Md Saif

A Laboratory Manual

for

Mechanical Engineering Materials

(22343)

Semester-III

(ME)

Maharashtra State
Board of Technical Education, Mumbai
(Autonomous) (ISO:9001:2015) (ISO/IEC 27001:2013)

XII Resources Used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
1.	Grinding m/c	600 RPm	01
2.	Disc Polising m/c	ϕ 200 600 RPm	01
3.	Aluminium oxide Soln	Gradel	01 bottle
4.	carbon Steel bar	ϕ 25 x 25 mm	01

XIII Actual procedure followed

- Cut the Sample material in dimension of 25x25mm by using grinding m/c
- Apply at oxide Soln on Surface of metal
- use disc polyshing m/c to remove Sharpness
- Dry it

XIV Precautions followed

- operate grinding m/c required Speed
- cut material as per required dimension
- polishing is done Slow, Smooth and Hot
- uniform pressure applied during polishing
- During polishing hold the material by both hands

XV Observations

- The raw material was a not as per required dimension so model if ϕ 25x25 mm by grinding m/c
- Material was having rough surface Sharp Edge and Stick with dust particles
- Made if Clean Smooth dust free by polishing m/c

XVI Results

1. Chamfered edges of the sample
2. Mirror like surface of the sample

XVII Interpretation of results

- Chamfered edges and Samples removed by polishing and grinding
- mirror like Surface obtaining by use of aluminium oxide abrasive Solution.

XVIII Conclusions and Recommendations (if any)

Sample are paration tecnique consists of grinding polishing operation use of Soln energy paper to make material ready for clear and visible microscopic observation.

XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Briefly (one concise sentence each) describe the steps involved in the preparation of a metallographic sample:
   - Sectioning
   - Mounting
   - Coarse Grinding
   - Fine Grinding
   - Polishing
2. Explain the need of washing and drying of metallographic samples before proceeding from one grinding or polishing operation to the next?
3. Explain the correlation of grade number of the emery paper with its nature
4. Suggest the method for polishing small size sample which cannot be hold properly in the hand
5. State the precautions to be taken to preserve the polished sample for future use.
6. List the various commercial brands of emery papers.
7. Describe the different ways of specifying the emery papers.

[Space for Answers]

1 Ans Sectioning - Selection of material on which microscope observation is to be Studied.

2. Ans. mounting : loading of material Sample on Sitting m/c as required position

3 Ans. Coarse Grinding : if grinding wheels has abrasive particles is 10, 12, 14, 16, 20, 24, Then Caves grinding

4 Ans. fine grinding : if grain Size of abrasive particals is 180, 100, 120, 150, 160 Then is Carse grinding

5 Ans. Polishing : A process using very fine abrasive mineral are used for Super finishing of material Surface if used for removing Scratches tool marks on surface

6 Ans. washing of material Surface is remove duct particles due to grinding preperation during is done to make Stable coating of Enchant applied.

Q3 Ans. i wash hands properly before polishing
ii use glarce to handle material
iii Do not touch Speciman after polishing
iv keep Speciman in Clean area, cover with protective Sheet.

XX References / Suggestions for further Reading

a. https://youtu.be/AwM1dOsWsoo?t=77
b. https://youtu.be/Cl0nBBu-gzA?t=53
c. https://youtu.be/fc8zrgYJCJw?t=75
d. https://youtu.be/UuHofNW40Yw?t=63

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (10Marks)		**40%**
1	Preparation of experimental set up	10%
2	Cutting of specimen using slitting machine or hack saw	10%
3	Grinding and Polishing of specimen	20%
Product Related (15Marks)		**60%**
4	Prepared specimen	30%
5	Interpretation of result	10%
6	Conclusions	10%
7	Practical related questions	10%
Total (25Marks)		**100 %**

Names of Student Team Members

1. .....
2. .....
3. .....

Marks Obtained			Dated signature of Teacher
Process Related(10)	Product Related(15)	Total (25)	
9	14	23	

XII Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
1.	Coarinding m/c	600 RPm	01
2.	Polishing m/c	ϕ 200, 600 RPm	01
3.	Aluminium Pried	greades	01 battede
4.	Exchaned Energy	Nitral, Picrad	usm/1vond
5.	Metablurgical micro lape	6V, 30w, 200X 100mm troved	01

XIII Actual procedure followed

Sample material is prepared by grinding, polishing and etching Process as perdimension
- keep material below magnification absorb structure adJust bight focus connected to See clear visible Image

XIV Precautions followed

only screw head should be fixed should be fixed.
Remove screw in one direction only to avoid backlash error

XV Observations and Calculations

Observations

S. No	The magnification used	Important phases noted	Shape	Size	Color	Distribution of phases
1	45 times	carbon	flakes	low	dark	irregular
2	100 times	carbon ferrite	flakes	moed	dark and white	irregular
3	150 times	ferrite cementtype	flakes and Spheroid	high	dark and white	Irregular

XVI Results

For each feature, one normally records the following characteristics:

1. Shape
2. Size
3. Color (in plane polarized light or with crossed polars)
4. Distribution of phases

XVII Interpretation of results

i. low Steel observed under microscope shows irregular shaped carbon takes in dark colour with ferrite phase and cementiles seen in which colour.

ii ferrite austenite, cementtile phasar, seen

XVIII Conclusions and Recommendations (if any)

- when material sample is prepared are fally free form from effects are as per dimension then it is kept below microscope cleans to observe structure phase of it -
- Any effect can also be delected

XIX Practical Related Questions

Note. Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Define Microscopy?
2. State the principle of Metallurgical Microscope?
3. List different etching agents used for specimen preparations?
4. Describe features of microstructures obtained in each case.
5. Examine the four requisite samples and photograph each at the optimal magnification (if a camera is not available then sketch each of the microstructures).
6. Briefly describe the salient features of the eutectoid specimens that you have examined. How many phases and constituents are present in each?
7. Based on the observed microstructure of the steel sample, can you determine the carbon content of the steel? If yes, then briefly explain how to know the carbon content.
8. Describe the microstructure of low carbon steel?
9. Describe the microstructure of alloy steel?

Describe the microstructure of medium carbon steel?

[Space for Answers]

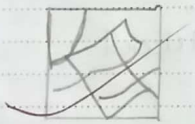
1 Ans microscope is the Study of Structure details of mechade alloy. be use of high magnification power metallargical microscope

Structure detail such as grain size Shape alistric betition of phase Inclusion Surface quantity mechanicle properties of memarion be found by microscope

2 Ans principle of melelurgical is Study of prepare metal surface using higher magnification power lense

3 Ans Reagent : Nital, Picrad ferrite hydrofluoric acid, hydrochloric acid, distilled water.

5 Ans



0.1%.C

0.6%.

ferrite & cementile

6 Q.Ans Eutectoid Steel =
Hypo Eutectioid = carbon less than 0.8%.
Hyper-Eutectioid = carbon betn 0.8% less
Hypo Eutectoid Steel
α ferrite amount = 75%.
Pearlite = 25%.
0.14 C = 12.5% pearlite

Hypo Eutectoid Steel
cementile amount = 6.8%
peolite = 93.2%
0.1% C = 1.7% fe3C.

9 Ans Alloy Steel : Pearlite · ferrite and cementile
ferrite = dark, cementile = white

XX References / Suggestions for further Reading

a) https://www.youtube.com/watch?v=fc8zrgYJCJw
b) https://www.youtube.com/watch?v=UuHofNW40Yw
c) https://www.youtube.com/watch?v=d4_xSRQxDxs
d) https://www.youtube.com/watch?v=zCznMbj2Yn4
e) https://www.youtube.com/watch?v=ljTEG-B-kGc

XXI Assessment Scheme

	Performance indicators	Weightage
	Process related (15 Marks)	**60%**
1	Preparation of experimental set up	10%
2	Etching the specimen with suitable etchant	25%
3	Observation of the microstructure of the specimen at different magnification using microscope	25%
	Product related (10 Marks)	**40%**
4	Follow Safety measures	10%
5	Answer experiment related questions	10%
6	Submit journal report on time	10%
7	Follow Housekeeping	10%
	Total (25Marks)	**100 %**

Names of Student Team Members

1. .....
2. .....
3. .....

