

Lab Manual
MECHANICAL METALLURGY LABORATORY



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LIST OF EXPERIMENTS:

1. Hardness Test: To determine the Brinell Hardness values of ferrous and non-ferrous samples.
2. To determine the Rockwell hardness values of heat treated steels.
3. To find the microhardness of phases by using vickers hardness tester.
4. Tension Test: - To determine the elastic modulus, ultimate tensile strength, breaking stress, percentage elongation, percentage reduction in area of the given specimen. - To determine the strain distribution along the gauge length.
5. Compression test
6. Three point bend test
7. Erichson cupping test
8. Impact Testing: - To determine the charpy and Izod (V & U Groove notch) values of a given material at room temperature. - To establish the ductile - brittle transition temperature of the material.
9. Creep test

LIST OF EQUIPMENT'S:

S.No	Name of the Equipment	Quantity
1	Vickers Hardnes Tester	1
2	Brinell HardnessTtester	1
3	Rockwell Hardness Tester	1
4	Impact Testing Machine	2
5	Erichsen Cupping Tesing Machine	1
6	Automatic Micro Hardness Tester	1
7	Universal Testing Machine	1
8	Survo Hydraluic	1
9	Creep Testing Machine	3
10	High cycle Fatigue Testing System	1

SAFETY PRECAUTIONS:

1. Apply the load slowly and gradually on the sample.
2. Distance between old impression and location for new impression should be 3D (three Times the ball diameter)
3. After applying the specified load wait for 15 sec then remove the load.
4. The thickness of the test piece must not be less than 8 times the depth of impression
5. Keep other people away when you are positioning the impact crosshead and your test Specimen.
6. Don't let anyone near the release mechanism while you are positioning a test specimen.
7. Do not use the equipment if the cable or plug shows any damages.

Brinell hardness tester

Aim : to determine the hardness of given sample by using brinell hardness tester machine

Technical data:

Description	Unit	RB-3000(J)
Load range	Kgf	500,750,1000,1500,2000,2500,3000
Maximum Test height of the sample	mm	254

Load and Indenters for brinell tests on various metals:

Ball diameter (D)	Load in kilograms			
	Ferrous Metals	Non-ferrous Metals		
	(Steel & Iron) $30 D^2$	(Brass) $10 D^2$	(Aluminum) $5 D^2$	(Soft Bearing Metals) $2.5 D^2$
10 mm	3000	1000	500	250
5 mm	750	250	-----	-----
205 mm	187.5	-----	-----	-----

