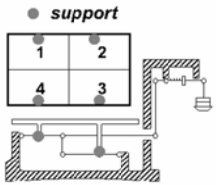
Eccentricity

Non self indication instruments :

Example : ***Max : 150*** kg, ***e : 50*** g,
Min : 1 kg, ***class 3***

➢***Determine type of load receptor , test load and mpe***

This Instrument has 4 points of support



n points of support with ***n ⩽ 4***

Test load = (Max + Additive tare effect) / 3

=150 kg / *3 = 50* kg

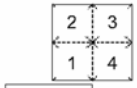
mpe = 50 g

AIST

Eccentricity

➢***Record in test report***

Location	L	I	SI	E	mpe
1	0				
1	50 kg				50 g
2	0				
2	50 kg				50 g
3	0				
3	50 kg				50 g
4	0				
4	50 kg				50 g



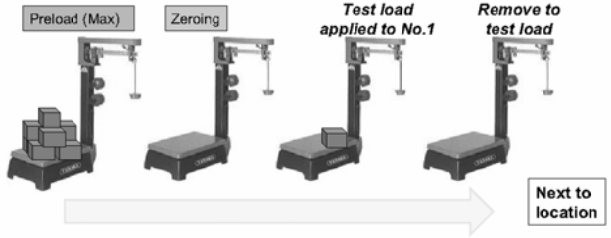
indicator

AIST

Eccentricity

Non self indication instruments

Example : ***Max : 150*** kg, ***e : 50*** g, ***Min : 1*** kg, ***class 3***



AIST

Eccentricity

Non self indication instruments :

Location	L	I	SI	E	mpe
1	0	0	0		
1	50 kg	50.000 kg	0		50 g
2	0	0	0		
2	50 kg	50.000 kg	+5 g		50 g
3	0	0	0		
3	50 kg	50.000 kg	+10 g		50 g
4	0	0	0		
4	50 kg	50.000 kg	-10 g		50 g

Pass or Fail

AIST

Eccentricity

Non self indication instruments :

Location	L	I	SI	E	mpe
1	0	0	0		
1	50 kg	50.000 kg	0	0	50 g
2	0	0	0		
2	50 kg	50.000 kg	+5 g	5 g	50 g
3	0	0	0		
3	50 kg	50.000 kg	+10 g	10 g	50 g
4	0	0	0		
4	50 kg	50.000 kg	-10 g	-10 g	50 g

Pass

AIST

Sensitivity

Only applied on non self indicating instrument

An extra load equivalent to the absolute value of the MPE for the applied load, shall be placed on the instrument at equilibrium and shall cause a permanent displacement of the indicating element of at least:

- 1 mm for an instrument of class 1 or 2;
- 2 mm for an instrument of class 3 or 4 with Max≤30 kg;
- 5mm for an instrument of class 3 or 4 with Max >30 kg.

The test shall be performed with a minimum of two difference loads (e.g. zero and Max)

AIST

Sensitivity

Non self indication instruments

Example : ***Max : 150*** kg, ***e : 50*** g, ***Min : 1*** kg, ***class 3***

- Determine test load and extra load :

  Zero = 0 kg : Extra load ? g

  Max = 150 kg : Extra load ? g

- Record in test report

Load	Extra load mpe	Displacement of indicating element	Requirement
0			
150 kg			

AIST

Sensitivity

Non self indication instruments

Example : ***Max : 150*** kg, ***e : 50*** g, ***Min : 1*** kg, ***class 3***

➢Determine test load and extra load :

Zero = 0 kg : Extra load 25 g

Max = 150 kg : Extra load 75 g

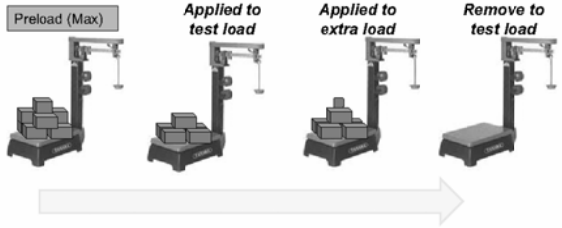
➢Record in test report

Load	Extra load mpe	Displacement of indicating element	Requirement
0	25 g		5 mm
150 kg	75 g		5 mm

AIST

Sensitivity

Non self indication instruments

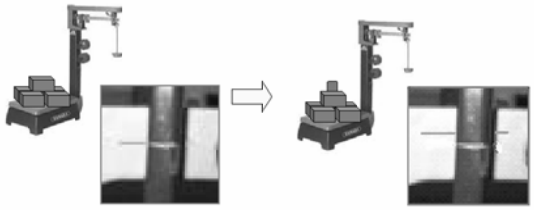


AIST

Sensitivity

Non self indication instruments

Applied to test load ***Applied to extra load***



Indicator ***Indicator***

Distance between the equilibrium positions shall be measured before and after loading of extra load

AIST

Sensitivity

Non self indication instruments

Example : ***Max : 150*** kg, ***e : 50*** g, ***Min : 1*** kg, ***class 3***

Load	Extra load mpe	Displacement of indicating element	Requirement
0	25 g	10 mm	5 mm
150 kg	75 g	9 mm	5 mm

Pass

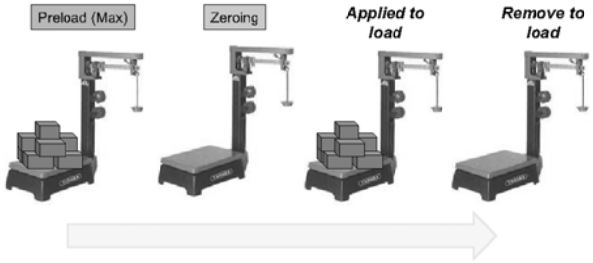
AIST

Zero setting accuracy

After zero setting the effect of zero deviation on the result of the weighing shall not be more than 0.25e; however, on an instrument with auxiliary indicating devices this effect shall be not more than 0.5d

AIST

Zero setting accuracy

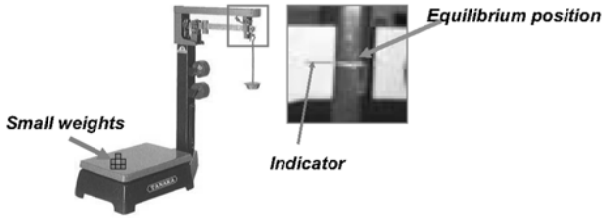


AIST

Zero setting accuracy

Zeroing

1. ***Small Weights put on the load receptor of no-load after preload.***
2. ***Zero setting device to equilibrium position.***



AIST

Zero setting accuracy

After the load is remove, Zero indicator shall be confirmed.

Confirm to position of indicator.

- ***If indicator is an accord with equilibrium position, the error is 0.***
- ***If indicator balanced above equilibrium position,***

  Small weights shall be removed until equilibrium position comes to the indicator. (-)

- ***If indicator balanced below equilibrium position,***

  Small weights shall be put on until equilibrium position comes to the indicator. (+)

AIST

Zero setting accuracy

Example : Max : 150 kg, ***e : 50*** g, ***Min : 1*** kg, ***classes 3***

zeroing	load	Indication	SI	Error	Mpe
0	***150*** kg	***0***	***-10*** g		***12.5***g

Pass or Fail

AIST

Zero setting accuracy

Example : Max : 150 kg, ***e : 50*** g, ***Min : 1*** kg, ***classes 3***

zeroing	load	Indication	SI	Error	Mpe
0	***150***kg	***0***	***-10*** g	***-10*** g	***12.5***g

Pass