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	
9	14	23	

XII Resources Used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
1.	Brihelld hardness tester	380x800mm 150 kg	01
2.	indecter	5omm	01
3.	mild Steel	ϕ25x25	01
4.	Dead weight	10-150kg	01

XIII Actual procedure followed

- Select material whose hardness to be measure
- Select indecter or m/c handed applied to be
- keep Select indecter of 5mm diameter
- turn hand wheel So that So material touches
- wait 10-15 Sec turn hand wheel and remain over
- 10-15 Sec turn bar-1 wheel by brihelld microscope use formula to calculate BHN

XIV Precautions followed

- Apply local Slowly
- After appling load wait for 15 Sec
- Surface of material Should be Smooth and clean

XV Observations and Calculations

Room temperature –

S.N.	Test specimen material	Dia. of indenter D mm	Applied load Kgf (F)	Diameter of indentation (d) mm			Average diameter (d)mm	Brinell Hardness Number
				1	2	3		
1	low Carbon Steel	5	187.5	1	1.1	1	1.03	205.33
2	low carbon Steel	2.5	100	0.01	0.8	0.08	0.08	2327.14
3	low carbon Steel	2.5	100	0.02	0.08	0.08	0.08	2357.14

Sample Calculation –

XVI Results

The Brinell hardness number of the give sample is -------

XVII Interpretation of results

BHN of Specimen is calculated consists of impression dice by indecter

$BHN = \frac{2P}{\pi D(D - \sqrt{D^2 - d^2})}$

XVIII Conclusions and Recommendations (if any)

Brihdeld hardness testing material consists of Standared hardness Steel band which is needed indected into Surface of Specimen by a gradually applied load and maintain load for 10-15 Second

XIX Practical Related Questions

Note: Below given are a few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the difference between Hardness & Hardenability?
2. Describe the surface conditions necessary for Brinell hardness testing.
3. Very hard materials cannot be tested in Brinell hardness testing machine. State the reason
4. List the different types of indenters used in hardness testing?
5. Thickness of the test piece must not be less than 8 times the depth of impression. Justify
6. List the materials which cannot be tested by Brinell hardness tester
7. Can cylindrical samples be tested on Brinell hardness tester?
8. State the reason for using ball indentors of different diameter for Brinell hardness testing
9. Can the sample after testing be used for the desired application? Justify

[Space for Answers]

1 Ans hardness: it is the resistance offered by metal to indecration scraing wear, tear.

2 Ans for BHN test Specimen Surface Should Smooth and free form Surface deform oil Exchanges materials

Thickness of materials Should be more than and time did of impression top Surface and bottom Surface Should be parallel.

3 Ans for very hard materials the indent or during test very deform permanant due to high load reading can be taken of impression diameter.

4 Ans Indirects - So load 100kg

Can(Grade)	A	B	C
1/15	F	B	G
1/9	H	E	K

05 Ans dead (P6) HN (4b) magnesium magnism Stainless Eigther very high material can not be tested

6 Ans The Impression Produced by indentor bad a depend on applied load (kg) material Speciman properties if indector had mont Selected properly than clear and circular impression will not be obtained and dies can't be measurement easy and correct

9 Ans Yes material can be used depending on its use

XX References / Suggestions for further Reading

1. https://youtu.be/6I2yMEVLclc?t=96
2. https://youtu.be/RJXJpeH78iU?t=3
3. https://youtu.be/Az4QF5uIew8?t=17
4. https://youtu.be/8Jx7sSNGsfw?t=19
5. https://youtu.be/9Bb884w5fEE?t=41

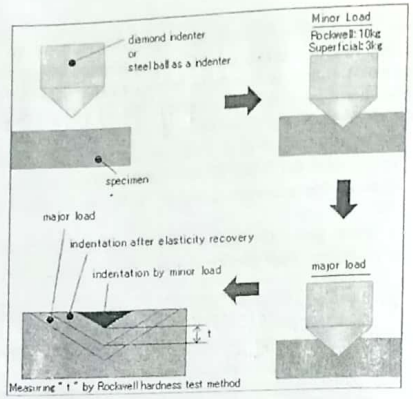
XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (15 Marks)		**60%**
1	Preparation of experimental set up , Selection of indentor and weight	20%
2	Following procedure	15%
3	Measurement of diameter	15%
4	Cleanliness	5%
5	Safety precautions	5%
Product Related (10 Marks)		**40%**
6	Calculation of BHN	10%
7	Interpretation of result	10%
8	Conclusions	10%
9	Practical related questions	10%
Total (25Marks)		**100 %**

Names of Student Team Members

1. .....
2. .....
3. .....

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	
9	14	23	



Rockwell Hardness Tester

IX Resources required

S. No.	Instrument /Components	Specification	Quantity	Remark
1	Rockwell Hardness Testing Machine	10 kgf minor load and major loads, are 60,100,150kgf, with Rockwell hardness scales HRA, HRB, HRC. Different types of indentors (Diamond / Ball), Test height x Throat is - 215 x 132 mm, Extra test height and throat of 295 x 148 mm, Machines strictly conforms to IS 1586-2000	2	
2	Digital Rockwell hardness tester	Easy-to-use Electronics Console Hi/Lo Tolerance Settings, Adjustable Time @ Load Average Test Group Results 2-9, Test Result Memory Capacity 5000 results, RS232 Output,- Average Range	2	
3	Set of standard specimen	Hardened steel, Mild steel, Brass, Copper, Aluminium	2	

X Precautions (if any)

1. The surface on which the Rockwell impression is to be made should be flat and sufficiently smooth.
2. Specimen should be cleanand free from scale, pits, and foreign materials.

3. The bottom surface also should be free from scale, dirt, or other foreign substances that might crush or flow under the test pressure and so affect the results.
4. Apply the load slowly and gradually on the sample
5. Distance between old impression and location for new impression should be 3D (three times the ball diameter)
6. The thickness of the test piece must not be less than 8 times the depth of impression

XI Procedure

1. Turn power switch located in lower rear panel "ON".
2. Select desired scale by means of the "TEST SCALE SCROLL". This key may be depressed for each scale advancement or held in for rapid scrolling.
3. Select and install the proper indenter, as indicated in the "PENETRATOR" display.
4. Select the proper major load, as indicated in the "MAJOR LOAD kg" display, by means of the weight selector dial.
5. Place the specimen on the anvil.
6. Raise specimen into contact with the indenter by turning capstan hand wheel clockwise slowly. The bar LEDs (red) will light up and the read display will show "MINOR LD"
7. Continue to slowly turn the capstan hand wheel. Stop the hand wheel when the bar LEDs reach the "SET" zone. The major load will automatically be applied and then removed. The read display will show "TESTING" and then the numerical value and the scale tested.
8. Remove the minor load by turning the capstan hand wheel counter-clockwise. Continue to lower the specimen until it clears the indenter. The test is concluded.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.	Rockwell hardness testing machines	150 kg 215 x132 mm	01
2.	Indentor	diamond	01
3.	Mild Steel	ϕ 25mm	01
4.	Dead weight	10-15 kg	01

XIII Actual procedure followed

- Prepare materials Specimen for hardness testing
- Place material on M/c table and apply load slowly
- Turn wheel and produce indentor impression to

XIV Precautions followed

- Specimen Surface Should be free from Scale, Pits foreign particles
- Surface Should be flate

XV Observations and Calculations

Room temperature –

S.N.	Material	Thickness	Scale	Type of Indenter	Minor Load kgf	Major Load kgf	Measured Hardness 1	2	3	Average Rockwell Hardness
1	Mild Steel	18 mm	A	25mm	10	60	48	60	57	55
2	Alloy Steel	18 mm	B	1/16"	10	100	64	49	57	56.66
3										

Sample calculation –

XVI Results

The Rockwell hardness number of the give material is 55.

XVII Interpretation of results

For ball Indenters

Hardness number = 130 − (depth of penetration (mm) / 0.002)

For ball Indentar

RHN = 100 − (depth of penetration (mm) / 0.002)

XVIII Conclusions and Recommendations (if any)

- All Types of material can be tested by using Suitable indentar
- 60 kg major load for thin metal 150 kg major load for thick metal.
- Depending on RHN value, metal can be used for high/medium/low hardness application.

(Hint) The given sample can be used for high/medium/low hardness application.

XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the purpose of applying the minor load in case of Rockwell Hardness test?
2. State the different types of indenters used in hardness testing?
3. Explain surface condition requirement for Rockwell hardness testing with justification.
4. State the factors which affect the hardness measurement?
5. State the reason for taking at least three readings for hardness testing.
6. State the other methods of hardness measurement.
7. Differentiate other hardness measurement methods with Rockwell method.
8. State the conditions in which hardness measurement by Rockwell method may not be preferred.
9. Can temperature of the surrounding affect hardness of the material?
10. State the course of action to be taken with justification if there is considerable difference between the three readings of hardness of the same sample.