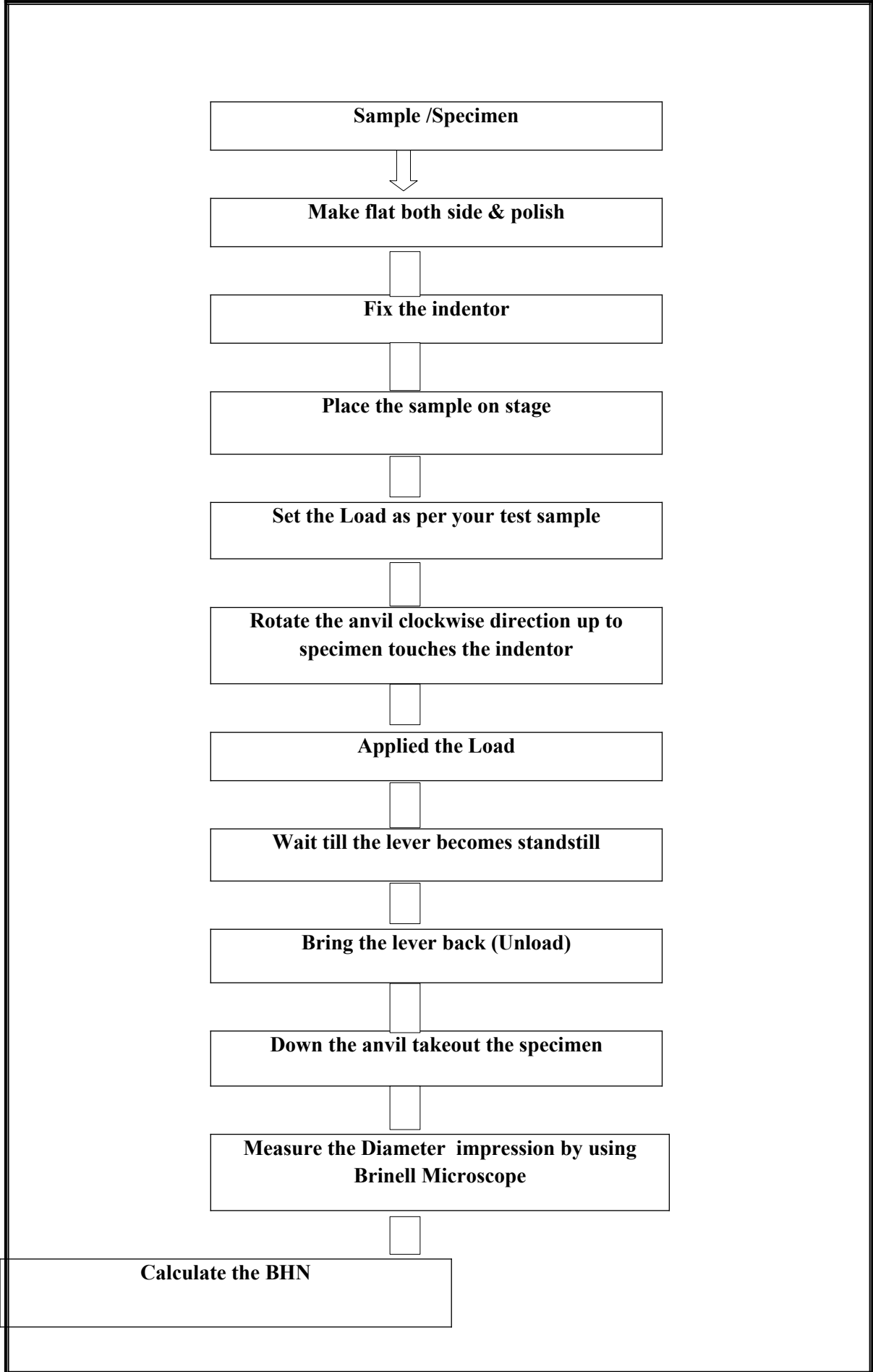
Test procedure:

For carrying out test the following procedure should be adopted very carefully. Any negligence may lead to spoil the indenter as well as the machine.

1. Take the sample and make the sample both side flat.
2. Polishing the sample with using emery paper.

3. Keep the operating level in horizontal position.
4. Fix the indenter as for your requirement with help of Allen key
5. Place the sample securely on testing table
6. Turn the hand wheel in clockwise direction, so sample touches the ball indenter.
7. Lift the operating lever from horizontal position upwards slightly after which it rotates automatically.
8. Wait till the lever becomes standstill.
9. Bring the lever back to horizontal position.
10. Turn back the hand wheel (anti clockwise direction) and remove the specimen or sample.
11. Measure the diameter of impression by Brinell Microscope and find out the Brinell hardness number

$$\text{Brinell formula } \frac{2P}{\pi D (\sqrt{D_d^2})}$$



Sample /Specimen



Make flat both side & polish



Fix the indentor



Place the sample on stage



Set the Load as per your test sample



Rotate the anvil clockwise direction up to specimen touches the indentor



Applied the Load



Wait till the lever becomes standstill



Bring the lever back (Unload)



Down the anvil takeout the specimen



Measure the Diameter impression by using Brinell Microscope



Calculate the BHN

Impact testing machine

Aim : To determine the impact strength through charpy test

Technical data:

Description	
Maximum impact energy of	30 kg-m/300 joules
Effective weight of	20.59 Kg/ 21-02Kg
Minimum value of scale graduation	0.2 Kgm/2 Joules
Maximum width of striker	18mm
Angle striking edge	$30^{\circ} \pm 1^{\circ}$
Sample Dimension	Length 55 mm \pm 0.6mm
	Width 10mm \pm 0.11mm
	Height 10mm \pm 0.11mm

Preparation of Test Sample:

- Impact test specimens for Charpy and Izod Tests must be prepared according to the standard. The notch is produced either by milling or grinding. The notch shall be carefully prepared so that the grooves appear at the base of the notch.

