

Machining

Level – I

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Acronym

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Introduction to the Module

In machining filed; **perform bench work** helps to know good work ethic characteristics it how to use work shop hand tools; to layout and mark features to know range of graduated devices to measure; to Perform basic drill, ream, hone and scraper operations Perform basic drill; ream, hone and scraper operation ;perform off hand grind cutting tools and quality assuring for irrigation filed.

The term '**bench work**' refers to the production of components by hand on the **bench**, where as fitting deals which the assembly of mating **parts**, through removal of **metal**, to obtain the required fit. Both the **bench work** and fitting requires the use of number of simple hand tools and considerable manual efforts. The operations in the above works consist of filing, chipping, scraping, sawing drilling, and tapping.

This module is designed to meet the industry requirement under the machining occupational standard, particularly for the unit of competency: **perform bench work** .

This module covers the units :

- ✓ work values/ethics
- ✓ prepare work piece
- ✓ range of graduated devices to measure/determine dimensions or variables
- ✓ hand tool operations
- ✓ basic drill, ream, hone and scraper operations
- ✓ Off-hand grind cutting tools
- ✓ Quality assure

Learning Objective of the Module

- ✓ Apply work values/ethics
- ✓ Plan and prepare work piece
- ✓ Use measuring devices and determining dimensions or variable
- ✓ Perform hand tools operation

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- ✓ Perform basic drill, ream, hone and scraper operations
- ✓ Perform Off-hand grind cutting tools
- ✓ Assure Quality for finished component

Module Instruction

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit one: work value or work ethics

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- work values/ethics/concepts
- ethical standards, organizational policy and guidelines
- personal behavior and relationships
- company resources.

This unit will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Apply work values or ethics or concepts
- Undertake and practices industry work ethical standards, organizational policy and guidelines
- Conduct personal behavior and relationships with co-workers and/or clients
- Use company resources

1.1 work value or work ethics

1.1.1 work

A job or activity that you do regularly especially in order to earn money the place where you do your job The things that you do especially as part of your job Activity in which one exerts strength or faculties to do or perform something:

Work Ethics

Work ethics are a set of standards and rules that are required by an individual for satisfactory work performance. The word ethics deals with moral issues and with right and wrong behavior in a workplace. By setting work ethics, the workers will know the proper working attitude the company expects from each one of them.

Types of Work Ethics:

A. Personal

Ethical Traits of Personal Work Ethics:

These are the personal qualities normally included in classic descriptions of ethical consciousness and integrity. Examples of such ethical qualities in social work are:

- Integrity
- Critical self-insight
- Responsibility
- Courage/moral courage
- A sense of justice
- Balanced judgment
- Tolerance/broad-mindedness
- Empathy/sensitivity
- A basic attitude of respect, friendliness and equality in relation to others

b. Specific to a Work Station

Examples of Work Ethics Specific to a Work Station:

- Keeping certain information confidential
- Maintaining cordial information with the clients and agencies that a company has
- Being prepared to take a new task

It Sets of formal and informal standards of conduct that people use to guide their behaviour at work. These standards are partly based on core values such as honesty, respect, and trust, but they also can be learned directly from the actions of others. For example, what people see their organizational leaders,

managers, and co-workers do on the job can influence their own views of what is acceptable or unacceptable behaviour.

Ethics is a branch of philosophy that addresses the questions of morality through a set of behavioural guidelines. A workplace being the source of bread and butter for many, also satisfies the self-actualization needs. It provides a reason as a standard of living. Hence, by that virtue, [business ethics](#), which sustain morality and help evolution have to be followed at a workplace.

Honesty, loyalty, commitment and rights go in building a conducive work culture in a workplace. Although personal ethics differ, they matter in making of the ethical standards of the organization. Because of the difference, every employees needs to be put on one single ethical platform

- Keeping certain information confidential
- Maintaining cordial information with the clients and agencies that a company has
- Being prepared to take a new task

Classification of work values/ethics

- Work values can be divided into two functional categories.
 1. **Intrinsic;** - values are those that relate to a specific interest in the activities of the work itself, or to the benefits that the work contributes to society.
 2. **Extrinsic;**-values relate to the favorable conditions that accompany an occupational choice, such as physical setting, earning potential, and other external features. Most people, in order to feel truly satisfied with their work, must find some personal intrinsic value in it.
- **Work values/ethics/concepts are:**
 - Commitment/ dedication
 - Sense of purpose
 - High motivation
 - Reliability and dependability
 - goal-oriented
 - Being knowledgeable
 - Sensitivity to others
 - Balancing between family and work
 - sense of urgency
 - love for work
 - orderliness
 - competence
 - sense of responsibility
 - loyalty to work/company
 - compassion/caring attitude
 - sense of nationalism
- **Concept of Work practices**
 - Quality of work
 - punctuality
 - efficiency

- effectiveness
- productivity
- resourcefulness
- innovativeness
- cost consciousness
- attention to details

Here are the seven key components of a work ethic.

1. Professionalism

Being professional involves everything from how you dress and present yourself in the business world to the way you treat others. Professionalism is such a broad category, in fact, that it basically encompasses all the other elements of a strong work ethic.

2. Respectfulness

You display grace under pressure: No matter how tight the deadline or heated the tempers, you always remain poised and diplomatic. Whether you're serving a customer, meeting with a client or collaborating with colleagues, you do your best to respect everyone's opinions, especially under trying circumstances. This shows you value people's individual worth as well as their professional contributions.

3. Dependability

You can be relied on to keep your promises. You are always on time and prepared for meetings, and deliver your work on schedule and on budget. Your reputation for reliability precedes you because you've proven over time that customers, clients and colleagues can trust you to do everything you say you will. In an uncertain world, your customers, colleagues and clients will appreciate the stability you embody.

4. Dedication

You don't stop until the job is done, and done right. "Good enough" is not good enough for you and your team. You aim for "outstanding" in everything you do. You put in the extra hours to get things right, giving attention to detail and devotion to excellence. Your passion shows in how hard you work and the results you achieve.

5. Determination

You don't let obstacles stop you, and enthusiastically embrace challenges like a mountain climber who ascends higher and higher until the summit is reached. You know that your job as an entrepreneur is to solve your clients' problems, and you resolve to continually seek better and more innovative answers. With purpose and resilience, you push ahead, no matter how far you have to go.

6. Accountability

You take personal responsibility for your actions and outcomes in every situation, and avoid making excuses when things don't go as planned. You admit your mistakes and use them as learning experiences so you won't make the same ones again. You also expect your employees to meet the same high standards, and support those who accept responsibility instead of blaming others.

7. Humility

You acknowledge everyone's contributions, and freely share credit for accomplishments. You show gratitude to colleagues who work hard, and appreciation to your loyal clients. You have integrity in spades, and are open to learning from others, even as you teach people through your words, actions and example. And, while you always take your work seriously, you strive always to maintain a sense of humor about yourself.

A work value

A value is a principal or standard that is held in high esteem by an individual and is related to all aspects of one's personal and work life. You may have values around family, work, spiritual, leisure, personal, etc. In this exercise you will focus on your work values. As you rank each value, think about how important the value is to you in a work setting. As you consider your work related values, keep in mind that there are no right or wrong work values; rather it is a process of identifying what matters most to you rather than someone else.

Often include such traditional virtues as trust, loyalty and commitment, honesty and respect for one another, and avoiding conflicts of interest. Values may also include newer elements such as innovation, teamwork, customer focus and continuous improvement.

Work Value Concepts

Often include such traditional virtues as trust, loyalty and commitment, honesty and respect for one another, and avoiding conflicts of interest. Values may also include newer elements such as innovation, teamwork, customer focus and continuous improvement.

- **Commitment/dedication:** - understand to achieve anything requires faith and belief in yourself, vision, hard work and determinations. Dedication or commitment is the act of concreting an altar, temple, church or other sacred building. It also refers to the inscription of books or other artifacts.
- **Sense of urgency:** - Drive people companies & countries to work much harder than normal and the common traits of highly productive people, companies and countries. As you can see, a touch of it can transform a person, company or a country to be highly productive.

1. Set a challenging goal with a dead line.

2. Set a minimum time to work on something.
3. Make yourself accountable.
4. See yourself to be in the losing side.
5. Be aware of potential danger.

- **Sense of Purpose:-** The quality of having a definite purpose, purposefulness and meaningfulness. The quality of having great value or significant.
- **Love for work:-** If you work from home you probably spend more time on the phone and less time doing work find out how to keep the balance between work.
- **Orderliness:** - It is associated with other qualities such as cleanliness, diligence the desire for order and symmetry. Having a sense of where things belong and how they relate to each other and keeping them organized (I want to arrange myself and my surroundings to achieve the greatest efficiency, the quality or state of being orderly, also systematic functioning perhaps the most fundamental form of organization is taking to higher.
- **Sense of responsibility:-** An awareness of your obligations, sense a general conscious, sense of duty, a sense of should, ought to, have to.
- **Goal Oriented:** - The concept of goal orientation was developed to describe variability in dispositional or situational goal.
- **Competence:** - It is possession and application of skills, knowledge and attitudes to perform work activities.

- **General Types of Work Values:**

1. **Intrinsic or Self Actualization Values** - directly express openness to change values-the pursuit of autonomy, interest, growth, and creativity in work.
2. **Extrinsic or Security or Material Values** - express conservation values; job security and income provide workers with the requirements needed for general security and maintenance of order in their lives.
3. **Social or Relational Values** - express the pursuit of self-transcendence values; work is seen as a vehicle for positive social relations and contribution to society. Values include being helpful, responsible, affiliation to friends and the community, social justice, and environmental protection. This is demonstrated by values that are near each other or on opposite sides of the diagram shown below.



Table 1 Personal Work Values

PERSONAL WORK VALUES	DESCRIPTIONS
Help Society	Do something which contributes to improving the world we live in
Help Others	Be directly included in helping other people, either individually or in small groups
Public Contact	Have a lot of day-to-day contact with the public
Work with Others	Work as a team member toward common goals
Work Alone	<u>Do projects by myself, with limited contact with others</u>
Competition	Engage in activities which pit my abilities against others
Make Decisions	Have the power to decide courses of action and policies
Work Under Pressure	Work in situations where time pressure is prevalent
Influence People	Be in a position to influence the attitudes or opinions of other people
Knowledge	Engage in the pursuit of knowledge and understanding
Work Mastery	Become an expert in whatever work I do
Artistic Creativity	Engage in creative artistic expression
General Creativity	Have the opportunity to create new programs, materials, or organizational structures



PERSONAL VALUES	WORK	DESCRIPTIONS
Aesthetics		Participate in studying or appreciating the beauty of things, ideas, etc.
Supervision		Have a job in which I am directly responsible for the work of other
Change and Variety		Have work activities which frequently change
Precision Work		Work in situations where attention to detail and accuracy are very important
Stability		Have a work routine and job duties that are largely predictable
Security		Be assured of keeping my job and receiving satisfactory compensation
Recognition		<u>Be publicly recognized for the high quality of my work</u>
Fast Pace		Work in circumstances where work must be done rapidly
Excitement		<u>Experience a high degree of (or frequent) excitement in the course of my work</u>
Adventure		Have work duties which require frequent risk-taking
Financial Gain		Have a high likelihood of achieving very great monetary rewards for my work
Physical Challenge		Do activities that use my physical capabilities
Independence		Be able to determine the nature of my work without significant direction from others
Moral Fulfillment		Feel that my work contributes to a set of moral standards which I feel are very important
Community		Live where I can participate in community affairs
Time Freedom		<u>Be able to work according to my own schedule</u>

Top 5 Work Values:

1. Strong Work Ethic

Employers value employees who understand and possess a willingness to work hard. In addition to working hard it is also important to work smart. This means learning the most efficient way to complete tasks and finding ways to save time while completing daily assignments.

2. Dependable and Responsible

Employer's value employees, who come to work on time, are there when they are supposed to be, and are responsible for their actions and behavior.

3. Possessing a Positive Attitude

Employers want employees who take the initiative and have the motivation to get the job done in a reasonable period of time. A positive attitude gets the work done and motivates others to do the same without dwelling on the challenges that inevitably come up in any job.

4. Adaptability

Employers want employees who are adaptable and maintain flexibility in completing tasks in an ever-changing workplace. Being open to change and improvements provides an opportunity to complete work assignments in a more efficient manner while offering additional benefits to the corporation, the customer, and even the employee.

5. Honesty and Integrity

Employers value employees who maintain a sense of honesty and integrity above all else. Good relationships are built on trust.

1.1.2. Sense of responsibility

1.2.3. Competence

Demonstrate a high degree of expertise and mastery of job skills and knowledge.

1.1.3. Team work

Team

Team is a group of people who work together a shared and meaningful outcome in ways that combine their individual skills and abilities and for which they are all responsible.

How does the team happen?

The first thing to recognize is that a real team does not just happen –you have to work at it, create it, maintain and sustain it. If you do all of these then you stand a good chance of having an effective team –one that really works. This team can move mountains, create miracles and solve big problems. It acts as a lens. It brings together and focuses all of the skill and abilities of the people who are a part of that team. When this happens, you will say that there is a high level of teamwork or a good team spirit in that team. Teams like this are powerful teams for all organizations and quite a lot of time spent trying to find out how such teams develop and keep their cutting edge.

3.2 Features of Teams

- Teams are composed of highly communicative groups of People
- Team members must have diversity in their skills, abilities, background and perspective
- Teams have a shared sense of mission
- Teams have clearly identified goals
- Teams share the credit for victories and the blame for the losses.
- Teams can simply do more than an individual can. *“One is too small a number to achieve greatness”*
- Make better decisions when issues are difficult
- Good when knowledge talent, skills, abilities are dispersed across organizational members
- Share responsibility

- Increased brainpower and group process
- Increases value of results
- Create synergy

3.3 Team Building

John Ruskin

When you build something - like a sun deck or a fence - what you do is to erect or construct it. This takes time, effort and planning; it is not usually an overnight process. But, if your building efforts are going to be successful, then they also have to be preceded by a number of other events:

- First, you decide where you are going to put that sun deck or fence and roughly, what size it will be.
- Second, you create or obtain a detailed design for your sun deck or fence.
- Third, you buy and bring together the material and parts that will make up your sun deck or fence.
- Fourth, you fit together or assemble those separate parts.

If you think about this, you will soon see that only one of these stages - the last one - represents what is usually thought of as what you do when you build something. But that last stage - the actual construction - can't take place unless the preceding three stages - choice, design and procurement - have been completed.

The process of building a team has much in common with all of this. For when you build your team, you construct, frame, rise up and assemble that team.

- First, you identify or are told about what the team task is.
- Second, you decide how big your team needs to be and what sort of functional skills it needs to handle this task.
- Third, you recruit people with those and other skills.
- Fourth, you enable these people to gel or meld together so that they can work as a real team rather than a fragmented group.

Again, it is the last stage that represents what is usually thought of as the team-building stage. But, as before, that stage can't take place unless the preceding three stages have taken place. But what takes place in these three stages is different from what happened for your sun deck. For team building they are, respectively, about:

- team task identification
- choice of team size and skills range
- Team recruitment.

Effective teams need:

- Autonomy
- support and understanding
- time to develop and grow and
- Recognition.

Teams need from five to seven people who:

- have the right mix of functional skills
- have good interpersonal skills, and
- are able to adjust their team roles to complement those of others.

All of the above are important. They will give you a solid, firm, basis for team efforts, a launch platform for team success. But, important as they are, they are not all that you will need. If you are going to be successful in building your team, you will need a special something else.

Team building functions

Task Functions

- Initiating,
- Information giving and seeking,
- Opinion seeking and giving,
- Goal setting,
- Clarifying and elaborating,
- Summarizing
- Consensus testing,
- Problem solving and decision making

3.4 Characteristics of Effective Teams

- High level of interdependence among team members
- Team leaders have good people's skills and is committed to team approach
- Each team member is willing to contribute
- Team develops a relaxed climate for communication
- Team members develop a mutual trust
- Team and individuals are prepared to take risks
- Team is clear about goals and established targets
- Team members roles are defined

- Team members know how to examine team and individual errors without personal attacks
- Team has capacity to create new ideas.
- Each team member knows he can influence the team agenda
- Leadership role is shared and rotates among team members depending on the situation at hand
- A working atmosphere that tends to be informal, comfortable, and relaxed.
- There is discussion in which virtually everyone participates, but it remains pertinent to tasks
- The task or objective of the group is well understood and accepted by the members
- The members listen to each other
- There is disagreement. Disagreements are not suppressed or overridden by premature group action
- When an action is taken ,clear assignments are made and accepted
- People are free to express their feeling as well as their ideas both on the problem and on the group's operation

Table 2 The difference between Teams and Groups

Groups	Teams
Task and individual oriented	Oriented towards team goals and agendas
Tend to be autocratic and hierarchical in nature	Participatory and self steering
Low level of interdependence	High level of interdependence and synergy
Difference is suppressed	Difference is welcomed
Avoid risks	Risk is accepted
Leadership is solo	Leadership is shared
Membership selection is not that much important	Membership selection is important
Competition is inward	Competition is with the outsiders

1.2.4. Commitment/ Dedication

When you have a good work ethic, you are dedicated to job that you deem valuable. You hold yourself to high standards of responsibility. You also keep yourself accountable for getting work done right and on time, and for making good business decisions that help people and companies succeed. Having a solid work ethic means you understand that productivity, organizational skills, being reliable and possessing good character are all attributes that successful people share.

1.2 ethical standards, organizational policy and guidelines

A job description defines a person's role and accountability. Without a job description, it is not possible for a person to properly commit to, or be holding accountable for a role.

As an employee you may have or be given the opportunity to take responsibility for your job description. This is good. It allows you to clarify expectations with your employer and your boss.

The process of writing job descriptions is actually quite easy and straightforward. Many people tend to start off with a list of 20-30 tasks, which is okay as a start, but this needs refining to far fewer points, around 8-12 is the ideal.

Any job description containing 20-30 tasks is actually more like a part of an operational manual, which serves a different purpose. Job descriptions should **refer** to the operational manual, or to 'agreed procedures', rather than include the detail of the tasks in the job description. If you include task detail in a job description, you will need to change it when the task detail changes, as it will often do.

1.1 job descriptions are important

Job descriptions improve an organization's ability to manage people and roles in the following ways:

- clarifies employer expectations for employee
- provides basis of measuring job performance
- provides clear description of role for job candidates
- provides a structure and discipline for company to understand and structure all jobs and ensure necessary activities, duties and responsibilities are covered by one job or another
- provides continuity of role parameters irrespective of manager interpretation
- enables pay and grading systems to be structured fairly and logically
- prevents arbitrary interpretation of role content and limit by employee and employer and manager
- serves as an essential reference tool in issues of employee/employer dispute
- provides important reference points for training and development areas

- provides neutral and objective (as opposed to subjective or arbitrary) reference points for appraisals, performance reviews and counseling
- enables organization to structure and manage roles in a uniform way, thus increasing efficiency and effectiveness of recruitment, training and development, organizational structure, work flow and activities, customer service, etc
- enables factual view (as opposed to instinctual) to be taken by employees and managers in career progression and succession planning

1.2 Writing job descriptions - summary guidelines

- A good job description must be a brief concise document - not lots of detail of how each individual task is done, which should be in an operational manual, which can of course then be referenced by very
- many different job descriptions, saving lots of time, especially when operational details change, as they inevitably do.
- A job description is in essence a list of 8-15 short sentences or points, which cover the main responsibilities of the role, not the detailed processes.

1.2.1. Legal and organizational policy/guidelines and requirement

Definitions:

Policy: A general frame work to attain the organizational objectives.

Policies focus on how organizational objectives will be achieved. Policies provide a general guideline to action. It is a framework for administrators to follow in making decisions and handling problem situations. Policy statements should be clear and understandable, stable over time and communicated to everyone involved.

Objective: It is a goal end toward the attainment of which plans and policies directed.

Objectives are statements of organization targets or the results that administrators seek to achieve. It is the general statement of the mission of the organization and of what intends to do.

Goal: It is a desired state of affairs to which planned effort is directed.

Program: A group of related projects and activities with a specified set of resources (human, capital, and financial) directed to the achievement of a set of common goals within a specified period.

Planning; is the process of defining organizational objectives and then articulating strategies, tactics, and operations necessary to achieve those objectives.

In planning process, it is necessary:

- To establish goals,
- To anticipate future developments,
- To identify course of actions required to attain the goals and
- To determine the time frame.

1.2.1 5S

5S Definition

A 5 level standard for organizing the workplace. The 5 stages (from most disorganized to most organize) are:

- 1S = “Seiri” = Sort: Separating needed and unnecessary, eliminating unnecessary material
- 2S = “Seiton” = Store: A place for everything & everything in its place
- 3S = “Seiso” = Shine: Cleaning: eliminating dirt, make like new
- 4S = “Seketsu”= Standardize: procedures and responsibilities
- 5S = “Shitsuke” = Sustain: making compliance automatic, a habit

5S Benefits to YOU

- It will make your workplace a safer, cleaner and more pleasant place to work
- Make your job more satisfying.
- Eliminate overburdens and disappointments.
- Make it easier to communicate with everyone you work with
- Gives you an opportunity to give creative input how your work place should be
- Gives you an opportunity to give creative input how your work place should be

5S Benefits to Organization

- Stability in the process allow optimization
- Zero defects brings higher quality

- Zero waste brings reduce cost
- Zero delay brings reliable delivery
- Zero accident, increase safety
- Zero breakdown, increase productivity
- Zero complaint brings greater confidence and trust

1.2.2. Innovativeness/Creativity

- Creativity is the act of turning new and imaginative ideas into reality. Creativity involves two processes: thinking, then producing.
- Innovation is the production or implementation of an idea.

1.2.3. Quality of work

quality

If a product fulfils the customer's expectations, the customer will be pleased and consider that the product is of acceptable or even high quality. If his or her expectations are not fulfilled, the customer will consider that the product is of low quality. This means that the quality of a product may be defined as "its ability to fulfill the customer's needs and expectations". Quality needs to be defined firstly in terms of parameters or characteristics, which vary from product to product. For example, for a mechanical or electronic product these are performance, reliability, safety and appearance. For pharmaceutical products, parameters such as physical and chemical characteristics, medicinal effect, toxicity, taste and shelf life may be important. For a food product they will include taste, nutritional properties, texture, and shelf life and so on.

1.3. personal behavior and relationships

Each person is different, with their own personal behavior, values and beliefs shaped by a number of factors that include culture, religion, nature, and personal experiences.

- Values relate to our personal principles, morals, and ideals that is, what we consider to be important.
- Attitudes relate to a person's views, which may be evidenced in the way they behave.
- Beliefs relate to those things in which an individual has faith 'religious beliefs for example which may not necessarily be founded on fact.

Dignity’ is a difficult concept to define and has a strong association with respect. ‘Privacy’ has been defined as ‘freedom from intrusion’ and ‘dignity’ as ‘being worthy of respect’ (DH, 2003). Within this module, four types of dignity were identified as follows.

- Merit—this relates to dignity or social status that is ascribed to people because of their role or position in society, or because of what they have achieved.
- Moral status—this is emphasized by the person’s moral autonomy or integrity. If an older person is able to live according to their own moral principles, then that person will experience a sense of dignity.
- Personal identity—this was found to be the most relevant in the context of older people: ‘It relates to self-respect, and reflects an individual’s identity as a person. This can be violated by physical interference as well as by emotional or psychological insults such as humiliation’.

By understanding these above mentioned differences among the co-workers and clients we can minimize the differences by creating tolerance.

Ethical Guidelines:

Fundamental values in the work and for the profession are human rights and humanity. The work shall contribute to creating a good and dignified life for all citizens and to developing the welfare of the society.

1. Profession and Personality

Professional workers shall

- In their work and way of life respect each individual’s equal and high worth
- Show particular responsibility towards persons and groups in a vulnerable position
- Use their professional position with responsibility and be conscious of the limitations of their own competence
- Maintain and develop their social work skills and strive towards ethical consciousness and personal development.