[Space for Answers]

1 Ans. minor load (10kg) is applied to inside small pointer on dial with index make 0. Dial pointer Should be vertical position before Starting further Procedure.

2 Ans. Indentars

Hardness Steel ball = 1/16", 1/8", 1/4", 1/2"

diameter brittle indentar (diamond)

3 Ans. Surface Should be flat and Smooth, free form pits foreign materials and top and bottom Surface are parallel

4 Ans. i. Type and Size of indentar used

ii. Applied load in kg

iii. Surface condition

5 Ans. i. meyer hardness test (ii) vickers hardness test

iii Rockwell Superfitional test (iv) Sonodur hardness

9 Ans. Temperature does not effect hardness testing method.

XX References / Suggestions for further Reading

a) https://youtu.be/NlWVmp_q_XE?t=10
b) https://youtu.be/KptkaeXiIs0?t=8
c) https://youtu.be/R3NUpHKviRU?t=4
d) https://youtu.be/G2JGNlIvNC4?list=PLHeMUbM1Zwsc8E3xaq8fu5kqOszaBQtHK&t=9
e) https://youtu.be/cYzAw9zZbR8?t=113

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (15Marks)		**60%**
1	Preparation of experimental set up	20%
2	Selection of scale, indentor and major weight	15%
3	Following procedure	15%
4	Cleanliness	5%
5	Safety precautions	5%
Product Related (10Marks)		**40%**
6	Calculation of RHN	10%
7	Interpretation of result	10%
8	Conclusions	10%
9	Practical related questions	10%
Total (25Marks)		**100 %**

Names of Student Team Members

1. .....
2. .....
3. .....

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	
9	14	23	

Practical No. 05: Hardness Testing of Mild Steel Before and After Heat Treatment

I Practical Significance

Hardness testing provides useful information, which can be correlated to tensile strength, wear resistance, ductility, and other physical characteristics. Hardness testing is therefore useful for monitoring quality control and for the materials selection process.Heat treatment is a process of heating the metal below its melting point and holding it at that temperature for sufficient time and cooling at the desired rate to obtain the required properties. The various heat treatment processes are annealing, normalizing, tempering, hardening, martempering, and austempering.

II Relevant Program Outcomes (POs) and PSO

PO 1- **Basic knowledge** : Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based mechanical engineering problems

PO 2- **Discipline knowledge**:- Apply mechanical engineering knowledge to solve broad-based mechanical engineering related problems.

PO 3-**Experiments and practice**:- Plan to perform experiments and practices to use the results to solve broad-based mechanical engineering problems

PO 4- **Engineering tools** :- Apply relevant mechanical technologies and tools with an understanding of the limitations

PO 8- **Individual and team work**:- Function effectively as a leader and team member in diverse/ multidisciplinary teams.

PSO 1-Manage mechanical engineering processes by selecting and scheduling relevant equipment, substrates, quality control techniques, operational parameters and software.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Use relevant mechanical engineering materials in different applications'**

1. Specimen identification skills.
2. Specimen mounting skills.
3. Use box furnace to give different heat treatment.
4. Use hardness tester to measure hardness.

IV Relevant Course Outcomes

(a) Identify properties of materials.
(b) Select relevant heat treatment process.
(c) Select relevant ferrous materials for mechanical components.

V Practical Outcome

Use Rockwell hardness tester to determine hardness of a given sample.

VI Relevant Affective domain related Outcome(s)

a) Follow safety practices.
b) Practice good housekeeping.
c) Demonstrate working as a leader/a team member.
d) Maintain tools and equipment.
e) Follow ethical Practices.

6. Quenching samples in oil can cause the oil to ignite. Be prepared to cover the container after immersion.
7. Use baskets or tongs for quenching in oil or water.

XI Procedure

Hardness Tester

1. Turn power switch located in lower rear panel "ON".
2. Select desired scale by means of the "TEST SCALE SCROLL". This key may be depressed for each scale advancement or held in for rapid scrolling.
3. Select and install the proper indenter, as indicated in the "PENETRATOR" display.
4. Select the proper major load, as indicated in the "MAJOR LOAD kg" display, by means of the weight selector dial.
5. Place the specimen on the anvil.
6. Raise specimen into contact with the indenter by turning capstan hand wheel clockwise slowly. The bar LEDs (red) will light up and the read display will show "MINOR LD".
7. Continue to slowly turn the capstan hand wheel. Stop the hand wheel when the bar LEDs reach the "SET" zone. The major load will automatically be applied and then removed. The read display will show "TESTING" and then the numerical value and the scale tested.
8. Remove the minor load by turning the capstan hand wheel counter-clockwise. Continue to lower the specimen until it clears the indenter. The test is concluded.

Heat treatment

1. First, the samples should be checked for hardness.
2. Then, keep them in furnace at 900°C for ½ an hour.
3. Afterwards, one sample is cooled to room temperature in air while other is quench hardened followed by again keeping it in furnace but now at 200-250°C.
4. Then, this sample is also air cooled.
5. As such, one sample is normalized and the other is tempered. Now, the samples are grinded and polished to obtain a flat surface and hardness of both the samples is checked again.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.	Brinell hardness test	380x200mm 15kg	01
2.	Indentor	5mm	01
3.	Mild steel	Ø 25 x25	01
4.	Dead weight	10-150kg	01

XIII Actual procedure followed

Hardness tester :- (i) Turn power switch located in lower rear Panel "on"

(ii) Select desired Scale by means of the "TEST" scale scrow. This key may be depressed for each scale advancement or held in for rapid Scrolling

(iii) Place the Specimen on the anvil

XIV Precautions followed

- The Surface which rockwell impression is to be made Should be flat and Sufficiently Smooth
- Specimen Should be cleaned free from Scale bitst and foreign materials.
- Apply the load Slowly gradually on Sample

XV Observations and Calculations

Brinell Hardness Measurement

SR No	Specimen	Indenter Diameter (D) mm	Total Load(P) Kgf	Diameter of Indentation (d) mm			Avg Diameter d_{avg}	BHN
				1	2	3		
1	Mild steel Specimen (without heat treatment)	1/16" ball	100	0.6	0.7	0.6	0.63	307.83
2	Mild steel Specimen (with heat treatment)	1/16" ball	100	0.4	0.42	0.45	0.42	708.46

Rockwell Hardness Measurement

SR No	Specimen	Type of Indenter	Rockwell Hardness Number(RHN)			Avg. RHN
			1	2	3	
1	Mild steel Specimen (without heat treatment)	1/16" ball	50.8	49.2	48.4	49.46
2	Mild steel Specimen (with heat treatment)	1/16" ball	184	169	195	189

Calculations

For Brinell Hardness-

Brinell Hardness Number (BHN) $= \frac{2P}{\pi D[D-\sqrt{D^2-d^2}]}$

XVI Results

1. The Rockwell hardness number of mild steel before heat treatment is 387.83
2. The Rockwell hardness number of mild steel after heat treatment is 108.46
3. The Brinell Hardness Number before Heat Treatment 49.46
4. The Brinell Hardness Number after Heat Treatment 189

XVII Interpretation of results

we have found that the hardness material is increasing according to addition or increasing the percentage of carbon in metal mild steel is a low carbon steel.

C % = 0.003 1

XVIII Conclusions and Recommendations (if any)

We use rock well hardness test are to determine hardness of given sample.

XIX Practical Related Questions

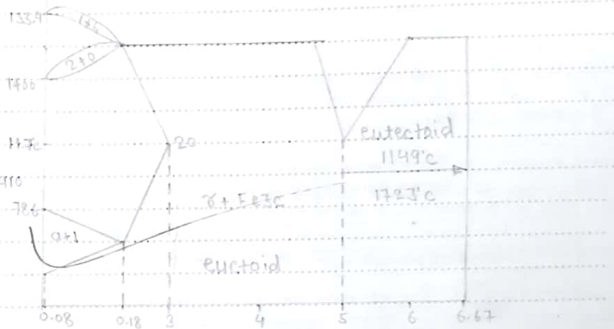
Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Give the composition of mild steel.
2. State effect of constituting elements on the properties of mild steel.
3. Draw iron-carbon diagram. Showing important phases.
4. State the effect of heat treatment on the properties of mild steel.
5. State various applications of mild steel.
6. State the limitations of mild steel.
7. Suggest various methods to improve properties of mild steel with justification.
8. List 5 applications with justification where mild steel is not a good choice.