Test procedure:

For Conducting Charpy Test,

1. Charpy Striker is to be firmly secured to the bottom of the hammer with the help of clamping piece.
2. The latching tube is to be firmly secured to the bracket fitted at the top of column with the help of socket head screws.
3. Adjust reading pointer with pointer carrier to 30 Kgm/300 joules dial reading.

4. Now raise the hammer by hands and latch in
5. Place the sample on the Specimen support touching end stop.(The specimen should be placed in such a way that the notch is opposite to the direction of impact)
6. Release the hammer by operating press down levers.
7. Wait until the is reversing its direction of motion and begins to swing slow.
Thereafter by applying the brakes
8. Read the position of the reading pointer against scale on the dial and note down the reading
9. Remove the broken specimen from the machine and bring reading pointer on 30 Kgs/300 J dial marking stated.

Charpy Striker is to be firmly secured to the bottom of the hammer



Fix the latching tube at Charpy test position



Adjust the reading pointer at 30 Kgm/300 J



Now raise the hammer by hand and latch in



Place the sample on the sample stage



Release the hammer by pressing the lever



Applying the brake



Note down the reading on reading scale



Remove the specimen

Erichsen testing machine

Aim : To determine the ductility of given sample by using Erichsen testing machine

Technical data:

Description	Unit	
Width of the Sample	mm	70 to 90
Thickness of the Sample	mm	0.12 to 2
Least count of micrometric device	mm	0.01/0.02
One turn of hand wheel	mm	1025 advance
Weight of appliance	Kgs.	20

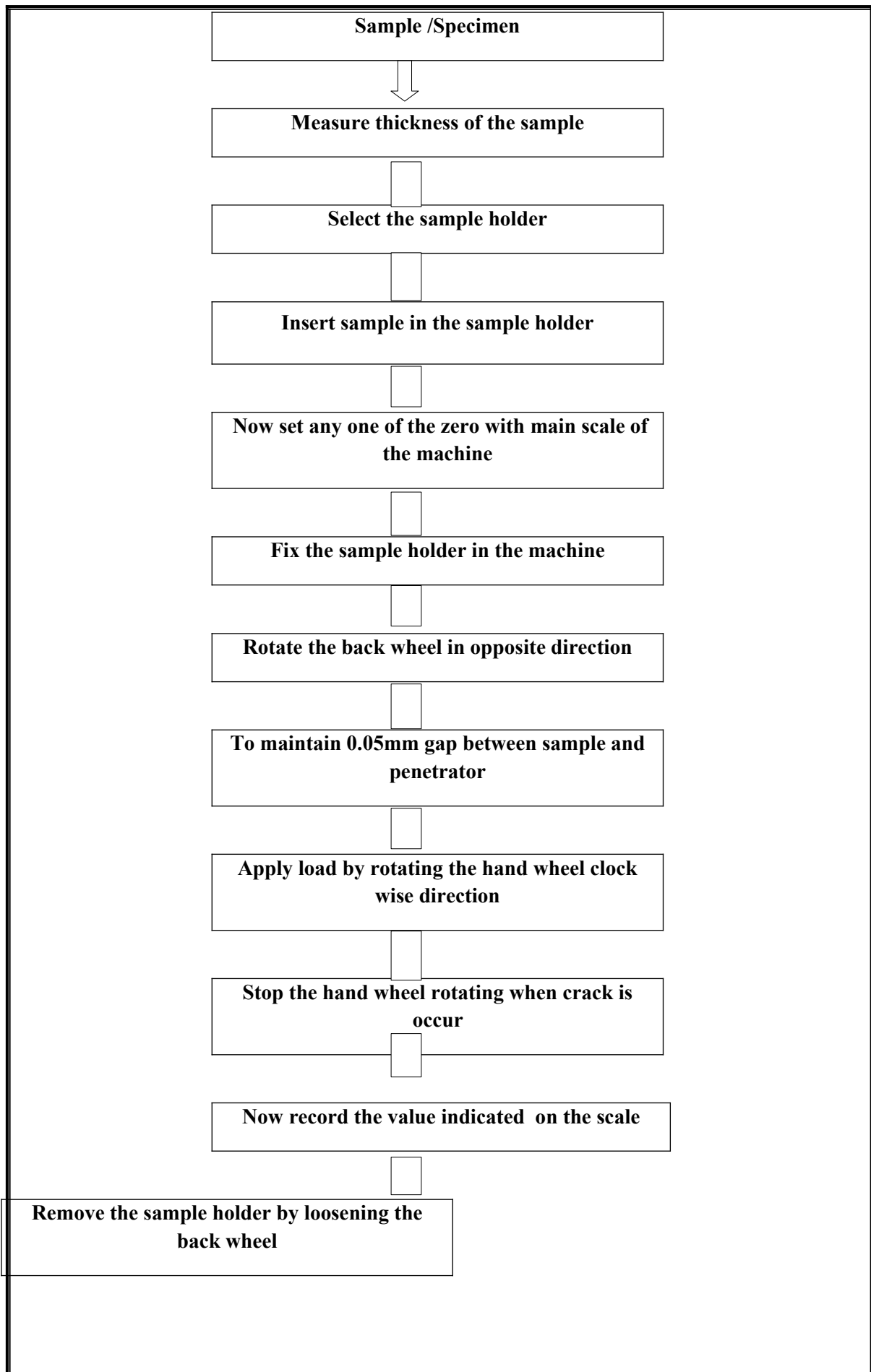
Preparation of Test Sample:

- The Sample size should be 90mm width or 70mm width

Test procedure:

For carrying out test the following procedure should be adopted very carefully. Any negligence may lead to spoil the indenter as well as the machine.

1. Take the test sample and measure the thickness of the sample by using vernier caliper
2. Initially Zero Setting is to be done before the test specimen in the machine
3. Select the test sample holder according to the specimen
4. Place it on the furrow –holder
5. Insert the specimen in machine and locate it by means of test sample holder
6. Now set any one of the zero line on the main scale of the machine
7. Now rotate the back screw in opposite direction (i.e decamping direction)
8. To maintain 0.05mm gap between test sample and penetrator as per standard procedure
9. Now Apply the load by rotating the clock wise direction of hand wheel ,slowly cupped by causing the punch to advance.
10. Travel of punch top from specimen holding surface up to the points.
Where the first one crack is occur on the reverse side of the specimen
11. Stop the hand wheel rotating when a crack is observed on the reverse side of the sample
12. Now record the Erichsen value indicated on the scale
13. Remove the specimen by loosening the back screw
14. Now Machine is ready for next test



Impact testing machine

Aim : To determine the impact strength through charpy test

Technical data:

Description	
Maximum impact energy of	16.52 kg-m/168 joules
Effective weight of	20.59 Kg/ 21-02Kg
Minimum value of scale graduation	0.14 Kgm/2 Joules
Maximum width of striker	18mm
Angle of striking edge	75° ±1°
Sample Dimension	Length 75 mm±0.6mm
	Width 10mm ±0.11mm
	Height 10mm ±0.11mm

Preparation of Test Sample:

- Impact test specimens for Charpy and Izod Tests must be prepared according to the standard. The notch is produced either by milling or grinding. The notch shall be carefully prepared so that the grooves appear at the base of the notch.

Test procedure:

For Conducting Izod Test,

10. Izod Striker is to be firmly secured to the bottom of the hammer with the help of clamping piece.
11. The latching tube is to be firmly secured to the bracket fitted at the top of column with the help of socket head screws.
12. Adjust reading pointer with pointer carrier to **16.52 Kgm/168 joules** dial reading.
13. Now raise the hammer by hands and latch in

14. The specimen for izod test is firmly secured in the specimen support with the help of clamping screw and Allen key. (The specimen should be placed in such a way that the notch on the specimen should face the striker.)
15. Release the hammer by operating press down levers.
16. Wait until the is reversing its direction of motion and begins to swing slow.
Thereafter by applying the brakes
17. Read the position of the reading pointer against scale on the dial and note down the reading
18. Remove the broken specimen from the machine and bring reading pointer on **16.52 Kgm/168 J** dial marking stated.