2. The client/citizen

Professional workers shall

- show an equalitarian attitude to other citizens and treat clients with respect, empathic attention and amiability
- respect the client’s personal integrity and safeguard the individual’s right to self - determination in so far as the same right for others’ is not infringed upon and there is no risk of damage to the client. Measures shall as far as possible be based on participation and mutual understanding

- inform the client as to rights and duties, i.e. clarify the conditions and resources that exist within the current activity and other authorities involved
- make sure that the demands placed on clients have a reasonable foundation and are capable of contributing to an improvement of their situation
- never use the position of dependency of the client in different situations to own advantage
- Maintain client confidentiality and make sure that information concerning the client is handled in conformance with the law and generally with great prudence.

3. The Organization, Colleagues and the Workplace

Professional workers shall

- Be aware of and show loyalty to the organization's basic task
- show loyalty and respect towards colleagues and other members of staff as well as towards members of the board
- Challenge and work against offensive or discriminatory attitudes and actions within the organization or in the behavior of colleagues or clients, aware that this may be in conflict with other loyalty demands
- contribute towards the upholding of high standards of quality in the work so that the profession can develop in step with citizens' needs and with changing conditions in the Society
- Help to make the workplace a constructive and responsive social environment.

4. Society

Professional workers shall

- Be open to cooperation with other organizations and other professions, under the condition that this is of value to clients and other citizens
- Strive to build up confidence in social work and in their own professional competence, as well as being open to demands for accountability and critical appraisal of the way the work is performed
- As a professional and as a citizen stand for a democratic social ideal comprising human rights, humanity and solidarity.

Respects Others

An employee with a strong work ethic is rarely late. You respect everyone's time, from coworkers to clients to interviewees. You're also polite, conscientious of people's feelings and considerate of workers in a shared workspace. In addition, someone with a strong work ethic uses time wisely so that deadlines are met. You'll keep personal phone conversations quiet and not disrupt others. Out of respect, you'll also hear and consider everyone's opinions.

1.4. company resources.

Concepts of resources

Resources are an organization's assets and are thus the basic building blocks of the organization. They include tangible assets, such as its plant, equipment, finances, and location, human assets, in terms of the number of employees, their skills, and motivation, and intangible assets, such as its technology (patents and copyrights), culture, and reputation.

Types of Company Resources

The Best types of **Company Resources** which are crucial to the business are the following:

- Material Resources
- Human Resources
- Financial Resources
- Intellectual Resources

1.4.1. materials/ Equipment/Machineries

Material Resources are the tangible assets of the company that can use to achieve its objectives and targets. Material resources can be touched or seen.

Material resources are dynamic in nature. They are changed with the change in time and technology. When new technology is implemented, it may replace old machines with a new ones for better performance.

Some examples of Material Resources:

- Machinery and Technological tools
- Real state and for furniture
- Raw material
- Manufactured Product

1.4.2.Human power

Human resources are the building block of any company. Without Human resources, there are no performance and achievement.

If you work at an organization, you already know a little bit about Human Resources. The organization has a department for recruitment of employees and dealing with staff, like paying salaries, on boarding, training, and development.

In this article, We are talking about people who work for organizations and their skills, Knowledge, Culture, and expertise. They play important roles in an organization because human resources impact company performance and achievement.

1.4.3. Financial resources

Financial Resources

Financial resources are the assets of the company which are used for company activities like paying salaries, buying raw materials, etc. The best financial resources management approach is important to achieve the objectives and target of the company.

The condition where the shortage of financial resources can compromise the short-period operation must be avoided. For example, if the organization does not have the fund to buy raw materials and pay salaries.

When a company needs Financial resources, the company used the following types of sources of funds.

- Share Capital or Equity Shares
- Preference Capital or Preference Shares
- Retained Earnings
- Debenture
- Trade Credit
- Factoring Services
- Working Capital Loans
- Bill Discounting
- Venture Funding
- Lease Finance

1.4.4. Intellectual Resources

Intellectual Resources are the intangible assets of the company that can be used to achieve its objectives. Intellectual Resources cannot be touched or seen.

It can include recipes for those who deal with food. Or it can include a particular way of doing things. It is impossible to measure the actual value of intellectual resources.

Some examples of Material Resources:

- Brand
- Patents
- Copyrights
- Partnerships
- Customer databases
- Software

Importance of Company Resources

- The company resources are basic building blocks of company authority and can use to achieve its objective and target.
- It provides you with an overview of everyone and everything involved in your company.
- It enables utilization planning and gives you control.
- It makes the planning and management process more transparent and helps you see problems before they start.

Self-Check 1	Written Test
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Directions: Answer all the questions listed below. (6 points)

Part I. choose the best answer (1 point for each)

Directions I: Choose the best answer for the following questions. (2 point each)

- _____ product fulfils the customer's expectations, the customer will be pleased and consider that the product is of acceptable
A. Product B. Quality C. Test D. Value
- is the classification of work values?
A. Intrinsic C. relational value
B. Extrinsic D. All
- Which one of the following are not work values?
A. Commitment
B. sense of urgency
C. Sense of purpose
D. love for work
E. none of the above

Directions II :- short answer

- list company resources

Directions III:- filling the blank

- _____ is the process of defining organizational objectives and then articulating strategies, tactics, and operations necessary to achieve those objectives.

Unit two : Plan and prepare work piece

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- work activities sequence.
- materials Selection .
- Lay out and mark dimensions/features

This unit will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- 2.1. Plan work activities sequentially.
- 2.2. Select materials.
 - 2.2.1. Ferrous
 - 2.2.2. Non Ferrous
- 2.3. carry out Lay out and mark dimensions/features

2.1 work activities sequentially

Definition of Planning

planning :-is the systematic process of establishing a need and then working out the best way to meet the need, within a strategic framework that enables you to identify priorities and determines your operational principles. Planning means thinking about the future so that you can do something about it now. This doesn't necessarily mean that everything will go according to plan. It probably won't. But if you have planned properly, your ability to adjust, without compromising your overall purpose, will be that much greater.

2.1.2. Reason for Plan

Four reasons for planning:-

- Provides direction
- Reduces uncertainty
- Minimizes waste and redundancy
- Sets the standards for controlling

2.1. Engineering:-

- Engineering is a professional art of applying science and technology to optimize the conversion of natural resources to the benefit of mankind. (Natural resources available in the universe are Iron ore, Air, Sun, Water, Space, Human etc.)
- Human resource is a supreme strength to develop Engineering to contribute the welfare and progress of the society or to this nation.

2.2. Engineer:-

- Engineer is a person having creative thoughts and ideas to develop technology for the noble cause of the society or to nation.
- All objects begins an idea, Conceived and visualized by the Engineer. He makes an internal representation of the object in his mind and communicates it to others through media of expression.

2.4.1. Professional activities of an engineer:

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1. Planning: (Proposal of doing something)

- It means a set of preparation is to do in order to achieve something or any kind of task/work. (Preparation means programmes, drawings, Materials requirement and their sources, time schedule, cost estimate, scheme and design and method of preparation etc.)
- It is a management function of defining goal of an individual / organizations.
- It determines the task/work and resources necessary to achieve set goals.
- It helps to save materials, labor, time, money efforts and process etc. so that any kind of work/task can be performed successfully without having any difficulty with full confidence.

2. Visualization (related to vision / creating picture in mind)

- It is a behavioral technique of improving performance of his individual.
- It encourage for creating mental picture for successful execution of any work.

3. Hard work and practice (doing something repeatedly)

There is no substitute for hard work. A spiritual person says that “Work is Worship”, “Practice makes the man perfect”. Practice makes a person to acquire skill to use their knowledge for gaining self-assurance and confidence to handle any kind of work without any difficulty.

4. Punctuality (being in time):

Punctuality is a moral goodness, which is to be practiced very well punctuality is nothing but courtesy to others. By being punctual you respect the value of time of others. This is more than anything else. It helps you to plan your activities and schedule with precision and efficiency.

5. Work place Environment:

Workplace environment is to be maintained neat and clean, and spread happiness, cheerful, love & affection around your work place, at home and also to the community.

6. Efficiency: It is the ability to do whatever we expected of us as promptly accurately and economically as possible.

These activities are to be performed by an engineer to maintain quality and integrity for successful execution of any task & to face the challenge of globalization.

2.3. Workshop:-

It is a place of work for preparing variety of jobs/products by using different kinds of Instruments, hand tools and Machines.

In order to prepare the products in W/s, the w/s is divided in to many branches according to nature of work.

Ex: 1.Fitting shop

2. Welding shop
3. Sheet metal shop
4. Machine shop
5. Foundry & Forging shop etc.

Required information to prepare the product

It is a common experience that when we want to prepare any product, the following information's are required:-

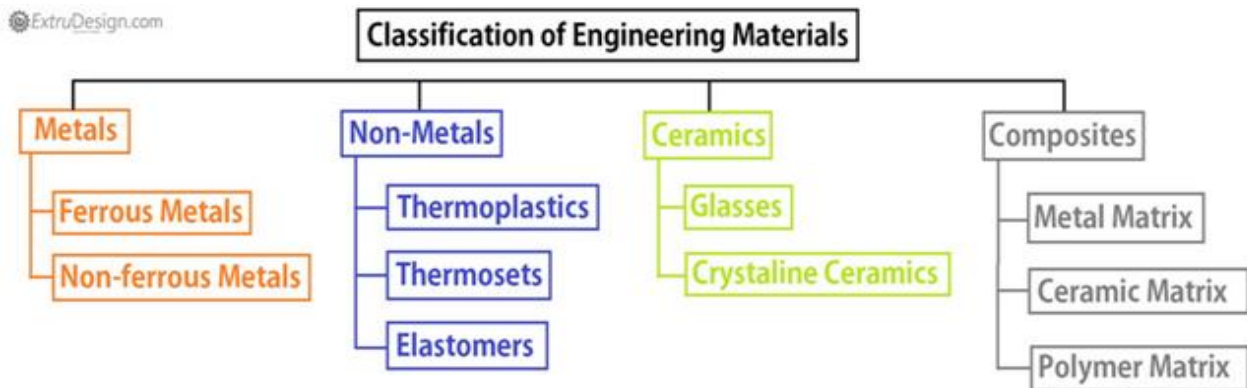
1. Actual Shape
2. Accurate Size
3. Manufacturing Method

Before taking up the construction of a product, the person who prepares it must have a clear picture of the shape and size of the object in his mind and to know the method of manufacturing process for successful execution of the work.

2.2 material selection

Concepts of engineering materials

The knowledge of materials and their properties is significant for a design engineer. The machine elements should be made of such a material which has properties suitable for the conditions of operation.



Metals can be classified in to two groups:-

2.2.1 Ferrous : - are those which contain iron as the main content.

E.g. Pig iron, wrought iron, cast iron, steel, alloy steel etc.

2.2.2 Non Ferrous : - are those which don't contain an iron.

E.g. Copper, zinc, tin, lead, brass, bronze, etc.

3.1.1. Identifying properties of ferrous and nonferrous metals

Metals are an element that can conducts heat & electricity. Metals have the following properties:

- Solid at room temperature
- Reflective when polished
- Expand up on heating & contract on cooling
- Good conductor of heat & electricity

2.3. Lay out

Marking out and measuring is a critical part of manufacturing and is usually subject to a number of quality control checks. If components are marked out and measured wrongly before being cut out, there is no chance of them fitting together when they are assembled. Always take marking out measurements from a datum as indicated in Figure 4.1. A datum edge is a flat face or straight edge from which all measurements are taken. This prevents cumulative errors being made. If you are using timber, choose the face side carefully, before marking it with a small symbol for identification purposes, as shown in Figure 4.2. Then select a face edge that is at right angles to the face side. Take all your measurements from this side and/or edge.

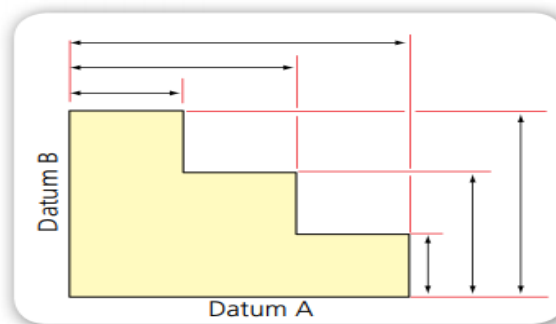


Figure 2. 1 Datum edges

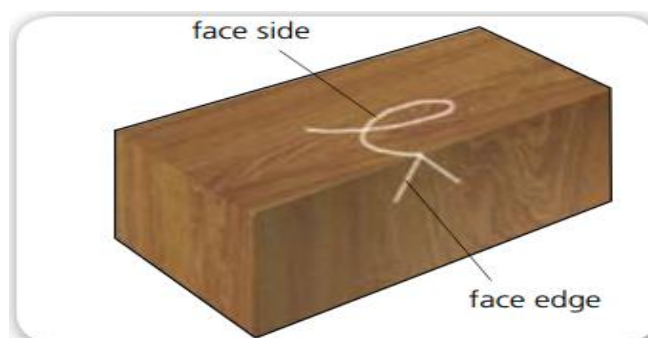


Figure 2 .3 Face edges

2.3.1. Laying out and laying out tools

I . Laying out tools

Layout is the process of making lines, circles, and other marks with a variety of hand tools to represent the features on the blueprint.

II. Laying out tools

- **Squares:**

There are a number of squares:

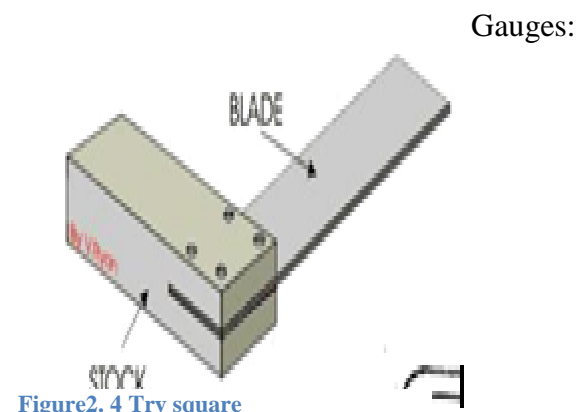
- ✓ Try square
- ✓ Miter square
- ✓ Engineer's square.

Both the try square and engineers square are used to mark lines at 90° to an edge. A try square is used on timber and an engineer's square is used on metals. Both can be used for marking out plastics. You can also use try squares and engineer's squares to check that a cut or an edge has been made at right angles to another. Hold the stock part of the square tightly against the edge that you have just cut. If you can see light between the two edges then the cut is not square. A miter square is used for marking out 45° or 135° angles on wood and plastic. Take great care when using any form of square for marking out or checking, and ensure that it is being held firmly and tightly against the surfaces or edges of the material.

In practice, try is used for checking the square ness of many types of small works when extreme accuracy is not required .The blade of the try square is made of hardened steel and the stock of cast Iron or steel. The size of the try square is specified by the length of the blade.

Item	Name and use
	try square marking out or checking right angles on wood or plastic
	engineer's square marking out or checking right angles on metal or plastic
	mitre square marking out or checking angles of 45° or 135°

Table 4. 3 The uses of squares



There are three basic types of gauge:

- ✓ marking gauge,
- ✓ mortise gauge
- ✓ cutting gauge.

A marking gauge is used for marking lines parallel to the face edge and side on wood. It consists of a stock that slides up and down the stem, allowing various measurements to be set. The gauge should be set using a steel rule that has a zero end. The spur (sharp point) is pushed into the wood as the gauge is pushed or pulled along the length of the timber. It is important to hold the stock tightly against the edge of the timber to ensure that you mark a parallel line.

A vernier height gauge is used for measuring height of an object or marking lines onto an object of given distance from a datum base.

A cutting gauge is used for cutting across the grain. It is used in the same way as a marking gauge, but has a blade instead of a spur. The blade cuts the fibers across the grain, making it easier and neater to cut with a saw.

A mortise gauge has two pins; one pin is fixed and the other is adjustable. It is used for marking two parallel lines where a mortise and tenon joint is to be cut. The process of marking out is exactly the same as with the two other gauges.

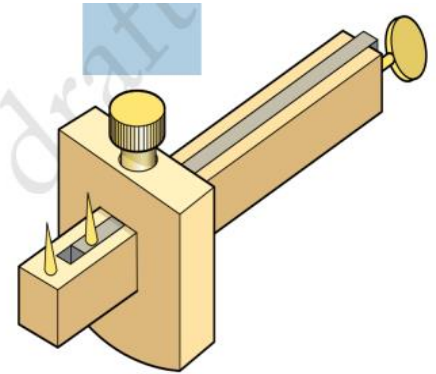


Figure e2 .3 Mortise gauge



Figure 2.4 Vernier Height Gauge

Scribers:

A scriber is used to scratch on the surface of metal and plastic lightly. If you are using a scriber on metal, it is a good idea to apply a coat of engineer's blue. This is a spirit-based liquid that is applied to a metal surface. When the scriber is dragged across the engineer's blue it leaves a clean line, which can be easily seen.



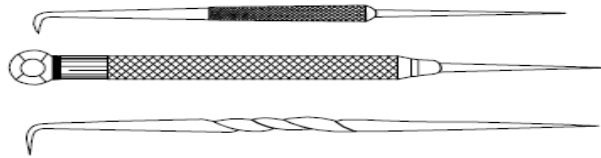


Figure 2.5 Scribes

- **Punches:**

Centre punches are used to make an indent in the surface where holes are to be drilled in metal, as shown in Figure 4.19. They provide a starting point for the drill and stop it skidding over the surface. Dot punches are used for marking the centers where dividers are to be used. They are similar to a center punch, except that the tips are ground to a 60° rather than a 90° point.

Center Punch Procedure

1. Make sure that the point of the punch is sharp before starting.
2. Hold the punch at a 45 degree angle and place the point carefully on the layout line.
3. Tilt the punch to a vertical position and strike it gently with a light hammer.
4. If the punch mark is not in the proper position, correct it as necessary.

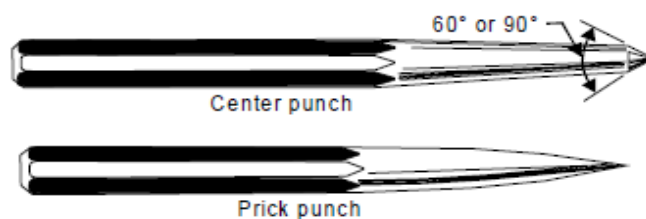
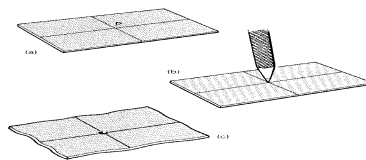


Figure 2.6 A Center punch, and the punch in use.

- **Hammer:**

Hammer is a common work shop hand tools used for striking purpose. There are different types of hammers based on their function.

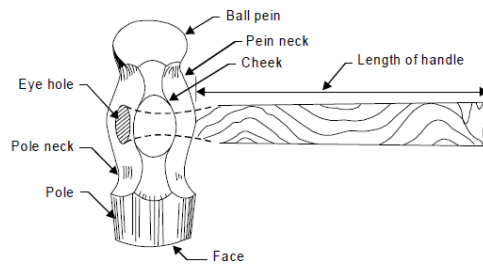


Figure 2.7 Common types of ball peen hammer and its parts

- Divider:**

It is basically similar to the calipers except that its legs are kept straight and pointed at the measuring edge. This is used for marking circles, arcs laying out perpendicular lines, by setting lines. It is made of case hardened mild steel or hardened and tempered low carbon steel. Its size is specified by the length of the leg.

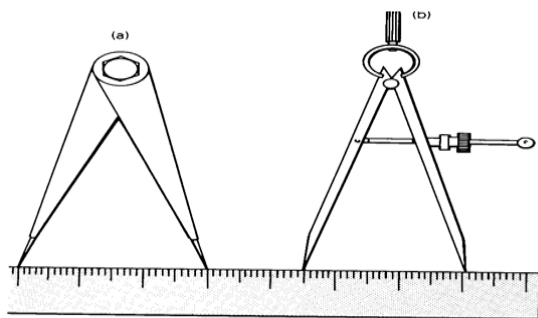


Figure 4.43 Setting dividers: (a) firm-jointed type; (b) spring-controlled type.

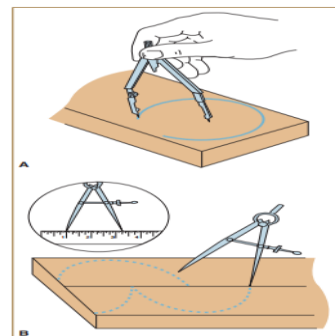


Figure 2.8 A-place and swing the compass on the center point of the circle or arc.

B-Use the Divider to Step off Measurement

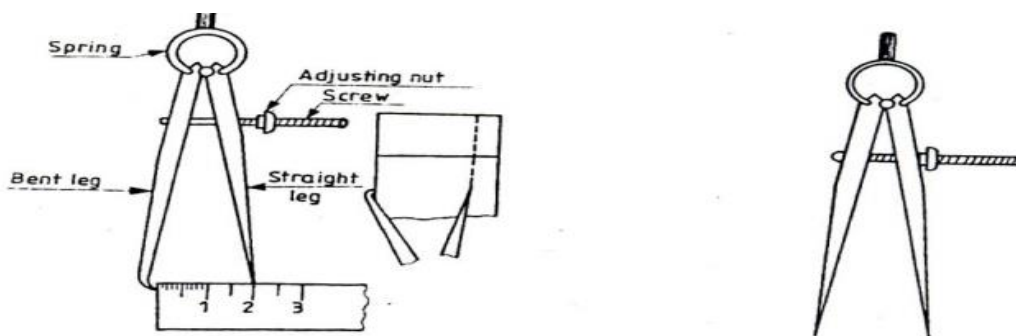


Figure 2.9 Odd leg caliper and divider.

Trammel Points:

Trammel points are used to mark large circles or make arcs that have large radii. They are used similarly to dividers. The beam is usually made of metal.

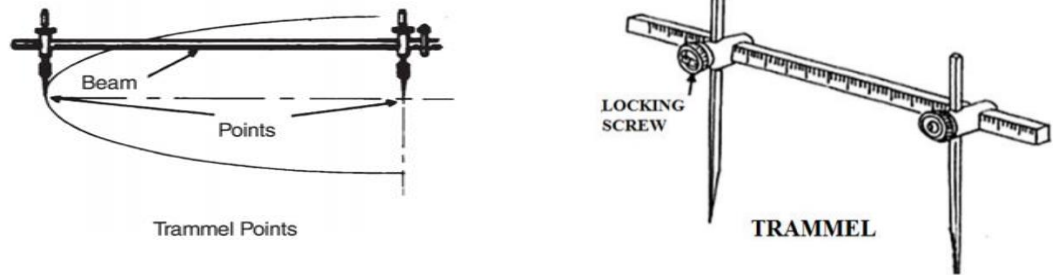


Figure 2.10 Trammel Points

Surface plate

The surface plate provides a 'plane of reference' for checking other surfaces. The plate is made from an iron casting. Its top surface is perfectly flat, and the underside is ribbed to prevent distortion of the plate (Figure 4.22). It is used generally for setting up work for marking out and testing. The surface table allows larger work to be checked for flatness.

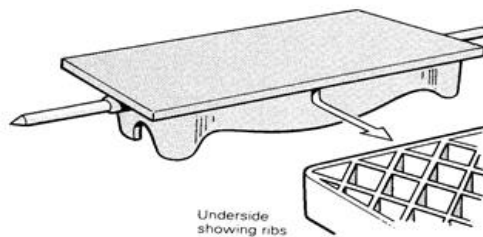


Figure 2.11 Surface plate

Surface gauge:

You use the surface gauge for marking parallel lines and finding centers. Figure 4.24 shows the procedure:

1. Set the scriber at the height you want, using the rule
2. Hold the work against an angle plate or on a vee block.
3. Move the block until the scriber touches the work.

Angle Plate:

The angle plate is made from a good-quality casting.

It consists of two faces machined at 90° to each other (Figure 4.25). You can fix work to the plate using bolts, which can pass through the slots provided. You can also use the angle plate to support work when you are using the surface gauge for marking out.