[Space for Answers]

Q1

Ans: The composition of mild steel is upto 0.03 % C and terminal iron



2 Ans The effect of heat treatments tensile Strength Yield and hardness

5 Ans i. wire nails rivet Screw and punnels
ii. wilding rods, Shipplate.
iii. Iron blandes gears, chain, Shaft crank Shaft
iv. connecting rod railway axel tube for bicycle and automobile

6 Ans There are can not be Strenthing beyond 1000 PSi without Signification loss in Roughness on ductility.

XX References / Suggestions for further Reading

1. https://youtu be/_yonqoGymzE?t=381
2. https://youtu.be/kLbbR_cpBnk?t=48
3. https://youtu.be/J8r6wRvskxU?t=14

XXI Assessment Scheme

Performance Indicators		Weightage
Process Related (15Marks)		**60%**
1	Preparation of experimental set up	20%
2	Selection of scale, indentor and major weight	15%
3	Following procedure	15%
4	Cleanliness	5%
5	Safety precautions	5%
Product Related (10Marks)		**40%**
6	Calculation of hardness	10%
7	Interpretation of result	10%
8	Conclusions	10%
9	Practical related questions	10%
Total (25Marks)		**100 %**

Names of Student Team Members

1. .....
2. .....
3. .....

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	
14	9	23	

Practical No.6: Hardness Testing of Alloy Steel before and after Heat Treatment

I Practical Significance

Hardness Testing provides useful information, which can be correlated to tensile strength, wear resistance, ductility, and other physical characteristics. Hardness testing is therefore useful for monitoring quality control and for the materials selection process. Heat treatment is a process of heating the metal below its melting point and holding it at that temperature for sufficient time and cooling at the desired rate to obtain the required properties. The various heat treatment processes are annealing, normalizing, tempering, hardening, martempering, and austempering.

II Relevant Program Outcomes (POs) and PSO

PO 1- **Basic knowledge** : Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based mechanical engineering problems

PO 2- **Discipline knowledge** - Apply mechanical engineering knowledge to solve broad-based mechanical engineering related problems.

PO 3-**Experiments and practice** - Plan to perform experiments and practices to use the results to solve broad-based mechanical engineering problems

PO 4- **Engineering tools** - Apply relevant mechanical technologies and tools with an understanding of the limitations

PO 8- **Individual and team work** - Function effectively as a leader and team member in diverse/ multidisciplinary teams

PSO 1-Manage mechanical engineering processes by selecting and scheduling relevant equipment, substrates, quality control techniques, operational parameters and software.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Use relevant mechanical engineering materials in different applications'**

1. Specimen identification skills.
2. Specimen mounting skills.
3. Use box furnace to give different heat treatment.
4. Use hardness tester to measure hardness

IV Relevant Course Outcomes

(a) Identify properties of materials
(b) Select relevant heat treatment process
(c) Select relevant ferrous materials for mechanical components

V Practical Outcome

Use relevant hardness tester to determine hardness of a given sample of alloy steel before and after heat treatment.

VI Relevant Affective domain related Outcome(s)

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.

quench hardened followed by again keeping it in furnace but now at 200-250°C.

4. Then, this sample is also air cooled.
5. As such, one sample is normalized and the other is tempered. Now, the samples are grinded and polished to obtain a flat surface and hardness of both the samples is checked again.

For Brinell Test

1. Keep the loading and unloading lever at unloading position.
2. Select the suitable indenter & weights according to the scale.
3. Place the Alloy Steel (without Hardening) specimen on testing table anvil
4. Turn the hand wheel to raise a job until it makes contact with indenter.
5. When the longer pointer of the dial gauge reaches steady position.
6. Remove the job from the platform and note down the diameter of the Indentation using Brinell microscope.
7. Similarly repeat the step for Alloy Steel (with Hardening) specimen

For Rockwell hardening Test

a. Keep the loading and unloading lever at unloading position.
b. Select the suitable indenter & weights according to the scale.
c. Place the specimen on testing table anvil.
d. Turn the hand wheel to raise a job until it makes contact with indenter.
e. When the longer pointer of the dial gauge reaches steady position take back the lever to the unloading position.
f. Turn back the hand wheel and remove the job.

XII Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
1.	BHN	d= 2.5 mm	1
2.	RHT	hardness = 100 DHN	1
3.	lab box furnaces	1200°C	2
4.	Alloy Steel Specimen	Standard	1

XIII Actual procedure followed

1. first Sample Should be checked for hardness
2. As then keep in furnace at 900°C for 12 hours
3. then its Sample is also air cooled

XIV Precautions followed

1. use tangs to insent or remove the specimen from surface.
2. use insulatary gives to open or close the door to furnace
3. The furnace Should be turned off.

XV Observations and Calculations:

a. Brinell Hardness Measurement

Sr No	Specimen	Indenter Diameter (D) mm	Total Load(P) Kgf	Diameter of Indentation (d) mm			Avg. Diameter d_{avg}	BHN
				1	2	3		
1	Alloy steel Specimen (without Hardening)	1/16" ball	150	1	1	1	1	170.03
2	Alloy steel Specimen (with Hardening)	1/16" ball	150	1.1	1.2	1.2	1	2.85

b. For Rockwell Hardness

SR No	Specimen	Type of Indenter	Rockwell Hardness Number(RHN)			Avg. RHN
			1	2	3	
1	Alloy steel Specimen (without Hardening)	1/16" ball	44	49.2	79	57.33
2	Alloy steel Specimen (with Hardening)	1/16" ball	74	79	108	87

Calculations

For Brinell Hardness-

Brinell Hardness Number (BHN) $= \frac{2P}{\pi D[D-\sqrt{D^2-d^2}]}$

XVI Results

1. The Rockwell hardness number of alloy steel before heat treatment is 107.03
2. The Rockwell hardness number of alloy steel after heat treatment is 2.85
3. The Brinell Hardness Number Before heat treatment is 57.33
4. The Brinell Hardness Number after heat treatment is 87

XVII Interpretation of results

Due to heat treatment process of alloy steel hardness no increase.

XVIII Conclusions & Recommendation

Hardness is does not depends on heating temp. Alloy material composition and occurecy of Instrument observer during measurement.

XIX Practical related Questions

Note. Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. Define heat treatment?
2. State the different types of heat treatment?
3. Enumerate the need for heat treatment of steel?
4. List different types of hardness testing methods?
5. Define BHN?
6. Differentiate between hardenability and hardness?
7. State the different types of indenters used in hardness testing?
8. State the factors which affect the hardness of steels?
9. State the reason for the minor load applied before applying the major load?
10. Derive the formula to calculate BHN.
11. Which steel sample was harder, the air-cooled or water quenched? Why was it harder?
12. Which steel alloy was harder? Why was it harder?
13. How did the different cooling rate affect the microstructure of the steel? Do these microstructures agree with what would be predicted from the TTT diagrams?
14. What did reheating do to the microstructure and properties of steels? Why?
15. Why are the steels heat treated?
16. If one of the specimens of the same kind of steel is normalized and the other is annealed, which will show more strength and why?
17. Out of the normalized and annealed samples, which one is more machinable and why?
18. How does the hardness vary with cooling rate?

[Space for Answers]

1 Ans. The use of heat for the sapetic purpose in medicine or to modify the properties of a metal espically in metuallurgy.

2 Ans. i Annealing
ii normalizing
iii hardening
iv tempering

3 Ans. Types of hardness testing method
1. Rockwell hardness testing
2. vickers hardness testing
3. knoop hardness testing
4. case deapth hardness testing

4 Ans. A number expressing brinell hardness and denating local applied in testing in kg divided by Sperical area of indentation produced in specimen in Save mills metal is called BHN

12 Ans. Titanium has highest Strength to weight ratio of any natural metal known to man

5 Ans The factor that effect mechanical properties of metal are varified into instance yield strength hardness the ductile brittle transition temp susplibility to environment condition are all effect can be improved by alterning grain

Q15 Metal hardening hardened material are usually tempered or stress relieved to improve their dimensional stability and toughness. Steel parts to ten repair a heat treatment to obtain improved mechanical properties such as increasing hardness strength.

Q 6.

Hardenability	Hardness
1 A hardness of steels is measure of a sample is resistance to indentation or Esscating.	1 Hardenability refering to its ability to be hardness to actual depth under a particular set of condition.
2. its important property for welding	it is inversly proportional to weldability

XX References / Suggestions for further Reading

a. https://youtu.be/AwM1dOsWsoo?t=77
b. https://youtu.be/Cl0nBBu-gzA?t=53
c. https://youtu.be/fc8zrgYJCJw?t=75
d. https://youtu.be/UuHofNW40Yw?t=63

XXI Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Preparation of experimental set up	20%
2	Selection of scale, indenter and major weight	15%
3	Following procedure	15%
4	Cleanliness	5%
5	Safety precautions	5%
Product related (10 Marks)		**40%**
6	Calculation of hardness	10%
7	Interpretation of result	10%
8	Conclusions	10%
9	Practical related questions	10%
Total (25Marks)		**100 %**

Names of Student Team Members

1. .....
2. .....
3. .....