Izod Striker is to be firmly secured to the bottom of the hammer



Fix the latching tube at Izod test position



Adjust the reading pointer at 16.52 Kgm/168 J



Now raise the hammer by hand and latch in



Place the sample on the sample stage



Release the hammer by pressing the lever



Applying the brake



Note down the reading on reading scale



Remove the specimen

Rock well Hardness

Aim: To determine the Rockwell hardness number of given specimen by using Rockwell Hardness Equipment.

Apparatus required:

- a) Rockwell hardness machine b) Diamond cone indenter
c) Steel ball indenter d) Specimen e) belt grinder

Type of Specimen	Type of Indenter	Scale	Total Load Kg-F
Hard metals	Diamond cone	C scale (Black graduations)	150
Soft metals	Steel ball(1/16" inch)	B scale (Red graduations)	100

Steps for Operating Procedure:

1. Take a Specimen and make both sides of the specimen should be flat by using belt grinder. And polish it for smooth surface as required for indentation on the top surface
2. For testing cylindrical test specimen, use V –type plat form
3. For soft metals like non ferrous metals and mild steels use Steel ball indenter by using Allen key and fix the load as 100kgf.
4. For hard materials use diamond indenter and fix the major load as 150Kgf
5. In the Dial Gauge there are two scales available B and C with colors red and black. B scale is used for steel ball indenter and C scale is used for diamond indenter
6. Place the polished sample on the test table and make sure that the load lever should be at unload position.
7. Turn the hand wheel ,so that specimen will push the indenter and show a reading on dial gauge as smaller pointer at “3” (red spot). The needle should not cross the red spot. The indenter may damages if it crosses the red spot.

8. Now apply the major load by turn the load lever gradually to the Load position. After applying major load wait for some time to allow the needle to come to rest, the waiting time may vary from 2 to 8 seconds. Now release the load lever to un load position .seconds and release the load.

9. Hardness number obtained on the dial gauge.

10. Repeat the same procedure for other readings.

11. Average of these readings will get Rockwell Hardness Number.

Precautions:

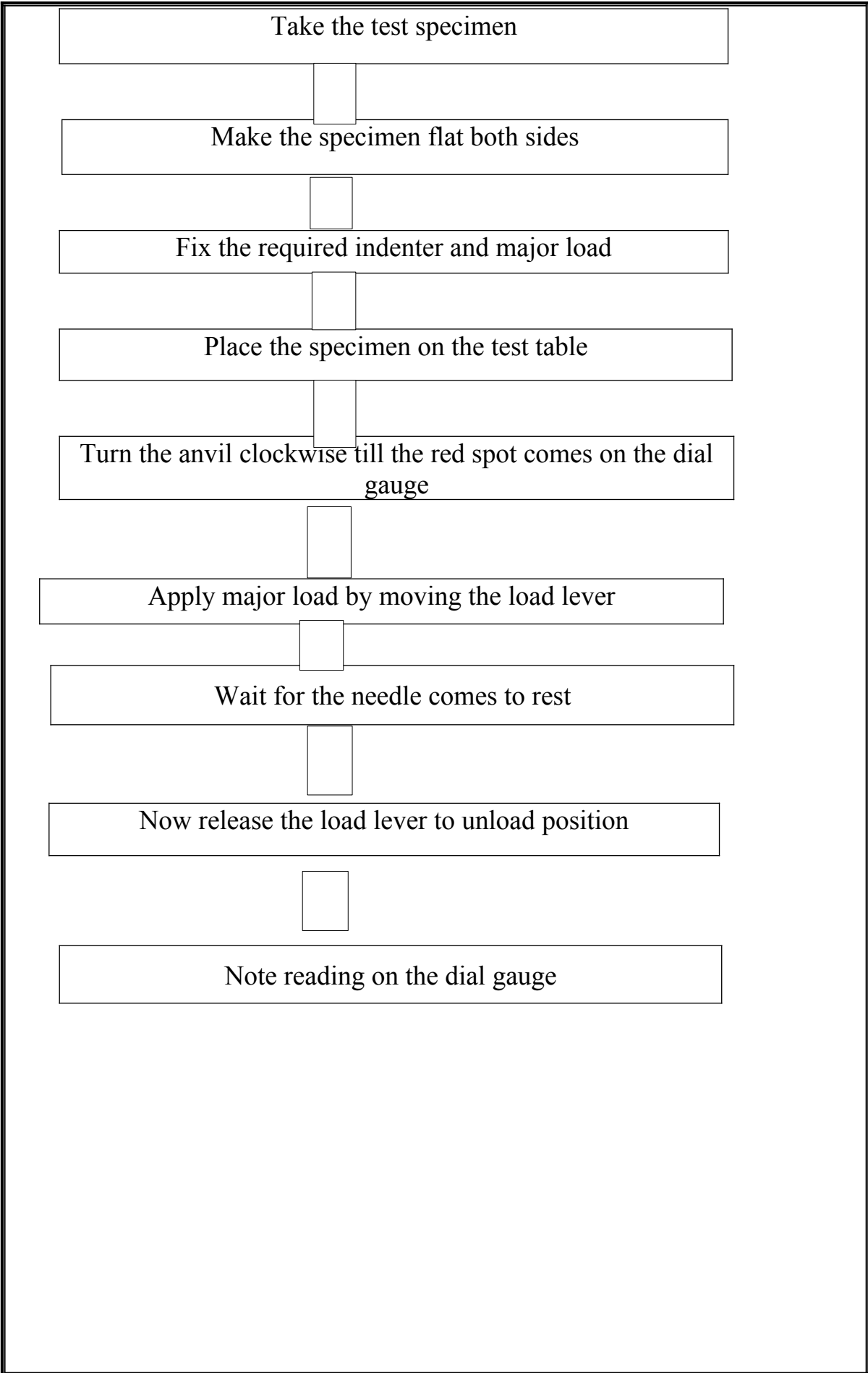
1. For testing cylindrical test specimen, use V –type plat form

2. Calibrate the machine occasionally using standard test blocks

3. For thin metal pieces place another sufficiently thick metal between the test specimen and the platform to avoid any damage which may likely occur to the platform.

4. Test specimen should not be subjected to any heating or cold working

5. The distance between the centers of the two adjacent indentations should be at least 2.5 times the diameter of the indentations.



VICKERS HARDNESS TEST

AIM:

To measure the Vickers hardness of the given test specimen.

Apparatus Required:

Vickers hardness equipment,

Test Specimen,

Emery Papers

FORMULA:

Vickers Hardness Number $\frac{1.854 F}{d^2}$

F= Force in Kg F

d = Arithmetic mean of two diagonals d1 and d2 in mm

Procedure :

1. Take the test specimen and polish it till mirror image gets on the top surface.
2. Select the weights according to the expected hardness of specimen to be tested by turning the “weight selection Knob” .The respective figure of weight is visible on one side of knob itself.
3. Place specimen securely on testing table
4. Turn the hand wheel clockwise slowly so that specimen will get focused on front screen sharply. At this stage a gap of about 0.2 to 0.25mm expected between tip of diamond inventor and top face of specimen.
5. Adjust the “Dwell” timer for required duration of load on specimen.
6. Press start push button. Keep it pressed till light inside “START” button will be “ON” even after release of push button .The loading cycle starts gradually

through a geared motor provided with a drive-cam. The loading /dwell/unloading cycle is fully automatic.

7. Index indent or head to next position so that objective of optical system will be exactly over the indentation

8. The indentation is now projected on front focusing Screen. Measure diagonal of impression in both axis one after other. Find out mean value .Calculate the hardness number by using formula.

9. To have next test, index the head to original position and bring back inventor on specimen, before starting loading/unloading operation.

Take the test specimen and polish until mirror imaged surface



Select the weights by turning weight selection knob



Place the test specimen on the table



Turn the hand wheel and focus the specimen



Set the Dwell time and push button



Measure the diagonals horizontally and vertically



Calculate the VHN by using formula