Vee Blocks:

You use vee blocks to support cylindrical work when you are testing it or marking it out. The blocks, which are supplied in pairs, are made from cast iron. There are grooves along the sides, which allow the clamp to be used (Figure 4.27). If the work is long, you will need a 'matching pair'.

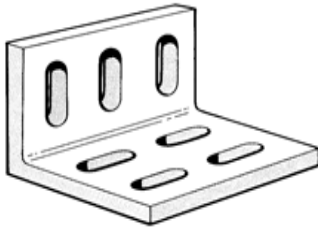


Figure 2.13 Angle plate

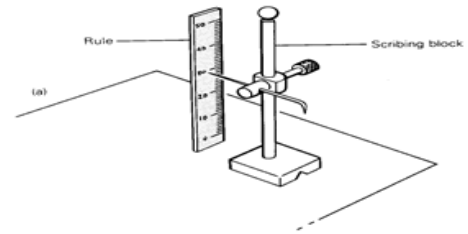


Figure 2.12 Surface gauge

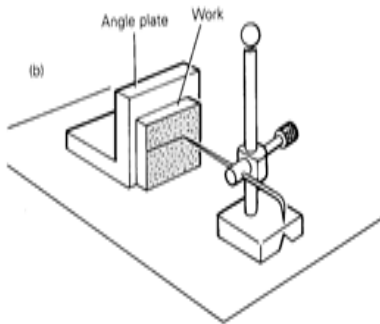


Figure 2.14 Using the surface gauge

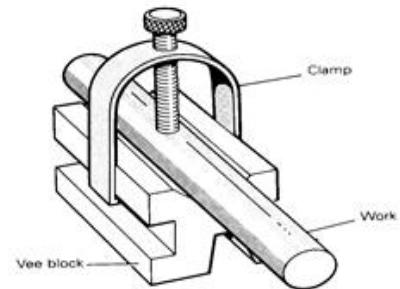


Figure 2.15 Using the Vee block

Combination Set:

The combination set (Figure 4.28) is an important tool in the workshop, because you can use it as a center square, a try square, a protractor for marking out, measuring and testing. There are three heads (protractor, square and center), which slide onto a rule, which can be fixed at any position using the nut provided.

The main parts of the combination set are used as follows.

1. The try square has angles of 45° and 90° , which you can use to mark out, or to check that a surface is vertical. You can also use it as a square (Figure 4.30(a)).
2. You can use the center square to find the center of circular pieces (Figure 4.30 (b)).
3. You use the protractor with the rule to mark out or measure angular surfaces (Fig 4.30 (c)).

Measuring and inspection tools

You can obtain detailed dimensions of work pieces using measuring tools such as the rule, or the combination set. You can also test existing features (such as holes) for accuracy using inspection tools such as plugs and gauges.

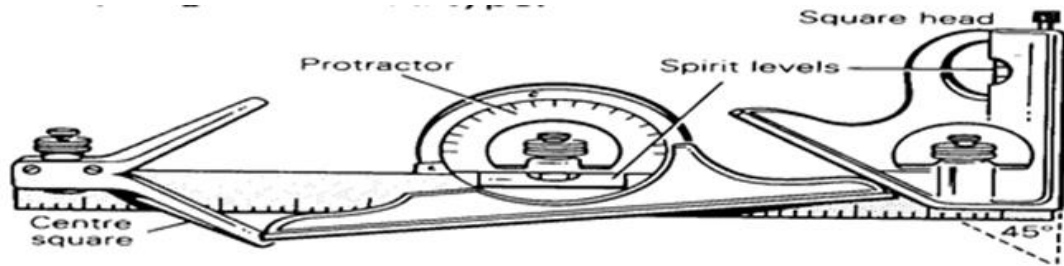


Figure 2.16 Combination set.

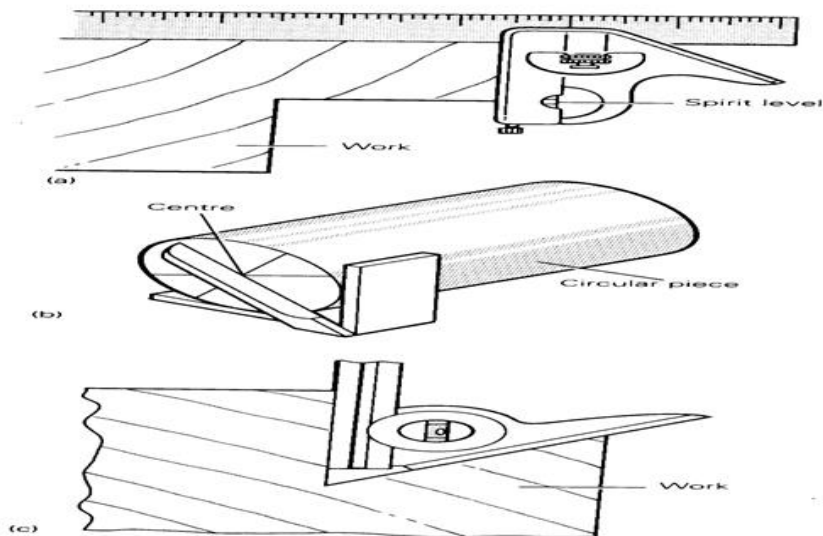


Figure 2.17 Using the combination set: (a) try square;

Self-Check -2

Multiple Choice

Directions I: Choose the best answer for the following questions. (2 point each)

1. The ability to do whatever we expected of us as promptly accurately and economically as possible is: _____.
a. Skill b. Knowledge c. Attitude d. Efficiency
2. Why planning is necessary?
a. To provides direction b. To reduces uncertainty
c. To minimize waste and redundancy d. All
3. _____ Is a marking out tool used to scratch on the surface of metals and plastics lightly.
a. punch b. Steel rule c. Try square d. Scriber
4. Which one of the following steel is a more precise measuring instrument than the others?
a. Micrometer c. Steel rule
b. Vernier caliper d. Divider

Directions II: filling the blank

5. _____ is a moral goodness, which is to be practiced very well punctuality is nothing but courtesy to others.
6. _____ ability to do whatever we expected of us as promptly accurately and economically as possible

Directions III: give short answer

7. What is lay out
8. what the deference between marking and measuring tool

Directions IV: marching

A	B
9. ____ Combination Set	A. consists of two faces machined at 90° to each other
10. ____ Surface gauge	B. There are three heads protractor, square and center,
	C. marking parallel lines and finding centers

Operation sheet 2.1: Planning work activities sequentially

• Operati

on title: Lay out and mark dimensions/features

- **Purpose:** To Lay out and mark dimensions/features
- **Instruction:** Using the figure below and given equipments lay out the length of each line. You have given 30Minut for the task

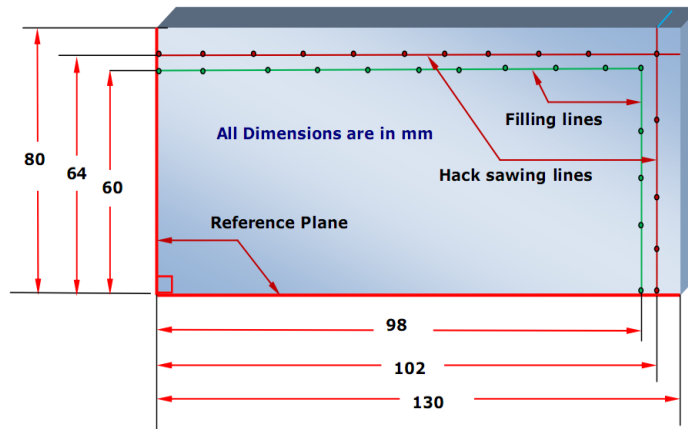


Figure 2.18 Figure given for operation sheet 2.1

- **Tools and requirement:**
 1. 10*85*135 mm plate
 2. Rule,
 3. scriber
- **Steps in doing the task**
- **Steps 1-** Locate the reference plane.
- **Step 2-** Use the surface plate, surface gauge and steel ruler to set the required height as shown in Fig.2.1.
- **Step 3-** Use the angle plate, surface gauge to scribe the first line and repeat the same procedure to scribe the other three lines.
- **Step 4-** Punch the scribed lines by using the prick punch.
- **Quality Criteria:** the given geometrical shape is measured with 0.5mm accuracy
- **Precautions:** use the given steel rule and try square.

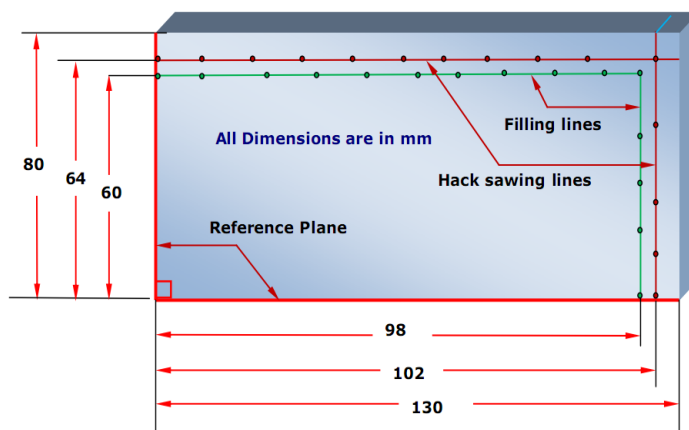
LAP Test	Practical Demonstration
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Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1-2** hours.

Task 1: Marking out



Unit three : Graduated Measuring Devices

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Measuring device or equipment
- Measuring Technique.
- Finest Graduation of Instrument..

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Select appropriate device or equipment to achieve required outcome.
- Use correct and appropriate measuring technique.
- Measure accurately to finest graduation of instrument..

3.1. General Characteristics and Selection of Measuring Instruments

The characteristics and quality of measuring instruments are generally described by various specific terms, defined as follows (in alphabetical order):

- **Accuracy:** The degree of agreement of the measured dimension with its true magnitude.
- **Amplification:** The ratio of instrument output to the input dimension; also called *magnification*.
- **Calibration:** The adjustment or setting of an instrument to give readings that are accurate within a reference standard.
- **Drift:** An instrument's capability to maintain its calibration over time; also called *stability*.
- **Linearity:** The accuracy of the readings of an instrument over its full working range.
- **Magnification:** The ratio of instrument output to the input dimension; also called *amplification*.
- **Precision:** Degree to which an instrument gives repeated measurement of the same standard.
- **Repeat accuracy:** The same as accuracy, but repeated many times.
- **Resolution:** Smallest dimension that can be read on an instrument.
- **Rule of 10 (gage maker's rule):** An instrument or gage should be 10 times more accurate than the dimensional tolerances of the part being measured. A factor of 4 is known as the *mil standard rule*.
- **Sensitivity:** Smallest difference in dimension that an instrument can distinguish or detect.
- **Speed of response:** How rapidly an instrument indicates a measurement, particularly when a number of parts are measured in rapid succession.
- **Stability:** An instrument's capability to maintain its calibration over time; also called *drift*.



The selection of an appropriate measuring instrument for a particular application also depends on:-

- (a) the size and type of parts to be measured,
- (b) the environment (temperature, humidity, dust, and so on),
- (c) the operator skills required, and
- (d) the cost of equipment.

3.2. Measuring device And measuring technique.

- **Rules:**

There are two basic types of rule: steel rule and steel tape. Both start at zero and have millimeter graduations.

Item	Name	Use	Advantages	Disadvantages
	steel rule	for measuring up to 300 mm in length	rigid form which means it will not bend and flex	ends can get worn, so the measurements are not accurate
	measuring tape	for making longer measurements up to 5 m	longer, so more versatile	can become twisted and break ends can break off, making them useless

✓ Steel rule

These are made up of stainless steel and are available in many sizes ranging from 1/2 ft. to 2 ft. These are marked in inches or millimeters. All the faces are machined true. The edges of steel rule should be protected from rough handling.



Figure 3. 2 Steel rule

• Micrometers:

A micrometer is a specialized instrument used to take very accurate measurements. The thimble, which rotates as the micrometer is tightened, has 50 equal divisions around its diameter, giving an accuracy of 0.01mm. A reading is taken by adding all the visible whole numbers to the nearest 0.5 mm. The reading from the thimble, which will be between 0 and 0.49 mm, is added to the main reading to get the exact measurement. Although the micrometer provides a very accurate measurement, it can be difficult to learn how to read it. A micrometer is a very useful instrument. It enables you to take measurements to within one hundredth of a millimeter (0.01mm). The metric micrometer is able to measure ranges of 25 mm (that is, for 0-25 mm, 25-50 mm, and so on). A common type is shown in Figure. The micrometer has a thread with pitch 0.5 mm.

This means that the spindle advances by 0.5 mm for each turn. However, there are 50 graduations on the thimble. So the movement advanced for each graduation of the thimble is $0.5/50 = 0.01$ mm. Micrometers are one of the precision measuring tools, used to measure to one-hundredth of a mm (0.01mm). On micrometers, the pitch of a screw thread is used to determine lengths or diameters. Each complete turn of the measuring screw changes the distance between the measuring surfaces by the pitch of its thread (e.g. 0.5mm).

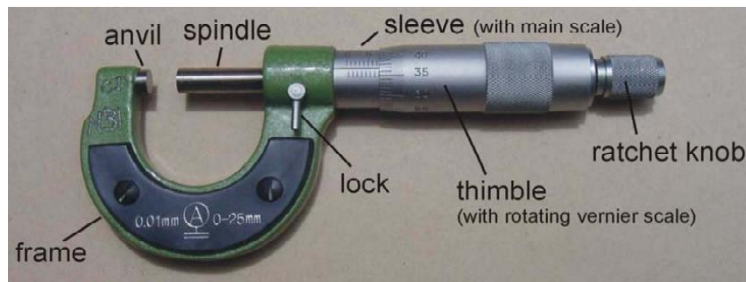


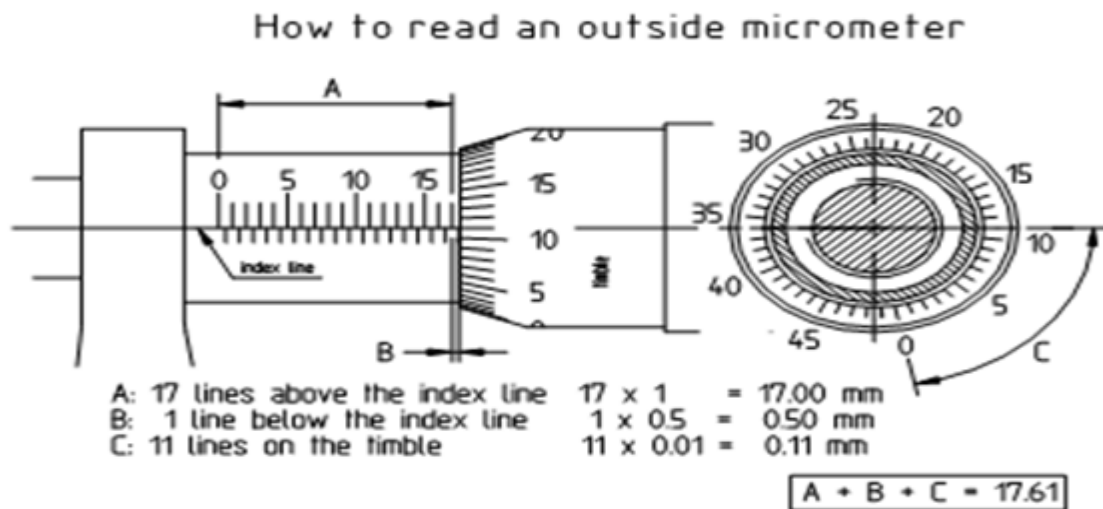
Figure 3. 3 outside micrometer

Types of Micrometers:

✓ Outside Micrometer:

An outside micrometer is used for measuring outside diameter of cylindrical objects, parallel surfaces or other outside dimension. The work to be measured is placed between the anvil and the tip of the spindle.

Reading the micrometer:



5 tside micrometer reading

For example

1. Upper main scale (sleeve) 12.00 mm
2. Lower main scale (no half mm) 0.00 mm
3. Circular thimble scale 0.13 mm
4. $13 \times 0.01 \text{ mm} = 0.13 \text{ mm}$
5. Total reading 12.13 mm

✓ Inside Micrometer:

The structure of this micrometer is as similar as that of an outside micrometer. It is used for measuring internal dimensions.



Figure 6.5 Inside Micrometer

Depth Micrometer:

Depth micrometers are used for measuring the depth of holes, slots, grooves, Keyway and shoulders etc. Note that the scales are graduated in reverse as compared with external or internal micrometers.

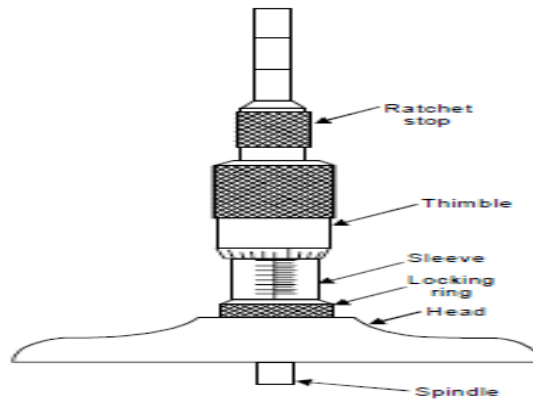


Figure 7.6 Depth micrometer

How to read a depth micrometer

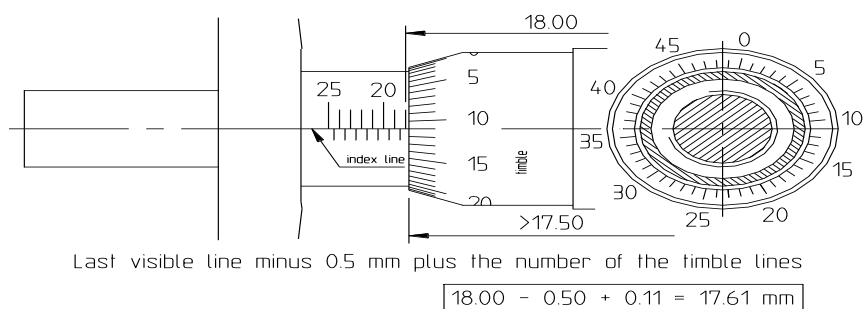


Figure 8.7 Depth micrometer reading

Vernir caliper

These are used for measuring outside as well as inside dimensions accurately. It may also be used as a depth gauge. It has two jaws. One jaw is formed at one end of its main scale and the other jaw is made part of a Vernier scale.

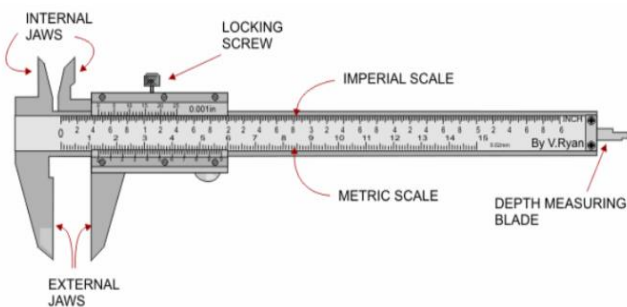


Figure 108 Vernier caliper



Figure 99 Digital caliper capable of recording inside

Outside, diagonal, hole edge and hole dimensional measurements Reading a 1/50th Vernier Caliper

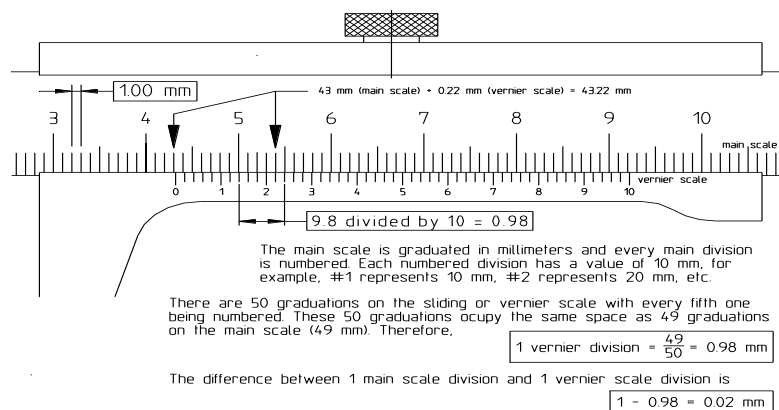


Figure 1110 Vernier caliper reading

• Calipers:

They are indirect measuring tools used to measure or transfer linear dimensions. These are used with the help of a steel Rule to check inside and outside measurements. These are made of Case hardened mild steel or hardened and tempered low carbon steel. While using, but the legs of the calipers are set against the surface of the work, whether inside or outside and the distance between the legs is measured with the help of a scale and the same can be transferred to another desired place. These are specified by the length of the leg. In the case of outside caliper, the legs are bent inwards. Calipers are used for transferring measurements.

The three common types are:

- ✓ Outside
- ✓ inside and

✓ odd-leg Hermaphrodite

You can use inside calipers as outside calipers by merely turning the legs about the hinge. and in the case of inside caliper, the legs bent outwards.

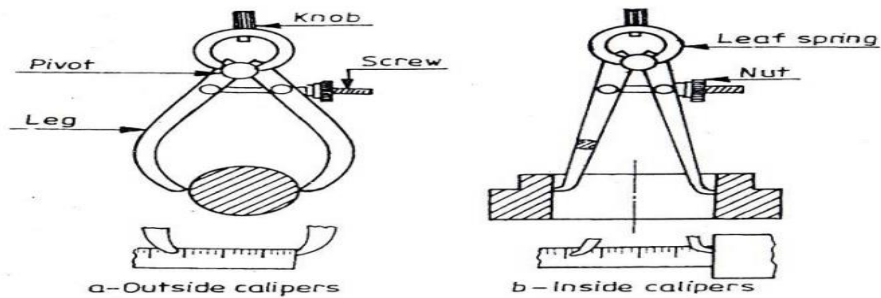


Figure 1211 Outside caliper and inside caliper.



Figure 13 A-firm joint outside caliper. B-Bow spring outside caliper. C-Firm joint inside caliper. D- Bow spring in side caliper. E-Hermaphrodite caliper

- **Protractor:**

Engineer's Protractor

An engineer's protractor, as shown in Fig. is a general purpose tool used for the measuring / checking angles, e.g. the angle of drill head, angle of cutting tool, and even for the marking out of angles on a component part.



Figure 1412 Engineer's Protractor and Vernier Protractor

- **Vernier Protractor:**

This is a precision measuring tool that the accuracy of measurement can reach ± 5 minutes of an angle through the vernier scale as shown in

- **Dial Indicator:**

A dial indicator (dial gauge) can measure dimensions up to an accuracy of 0.01mm or even less. The principle of it is that the linear mechanical movement of the stylus is magnified and transferred to the rotation of pointer as shown in Fig. 12. It is usually used as a comparator for calibration or alignment of machine.



Figure 1513 Dial Indicator.

3.3. finest graduation of instrument

The term graduation refers to the marking present on a measurement instrument that signifies a particular space or distance. The graduation indicates the measurement.

There are two different kinds of graduation,

- linear graduation and
- curved graduation.

Whenever the instrument is straight in shape, such as a ruler, then there will be linear graduation. These can be linear in nature, such as the common inches or millimeters on a ruler or tape measure, or they can be non-linear in nature. The non-linear graduations are typically either logarithmic scales, which are based on orders of magnitude, or transcendental scales, which are based on algebra independent from the variable. Volumetric graduations also fall within the title of linear graduations, and are used to measure a particular volume of liquid at a particular temperature. Curved graduations are typically seen on a circular limb or offshoot of a measurement instrument. There are both non-circular and circular graduations. The circular graduations tend to divide up angular space, as is done by degrees and seconds.