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	
14	9	23	

IX Resources required

S. No.	Instrument /Components	Specification	Quantity	Remark
1	Optical Microscope	Metallurgical Reflected light Microscope 6V, 30W, halogen Light,200x magnification, 191x126x100 mm specimen stage, size with 100 mm travel	05	
2	Standard cast iron Specimen	Rectangular shape 25 mm x 25 c/s area or circular shape of 25 mm diameter or as per the availability White cast iron,Gray cast iron,Malleable cast iron,Ductile cast iron	5 specimen	

X Precautions (if any)

1. All specimens are cut to a suitable size, and the smaller specimens mounted in thermo-plastic resin in a mould.
2. Sanding is done using successive grades of waxed emery paper, finishing at grade 000.
3. Polishing is done on a polishing machine, using a paste of magnesium oxide on selvyt cloth.
4. Etching is carried out with the reagent Nital, 4% Nitric Acid in Alcohol.

XI Procedure

1. Polish the specimen by using (80,120,240,400,600) grade emery papers. Subject the given specimen to mirror like finish by using disc polishing machine and with suitable abrasive. Clean the specimen with alcohol and wash it under the stream of flowing water
2. After washing, the specimen is dried. After drying apply the suitable etching agent for 30 to 50 sec.
3. After etching wash the specimen under stream of flowing water.
4. Dry the specimen with the help of air drier.
5. Place the specimen for metallurgical studies.
6. Draw the microstructure and analyze the properties.

XII Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
1.	optical Microscope	Metallurgical reflected light	05
2.	Standard iron Specimen	Rectangular Size - 25mm x 25mm	5 - Specimen
3.			
4.			

XIII Actual procedure followed

1. After washing the specimen is dried. After drying apply the suitable etching agent for 30 to 50 Sec.
2. After etching wash the specimen under stream of following water

XIV Precautions followed

1. All specimen are cut to a suitable size, and the smaller specimen mounted in thermo-Plastic resins a mould.
2. Dry the specimen with the help of air drier.
3. Etching carried out with the agent Nital 4% Nitric acid in Alcohol.

XV Observations and Calculations (Draw microstructure & state properties)

Metallurgical analysis is a valuable tool

XVI Results

For each feature, one normally records the following characteristics

1. Shape
2. Size
3. Color (in plane polarized light or with crossed polars)
4. Distribution

XVII Interpretation of results

S. No	The magnification used	Important phases noted	Shape	Size	Color	Distribution
1	108 x 200	a=Ferrite	Rectangular	course	dark	Mi Form
2		Pearlite	bounded	fine	dark	Super
3		cementile	bounded	Course	—,—	randum

XVIII Conclusions and Recommendations (if any)

observed and (1 graplite peralite , ferrite and cementile

XIX Practical Related Questions

Note: Below given are a few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO

1. Based on the observed microstructure of the cast iron sample, can you determine the carbon content of the cast iron? If yes, then briefly explain how you can determine the carbon content.
2. State the type of cast iron is more ductile in comparison to others?
3. On the basis of microstructure, explain why gray cast iron is brittle and weak in tension?
4. Is it possible to produce malleable cast iron in pieces having large cross sectional dimensions? Explain the reason.
5. Compare gray and malleable cast irons with respect to (a) Microstructure and (b) Mechanical characteristics.

[Space for Answers]

1. yes, is a group of iron carbon alloy with carbon center grates than 2% rangling form 1.84 wt and Silicon 1.3 wt are man alloying Element of CI Expect for mallable C.I

2 Ans. Modular cast Iron is more ductile in can Parision to other.

3 Ans. Gray cast iron brittle because The tips graphite Plank's act as point of Stress connections Gray cast iron of graphite blanks are enabled in peraliter pearlite matrix

4 Ans its not possible to produce mallable iron in piece having large cross-sectional dimension while C.I pressure of mellable measure for formation of while iron

5 Ans with respect to micro structure gray iron graphite blanks are embended im a ferrite or pearlite matrix

e. Follow ethical Practices.

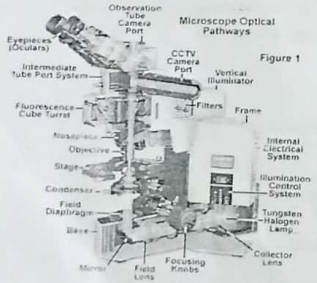
VII Minimum Theoretical Background

Metallography is the general study of metals and their behavior, with particular reference to their microstructure and macrostructure. Microstructure is the characteristic appearance and physical arrangement of metal molecules as observed with a microscope. Preparation of specimen is necessary to study its microstructure. The metallurgical microscope makes use of the principle of reflection of light from the specimen to obtain the final image of the metal structure.

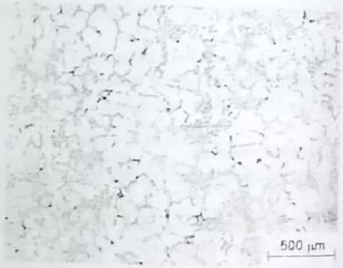
Nonferrous metals and alloys contain elements other than iron as a main constituent. They exhibit different properties compared to ferrous metals and alloys. Hence their application also differs from ferrous metals. Aluminum is a soft, silvery metal with a face-centered cubic crystal structure. Aluminum, like chromium, niobium and titanium, is very corrosion resistant and a thin, transparent oxide film will form on a freshly polished surface. This film is responsible for its good corrosion resistance, but also makes etching difficult. Aluminum alloys contain a rather high content of intermetallic precipitates. Aluminum and its alloys are low in strength and hardness.

Etchant	Composition	Application	Conditions
*Kellers*Reagent	Distilled water 190 ml Nitric acid 5 ml Hydrochloric acid 3 ml Hydrofluoric acid2 ml	For most aluminum and aluminum alloys	10-30 second immersion Use fresh eagent for each immersion
	Methanol 25 ml Hydrochloric acid 25 ml Nitric acid 25 ml Hydrofluoric acid 1 drop	Pure aluminum, aluminum-magnesium, and aluminum-magnesium-silicon alloys	10-60 seconds
Krolls Reagent	Distilled water 92 ml Nitric acid 6 ml Hydrofluoric acid 2 ml	Aluminum-copper alloys	15 seconds

VIII Experimental set-up



Metallurgical Microscope



Microstructure of Aluminium

IX Resources required

S. No.	Instrument /Components	Specification	Quantity	Remark
1	Optical Microscope	Metallurgical Reflected light Microscope 6V, 30W halogen Light, 200X magnification, 191x126x100 mm specimen stage ,Size with 100 mm travel	05	
2	Standard specimen of Aluminum	Rectangular shape 25 mm x 25 c/s area or circular shape 25 mm diameter or as per the availability	5 specimen of each type	

X Precautions (if any)

1. All specimens are cut to a suitable size, and the smaller specimens mounted in thermo-plastic resin in a mould.
2. Sanding is done using successive grades of waxed emery paper finishing at grade 000.
3. Polishing is done on a polishing machine, using a paste of magnesium oxide on selvyt cloth.
4. Uniform pressure is applied throughout the polishing
5. Etching is carried out with the reagent Nital, 4% Nitric Acid in Alcohol.

XI Procedure

1. Polish the specimen by using (80,120,240,400,600) or (1/0, 2/0,3/0,4/0,) grade emery papers. Polish the given specimen to mirror like finish by using disc polishing machine and with suitable abrasive. Clean the specimen with alcohol and wash it under the stream of flowing water
2. After washing the specimen is dried. After drying, apply the suitable etching agent for 30 to 50 sec.
3. After etching wash the specimen under stream of flowing water.
4. Dry the specimen with the help of air drier.
5. Place the specimen for metallurgical studies.
6. Draw the microstructure and analyze the properties

XII Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
1.	optical microscope	Metallurgical reflected light micro scope	05
2.	Standard Speciman of Aluminium	Rectangular Shape 25 X 25 mmc/s	5 Specimen of Each Type
3.			
4.			