Graduations can be made using a couple of different methods and are usually classified based on their style. The marks signifying different graduations can be put on an instrument through etching or

engraving, as well as through printing or painting. Etching and engraving is preferable because these marks will last longer and ensure more accurate measurements in the long term. Sometimes both an engraving and paint or ink are combined to better mark the surface. Additionally, some higher-grade measurement tools are even built with a double layer of plastic or glass to protect the graduation marks. Graduation styles are demarcated using a number and the letter R. For example, a graduation of 3R shows 1/10th, 1/32nd, 1/50th, and 1/64th increments; 4R shows 1/8th, 1/16th, 1/32nd, and 1/64th increments; 5R shows 1/10th, 1/32nd, 1/64th, and 1/100th increments; and 16R shows 1/32nd, 1/50th, 1/64th, and 1/100th increments.

Graduated measurement instruments are vital to both precision and accuracy. The degree of sensitivity of a graduated instrument increases as the distance between graduations decreases. The overall accuracy of a measurement using a graduated instrument is impacted by a few important factors. The original graduation measurements must have been accurate themselves, the degree of resolution on the marks needs to be high, and the mark lines must not be too thick or poorly defined in order to ensure higher accuracy. Basically, the graduation marks themselves hold a great deal of power when it comes to the final measurement taken from the tool they are on. There is also potential for observational or user error when reading off the graduation marks. However, the best practice is to start with the best made graduation marks possible.

The graduation of an instrument, while simple in concept and design, is incredibly important in the final accuracy of a measurement. Understanding how they are made and work, as well as knowing how to judge their quality will help any metrologist when choosing an instrument that includes graduation marks. In the end, the better the graduation on your precision measurement tool, the greater the accuracy of your measurements.

Refer:https://www.govst.edu/uploadedFiles/Academics/Colleges_and_Programs/CAS/Trigonometry_Short_Course_Tutorial_Lauren_Johnson.pdf

Self-Check -3	Multiple Choice
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Directions I: matching

A	B
___1. Accuracy	The adjustment or setting of an instrument to give readings that are accurate within a reference standard.
___2. Amplification	The degree of agreement of the measured dimension with its true magnitude.
___3. Calibration	The ratio of instrument output to the input dimension; also called <i>magnification</i> .

Directions II: Choose the best answer for the following questions. (2 point each)

4. Which one of the following information is required when we want to prepare any product?
 - a. Actual shape b. manufacturing method c. accurate size d. All
5. Which one of the following is ferrous metal?
 - a. Zinc b. Wrought iron c. Lead d. Bronze
6. What is the basic source of iron?
 - a. Pig iron b. Steel c. Iron ore d. Furnace

Directions III: filling the blank (2 point each):

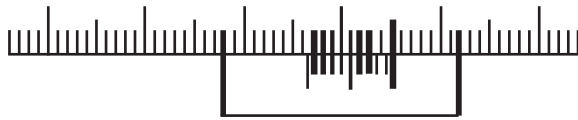
7. _____ is made up of stainless steel and are available in many sizes ranging from 1/2 ft. to 2 ft.
8. _____ used for measuring outside as well as inside dimensions accurately. It may also be used as a depth gauge .

Directions IV: give brief explanation

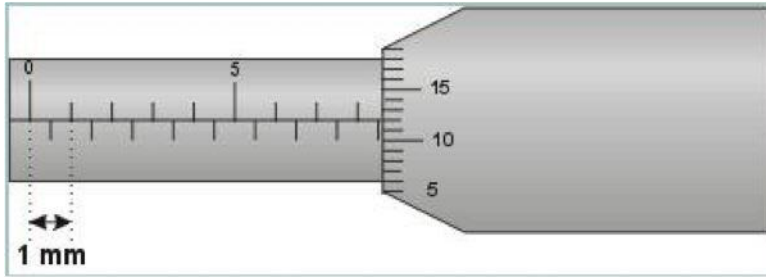
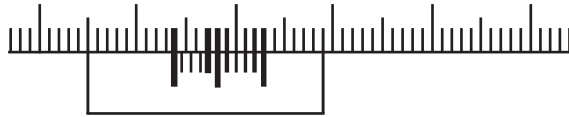
9. Write types micrometer
10. what is the meaning of graduated instrument

Directions VI: read the following instrument

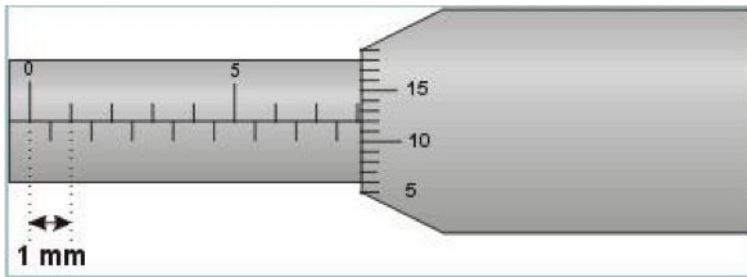
1. 1 2 3 4 5 6 _____mm



2. 1 2 3 4 5 6 _____ mm



_____ mm



_____ mm

Operation sheet 3.1 Use a range of graduated devices to measure/determine dimensions or variables

- **Operation title:** Measuring device And measuring technique
- **Purpose:** To Lay out and mark dimensions/features

Instruction: Using the figure below and given equipments lay out the length of each line. You have given 30Minut for the task

NOTE:

The accuracy of your readings should be in a range of 0.5 mm.

Fig.1.1: V-Block

Table of measurements:

Dimension	A	B	C	D	E	F
Dimension in (mm)						

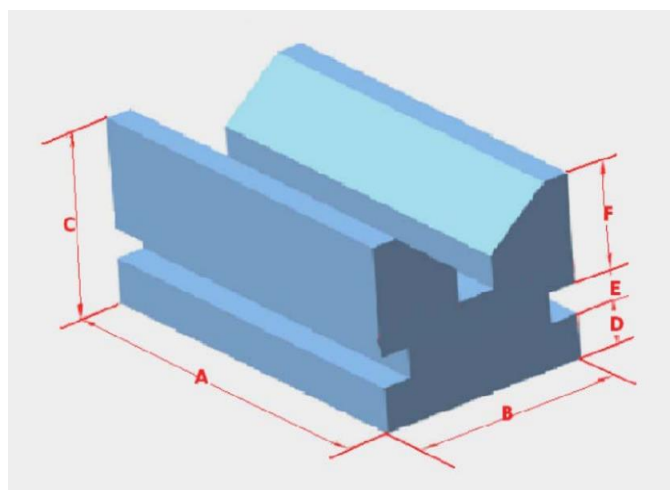


Figure 16 dimensions A to F to be measured on a V-Block.

- **Tools and requirement:**

1. V block
2. Steel rule
3. Vernier caliper

- **Steps in doing the task**

Steps 1- Measuring work pieces using different measuring instruments;

Steps 1- Use bench work tools and equipment.

Step 2- Use measuring instruments.

Step 3- Prepare work piece to be measured.

Step 4- Select the appropriate measuring instruments.

Step 5- Measure the work piece.

Step 6- Record the results

Quality Criteria: the given geometrical shape is measured with 0.5mm accuracy

Precautions: use the given steel rule or vernier caliper.

LAP Test	Practical Demonstration
-----------------	--------------------------------

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **30-60** min.

Task-1: Perform liner measurement using rule and virner caliper



Unit four : Perform hand tool operations

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- work holding devices.
- hand tools
- Cut, Chip, file or scrap work pieces.
- Cutting threads
 - Internal threads
 - External threads
- bench work operations

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Clamp work pieces in work holding devices.
- Select and use hand tools according to task and safety regulations.
- Cut, Chip, filed or scrape work pieces within tolerances.
- Cut threads
 - Internal threads
 - External thread
- Perform bench work operations

Unit four : Perform hand tool operations

4.1 work holding devices.

Concepts of clamping or work holding

Once work piece is located, it is necessary to press it against locating surfaces and hold it there against the force acting upon it. The tool designer refers to this action as clamping and the mechanisms used for this action are known as clamps. It is necessary that the work should be properly and securely held on for machining operations, a VISE is an effective work holding device.

Vises: Vises are the most common appliances for holding work on table due to its quick loading and unloading arrangement.

1.1. Types of work holding devices

- **Bench vice**

A **bench vice** is like an extra hand and is a common tool found in any shop or garage. It is attached to a **workbench** and its purpose is to hold material steady, allowing you to use both hands to work on the material with other tools. They are ideal for sawing, sanding, planing, drilling, screwing, soldering and more.

Bench Vises with Swivel Base

There are mainly three types of vises commonly used:

- Plain vise
 - Swivel vise
 - Tool makers universal vise
2. Removable hardened alloy steel jaw inserts.
 3. Completely enclosed center screw.
 4. Attractive hammered enamel finish

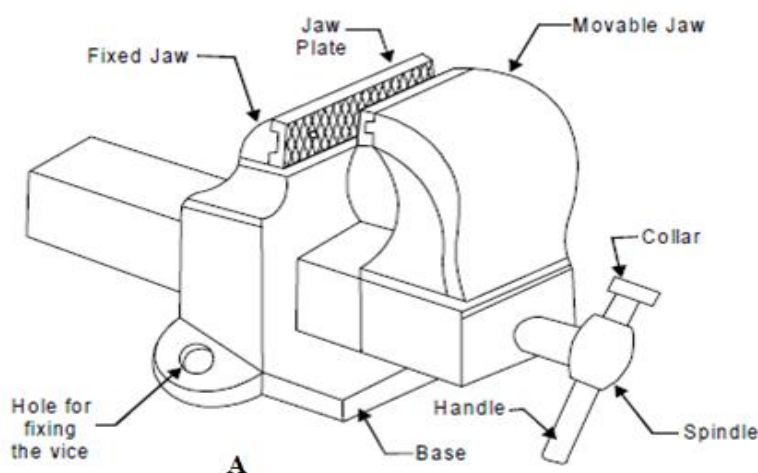


Figure 4.1 A Bench Vice and Machine vice

V-block

V-block is rectangular or square block with a V-groove on one or both sides opposite to each other. The angle of the 'V' is usually 90° . V-block with a clamp is used to hold cylindrical work securely, during layout of measurement, for measuring operations or for drilling for this the bar is faced longitudinally in the V-Groove and the screw of V-clamp is tightened. This grip the rod is firm with its axis parallel to the axis of the v-groove

- **C-Clamp**

This is used to hold work against an angle plate or v-block or any other surface, when gripping is required. Its fixed jaw is shaped like English alphabet 'C' and the movable jaw is round in shape and directly fitted to the threaded screw at the end .The working principle of this clamp is the same as that of the bench vice.

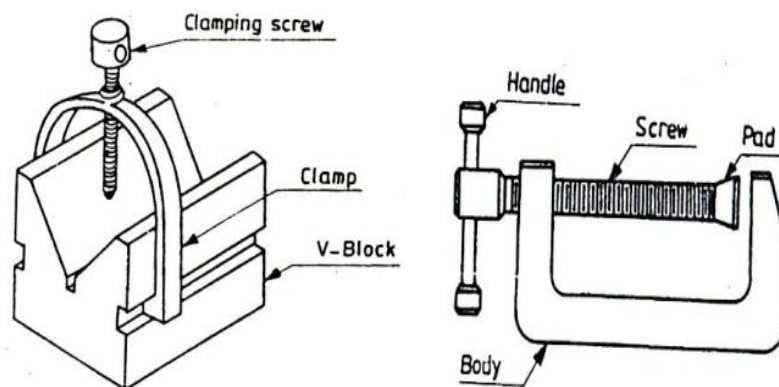


Figure 4.2 V-Block and C- Clamp

Pliers

There is a vast range of pliers used in the vehicle body building industry, with the most common being combination pliers, slip joint pliers, side cutters, circlip pliers, long-nosed pliers and multi grips. The correct pliers to use depend on the type of vehicles being built. For example, long-nosed pliers are used to hold and grip small work in awkward places so these may be used extensively with hydraulic or electrical work. However, they may not be much use when building a semitrailer. Name these pliers:

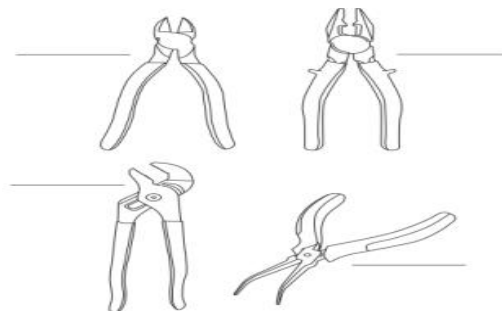


Figure 4.3 Pliers

- **Parallel Clamps**

Jaws are made of hardened and tempered steel. Clamps are equipped with spring clips



Figure 4.4 Parallel Clamps

4.2 hand tools

Tools

Tools can be divided into two main groups: hand tools and power tools. Hand tools are operated by the physical strength of the user. Power tools require an external source of power such as electricity or compressed air to operate. Each of these groups can also be divided into sub groups.

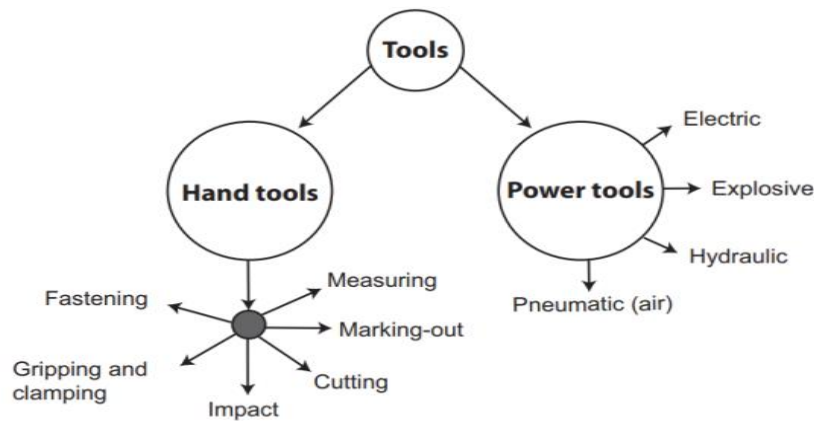


Figure 4.5 Division of tools

4.3 Hand tools

Hand tools have been devised to enable trades people to carry out a job more efficiently, quickly and safely than would otherwise be possible. Some tools are quite simple, such as a screwdriver, which is almost indispensable for undoing a countersunk screw located in a recess. Others are more complicated, such as a micrometer; these are indispensable when measuring fine tolerances.

4.3.1 Hand tools can be classified into several groups:

- fastening tools
- gripping and clamping tools
- impact tools
- cutting tools
- marking-out tools

- Measuring tools.

Fastening tools

4.3.1.1 Spanners

There are several types of spanners, each suitable for a specific job. The most commonly used spanners in a vehicle body building workshop are:

- ✓ open-ended spanners
- ✓ ring spanners
- ✓ combination spanners
- ✓ sockets and their accessories
- ✓ hook spanners
- ✓ pin spanners
- ✓ adjustable spanners

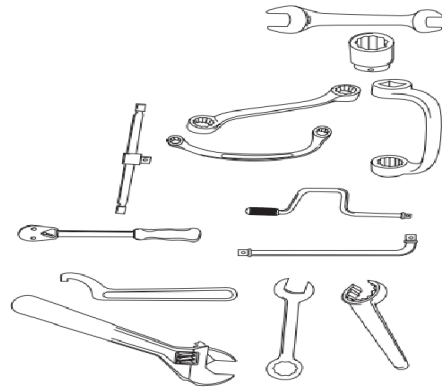


Figure 4.6 spanners

spanners

- ✓ Flare nut spanners.

4.3.1.2 Wrenches

Wrenches are tools used for holding and turning. A variety of wrenches are used in the vehicle body building industry. Adjustable pipe wrenches are sometime called still son wrenches. Typically, they are used on cylindrical objects such as pipes and rails where there are no flats on which to use a spanner. Another type of wrench is the hexagon wrench, which would typically be used for undoing hexagonal recessed drain plugs. Smaller hexagon wrenches are called Allen keys. Torque wrenches are used to tighten nuts or bolts to a specific tension and are sometimes called tension wrenches. They are used to correctly tension down the bolts holding engineering components such as power take-off units or bolts on kingpins. Never use a torque wrench to undo nuts or bolts, as this may damage or alter the accuracy of the wrench.



Figure 4.7 Torque wrench

2.3.1.1. Screwdrivers

Screwdrivers are accurate precision tools and are not designed to be used as punches or cold chisels. The most common types of screwdrivers are the standard (straight blade or flat) type and the Phillips screwdriver, and they are available in many different sizes

and lengths. There are also special screwdrivers designed for hard-to-get screws, for example right-angle screwdrivers.

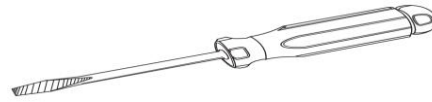


Figure 4.8 Flat screw driver

2.3.1.2. Keys

Keys used in the trade include drill chuck keys, lathe chuck keys and hexagon keys. Hexagon keys are also called Allen keys and include ball driver keys which can be used at an angle, unlike straight hexagon keys, which must be inserted squarely into the hexagonal recess.

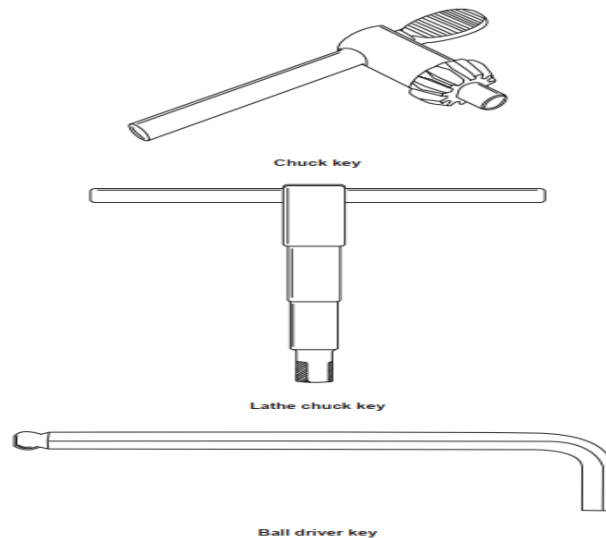


Figure 4.9 (a) Chuck key, (b) Lathe Chuck key, (c) Ball driver key

2.3.1.5 Hand snips

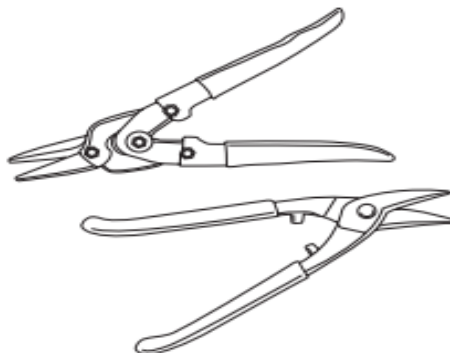


Figure 4.10 Hand snips

2.3.1.6. Taps and wrenches

Taps are used to cut internal threads in holes which are usually drilled for the purpose of attaching an item with bolts or metal threads. Taps come in all sizes and threads to match the wide variety of bolts and metal threads available in the trade.

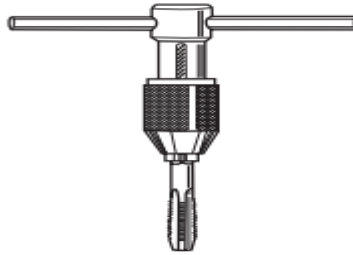


Figure 17 tap and tap wrenches

2.3.1.7. Stock and dies

Dies are used to cut external threads on rods, studs, shafts or bolts. They can also be used to clean up or repair damaged external threads.

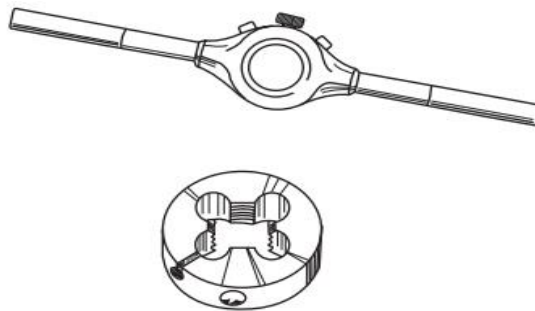


Figure 18 Die and die- stock

4.3 Cut, Chip, file or scrap work pieces

1.1. Concepts of Cutting metals

Sawing is the process of cutting metal stock that is impractical to use a file, a chisel or a machine with a multi-point cutting tool called a hand hack saw. A hand hack saw can also be used for cutting off a jammed bolt, pipes, tubing and rods for special or custom fittings on the job (on the field work).

Some of the most common tools used to cut metals are **hacksaws, band saws, cold chisels, bolt cutters, tin snips, and abrasive saws**. Large stock is sawed, while bar stock is either sawed or cut with a cold chisel. Sheet metal is usually cut with metal snips. In fabrication facilities, large amounts of metal are cut with horizontal band saws or metal shears, commonly called “ironworkers. Layout tools are used to measure and mark metal stock before cutting, shaping, and doing other types of work with cold metal.

1.1.1. Saws

Saws are used to cut material that is not needed away from material which is. Saw blades have alternate teeth bent out or 'set' in opposite directions. This is so that when they cut, they make a gap, called the kerfs. The kerfs must be wider than the saw blade so that the blade cannot get stuck. When using a saw, you should always cut to the waste side of the marked line so that you leave a small amount for finishing by either sanding or filing. Whatever you are cutting, it is important to keep as many teeth in contact with the piece being cut as possible. You should choose the correct saw for the type of material you are using. Table 2.3 on the next page shows the most common types of saws used in school workshops.

- **Cutting process**

The saw is moved from the right to left and shows how the chip is formed. The cutting process is the result of the horizontal cutting direction and the pressure on the work piece. The angle of the teeth enables the saw to cut the material effectively. The teeth are set (bent out) that they do not get jammed in the cut.

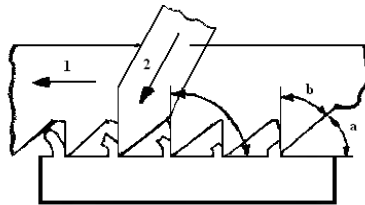


Figure 19 Teeth setting

a = clearance

b = cutting angle

Forces on a saw blade:

1 = indicates the cutting direction

2 = indicates the pressure on the work piece

- **Steps to Follow in Making the Cut with a Hacksaw**

Place the metal to be cut in a vise and mark it. The mark should be placed near the jaws, especially if the metal is thin. It may be necessary to use boards between the vise jaws to prevent scarring the work. Mark over the original mark with a file.

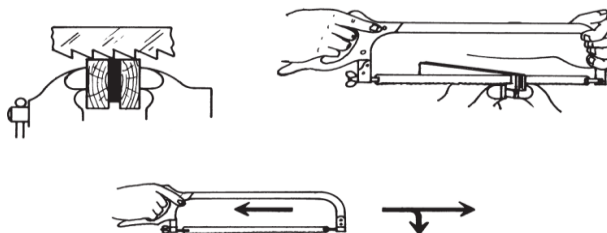


Figure 20 Using a hack saw

Depending upon the direction of cut, blades are classified as:

- ✓ Forward cut
- ✓ Backward cut.

Depending upon the pitch of the teeth (Distance between the two consecutive teeth) blades are classified as:

- ✓ Coarse (8-14 teeth per Inch)
- ✓ Medium (16-20 teeth per inch)
- ✓ Fine (24-32 teeth per inch)

• **Parts of a hacksaw**

1. Saw frame
2. Handle protector
3. Handle
4. Tang
5. Blade holder
6. Blade
7. Pins
8. Wing-Nut
9. Pins

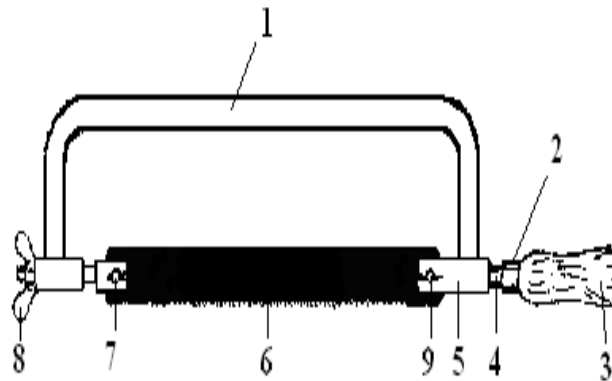


Figure 21 Parts of hack saw

• **Types of blades for hacksaws**



One side toothed



Both sides toothed

Fig. 22. Types of hack saw blades.

How to handle a hacksaw?

1 and 3 Indicate the forward stroke with pressure

2 and 4 The backward stroke without pressure the circle shows the direction of teeth (facing the front of the hacksaw) all strokes should be in a straight line and along the whole length of the blade.

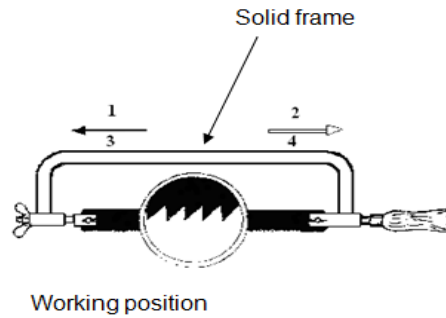


Figure 23 Non- adjustable frame (fixed frame)

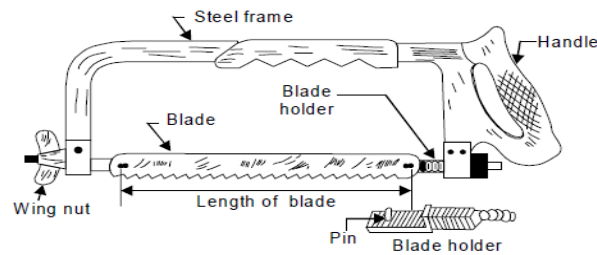
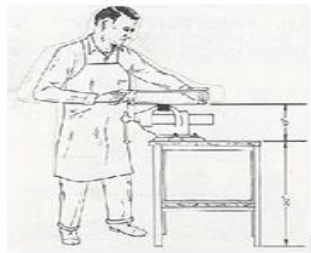


Figure 24 Adjustable frame

The work piece must be clamped to allow free movement when sawing. Left-handed people clamp their work to the right of the vice and right-hander people to the left.



Working Position

Body position when sawing.

Figure 25 Working position.

Table 4.1 Saw teeth for different materials

No of teeth /inch	Functions
14	For solid sections of soft materials
18	Suitable for general use. Solid sections of soft materials and large sections of hard materials (e.g. alloy steel)
24	Small solid sections, between 3 and 6 mm(e.g. heavy tubing and sheets)
32	For sections less than 3 mm thick

Note: At least three consecutive teeth should be in contact with the material. If the material is soft and has a large section, use a blade with few teeth per 25 mm (14 or 18 teeth per 25 mm) Use a fine-tooth blade when cutting a fairly thin section.

Hacksaw blades are made of high-speed steel.

There are two types: all-hard and flexible. The difference between the two is that the all-hard snaps easily, and it is therefore not recommended for school work. The blades come in the following lengths: 200, 250 and 300 mm. They are also available with 14, 18, 24 and 32 teeth per 25 mm for cutting different materials

3.2. Chipping

Removing the metal with a chisel is called chipping and is normally used where machining is not possible. While chipping, safety goggles must be put on to protect eyes from the flying chips. To ensure safety of others, a chip guard is placed in position. Care should be taken to see that the chisel is free from mushroom head.

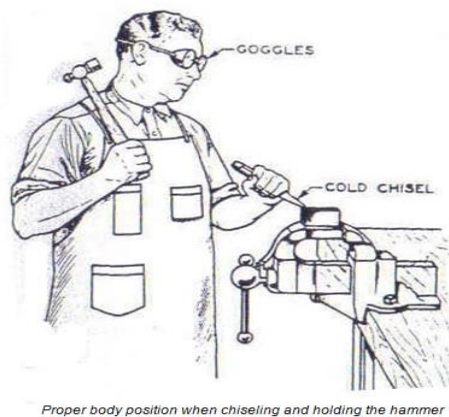


Figure 26 Proper body position when chipping

- **Chisels**

- ✓ **Types of chisls:**

These are sometimes referred to as cold chisels because they are used to cut cold metals. They are made of cast steel or alloy steel, with a hardened and tempered cutting edge.

The common types of chisel (Figure 3.8) include:

1. **The flat chisel:** used for general-purpose chiseling;
2. **The cross-cut chisel:** used for cutting grooves such as keyways, and for chipping;
3. **The half-round-nosed chisel:** used for cutting grooves (which are either curved or half-round);
4. **The diamond-pointed chisel:** used for working into corners and cutting small grooves.

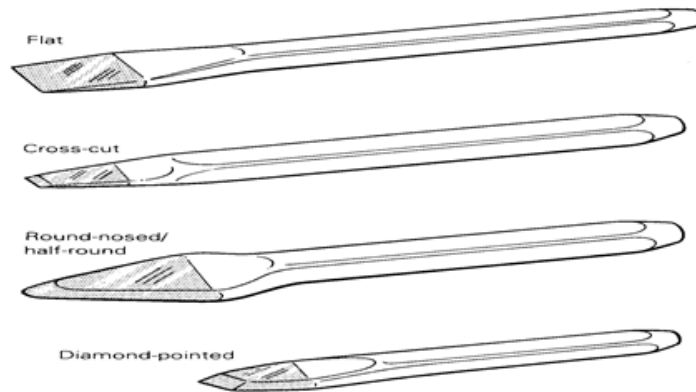


Figure 27 28 Common types of chisel

3.3. Filing

Filing is a method of removing metal, and the file (Figure 3.9), which is the most widely used hand tool in the school workshop, is used for this cutting operation. It is made of carbon tool steel containing about 1.3 per cent carbon.

- The Main Parts

A file is a hand cutting tool made of high-carbon steel, having a series of teeth cut on the body by parallel chisel cuts. The parts of a file are shown in figure. 3.9. Files are used to remove surplus metal and to produce finished surfaces.

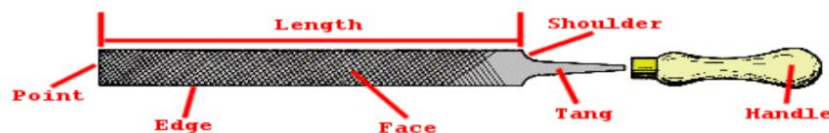


Figure 29 Flat file and its parts

- Methods of filing:

There are several methods of filing, each with a specific purpose. With reference to the figure, the following may be noted:

1. **Holding the file:** For heavy work and to remove more metal, a high pressure is used. For light and fine work, a light pressure is applied.
2. **Filing internal curves:** A part of half round file only makes contact as shown during filing operation. Movement of the file is indicated by arrows.
3. **Cross filing:** It is the most common method of filing. Cross filing is carried out across two diagonals, to produce medium surface finish. It is used when large an amount of metal is to be removed. By cross filing 'rounding' the surface is reduced.

4. **Straight filing:** When a short length of work piece is required to have a flat surface, straight filing is used. File marks made during cross filing may be removed, to produce a relatively smooth surface.
5. **Draw filing:** It is done to get a finely finished surface. It produces a smoother surface finish than straight filing. A smooth or dead smooth flat file is used for this.

Use the single cut on softer materials (such as brass and aluminum) and the double cut for general filing, especially on iron and steel.

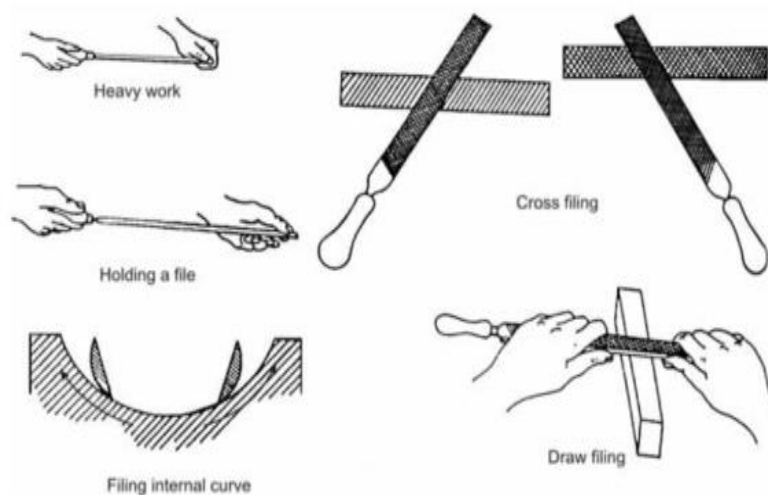


Figure 30 Methods of filing

Table 4.2 grade of file cut

The coarseness of file cuts is described by the terms listed in Table 4.1.

Table 4.1 Grades of file cut

Cut	Typical use
Rough	Filing soft metals, plastics
Bastard	Shaping steel and fettling iron castings
Second cut	Generally used for harder metals and for good finish
Smooth cut	Draw filing and finishing hard metals
Dead smooth	Accurate filing with a high finish

- Types of file based on their shapes:



Figure 31 types of file

3.4. Scraping

Scraping is the process of removing high spots on the surface of a piece of work. It is a difficult operation, and is not often performed in the school workshop.

- Types of scrappers:

These sharp edged tools are used to remove uneven spots on the surfaces. They are of different shapes.

3.4.1. Flat scraper

It is used for removing metal from flat surfaces. The blade must have a slight curvature at the cutting edge. The corners are rounded to help the user, scrape at the exact spots.

3.4.2. Half round bearing scraper

This is used for scraping curved and cylindrical surface split bearings, big bush bearings etc.

3.4.2. Triangular scraper

This is used for scraping curved surfaces, holes and bores. Specification is by length. Example: 200 mm, 300 mm etc.

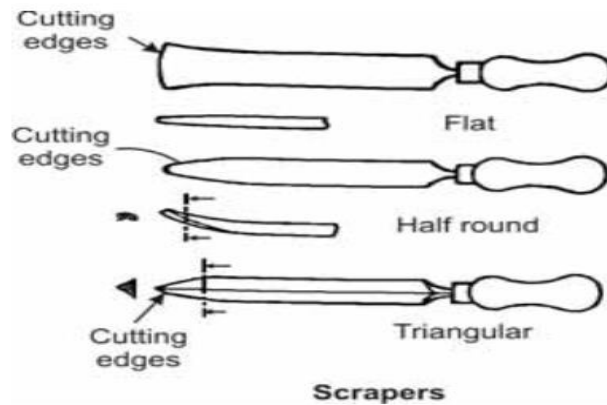


Figure 32 Common types of scraper

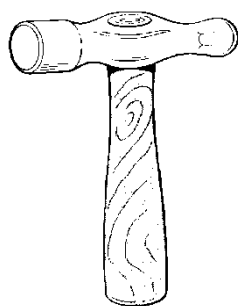


Figure 4.14 Ball pein hammer.

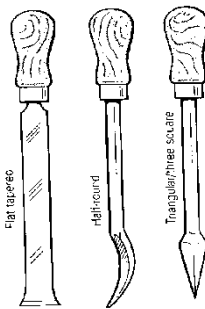


Figure 4.15 Scrapers.

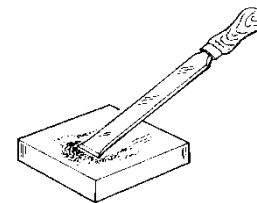


Figure 4.16 Scraping with a flat scraper.

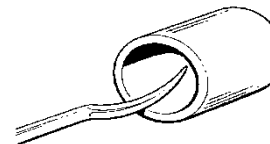


Figure 4.17 Using the half round scraper.

Figure 33 Using half round scraper

4.4 Cutting threads

Introduction

Threads may be cut internally using a tap externally using a die. The proper selection and use of these threading tools is an important phase of machine shop work.

- **Dies**

Dies are made either of high-carbon steel or of high-speed steel. Unlike taps, dies are used for cutting external (male) threads. There are three types (Figure blow). The circular split die is a circular piece with a split across one of the flutes. The split is provided to enable small adjustments to be made, using three set screws in the stock. The half die comprises two loose pieces, which are held in the stock. There is a small screw on the stock for adjustment. The die nut has a hexagonal body. This type, strictly speaking, does not cut new threads but is used to 'clean up' threads that are damaged.

- **Taps and dies**

Screwing is a temporary method of fastening parts together. Methods for cutting screw threads include the use of the centre lathe. For bench work, however, taps and dies are used.

✓ Taps

These are the tools used for cutting internal (female) threads. They are made of high-carbon steel or high-speed steel. The tap has a shank with a square end to take the tap wrench or holder. The shank is smaller than the threaded portion. The tap has four rows of threads, cutting edges or teeth, which suit a particular thread form. They perform the cutting action. The grooves between the cutting edges are called flutes. They allow waste material (chippings) to escape. They also allow cutting oil into the work.

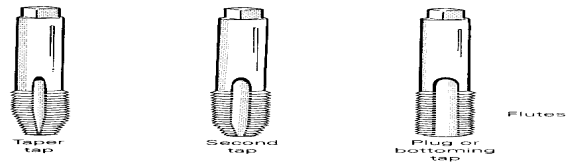


Figure 4.18 Taps for cutting internal threads.



Figure 4.19 Tap wrench.

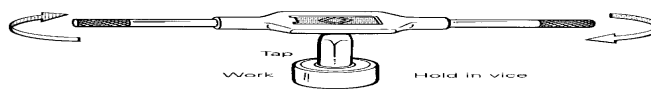


Figure 4.20 Using taps.

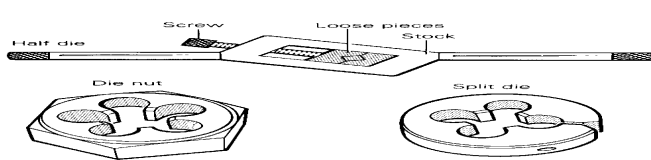


Figure 4.21 Dies for cutting external threads.

Figure 34 Taps and dies

The procedure for cutting external threads is as follows:

1. Square the end of the work and chamfer it (using a file, grinding machine or centre lathe) for an easy start.
2. Grip the die, held in the stock, firmly and squarely on the work.
3. Turn clockwise, about a quarter-turn, and ease back to remove chippings.
4. Apply a good supply of oil (lubricant).
5. Make adjustments of the screws after making a full cut until the depth required is achieved.

Care and maintenance is important:

1. Do not use either the stock or the die as a hammer; the threads may be broken.
2. Remove the die from the stock after every thread cutting, clean them and pack them into their boxes.
3. Use plenty of oil during cutting to reduce friction.

Tap Drill Size

Before a tap is used, the hole must be drilled to the correct tap drill size. This is the drill size that would leave the proper amount of material in the hole for a tap to cut a thread. When a chart is not available,

the tap drill size for the ISO (International Standards Organization) thread can be found easily by applying this simple formula:

$$\boxed{TDS = M - P}$$

TDS = tap drill size
M = metric diameter of the tap
P = pitch of the thread in millimeters

Hand Tap

A tap is a cutting tool used to cut internal threads. Normally it's made of high-speed steel (HSS). Hand taps are usually made in sets of three, because it is better to distribute all the cutting work during the thread-process to three taps.

No. 1 (taper) tap: 1 ring on shank

No. 2 (plug) tap: 2 rings on shank

No. 3 (bottoming) tap: without ring

The most common taps have two or three flutes in order to form the cutting edges, transport the chips out of the hole and give way for the lubricant. The end of the tap is square so that a tap wrench can be used to turn it into a hole.

Tapping a Hole

Before a tap is used, a hole must be **drilled** in the work piece to the correct tap drill size. The tap drill size (T.D.S.) is the size of the drill that should be used to leave the proper amount of material in the hole for a tap to cut threads. Then **countersink** both sides of the hole.

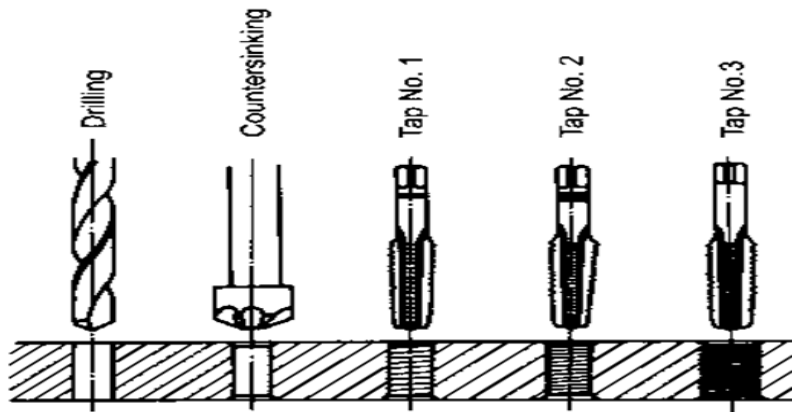


Figure 35 Drill, Countersink and tapping a hole

Working Steps for Hand Tapping

1. Select the correct size and type of tap for the job (blind hole or through hole).
2. Select the correct tap wrench for the size being used.
3. Use a suitable cutting fluid (No cutting fluid for brass or cast iron).
4. Place the tap in the hole as near to **vertical** as possible.

5. Apply equal down pressure on both handles, and turn the tap clockwise (for right-hand thread) for about two turns.
6. Remove the tap wrench and check the tap for squareness. Check at two positions 90 degree to each other.
7. If the tap has not entered squarely, remove it from the hole and restart it by applying slight pressure in the direction from which the tap leans. Be careful not to exert too much pressure in the straightening process, otherwise the tap may be broken.
8. Turn the tap clockwise one-half turn and then turn it backward about one-quarter of a turn to break the chip. This must be done with a steady motion to avoid breaking the tap.

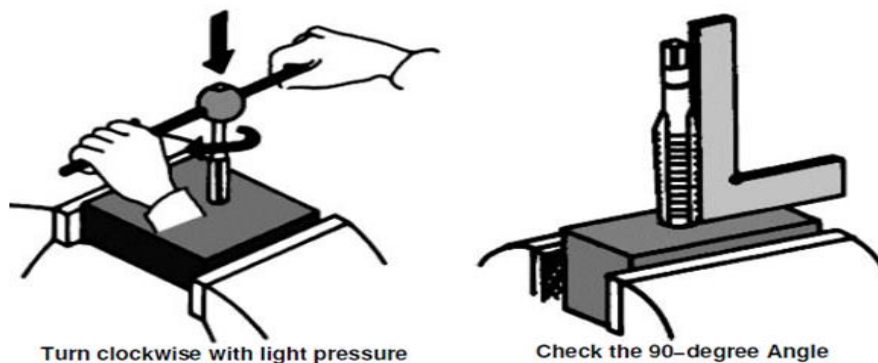


Figure 36 Tapping operation

Table 4.3 .Drill size

Metric	Pitch mm	Drill Ø mm	UNC	TPI	Drill Ø mm	UNF	TPI	Drill Ø mm
M 3	0.50	2.5	1/4"	20	5.1	1/4"	28	5.5
M 4	0.70	3.3	5/16"	18	6.6	5/16"	24	6.9
M 5	0.80	4.2	3/8"	16	8.0	3/8"	24	8.5
M 6	1.00	5.0	7/16"	14	9.4	7/16"	20	9.9
M 8	1.25	6.8	1/2"	13	10.8	1/2"	20	11.5
M 10	1.50	8.5	9/16"	12	12.2	9/16"	18	12.9
M 12	1.75	10.2	5/8"	11	13.5	5/8"	18	14.5
M 16	2.00	14.0	3/4"	10	16.5	3/4"	16	17.5
M 20	2.50	17.5	7/8"	9	19.5	7/8"	14	20.4
M 24	3.00	21.0	1"	8	22.25	1"	12	23.25

Threading Dies

A threading die is used to cut external threads on round work pieces. The most common threading dies are the adjustable and solid types. The round adjustable die is split on one side and can be adjusted to cut slightly over or undersized threads. It is mounted in a die stock, which has two handles for turning the dies onto the work. The solid die, cannot be adjusted and generally used for recutting damaged or oversized threads. Solid dies are turned onto the thread with a **special** diestock, or adjustable wrench.

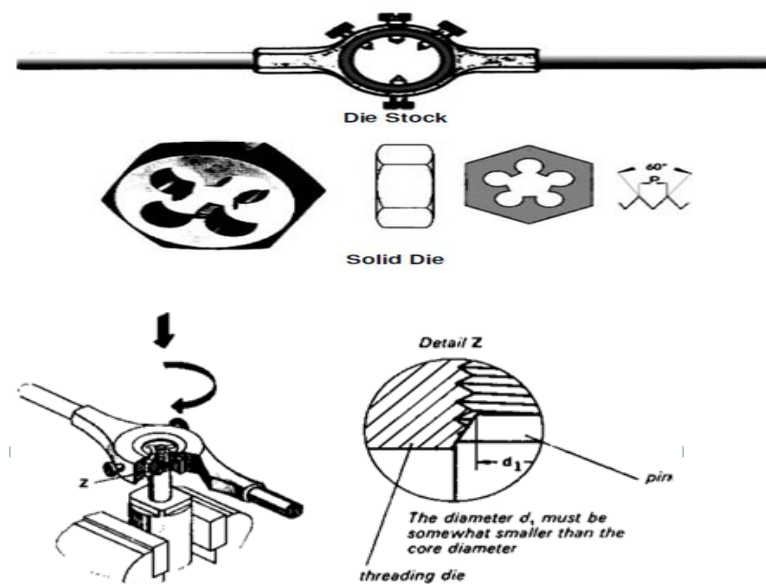


Figure 37 Die and its operation

Thread with a Hand Die Working Steps

The threading process requires the machinist to work carefully to produce usable parts and avoid damage. The following describes the procedure to be used.

1. Chamfer the end of the work piece with a file or on the grinder. Consider that a 3/4" thread requires a bolt with an outside diameter of 3/4".
2. Fasten the work piece securely in a vise. Hold small diameter work short to prevent it from bending.
3. Select the proper die and die stock.
4. Lubricate the tapered end of the die with a suitable cutting lubricant.
5. Place the tapered end of the die squarely on the work piece.
6. Apply down pressure on both die stock handles and turn clockwise several turns.
7. Check the die to see if it has started squarely with the work.
8. If it is not square, remove the die from the work piece and restart it squarely, applying slight pressure while the die is being turned.
9. Turn the die forward one turn, and then reverse it approximately one half of a turn to break the chip.
10. Apply cutting fluid frequently during the threading process.

Metric Threads

These threads are identified by the letter „M“, the nominal diameter, and the pitch. For example, a metric thread with an outside diameter of 5mm and a pitch of 0.8mm would be identified as follows: M5x0.80

Table4.4. Pitch of metric thread

nom. dia.	pitch	nom. dia.	pitch
-----------	-------	-----------	-------

4.5 bench work operations

Bench work operations for the manual mill often occur before and after the machining of the part. These operations are commonly performed on a standard workbench with the part secured in a **vise**, or secured to the worktable depending on the operation. Bench work operations involve processes that allow the work piece to achieve the accuracies specified by the blueprint. These operations require operator skill and attention to detail.

- ✓ Follow safety and correct working procedures to perform bench work operations.

Bench work operations performed prior to machining include the following:

- Layout

- Cutting: in the metal work shop materials (especially metals) are cut to shape before filing. There are numerous types of cutting operations.

✓ Points to watch when using the hack saw:

1. Hold the work securely in the vice.
2. Grip the hack saw firmly, using both hands.
3. Use the same stance as filing.
4. Use the full length of the blade.

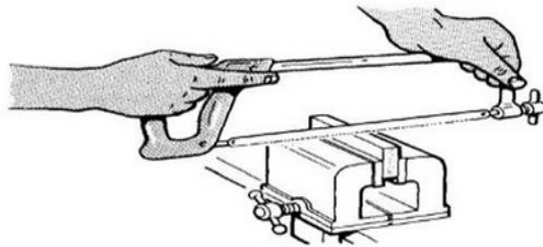


Figure 38 Sawing operation

- Chipping:

✓ chipping metal (chiseling)

Chiseling is one of the methods of cutting materials.

-you can chip the metal to produce grooves or to reduce the width or thickness.