XIII Actual procedure followed

1 Polish the specimen by using (80, 120, 240, 400) or (1/0, 2/0, 3/0, 4/0) grade Emery paper polish the given Specimen to mirror like Punish by using abbrasive disc polishing machine and with Suitable

XIV Precautions followed

All Specimens are cut to a Suitable size and the Smaller Specimens mounted in thermoplastic resin in mould

XV Observations and Calculations

Table 1: microstructure observations

S. No	The magnification used	Important phases noted	Shape	Size	Color	Distribution
1	200	Fe Al3	intermitl precibiles	Crystal	different	Randamely super
2	300	Fe Si2	—11—	Crystal	Colour according	impose
3						

XVI Results

For each feature, one normally records the following characteristics:

1. Shape
2. Size
3. Color (in plane polarized light or with crossed polars)
4. Distribution

XVII Interpretation of results

XVIII Conclusions and Recommendations (if any)

observe Shape, Size, Colour distribution

XIX Practical Related Questions

Note Below given are a few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the specifications of grinding and polishing machines?
2. Define lapping? Which degree of accuracy can be achieved in metals by polishing?
3. Grinding performed before polishing? Justify
4. State the need for polishing on four grades of emery paper?
5. State the reason for specimen rotated by 90°, while changing from one grade of emery paper to another?
6. Dry polishing done before wet polishing? Give reason
7. State the purpose of wet polishing after dry polishing?
8. Alumina powder used in wet polishing? Give reason
9. State the purpose of etching?
10. Name the etchants use for etching Mild steel, Aluminium and Copper.
11. State the principle of working of metallurgical microscope
12. Draw neatly the microstructure of all the samples as observed under optical microscope. State the machines materials and etchants used. Write the optimum time required to obtain a reasonably good microstructure.
13. Describe Microscopy?
14. It is necessary to mount the specimen before grinding and polishing? Justify
15. List the different etching agents used for specimen preparations?
16. Draw the microstructure of pure Aluminum.

[Space for Answers]

1 Grinding :- grindness are grinding M/c remove material and improve Surface finish abbrasive Stones grinding wheels, abbrasive Stone between abbrasive disc.

Polishing : Polisheness polishing other and polishing materials are Specified machines that produce bright, Smooth fine. Surface finished

9 Ans Etching is traditionally the process of using strong acid or mordant to act into unprotected parts of metal surface to create design intrigal manufacturing others chemicals may using in other types of material.

13 Ans Microscopy is science of investing acting small objects and structure using such as instrument microscopic means invisible to eye unless divided by microscope

11 Ans Metallurgical microscope unlike biological microscope works on principle of reflected light microscope Sine the metallurgical specimen are operate to light sample so must be illumated by reflected light

XX References / Suggestions for further Reading

a. https://www.youtube.com/watch?v=are5impxItM
b. https://www.youtube.com/watch?v=LcXnWh_2Zxk
c. https://www.youtube.com/watch?v=fc8zrgYJCJw
d. https://www.youtube.com/watch?v=LznZz38OUCk

*Note : please verify whether the above resources have a license which permits its free use.

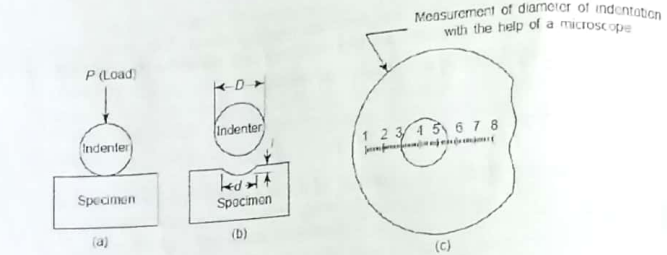
XXI Assessment Scheme

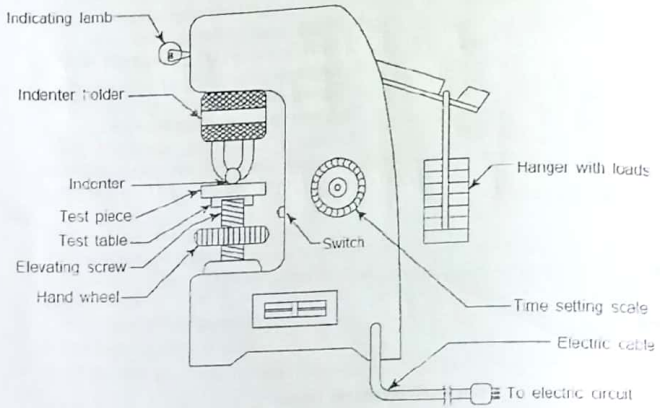
Performance indicators		Weightage
Process related (15 Marks)		60%
1	Preparation of experimental set up	20
2	Etching the specimen with suitable etchant	20
3	Observation of the microstructure of the specimen at different magnification using microscope	20
Product related (10 Marks)		40%
4	Follow Safety measures	10
5	Answer experiment related questions	10
6	Submit journal report on time	10
7	Follow Housekeeping	10
Total (25Marks)		100 %

Names of Student Team Members

1. .....
2. .....
3. .....

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	
14	8+1	23	





Brinell hardness testing machine

IX Resources required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Brinell hardness tester	Ball Indenter of diameter 2.5mm and 5mm,Maximum application of load =250 Kgf, Ability to determine hardness up to =1411 BHN	01	
2.	Rockwell hardness tester	Diamond cone indenter, ball indenter. Ability to determine hardness up to = 100 RHN. Maximum application of load = 150 Kgf	01	
3.	Copper Specimen		02	

X Precautions

1. Do not apply excessive load on specimen. Use 50.0 kg load for hardness testing of soft alloys using Brinell hardness tester.
2. Select the appropriate scale if using Rockwell hardness tester
3. Ensure clean and well positioned indenter and anvil
4. The test sample should have clean, dry, smooth and oxide-free surface
5. The surface should be flat and perpendicular to the indenter
6. Specimen thickness should be 10 times higher than the depth of the indenter
7. The spacing between the indentations should be 3 to 5 times of the indentation diameter
8. Loading speed should be standardized.

XI Procedure

For Rockwell hardening Test

a. Keep the loading and unloading lever at unloading position.
b. Select the suitable indenter and weights according to the scale.
c. Place the specimen on testing table anvil.
d. Turn the hand wheel to raise a job until it makes contact with indenter.
e. When the longer pointer of the dial gauge reaches steady position take back the lever to the unloading position.
f. Turn back the hand wheel and remove the job.

For Brinell Test

1. Keep the loading and unloading lever at unloading position.
2. Select the suitable indenter and weights according to the scale.
3. Place the specimen on testing table anvil.
4. Turn the hand wheel to raise a job until it makes contact with indenter.
5. When the longer pointer of the dial gauge reaches steady position.
6. Remove the job from the platform and note down the diameter of the Indentation using Brinell microscope.
7. Similarly repeat the step for multiple readings

XII Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
1.	Brinell hardness tester	Ball indenter diameter 2.5mm	1
2.	Rockwell hardness tester	Diamerter cone indenter	1
3.	Copper Specimen		2
4.			
5.			

XIII Actual procedure followed

1. Keep loading and unloading lever at unloading position
2. Select the suitable indentor and weights according to the scale
3. Ensure clean and well positioned indentor and anvil
4. The test sample should have clean dry, smooth and oxide free

XIV Precautions followed

1. Do not apply excessive load on specimen use 50 kg. for hardness testing of soft alloys using brinell hardness tester
2. Select the appropriate scale if using rockwell hardness tester.

XV Observations and Calculations:

c. Brinell Hardness Measurement

SR No	Specimen	Indenter Diameter (D) mm	Total Load(P) Kgf	Diameter of Indentation (d) mm			Avg Diameter d_{avg}	BHN
				1	2	3		
1	Copper	Ball (1/16")	100	1	1.1	0.9	1	113

d. For Rockwell Hardness

SR No	Specimen	Type of Indenter	Scale	Total Load(P) Kgf	Rockwell Hardness Number(RHN)			Avg RHN
					1	2	3	
1	Copper	1/16"	13	100	86.5	97	97	93.4

Calculations

For Brinell Hardness-

$$\text{Brinell Hardness Number (BHN)} = \frac{2P}{\pi D[D-\sqrt{D^2-d^2}]}$$

The formulas used for calculating Rockwell Hardness values are as follows:

For regular Rockwell Hardness using spheroconical "Brale" Indenter

HR[Scale] = 100 - h/0.002

Where Scale is A, C, D and h is the depth penetrated in mm.
For regular Rockwell Hardness using a steel ball

HR[Scale] = 130 - h/0.002

where Scale is B, E, F, G etc. and h is in mm

XVI Results

The hardness of copper is ------- 1) BHN 113 2) RHN 93.5

XVII Interpretation of results

3HN load = 100 kg, d = 1m, D = 150 mm

$$BHN = \frac{2D}{\pi D(D-\sqrt{D^2-bd^2})} = 113$$

XVIII Conclusions & Recommendation

Scale = D
load = 100
RHN = 10-b/0.002

XIX Practical related Questions

1. Define Hardness.
2. State the applications of Rockwell Hardness A – Scale, B-Scale, C-Scale.
3. Name the type of indentor used in the three different scales of 'Rockwell Hardness Test'.
4. List the different types of hardness testing methods.
5. State the size of the ball to be used in 'Ball Indentor' of 'Rockwell Hardness Test'.
6. State the diameters of the different balls used in 'Brinell Hardness Test'.
7. State the selection of load in 'Brinell Hardness Test'.
8. State the selection of load in 'Rockwell Hardness Test'.