Procedures to chip metal:

1. hold the metal in the vice
2. Hold the chisel at an angle of about 45° to the work.
3. Hammer to remove the chip.
 - Filing: is a method of removing metal.
 - Filing: is a skill that is difficult to learn. It is not easy to explain how to use a file.

Self-Check 4	Written Test
---------------------	--------------

Directions I : Choose the best answer for the following questions. (2 point each)

- Which one of the following is not clamping tools?
 - Vice
 - V- block
 - hacksaw
 - C- clamp
- One of the following is not the parts of bench vice.
 - Jaw face
 - Thimble
 - Fixed jaw
 - Movable jaw
- Which one of the following is not include under hand tools?
 - Wrench
 - Power hacksaw
 - Taps
 - all
- Removing the metal with a chisel is called_____
 - Scrapping
 - Filling
 - Chipping
 - All
- Some of the most common tools used to cut metals are_____
 - hacksaws
 - tin snips
 - cold chisels,
 - all

Directions I I:

- _____is used to cut internal threads in holes which are usually drilled for the purpose of attaching an item with bolts or metal threads.
- _____is hand tools used for holding and turning materials.
- _____a file is used when largamoofmetal is to be removed
- _____is used for clamping work piece
- _____is used for scraping curved and cylindrical surface split bearings, big bush etc.

Direction III short answer

- Write procedures for cutting external threads.

Operation sheet 4.1: Perform hand tool operations

- **Operation title:** bench work operations
- **Purpose:** Cut the work piece to produce a drill gauge according to the dimensions given
- **Instruction:** Use the given figure below (Figure 2.13), the tools and equipment lay out and mark on the work piece. For this operation you have given 2Hour and you are expected to operation.
- **Tools and requirement:**
 1. Steel Rule,
 2. scribe
 3. work piece 80*130
 4. hack saw
- **Precautions:** Measure at least three times before cutting
- **Procedures in doing the task**

Step-1: . Wear the safety clothes required.

Step 2. Measure the stock to the required dimension.

Step- 3. Mount the work piece firmly on the vice.

Step- 4. Choose the correct blade according to the type of material and thickness being cut.

Step- 5. Install the hacksaw blade.

Step- 6. Use the blade check list to ensure proper installation.

Step- 7. Use the hacksaw to cut the work piece. Use the marked sawing lines to guide the cutting process

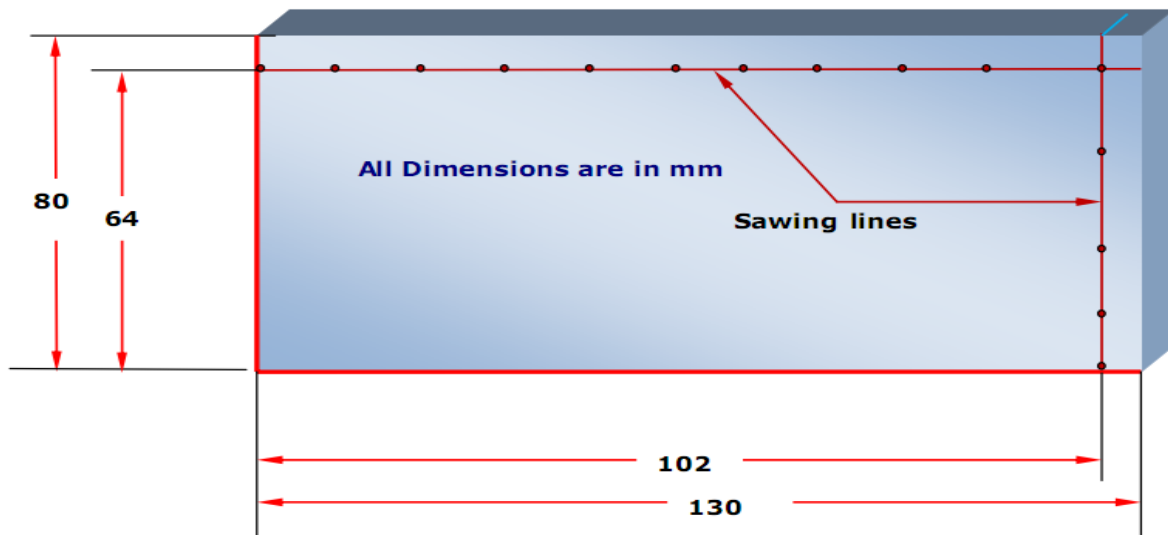


Figure 39 Figure given for operation sheet 4.1

- **Quality Criteria:** the given bench work operation measuring with 0.5 mm accuracy

Operation sheet 4.2: Perform hand tool operations

- **Operation title:** bench work operations
- **Purpose:** Cut the work piece to produce a drill gauge according to the dimensions given
- **Instruction:** Use the given figure below (Figure 2.13), the tools and equipment lay out and mark on the work piece. For this operation you have given 2Hour and you are expected to operation.
- **Tools and requirement:**
 1. Steel Rule,
 2. Scriber
 3. Hammer
 4. Center paunch
 5. Different size of drill bit
 6. Bench drill machine
 7. work piece 60*98
 8. Different size of taps and tap wrench
- **Precautions:** Measure at least three times before punching
- **Procedures in doing the task**

Step-1 Select the correct taps and tap wrench

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Step- 2. Apply suitable cutting fluid to the tap

Step-3. Place tap in hole as vertically as possible

Step-4. Press downward on wrench, applying equal pressure on both handles

Step-5. If tap is not entered squarely, remove from hole and restart it by applying pressure

Step- in direction from which tap leans

Step-6. Turn tap clockwise one-quarter turn, and turn it backward about $\frac{1}{2}$ turn to break the chip (must turn with steady motion)

Step-7. Care must be taken not to tap too deep for a blind hole

Step- 8. When finished, clean hole and check with thread gage or appropriate bolt

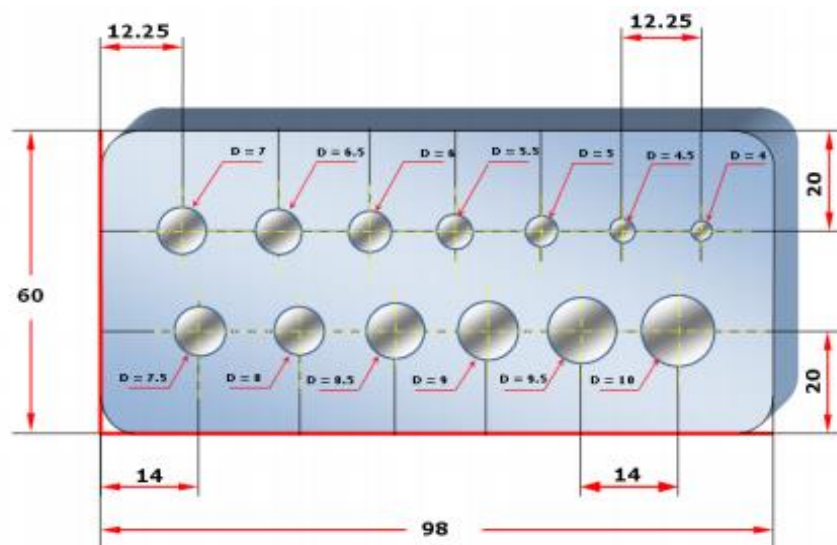


Figure 40 Figure given for operation sheet 4.2

- **Quality Criteria:** the given bench work operation measuring with 0.2 mm accuracy

LAP Test	Practical Demonstration
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Name: _____ Date: _____

Time started: _____ Time finished: _____

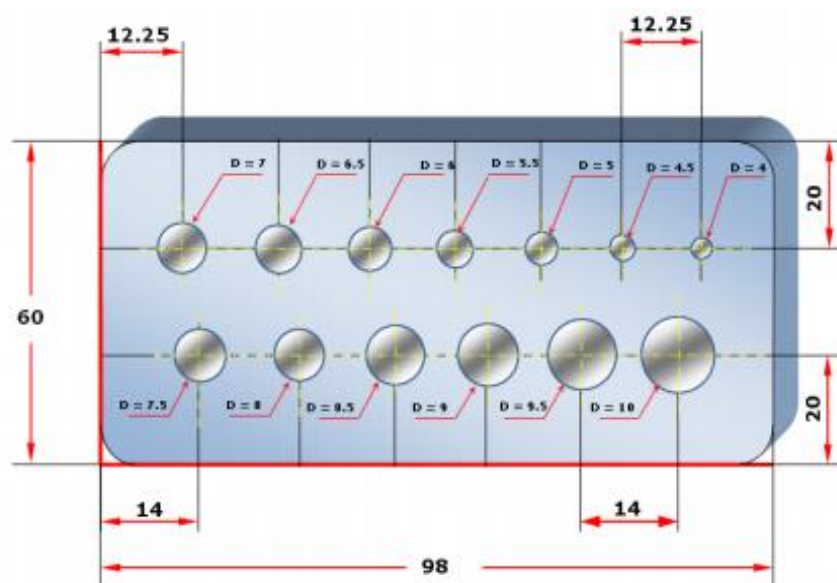
Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **2-5** hours.

Task 1: lay out mark feature

Task 2: cut and file

Task 3 Cut the work piece to produce a drill gauge according to the dimensions given.

Task 3 : tapping according to their pitch



Unit five : Perform basic drill, ream, hone and scraper operations

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- personal protective devices.
- Drill, Ream and Hon boreholes.
- scrapers

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Perform all operations using personal protective devices.
- Perform Drill, Ream and Hone boreholes.
- Scrap

5.1 personal protective equipment

Do you work in an industry that uses a drill press on a regular basis? Featuring a motorized transmission with spur gearing these devices are used to create a consistent, powerful drive. Businesses of all shapes and sizes use drill presses in their daily applications. Due to the powerful nature of these machines, however, certain safety precautions must be taken to ensure workers' safety.

As with any piece of heavy machinery, a drill press should only be used by someone who's familiar with its mechanics and function. The exact method of operation varies depending on the particular model, which is why it's important to read the owner's manual. In the even if you no longer have the owner's manual, visit the manufacturer's website to see if you can download a copy. As a last ditch effort, you can always call the manufacturer to request another owner's manual.

In terms of personal protective equipment (PPE), the only piece of equipment that's absolutely necessary when operating a drill press is a pair of high-grade, shatter-proof goggles with side shields. Eye injuries are known to occur when metal shards or debris are shot from underneath the drill. This is easily avoided, however, be wearing proper eyewear. Check out the Occupational Safety and Health Administration's (OSHA) website at <https://www.osha.gov/SLTC/etools/eyeandface/faqs.html> for more information on choosing the right eyewear.

Safety Tips To Follow When Operating a Drill Press

- A good rule of thumb is to keep a 2-foot perimeter of clearance around your drill press at all times.
- Noise-cancelling headphones may also be worn to minimize the sound produced by a drill press.
- Never wear watches, rings, necklaces, bracelets, or other jewelry.
- Contrary to what some people may believe gloves should *not* be worn when operating a drill press. The fabric material may stick to the drill, dragging the user's hand inside.
- Perform an inspection of your drill press to ensure all covers and safety guards are functional before operating it.
- The wood shavings produced by a drill press are hot due to friction, so avoid touching them.

- Keep your hands at least 4 inches away from the drill.
- Maintain a clean workstation that's free of obstruction and debris.
- Center-punch the initial drill hole into the composition.

5.2 Drill, Ream and Hon boreholes

1. Introduction to drilling

Drilling: is a process of producing round holes in a solid material or enlarging existing holes with the use of multi tooth cutting tools called drills or drill bits. In other words it is the process of making holes of cylindrical shape on metals and other materials using drill bits and drilling machines.

Drilling machine: are driven either manual or by electrical power.

1.1. Classification of drilling machines

Drilling machines: are classified into hand and breast drill, portable electrical drill, bench drill, pillar dills and others.

- 1. The hand and breast drill:** are driven by hand and are commonly used where electricity is unavailable and are used for light work
- 2. Portable electrical drill:** are most suitable to work which cannot be done with bench drill.
- 3. Bench drill:** is one of the most common used machines in the work shop. This machine has the following parts. The base, the column, the head, the spindle, the pulleys, the motor, the belt, the safety swatch, the feed handle, the depth gauge, the head locking handle, the gear lever, the collar, the chuck and the main switch.
- 4. Pillar dills:** is similar in design to the bench drill. But it is floor mounted and usually much large.

Various cutting tools are available for drilling, but the most common is the *twist drill*.

• Standard Operations

Drilling machines may be used for performing a variety of operations besides drilling a round hole.

A few of the more standard operations, cutting tools and work set-ups will be briefly discussed.

A. Drilling – may be defined as the operation of producing a hole by removing a metal from a solid mass using a cutting tool called a twist drill.

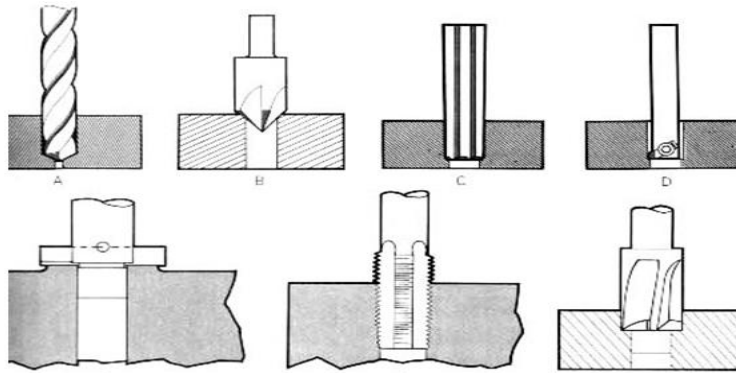


Figure 5.1 Variety of operations of drilling machine.

- B. Countersinking** – is the operation of producing a tapered or cone shaped enlargement to the end of the hole.
- C. Reaming** – is the operation of sizing and producing a smooth round hole from a previously drilled or bored hole with the use of a cutting tool having several cutting edges.
- D. Boring** – is the operation of enlarging and truing a hole by means of a single-point cutting tool which is usually held in a boring bar.
- E. Spot-facing** – is the operation of smoothing and squaring the surface around a hole to provide a seat for the head of a cap screw or a nut. For the spot facing operation, the work being machined should be securely clamped and the machine set approximately $\frac{1}{4}$ of the drilling speed.
Spot facing is a process of machining a flat surface around the mouth of a hole in order to provide a flat seat for the head of a bolt or a nut.
- F. Tapping** – is the operation of cutting internal threads in a hole with a cutting tool called a tap. Special machine or gun taps are used with a tapping attachment when this operation is performed by power in a machine.
- G. Counter boring** – is the operation of enlarging the top of a previously drilled hole to a given depth to provide a square shoulder for the head of a bolt or a cap screw. Counter boring is used to form a flat, recessed seating for a cheese head bolt or cap screw.

Sensitive Drill Presses

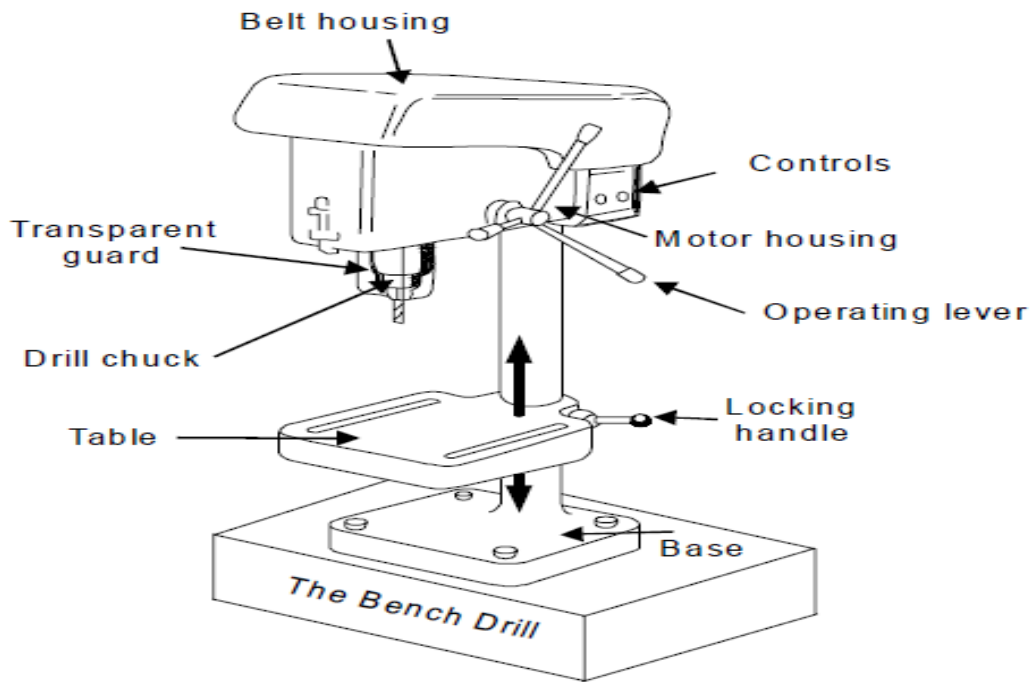


Figure 5.2 Parts of drill Presses.

1.2. Drill Bits

Introduction

Twist drills are end-cutting tools used to produce holes in most types of material. On standard drills, two helical grooves, or flutes, are cut lengthwise around the body of the drill. They provide cutting edges and space for the cuttings to escape in the drilling process. Since drills are one of the most efficient tools, it is necessary to know the main parts, how to sharpen the cutting edges, and the correct speeds and feeds for drilling various metals in order to use them most efficiently and prolong their life.

1.2.1 Parts of Twist drills

Shank

Most twist drills used in machine shop work today are made of high-speed steel. High-speed drills have replaced carbon-steel drills since they can be operated at double the cutting speed and the cutting edge lasts longer. A drill may be divided into three main parts: the shank, the body and the point.

- Generally drills up to 13mm in diameter have straight drill shanks, while those over this diameter usually have tapered shanks. Straight-shank drills (fig. 08/02) are held in a drill chuck; tapered-shank drills (fig. 08/01) fit into the internal taper of the drill press spindle.
- A tang (fig. 08/01) is provided on the end of tapered-shank drills to prevent the drill from slipping while it is cutting and to allow the drill to be removed from the spindle or socket without the shank being damaged by using a drill drift.

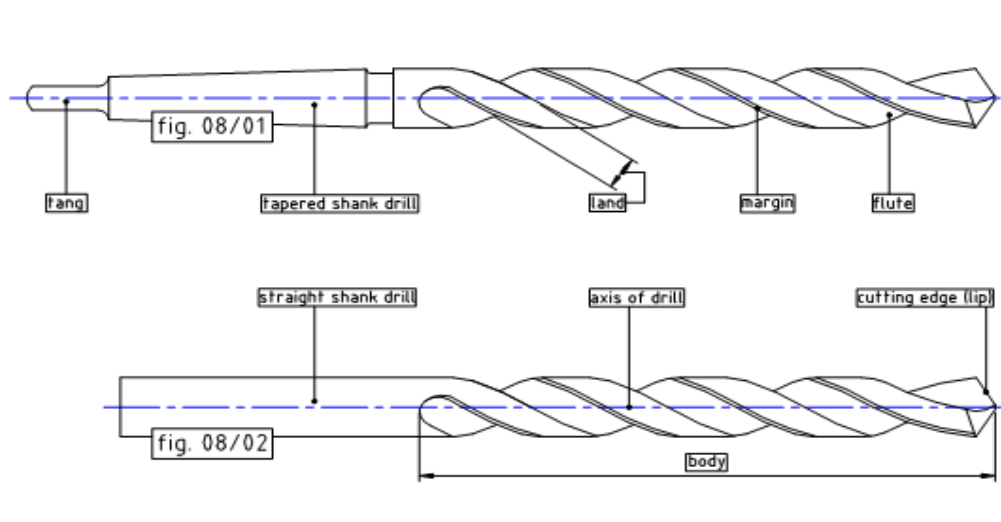


Figure 5.3 Twist drills bit

Body

The body is the portion of the drill between the shank and the point. It consists of a number of parts important to the efficiency of the cutting action.

The flutes are two or more helical grooves cut around the body the body of the drill. They form the cutting edges, admit cutting fluid, and allow the chips to escape from the hole.

- The margin is the narrow, raised section on the body of the drill. It is immediately next to the flutes and extends along the entire length of the flutes. Its purpose is to provide a full size to the drill body and cutting edges.
- The lip clearance is the undercut portion of the body between the margins and the flutes. It is made smaller to reduce friction between the drill and the hole during the drilling operation.
- The web is the thin partition in the center of the drill which extends the full length of the flutes. This part forms the chisel edge at the cutting end of the drill. The web gradually increases in thickness toward the shank to give the drill strength.
- Point The point of a twist drill consists of the chisel edge, the lips, the lip clearance angle and the heel.
- The chisel edge (web) is the chisel-shaped portion of the drill point.

- The lip (cutting edge) is formed by the intersection of the flutes. The lips must be equal length and have the same angle so that the drill will run true and will not cut a hole larger than the size of the drill.
- The lip clearance angle is the relief which is ground on the point of the drill extending from the cutting lips back to the heel. The average lip clearance is from 8° to 12° , depending upon the hardness or softness of the material to be drilled.

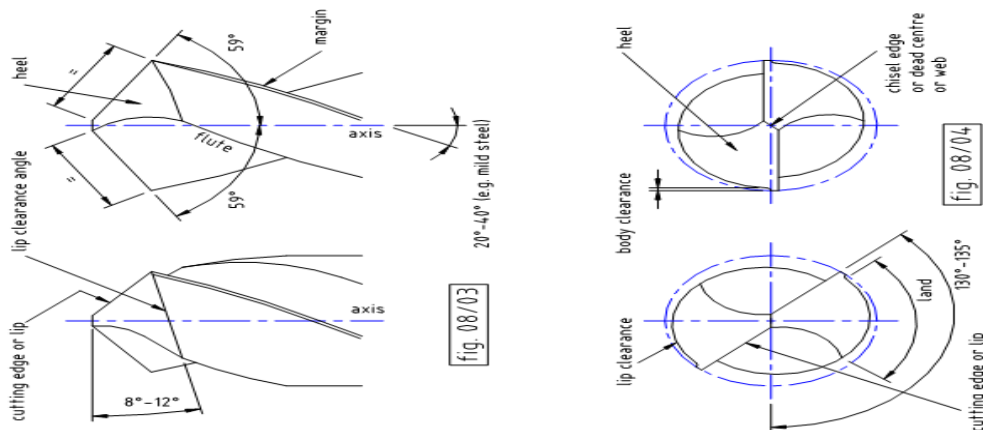


Figure 41 Body of Twist drills.

1.2.2

Speed

A wide range of drills and drill sizes is used to cut various metals; an equally wide range of speeds is required for the drill to cut efficiently. For every job, there is the problem of choosing the drill speed which will result in the best production rates and the least amount of downtime for regrinding the drill. The recommended cutting speeds for drilling various types of materials may be found in the table shown below. The most economical drilling speed depends upon many variables such as:

- the type and hardness of the material
- the diameter and material of the drill
- the type and condition of the drill press
- the efficiency of the cutting fluid employed

To determine the correct number of r/min (revolution per minute) of a drill press spindle for a given size drill, the following should be known:

- ✓ the type of material to be drilled
- ✓ the recommended cutting speed of the material
- ✓ the type of material from which the drill is made

Table 1.1. Drill size and types of materials.

Table 5.1 Cutting Speed

Drill size stainless steel tool steel cast iron machine steel aluminum

2	1910	2865	3820	4775	9550
3	1275	1910	2545	3185	6365
4	955	1430	1910	2385	4775
5	765	1145	1530	1910	3820
6	635	955	1275	1590	3180
7	545	820	1090	1365	2730
8	475	715	955	1195	2390
9	425	635	850	1060	2120
10	350	520	695	870	1735
15	255	380	510	635	1275
20	190	285	380	475	955
25	150	230	305	380	765

CS = 12 CS = 18 CS = 24 CS = 30 CS = 60

- ✓ CS in m/min CS x 1000 CS x 320
- ✓ Formula $r/min = \frac{CS}{\pi D}$ \Rightarrow \Rightarrow
- ✓ $\pi \times D$ in mm $3.14 \times D$
- ✓ D For metric calculations, the formula is used:

$$rpm = \frac{CS(m)}{\pi D(mm)}$$

It is necessary to convert the meters in numerator to millimeters so that both parts of the equation are in the same unit. To accomplish this, multiply the CS in meters per minute by 1000 to bring it to millimeters per minute.

$$rpm = \frac{CS \times 1000}{\pi D} \quad \text{This can be simplified to} \quad rpm = \frac{CS \times 320}{D}$$

This is done for the reason that not all machines have variable speed drives and therefore cannot be set to the exact calculated speed. Dividing 1000 by π (3.14) we arrive at the formula above. This formula is accurate enough for most drilling operations.

Example:

Calculate the rpm required to drill a 15mm hole in tool steel using a high speed steel drill.

Solution:

$$rpm = \frac{CS \times 320}{D} = \frac{18 \times 320}{15} = \frac{5760}{15} = 384$$

1.1.1. Feed

Feed is the distance that a drill advances into the work for each revolution.

In other words the feed of a drill is the distance the drill moves into the job at each revolution of the spindle. It is expressed in millimeter. The feed may also be expressed as feed per minute. The feed per minute may be defined as the axial distance moved by the drill into the work per minute. The feed per minute may be calculated as:

$$F = Fr \times N$$

The rate of feed is generally governed by:

- the diameter of the drill
- the material of the work piece
- the condition of the machine

Table5.2. Drill size and feed per revolution.

Drill size	feed per revolution	
1 to 3		0.02 to 0.05
3 to 6		0.05 to 0.10
6 to 13		0.10 to 0.18
13 to 25		0.18 to 0.38

2. Boring holes

2.1 Introduction to Boring

In machining, **boring** is the process of enlarging a hole that has already been drilled (or cast) by means of a single-point cutting tool (or of a **boring** head containing several such tools), such as in **boring** a gun barrel or an engine cylinder

3. Reaming holes

Reaming: is similar to drilling operation. It is basically used for finishing of holes and enlarging of small holes. Reaming is carried out by the reamer, which has large number of flutes. Each component in a product must be made to exact standards in order for that product to function properly. Since it is impossible to produce holes which are round, smooth and

accurate to size by drilling, the reaming operation is very important. Reamers are used to enlarge, and finish a hole previously formed by drilling or boring. Speed, feed, and reaming allowances are the three main factors which will affect the accuracy and finish of the hole and the life of the reamer.

a. Reamers

A reamer is a rotary cutting tool with several straight or helical cutting edges along its body. It is used to accurately size and smooth a hole which has been previously drilled or bored. Some reamers are operated by hand (hand reamers), while others may be used under power in any type of machine tool (machine reamers).

3.3 Parts of the Reamer

Reamers generally consist of three main parts: shank, body and angle of chamfer.

The **shank**, which may be straight or tapered, is used to drive the reamer. The shank of machine reamers may be straight or tapered, while hand reamers have a square end on the end to accommodate a tap wrench.

The **body** of a reamer contains several straight or helical grooves or *flutes*, and *lands* (the portion between the flutes). A *margin* (the top of each tooth) runs from the angle of chamfer to the end of the flute. The *body clearance angle* is the relief or clearance behind the margin which reduces the friction while the reamer is cutting. The *rake angle* is the angle formed by the face of the tooth when a line is drawn from a point on the front marginal edge through the center of the reamer. If there is no angle on the face of the tooth, the reamer is said to have radial land.

The **angle of chamfer** is the part of the reamer which actually does the cutting. It is ground on the end of each tooth and there is clearance behind each chamfered cutting edge. On rose reamers, the angle of chamfer is ground on the end only and the cutting action occurs at this point. On fluted reamers, each tooth is relieved and most of the cutting is done by the reamer teeth.

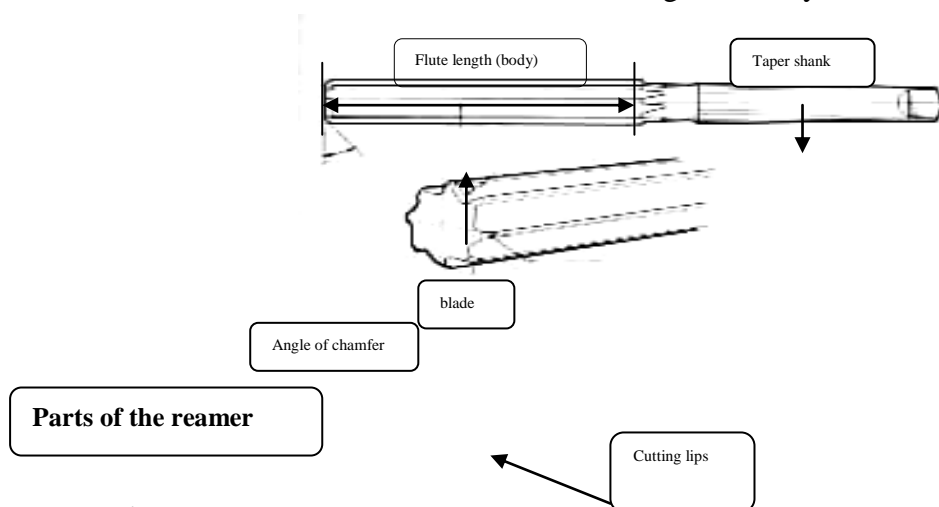


Fig 5.5 Types of Reamers

Reamers are available in a variety of design and sizes; however, they fall into two general classifications: *machine* and *hand* reamers.

- **Hand Reamers**

Hand reamers are finishing tools used when a hole must be finished to a high degree of accuracy and finish. Holes to be hand reamed should be bored to within 0.07 to 0.12mm of the finish size. Never attempt to ream more than 0.12mm with a hand reamer.

A square on the shank end allows a wrench to be used for turning the reamer into the hole. The teeth on the end of the reamer are tapered slightly for a distance equal to the reamer diameter so that it can enter the hole to be reamed.

A hand reamer should never be used under mechanical power and should never be turned backwards. When using a hand reamer, keep it true and straight with the hole. The dead center in a lathe or a stub center in a drill press will help keep the reamer aligned during the hand reamer operation.

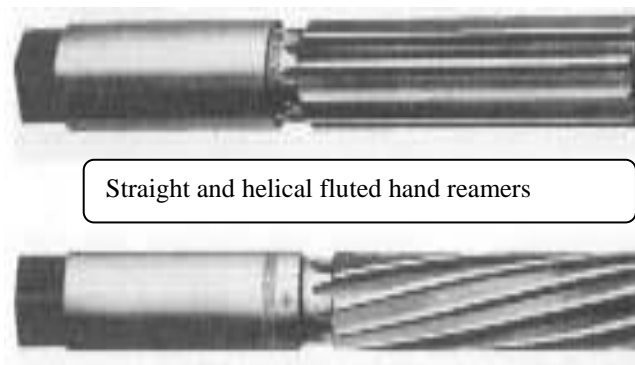


Fig5.6 Hand reamers

Reaming cannot correct a badly positioned hole; it can only smooth it.

Points to remember in hand reaming include the following:-

1. Drill the hole to be reamed with care.
2. Hold the work securely in the vice.
3. Use a good supply of cutting lubricant to help remove chips and reduce friction to obtain a smooth finish.
4. **Honing holes**

- **Purpose of Honing**

Honing is the abrading process done mostly for finishing round holed Produced by drilling, reaming or boringly means of bonded abrasive stones Called ‘hones’. Honing is a machining process

and is used to remove metal up to 0.25 mm. The surface roughness value can be maintained between 0.025 and 0.4 microns. So honing is used to correct some out of roundness, tapers, tool marks and axial distortion.

Honing is a finishing process performed by a honing tool, which contains a set of three to a dozen and more bonded abrasive sticks. The sticks are equally spaced about the periphery of the honing tool. They are held against the work surface with controlled light pressure, usually exercised by small springs. The honing tool is given a complex rotational and oscillatory axial motion, which combine to produce a crosshatched lay pattern of very low surface roughness:

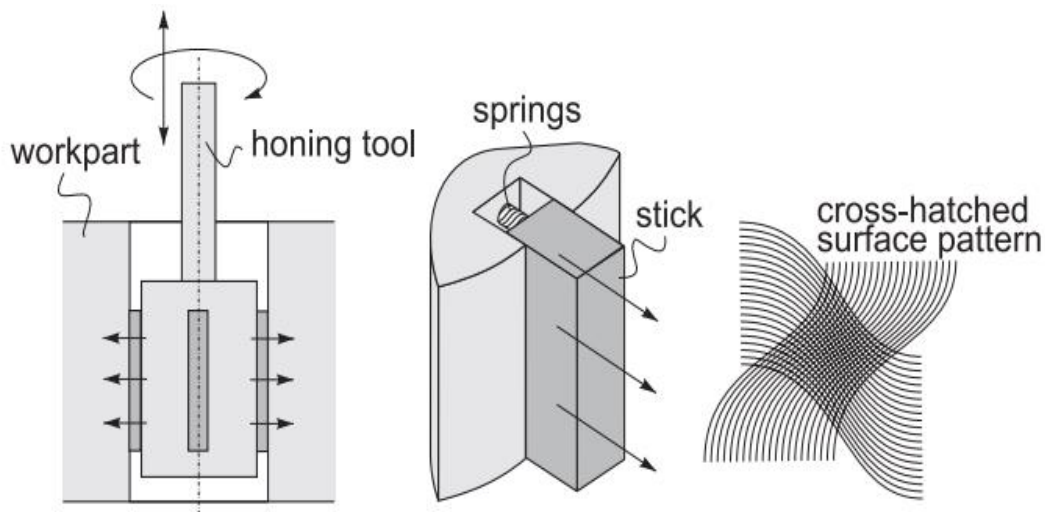


Figure 5.7 Honing Operation

Schematics of honing process showing the honing tool, how the abrasive sticks are pressed against the work surface by springs, and the resulting surface pattern.

In addition to the surface finish of about $0.1 \mu\text{m}$, honing produces a characteristic crosshatched surface that tends to retain lubrication during operation of the component, thus contributing to its function and service life. A cutting fluid must be used in honing to cool and lubricate the tool and to help remove the chips. A common application of honing is to finish the holes. Typical examples include bores of internal combustion engines, bearings, hydraulic cylinders, and gun barrels.

5. Lapping

In lapping, instead of a bonded abrasive tool, oil-based fluid suspension of very small free abrasive grains (aluminum oxide and silicon carbide, with typical grit sizes between 300 and 600) called a lapping compound is applied between the work piece and the lapping tool. The lapping tool is called a lap, which is made of soft materials like copper, lead or wood. The lap has the reverse of the desired shape of the work part. To accomplish the process, the lap is pressed against the work and moved back and forth over the surface in a figure-eight or other motion pattern,

subjecting all portions of the surface to the same action. Lapping is sometimes performed by hand, but lapping machines accomplish the process with greater consistency and efficiency.

The cutting mechanism in lapping is that the abrasives become embedded in the lap surface, and the cutting action is very similar to grinding, but a concurrent cutting action of the free abrasive particles in the fluid cannot be excluded. Lapping is used to produce optical lenses, metallic bearing surfaces, gages, and other parts requiring very good finishes and extreme accuracy.

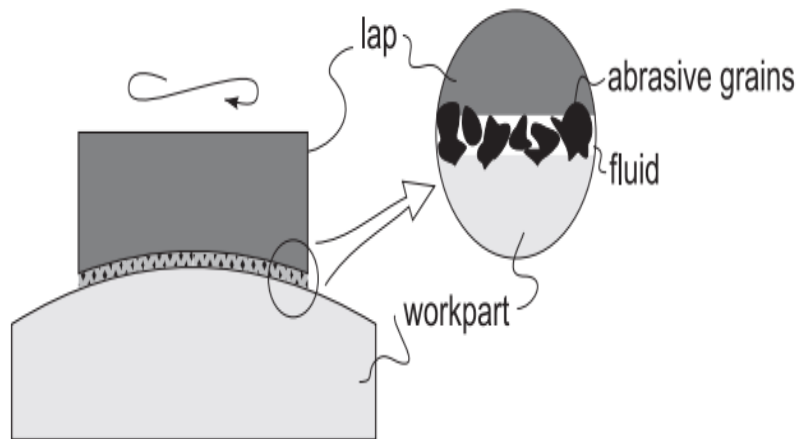


Figure 42 Schematics of lapping process showing the lap and the cutting action of

Figure 5.8 Select scrapers

Scraping

Scraping is the process of removing high spots on the surface of a piece of work. It is a difficult operation, and is not often performed in the school workshop.

- **Types of scrapers:**

These sharp edged tools are used to remove uneven spots on the surfaces. They are of different shapes.

3.4.1. Flat scraper

It is used for removing metal from flat surfaces. The blade must have a slight curvature at the cutting edge. The corners are rounded to help the user, scrape at the exact spots.

3.4.2. Half round bearing scraper

This is used for scraping curved and cylindrical surface split bearings, big bush bearings etc.

3.4.2. Triangular scraper

This is used for scraping curved surfaces, holes and bores. Specification is by length. Example: 200 mm, 300 mm etc.

Self-Check 5	Written Test
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Directions I: Choose the best answer for the following questions. (2 point each)

- 1_____is the process of producing round hole in a solid material or enlarging existing holes.
 - a. Reaming b. Drilling c. Honing d. Filling
2. Which one of the following is a finishing process of drilled holes?
 - a. Honing b. filling c. Sawing d. Drilling
- 3 _____is the process of enlarging a hole that has already been drilled.
 - a. Drilling b. Honing c. Boring d. None

Directions II: Answer all the questions listed below. (8 points)

- a. .What mean by PPE? (2 points)
- b. Write the steps to provide drilling operation. (2 points)
- c. Write the importance of PPE in the work shop. (2 points)
- d. List out the types honing tools. (2 points)
- e. Write the function of honing operation. (2 points)

Operation sheet 5.1: Perform hand tool operations

- **Operation title:** bench work operations

Purpose: filing, checking, marking, punching, cutting, drilling, tapping, reaming, and finishing

- **Instruction:** Use the given figure below (Figure below) the tools and equipment lay out and mark on the work piece. For this operation you have given 2Hour and you are expected to operation.

- **Tools and requirement:**

2. Steel Rule,
9. Scriber
10. Hammer
11. Center paunch
12. Different size of drill bit
13. Bench drill machine
14. work piece 60*98
15. Different size of taps and tap wrench

- **Precautions:** Measure at least three times before punching

- **Procedures in doing the task**

- step 1. Hold the mild steel flat piece of 50 x 50 x 6mm between the jaws of the bench vice.
- step 2. Start filing on first flat surface after removing the rust with the tip of flat file.
- step 3. Straight filing is continued till the surface is formed perfectly flat.
- step 4. Check the straightness by using straight edge.
- step 5. Turn to the adjacent side which is narrow and make it straight, flat and 90° with flat surface prepared.
- step 6. File the next adjacent side and make it flat and perpendicular to both flat surface and first narrow side which is already prepared.
- step 7. Apply chalk on the finished flat surface and mark dimensions
- step 8. Use surface plate V-block and vernier height gauge for marking.
- step 9. Marked lines are punched by using dot punch and ball peen hammer.
- step 10. File to correct dimensions in length and width and check the dimensions using an outside caliper and steel rule.

- step 11. Mark two curve on the edge of M.S flat using divider.
step 12. Make curve using round file.

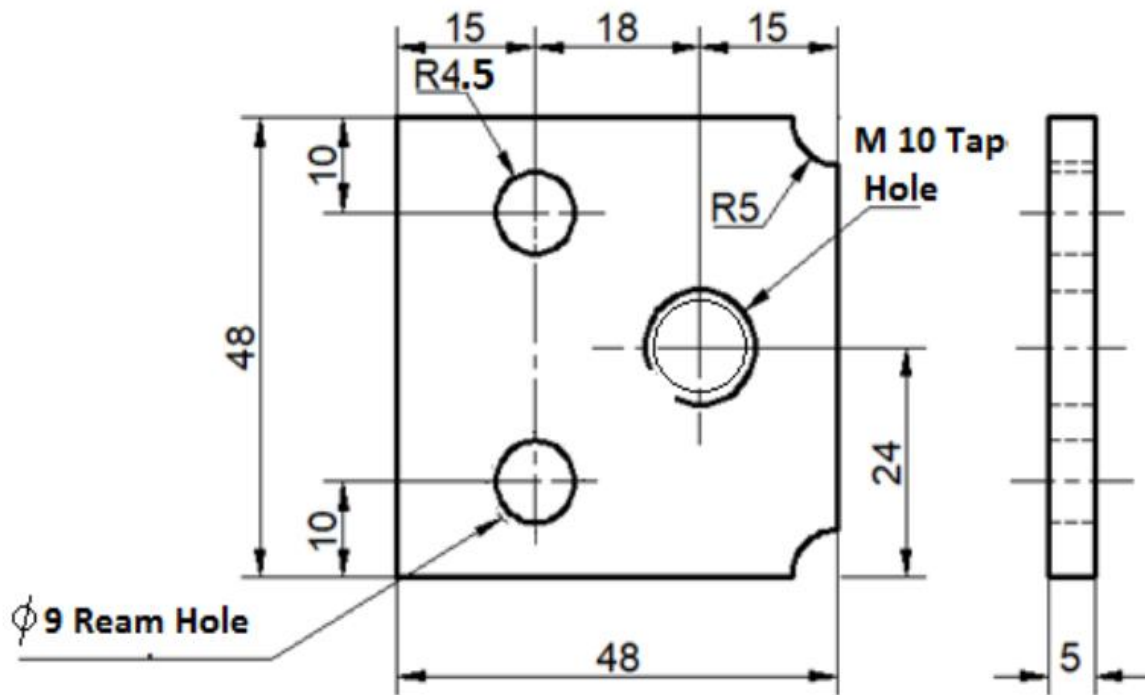


Figure 43 given for operation sheet

- **Quality Criteria:** the given drilling operation measuring with 0.2 mm accuracy

LAP Test	Practical Demonstration
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Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **2-5** hours.

Task 1. lay out mark feature

Task 2. Punching

Task 3. Cutting

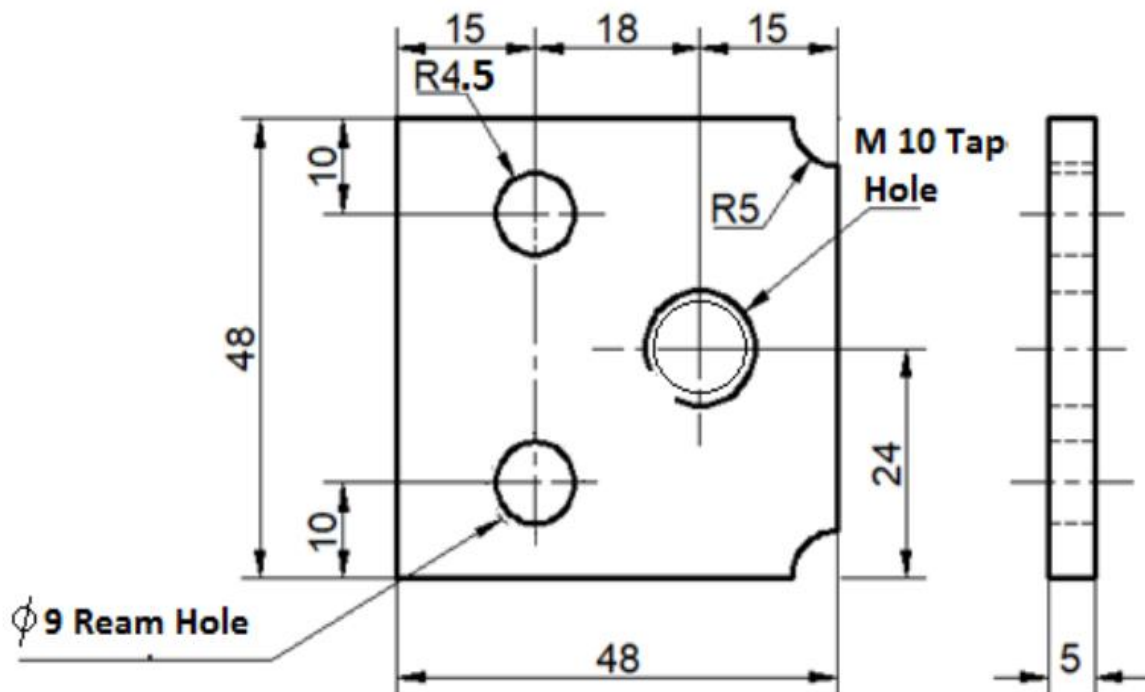
Task 4. Drilling

Task 5. reaming,

Task 6. Tapping

Task 7. Checking

Task 8. finishing



Unit six : Perform Off-hand grind cutting tools

This unit is developed to provide you the necessary information regarding the following content coverage and topics

- Hone cut edges
- cutter Sharpening
- cooling agents
- personal protective devices.

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Hone cut edges free of burrs
- Sharpen cutter to conform to specifications
- Ground cutters using appropriate cooling agents
- Perform cutting tool grinding using personal protective devices

Concepts of off-hand grinding

Off – hand grinding is the term used in engineering to describe the process where the work is held by hand material is removed using an abrasive wheel.

This type of grinding is carried out in the workshop for such work as:

- Removing excess materials
- Smoothing surfaces
- Preparing plates for welding
- Sharpening cutting tools (drills, chisels, punches, shaper and lathe tools)

Off – hand grinding must be performed with great regard of safety. The principle of operation requires an exposed portion of the abrasive wheel to be in close proximity to the operator.

Hazard may be created by having relatively heavy abrasive wheels rotating a high speed. The wheels on all types of machines must be heavily guarded.

The guard exposes enough of the wheel surface to enable the operator to perform the work required.



Figure 6.1 bench and pedestal grinder

- Parts and Functions (features of machines)
 - Work Rests
 - Wheel Guards
 - Wheel Speed
 - Wheel Rotation

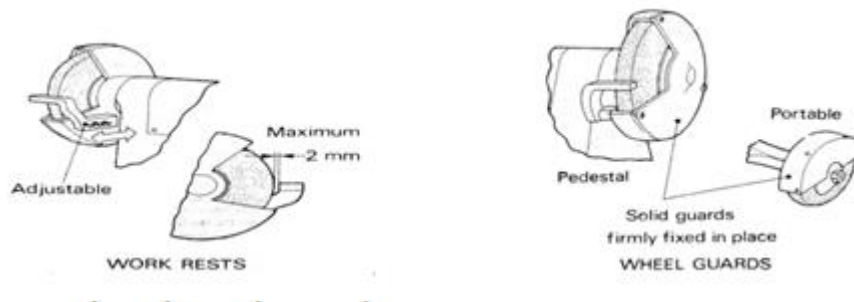


Figure 6.2 Parts of Bench Grinding machine.

ANGLE GRINDER:

An angle grinder, also known as a side grinder or disc grinder, is a handheld power tool used for cutting, grinding and polishing. Angle grinders can be powered by an electric motor, petrol engine or compressed air. The motor drives a geared head at a right-angle on which is mounted an abrasive disc or a thinner cut-off disc, either of which can be replaced when worn. Angle grinders typically have an adjustable guard and a side-handle for two-handed operation. Certain angle grinders, depending on their speed range, can be used as sanders, employing a sanding disc with a backing pad or disc. The backing system is typically made of hard plastic, phenolic resin, or medium-hard rubber depending on the amount of flexibility desired.

Angle grinders may be used both for removing excess material from a piece or simply cutting into a piece. There are many different kinds of discs that are used for various materials and tasks, such as cut-off discs (diamond blade), abrasive grinding discs, grinding stones, sanding discs, wire brush wheels and polishing pads. The angle grinder has large bearings to counter side forces generated during cutting, unlike a power drill, where the force is axial.