[Space for Answers]

Q1 Ans
- Hardness of material is generally defined as resistance to the permanent indentation uses static and dynamic load

2 Ans
1. Brinell hardness test
2. Rock well hardness test
3. Knoop hardness test
4. Vickey hardness test

3 Ans Both ball are diamond cone type of identely are used in this test three Scale are m/s Scale. it with indentor used for performing test on thim steel

4 Ans Rockwell hardness testing
brinell hardness testing
Knoop hardness testing
vickey hardness testing

5 Ans
Hardness is characterstics material of hot a fundamental physical property it is state the resistance to indentation. determine by indentation

Q8 Ans it States measuring depth of indentation

XX References / Suggestions for further Reading

1 https://www.youtube.com/watch?v=i1x-vJ85sBA
2 https://www.youtube.com/watch?v=ysInnHOoouc
3 https://www.youtube.com/watch?v=NlWVmp_q_XE
4 https://www.youtube.com/watch?v=RJXJpeH78iU
5 https://www.youtube.com/watch?v=G2JGNlIvNC4

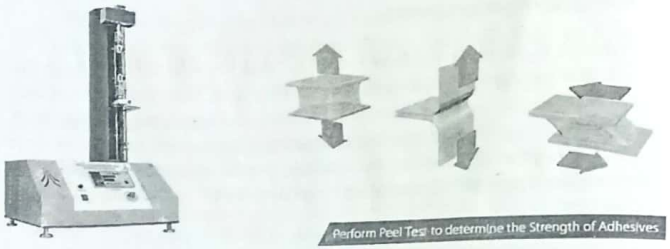
XXI Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Handling of hardness tester	20
2	Mounting of specimen	20
3	Hardness testing	20
Product related (10 Marks)		**40%**
4	Specimen tested	10
5	Interpretation of result	10
6	Conclusions	10
7	Practical related questions	10
	Total (25Marks)	**100 %**

Names of Student Team Members

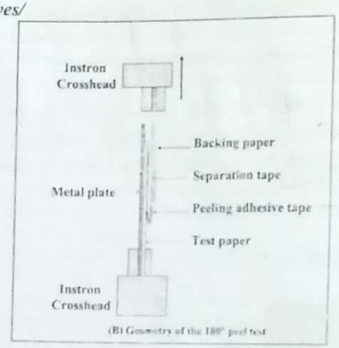
1. .....
2. .....
3. .....

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	



Perform Peel Test to determine the Strength of Adhesives

http://www.testing-instruments.com/blog/perform-peel-test-to-determine-the-strength-of-adhesives/



(B) Geometry of the 180° peel test

IX Resources required

S. No.	Instrument /Components	Specification	Quantity	Remark
1	Digital Peel Tester	Load capacity: Up to 5 kg No. of load cell: One Cross Travel: Up to 250 mm Speed: 300 mm/minute Direct display: Peak load Paint: Powder coated Power: 230 Volts, 50 Hz, single phase	01	
2	Peeling Strength Tester	Capacity Range 0~200 N (30 N, 50 N and 100 N are optional) Accuracy 1% of reading value Resolution 0.01N Test Speed 50, 100, 150, 200, 250, 300, 500 mm/min Specimen Width ≤30 mm Stroke 500 mm	01	

3	Cellophane Tape	Type: Adhesive Tape Length: 6 m	1 in group of 5	
4	Duct Tape	Tape Length: 10-20 m, 40-50 m, 0-10 m, >50 m, 30-40 m, 20-30 m Tape Width: >100 mm, 80-100 mm, 0-20 mm, 20-40 mm, 60-80 mm, 40-60	1 in group of 5	

X Precautions (if any)

1. Use peel tester carefully
2. Apply tapes on test plate properly

XI Procedure

1. Adhere the specimen to the testing plate.
2. Fold an end of the specimen to create a tab parallel to the plate.
3. Secure the end of the plate farthest away from the tab to the moving grip.
4. Secure the tab to the static grip.
5. Move the plate and begin peeling the tape at a 180 degree angle at the specified rate.
6. Record the average force required for peeling.

Or

1. Prepare at least 10 specimens according to the guidelines in the specification. A specimen consists of a flexible adhesive capable of folding back and peeling at a 180 degree angle as well as a substrate material to bond the adhesive to. The substrate object may be wood, textile, metal, or rubber. Samples must be conditioned according to the standard between preparation and testing.
2. Bond approximately six inches of the adhesive to the substrate material. Fold back the free end of the tape or sealant to a 180 degree angle.
3. Attach the free end of the substrate material to the vice grip on the testing machine's crosshead section. Keeping at least one inch of separation between the substrate material and the free end of the adhesive, secure the free part of the adhesive to the second vice grip.
4. Ensuring that the sample is in the plane of the vice grips, zero the materials testing machine. Move the crosshead at the specified rate until at least half of the bonded section has been peeled.
5. Record the average load. Repeat this test at least 10 times for each adhesive type.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.	Digital Peel tester	load capacity 5	1
2.	Peeling Strength tester	capacity Range 0~200N	1
3.	cellophane Tape	Adhesive tape	1/in group of 5

XIII Actual Procedure Followed

1. Adhere the specimen to the testing plate
2. Fold on end of the specimen to create a tab parallel to the plate
3. Secure the end of the plate for test away from the tab to the moving grip

XIV Precautions Followed

1. use peel tester carefully
2. Apply tapes on test place properly

XV Observations and Calculations

Name of tape	Load (N)	Thickness (t) mm	Width (b) mm	Avg Peel Strength N/mm^2

Calculation: Peel Strength = Load/ Area under Load

XVI Results

1. Adhesive strength of Cellophane is ------
2. Adhesive strength of duct tape is ------

XVII Interpretation of results

The no. of Strength is to of the Inductor is the impact of the no.

XVIII Conclusions & Recommendation

Hence I can used Hed tester to check adensine Strength of cellophane

XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. List the uses of duct tape?
2. Name the five brands of cellophane tape in market.
3. Name the five different commercial brands of tapes in the market.
4. Define the term 'Peel Strength'
5. Name any five different adhesive tapes used in industrial applications with their specifications.
6. Explain whether the process that makes adhesive tape sticky is physical or chemical?
7. Is the tape conductive?

[Space for Answers]

Q4.

Peel Strength :- The peel Strength of avg. force to Part two bonded material like tape labels, textile or plastic films

Q5

i Box-Sided tape
ii Double Sided Tape
iii bundles tape
iv Duct tape

Q1

Duct papes is commonly used in situation that require a strong, flexible and very sticky tape.

Q6

The simple and that I can the question is that pressure sensitivity are strictly the are esentropically very high viscosity liquid that also have some elastic

XX References / Suggestions for further Reading

1. https://www.youtube.com/watch?v=wLRptWkhlyY
2. https://www.youtube.com/watch?v=lwA_TGnJyUI
3. https://www.youtube.com/watch?v=6SbwBiN5YIs
4. https://www.youtube.com/watch?v=XQq5xCmXRyA
5. https://www.youtube.com/watch?v=xMn6HqrTVI8
6. https://www.youtube.com/watch?v=kTRk42hzxI8

XXI Assessment Scheme

Performance indicators		Weightage
Process related (10 Marks)		**40%**
1	Preparation of experimental set up	10%
2	Mounting of tapes	10%
3	Testing of tapes	20%
Product related (15 Marks)		**60%**
4	Prepared tape specimen	30%
5	Interpretation of result	10%
6	Conclusions	10%
7	Practical related questions	10%
Total (25Marks)		**100 %**

Names of Student Team Members

1. .....
2. .....
3. .....

Marks Obtained			Dated signature of Teacher
Process Related(10)	Product Related(15)	Total (25)	

X Precautions (if any)

1. Use protective equipment such as tongs or high temperature gloves when handling hot items, and beware of electric shock.

XI Procedure

1. Fill the beaker with water.
2. Place the beaker on the hot plate and turn to 'High'. The water should be heated to just below boiling.
3. Bend the nitinol wire to a desired shape.
4. Place the nitinol wire in the hot water.
5. The nitinol wire should immediately return to its original shape.
6. Remove the nitinol wire from the beaker using the pliers and show it to the students.
7. Repeat steps 3-6, trying different shapes and amounts of deformation.
8. Repeat steps 3-6 with the steel wire.

XII Resources Used

S. No.	Instrument /Components	Specification	Quantity
1.	Shape memory alloy wire	min 10 mm	
2.	Glass beaker	Suitable Size	
3.	Heat Source	a power Source	
4.	High temperature	Suitable Type	
5.	gloves / tongs		

XIII Actual Procedure Followed

1. fill the beaker with water
2. place the beaker on the hot plate and turn to (High) the water should be heated to just below boiling
3. Bend the nitinol wire in the hot water

XIV Precautions Followed

1. use protective equipment such as tongs or high temperature gloves when handling hot items.

XV Observations

the cooling rate determine the behaviour of material the properties increases of reduced due to heat-treatment

XVI Results

1. Heated wire
2. Cooled wire

XVII Interpretation of results

if we want to increase same ability or decrease we can adjust its property by heat treatment

XVIII Conclusions & Recommendation

we can able high temperature-over Electrical power Source to turn a wire into a desired shape

XIX Practical Related Questions

Note: Below given are a few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the difference between shape memory and super elasticity on a macroscopic level and on a microscopic level?
2. The nitinol wire change shape, but not the steel wire?Justify
3. State the uses can you think of for materials that have this special behavior?
4. Explain the difference in super-elasticity and the shape memory effect. How are both achieved?

5. Name the forms of SMA have the same physical appearance?
6. State Practical applications for shape memory alloys
7. Explain the effect when a metal is heated above its transformation temperature? How can this effect be reversed?
8. State the effect of the structure of a SMA during transition?

[Space for Answers]

2 Ans Nitinol is also known as nickle, titanium and its alloy where, or steel is alloy of carbon and iron iron is a hard metal and the nicked and titanium Surface compare

3 Ans Plastic : more durability
copper : Good Electrical and Thermal conductivity
iron : hard metal
Glass : transparent
tungestin : High melting point
Steel : High corrosion resistance
rubber : High Electricity

4 Ans Super Elastic material regains its original properties when force is remove Elongate when Stored

Shape memory alloy does not regain their original property naturally but they need heat

7 Ans when this alloy is in below transformation temp it undergoes low yield Strength and when deform Easily into any new Shape which it will retain if this alloy heated above its transformation temperature

IX Resources required

S. No.	Instrument /Components	Specification	Quantity	Remark
1	Laboratory box furnaces	1200°c	02	
2	Digital Rockwell hardness tester- Easy-to-use Electronics Console	Hi/Lo Tolerance Settings, Adjustable Time @ Load Average Test Group Results 2-9, Test Result Memory Capacity 5000 results, RS232 Output,- Average Range	02	

X Precautions (if any)

1. For quenching, the sample should be immediately transferred from the furnace to the water/oil bath.
2. The quenching media should be agitated
3. The specimen should be well grinded and polished before measuring hardness.
4. Hardness should be checked in cold state.

XI Procedure

1. Put all the samples in the furnace and heat it for the selected temperature.
2. Hold the samples in the furnace for given soaking period.
3. Select any two cooling medium for quenching.
4. Take out the samples one by one and immerse it in quenching mediums.
5. As sample gets cooled, its faces are ground and polished to get an even surface.
6. Check hardness and plot graph, if desired.

Selection of heat treatment conditions

	Heating temperature	Socking time	Quenching media
	880°C, 920°C, 960°C	1 hour	Water, Brine, Oil or Air

XII Resources used (with major specifications)

S. No.	Instrument /Components	Specification	Quantity
1.	laboratory box	1200°C	1
2.	Digital rock well	Hi/Lo tolerance	1
3.	hardness tester	Setting, adjust time	
4.	Easy-to-use		
5.	Electronics Console		

XIII Actual procedure followed

1. Select any two cooling medium for quenching.
2. note reading.

XIV Precautions followed

The quenching media should be agitated
Hardness should be checked in cold State

XV Observations and Calculations

Table 1: Measurement of hardness from test

Sr. No	Specimen	Indentor Diameter(D) in mm	Total load(P) Kg-F	Diameter of Indentation(d) in mm			Average dia	RHN
				1	2	3		
1	Al	2.5	150	1.6	1.7	19	1.73	84.95
2	Cu	2.5	150	1.2	1.7	11	1.1	150
3	MS	2.5	150	0.8	0.7	0.76	0.76	9.22

Table 2: Measurement of effect of quenching on hardness

Material	Initial Hardness (RHB)	Hardness after quenching			
		Quenching Medium			
		Water	Brine	Oil	Air
Al 35	54.33	59.8	63	61.4	56.5
Cu	150	102	107	164.5	154.8

Calculations :

Calculate Hardness after quenching treatment:=

XVI Results

quenching is best cooling process after heat treatment

from above observation table it is conclude that oil is medium like water

The effect of different oil-quenching temperatures on the properties and structures of steel.

XVII Interpretation of results

Hardness is depend upon heating from temperature quenching medium material composition from observation table it proved that hardness no change with quenching medium.

XVIII Conclusions and Recommendations (if any)

Al = 54.95
Cu = 180
After quenching with oil
Al = 610.4
Cu = 164.5

XIX Practical Related Questions

Note: Below given are a few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

1. State the importance of cooling rate?
2. Plot a graph of different hardness values in Rc scale for various heat treated low carbon steel specimen.
3. Plot a graph 'Hardness vs. tempering temperature for constant tempering time of 1 hour'.
4. Plot a graph 'Hardness vs. tempering temperature for constant tempering time of 1 ½ hour'.

5. Plot a graph 'Hardness vs. tempering temperature for constant tempering time of 2 hour'.
6. When austempering steel, after the 30 minutes in the 400°C bath the specimen is removed from the bath and can be either quenched in water or allowed to air cool at room temperature. Will these two procedures produce different results? Explain.
7. Discuss the relationship between heat treatment and the resulting hardness values obtained in this experiment.
8. State the effect of water contamination affect the performance of quench oil?
9. State the effect of oxidation of oil on quench oil performance?
10. State bath agitation affect quenching?
11. State the effect of salt concentration in brine?
12. Some heat treated components develop cracks? Give reason.
13. State the reason for stresses develop during quenching?
14. State distortion of quenched component due to?
15. Is there a way of calculating the required cooling rate for a given component?
16. Is there a simplified approach for guiding in the selection of proper quenchant?

[Space for Answers]

1 Ans The hardness of material depend on the cooling state of material

The cooling state determine the property of material if we cool it fast will het other properties other than we want

2 Ans After removal from brine dry salting is followed by peaking of storage
The Effect of salt concentration in the brine has been in matter of continuously with form

Q9 Ans Contamination of quench oil can make marketty affect their performance Surface of water include water cooled bearing, fan, water oil

XX References / Suggestions for further Reading

a. https://www.wikihow.com/Harden-Steel
b. https://www.youtube.com/watch?v=QQ051Zie8pk
c. https://www.youtube.com/watch?v=Gmqkuc-n_IU
d. https://www.youtube.com/watch?v=U1patVgm8C0
e. https://www.youtube.com/watch?v=U-DesKKNi9g
f. https://www.youtube.com/watch?v=hw4Rl0uG7ok
g. https://www.youtube.com/watch?v=gPKkgmDoEoU
h. https://www.youtube.com/watch?v=bkxVLi3ezwA
i. https://www.youtube.com/watch?v=ulfCxDsVTWo

XXI Assessment Scheme

Performance indicators		Weightage
Process related (15 Marks)		**60%**
1	Hardening of specimen	20
2	Quenching of specimen	20
3	Hardness measurement of specimen	20
Product related (10 Marks)		**40%**
4	Hardened specimen	20
5	Quenched specimen	20
Total (25Marks)		**100 %**

Names of Student Team Members

1. .....
2. .....
3. .....

Marks Obtained			Dated signature of Teacher
Process Related(15)	Product Related(10)	Total (25)	