Angle grinders are widely used in metalworking and construction, as well as in emergency rescues. They are commonly found in workshops, service garages and auto body repair shops.



Figure 6.3 portable grinder

CUT OFF MACHINE:

An abrasive saw, also known as a cut-off saw or metal chop saw, is a power tool which is typically used to cut hard materials, such as metals. The cutting action is performed by an abrasive disc, similar to a thin grinding wheel. The saw generally has a built-in vise or other clamping arrangement, and has the cutting wheel and motor mounted on a pivoting arm attached to a fixed base plate.

They typically use composite friction disk blades to abrasively cut through the steel. The disks are consumable items as they wear throughout the cut. The abrasive disks for these saws are typically 14 in (360 mm) in diameter and 7/64 in (2.8 mm) thick. Larger saws use 410 mm (16 in) diameter blades. Disks are available for steel and stainless steel.



Figure 6.4 cut off machine

Honing cut edges

Importance of honing:

Honing is an abrasive machining process that produces a precision surface on a metal work piece by scrubbing an abrasive stone against it along a controlled path. Honing is primarily used to improve the geometric form of a surface, but may also improve the surface texture. Typical applications are the finishing of cylinders for internal combustion engines, air bearing spindles and gears. There are many types of hones, but all consist of one or more abrasive stones that are held under pressure against the surface they are working on.

In terms of sharpening knives, a honing steel does not actually hone knives, but simply realigns the metal along the edge.

Other similar processes are lapping and super finishing.

Honing uses a special tool, called a *honing stone* or a *hone*, to achieve a precision surface. The hone is composed of abrasive grains that are bound together with an adhesive. Generally, honing grains are irregularly shaped and about 10 to 50 micrometers in diameter (300 to 1,500 mesh grit). Smaller grain sizes produce a smoother surface on the work piece.

A honing stone is similar to a grinding wheel in many ways, but honing stones are usually more friable so that they conform to the shape of the work piece as they wear in. To counteract their friability, honing stones may be treated with wax or sulfur to improve life; wax is usually preferred for environmental reasons.

Any abrasive material may be used to create a honing stone, but the most commonly used are corundum, silicon carbide, cubic boron nitride, or diamond. The choice of abrasive material is usually driven by the characteristics of the work piece material. In most cases, corundum or silicon carbide are acceptable, but extremely hard work piece materials must be honed using super abrasives.

The hone is usually turned in the bore while being moved in and out. Special cutting fluids are used to give a smooth cutting action and to remove the material that has been abraded. Modern advances in abrasives have made it possible to remove much larger amount of material than was previously possible. This has displaced grinding in many applications where "through machining" is possible. External hones perform the same function on shafts.

Concepts of Sharpening Cutters

The word sharpening is usually used for the final finishing of edge tools. Like all edge tools, a drill bit needs to have the right shape before you can start to sharpen it. Creating the initial shape often means that quite a lot of steel needs to be re-moved when for example, you change the point angle of a drill or you shape a broken or heavily worn drill. Once the geometry of the point is established, you maintain the sharpness by sharpening. With the Tormek system you can exactly replicate an existing shape and therefore you just need to touch up the edges. Shaping and Sharpening

Edge tools need to be sharp to work efficiently. The bevels of a sharp edge tool end in a uniform tip. After a period of use the tip becomes rounded and the edge is no longer sharp.

You can sharpen tools with a bench stone or, in the case of knives, with a sharpening steel.

This means that you work on the very tip of the bevel and the tool is sharp again.

When sharpening with a steel or a bench stone, a very limited amount of steel is removed.

After several sharpening or honing, the edge angle becomes too wide and the tool must be re-shaped. Sooner or later all edge tools need to be re-shaped and this is done by grinding on a grindstone or a grinding wheel. When only a limited amount of steel is removed this operation is also called sharpening.

Grinding means that so much steel is removed from the tool that the edge is restored to the original angle or altered on purpose to a new angle. The shape of the tool can also be changed according to your requirements.

1.1. Tool Sharpening

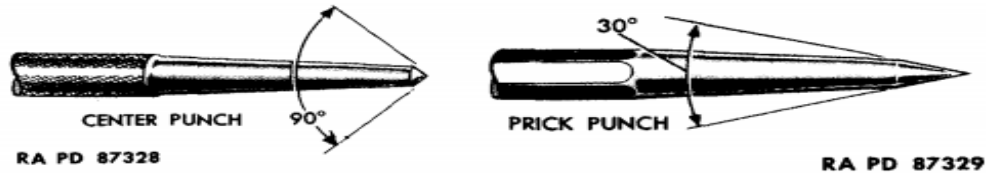
For some tools it is very important to keep them sharp at all times. Common tools, such as scribes, center punch, chisels, drill bits, tool bits for lathe machine needs to be sharpened every time you feel that they do not cut well.

- **Sharpening Scriber and Center Punch**

1. Scriber and center punch should be ground in the position as shown beside.
2. Use the tool rest to rest your hands while bringing the tool in the right position.
3. Rotate the tool while grinding.
4. Cool the tool down from time to time.
5. Do not overheat the metal.

Cone-pointed Punches

Center punches and prick punches are ground to cone points. Correct point angle for center punches is about 90 degrees. Right point angle for prick punch is approximately 30 degrees. These angles may be altered for special work.



Correct Punch Point Angles

Adjust rest so punch meets face of wheel at desired angle (see illustration). Rotate punch during grinding to make point symmetrical. Dip punch in water at frequent intervals to avoid "burning." Do not grind away more material than necessary to secure satisfactory point.



Figure 6.5 Punches and their grinding angles

Refer: <https://www.youtube.com/watch?v=zxvbKlur96A>

• Sharpening Chisel

- ✓ Use the tool rest to rest your hands while bringing the tool in the right position.
- ✓ Use the whole grinding wheel while grinding. Move with the tool regularly from the left to the right side and back.
- ✓ Cool the tool down from time to time.
- ✓ Do not overheat the metal.
- ✓ Grind the chisel-point parallel and straight. See also the pictures below.

1.2. Grinding twist drills

Twist drills may be ground in a drill holder fixture or free hand. Use fixture if available.

Grind drill lips or cutting edges at an angle of 59 degrees, as illustrated below (50 to 60degrees for drilling brass or bronze, 68 degrees for extremely hard material). Both cutting edges must make same angle with drill angle with angle drill axis, and both cutting edges must be same length.

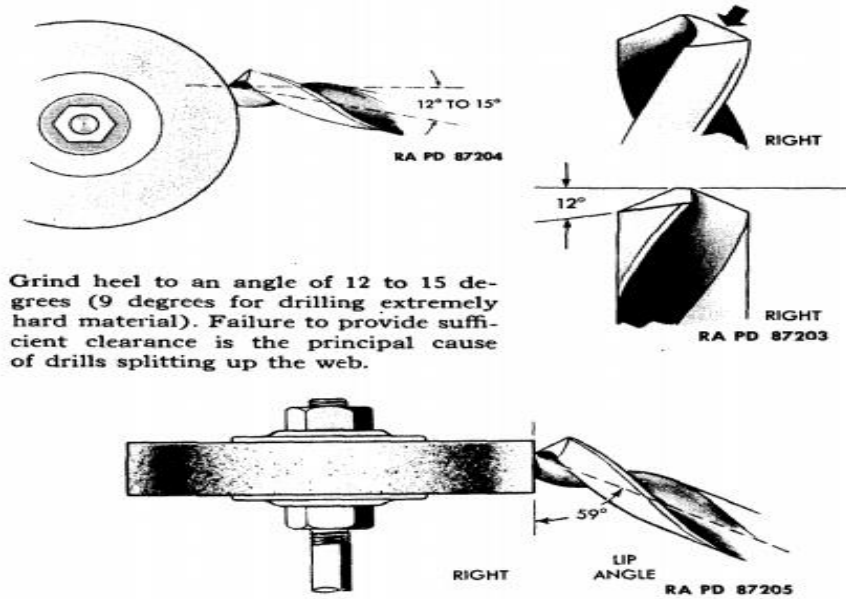


Figure 6.6 Grinding angles of Twist drill points

- **Using Drill Holder Fixture**

Exact procedure for grinding will vary with make of drill grinding machine used. General procedure, which applies to conventional type machine, is given in the following steps:

- ✓ **Adjust** machine to desired cutting edge and heel angles.
- ✓ **Place** drill in V- block of holder. Turn so cutting edge will contact abrasive wheel as drill is feed in to wheel.
- ✓ Start motor and advance tailstock until drill makes contact with wheel.
- ✓ **Hold** drill in place in V- blocks and swing holder spindle slowly through its arc. Without changing tailstock adjustment , revolve drill one- half turn in V- blocks and sharpen other lip of dill in same manner.

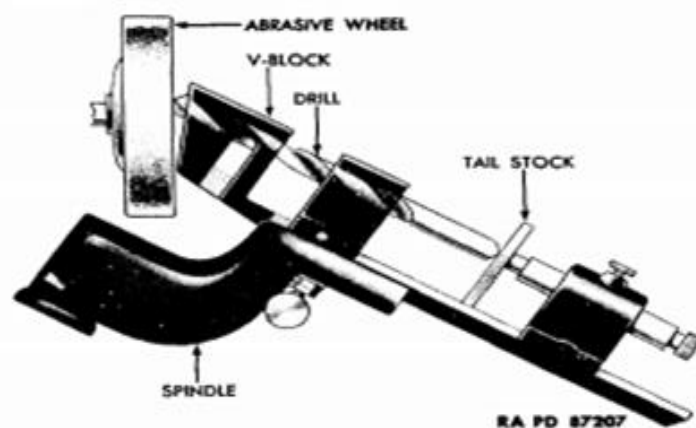


Figure 6.7 Grinding with Drill Holder Fixture.

- ✓ **Inspect** drill point to see if it has been ground block far enough to eliminate all nicks.
Repeat grinding and inspections operations until perfect appearing points are obtained.

- **Free Hand Grinding**

1. **Adjust** tool rest to convenient height for resting back of forehead on it while grinding.
2. **Hold** drill between thumb and index finger of right or left hand grasp body of drill near shank with other hand.
3. **Place** forehand on drill rest with centerline of drill making desired angle with cutting face of wheel and slightly lower shank end of drill as illustrated.
4. **Slowly** place heel of drill against grinding wheel.
5. **Check** results of grinding with a gage to determine if cutting edge Are same length and at desired angle and if heel is ground to angle of 12 to 15 degree.



Figure 6.8 Free Hand Grinding

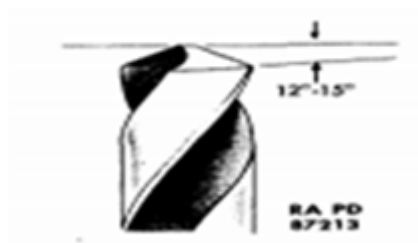


Figure 6.9 Heel Angle.

Web thinning

On a conventional twist drill bit there is what is known as a web. The web is the center part of the body that joins the lands (Figure)

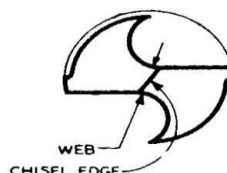


Figure 6.10 Twist drill point

The extreme ends of the web form the chisel edge. The thickness of the web is not uniform; it increases from the point to the shank (Figure).



Figure 6.11 Twist drill bit

The web thickness gets larger toward the shank of the drill.

The cutting action of the chisel edge requires a relatively large amount of thrust be used to cause the drill to penetrate into the work piece. The increased amount of thrust needed to drive the chisel edge becomes more apparent as the drill is sharpened, since the web of the drill is made thicker toward the shank. We can reduce the amount of force it takes to cause the drill to penetrate by thinning the web of the drill (Figure).

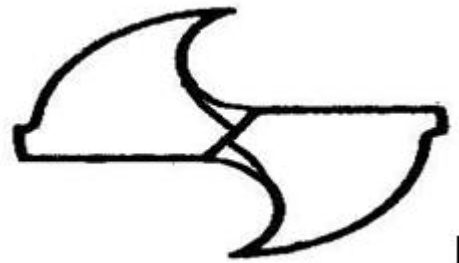


Figure 6.12 Web thinning

The best way to thin the web of a drill is by using a machine equipped with a drill point thinner. It is possible, however, to thin the web of a drill by hand using a pedestal grinder.

Web Thinning on a pedestal Grinder

- When thinning the web be careful not to make the web any thinner than it was when original and **do not** disturb the cutting lips of the drill. Start with a clean, sharp grinding wheel. Hold the drill at approximately 35 degrees of the axial centerline of the drill.



Figure 6.13 Holding the drill at a 30- degree angle

Line up the corner of the wheel with the tip of the web (Figure).

Turn the cutting lip out approximately 10 degrees. Lightly grind away the web of the drill. You have to grind the same amount off of each web to assure that the drill point will remain on center. Try to stay away from the cutting edge as much as possible.



Figure 6.14 Line up the end of the web with the corner of the wheel

Modified split point done on a pedestal grinder

It is sometimes easier for a beginning student to grind a modified split point by hand than it is to do off-hand web thinning. The split point drill (Figure) accomplishes the same end result, a thinned web, but you are actually grinding away the heel or non-cutting side of the drill point.

<https://www.ibiblio.org/hyperwar/USA/ref/TM/pdfs/TM9-867.pdf>



Figure 6.15 Split point

Procedures:

1. Start with a clean sharp grinding wheel. Hold the drill at approximately 55 degrees off of the axial centerline of the drill (Figure).



Figure 6.16 approach angle is steeper when web splitting

2. Line up the corner of the wheel with the tip of the web (Figure). Turn the cutting lip out approximately 10 degrees away from the wheel edge.
3. Lightly grind away the heel of the drill until you have ground away the appropriate amount of the web of the drill.

Grounding cooling agents

3.1. Properties of Cutting Fluids

- **Functions of cutting fluids**

Cutting fluids are used in metal machining for a variety of reasons such as improving tool life, reducing work piece thermal deformation, improving surface finish and flushing away chips from the cutting zone.

Cutting fluids consist of those liquids and gases that are applied to the tool and the material being machined to facilitate the cutting operation. Vast quantities are used annually to accomplish a number of objectives. (Boston, 1952)

- 1) To prevent the tool from overheating, i.e. so that no temperature is reached where the tool's hardness and resistance to abrasion are reduced, thus decreasing the tool life.
- 2) To keep the work cool, preventing machining those results in inaccurate final dimensions.
- 3) To reduce power consumption, wear on the tool, and the generation of heat, by affecting the cutting process. This investigation wishes to establish a relationship between the surface chemistry of the lubricants involved and how they can accomplish reducing the contact length on the rake face of the tool where most of the heat during cutting is produced.
- 4) To provide a good surface finish on the work.
- 5) To aid in providing a satisfactory chip formation (related to contact length)
- 6) To wash away the chips/clear the swarf from the cutting area.
- 7) To prevent corrosion of the work, the tool and the machine.

- The desirable properties of cutting fluids in general are (Boston, 1952)

- 1) High thermal conductivity for cooling
- 2) Good lubricating qualities
- 3) High flash point, should not entail a fire hazard
- 4) Must not produce a gummy or solid precipitate at ordinary working temperatures
- 5) Be stable against oxidation.
- 6) Must not promote corrosion or discoloration of the work material.
- 7) Must afford some corrosion protection to newly formed surfaces.
- 8) The components of the lubricant must not become rancid easily
- 9) No unpleasant odour must develop from continued use
- 10) Must not cause skin irritation or contamination
- 11) A viscosity that will permit free flow from the work and dripping from the chips.

3.2 Types of cutting fluids

Cutting fluids may be divided into four main categories (FVTC, 2000):

- i- straight or neat cutting oils
- ii- water miscible or water-based fluids
- iii- gases
- IV- paste or solid lubricants

i. Straight Cutting Oils

Straight cutting oils are not mixed with water. Cutting oils are generally mixtures of mineral oil and animal, vegetable or marine oils to improve the wetting and lubricating properties. Sulphur, chlorine, and phosphorous compounds are sometimes added to improve the lubrication qualities of the fluid for extreme pressure applications. There are two main types of straight oils: active and inactive.

ii. Water miscible or water-based fluids

The water-based fluids act mainly as coolants and the neat cutting oils act mainly as lubricants. There are many variants of both types. Fatty acids are often incorporated in the neat oils. Until recently both the emulsions or soluble oils as they are also called and the neat oils, contained chlorine and sulphur additives that improved lubrication under extremely difficult conditions. Chlorine affects the skin detrimentally and its degradation products are often carcinogenic and sulphur is environmentally unacceptable. Consequently other lubrication improvers under difficult conditions are searched for. Ester technology is used successfully for softer materials where high rates of metal working are needed, and where heat generation is not a major problem. (du Plessis, 2001)

These can operate at higher temperatures as they have better resistance to thermal degradation than mineral oils. (Mortier & Orszulik, 1993) They are biodegradable and do not cause dermatitis and are therefore more environmentally acceptable. In many cases phosphor and sulphur do however still form part of the cutting fluid. (FYTC, 2000)

For the water miscible fluids water quality has a large effect on the coolant. Hard water (high mineral content) can cause stains and corrosion of machines and work pieces.

Water can be deionized to remove the impurities and minerals. Water is the best fluid for cooling. It has the best ability to carry heat away. Water, however, is a very poor lubricant and causes corrosion.

Oil is excellent for lubrication but very poor for cooling, and it is also flammable. It is clear that, from a lubrication point of view water and oil have strengths but also some weaknesses. If water and oil are combined and an attempt is made to minimise the

weaknesses the best properties of both may be balanced to obtain desirable end properties for the cutting fluid. Water-soluble fluids have been developed which have good lubrication, cooling ability, low-flammability and corrosion resistance. These fluids are usually mixed on site. It is crucial that the mixing directions and concentrations are followed very closely to get the maximum benefit from the coolant. (FYTC, 2000)

Emulsions

An emulsion is a dispersion of oil droplets in water. Soluble oils are mineral oils that contain emulsifiers. Emulsifiers are soaps or soap-like agents that allow the oil to mix with water and stay in suspension. Emulsions (soluble oils) when mixed with water produce a milky white product. Lean concentrations (more water, less oil) provide better cooling but less lubrication. Rich concentrations (less water, more oil) have better lubrication qualities but poorer cooling properties.

There are different types of soluble cutting fluids available including extreme pressure soluble oils. These are used for extreme machining conditions like broaching and gear hobbing for example. (FYTC, 2000)

Chemical Fluids

Chemical coolants are also miscible cutting fluids. Chemical cutting fluids are pre-concentrated emulsions that contain very little oil. Chemical fluids mix very easily with water to form an emulsion. The chemical components in the fluid are used to enhance the lubrication, bacterial control, and rust and corrosion characteristics. There are several types of chemical coolants available including coolants for extreme cutting conditions.

Inactive chemical cutting fluids are usually clear fluids with high corrosion inhibition, high cooling, and low lubrication qualities. Active chemical fluids include wetting agents.

They have excellent rust inhibition and moderate lubrication and cooling properties.

Sulphur-, chlorine- and phosphorous- containing compounds are sometimes added to improve the extreme pressure characteristics. These are usually in an organic form, i.e. the sulphur, chlorine or phosphorus IS grafted onto a hydro-carbon backbone. (FVTC, 2000).

iii. Gases and vapours

Cutting oils and water miscible types of cutting fluids are the most widely used. Compressed air, inert gases like carbon dioxide, Freon, and Nitrogen are sometimes used. A vortex tube may be used to apply gaseous lubricants or coolants (ARTX, 2002). Using this tube, it is possible to apply the gases at a very low temperature and under medium pressure thereby facilitating a higher gas density and cooling and lubrication capability. Cutting using sub-zero cold gas is known as cryogenic cutting. The gas stream also helps to blow away chips from the cutting area. (FVTC, 2000)

iv. Paste and Solid Lubricants

Waxes, pastes, soaps, graphite and molybdenum disulphide are examples falling into this category. These are generally applied directly to the work piece or tool or in some cases impregnated directly into the tool, for example the grinding wheel of a grinder. One example of a paste lubricant is lard. Many experienced journeymen recommend lard for tapping.

grind using personal protective devices

MACHINE SAFETY

Grinding machines are used daily in a machine shop. To avoid injuries follow the safety precautions listed below.

- Wear goggles for all grinding machine operations.
- Check grinding wheels for cracks before mounting.
- Never operate grinding wheels at speeds in excess of the recommended speed.
- Never adjust the work piece or work mounting devices when the machine is operating
- Do not exceed recommended depth of cut for the grinding wheel or machine.
- Remove work piece from grinding wheel before turning machine off.
- Use proper wheel guards on all grinding machines.

- On bench grinders, adjust tool rest 1/16 to 1/8 inch from the wheel.



Figure 6.17 PPE

Self-Check 6	Written Test
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Directions I: Choose the best answer for the following questions. (2 point each)

- _____ is usually used for the final finishing of edge tools. (2 points)
 - Sharpening
 - cutting
 - drilling
 - boring
- _____ (2 points)
 - Drill holder fixture
 - drill chuck
 - free hand
 - a & c
- _____ (2 points)
 - Shank
 - web
 - body
 - chisel edge
- The web thickness gets larger toward the shank of the drill. . (2 points)
 - True
 - false
- Which one of the following is correct point angle for center punches? . (2 points)
 - 30 degrees
 - 45 degrees
 - 90 degrees
 - 75 degrees

5 Which one of the following is not the reason that cutting fluid is used in metal reducing work piece thermal deformation c) reducing surface finish

- improving tool life
 - flushing away chips from the cutting zone
- 6 Which one of the following oils are not mixed with water? (2 points)
- straight cutting oils
 - Gases and vapours
 - paste and Solid Lubricants
 - Water miscible or water-based fluids
7. Which one of the following is paste and solid lubricants? (4 points)
- be stable against oxidation
 - must not cause skins contamination

- b) good lubricating qualities d) all of the above
8. Which one of the following is the desirable property of cutting fluids?
- a) be stable against oxidation c) must not cause skins contamination
- b) good lubricating qualities d) all of the above

Directions I I

1. A dispersion of oil droplets in water is _____ .
- 2 . Twist drills may be ground in_ is _____
- 3 _____ Is the center part of the body of twist drill bit that joins the land.
- 4 Honing tool is used for _____ .
- 5 Honing operation is _____

Direction III say true if the statement is true if not say false

1. Always keep hands at a safe distance from moving machine parts.
2. A utility grinder mounted on its own freestanding base is called upright grinder
- 3 . The main purpose of a grinding wheel guard is to Protect the operator from flying sparks

Operation sheet 6.1: Perform hand tool operations

- **Operation title:** bench work operations

Purpose: filing, checking, marking, punching, cutting, drilling, tapping, reaming, and finishing

Instruction: Perform the following tasks using necessary bench work operations.

1. Measure the stock using proper tools.
2. Lay out according to the drawing.
3. Cut within the given dimension.
4. File and make it smooth.
5. Drill according to given dimension
6. For this operation you have given 2Hour and you are expected to operation.

- **Tools and requirement:**

1. drill bit
2. center punch

- **Precautions:** Measure at least three times before punching

- **Procedures in doing the task**

Adjust safety glass shields on the grinder to permit clear vision of the part

Step1- to be ground and still protect the operator from flying particles.

Step 2- Dress grinding wheel with dressing tool.

Step 3- Hold drill bit against face of wheel at 59° angle on cutting lip.

Step 4- Carry drill bit up the wheel face by dropping end and rotating very slightly in a clockwise direction.

Step5- Make slow deliberate strokes, the full width of the cutting lip.

Step 6- Do not lower cutting lip below the horizontal position as this will round the cutting edge.

Step 7- When one lip is ground, rotate the drill one half turn and grind the other lip.

Step 8- Use tool gauge to check equal lengths of lips, 59° angle cutting lip and 12-15⁰ lip

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clearance.

Step 9- Test bit by boring hole in mild steel plate.

Step 10- Stop while drilling, turn drill press in reverse direction to release drill bit from hole.

Step 11- Make grinding corrections on drill bit as indicated by hole.

Step 12- Submit drill bit and metal for evaluation.

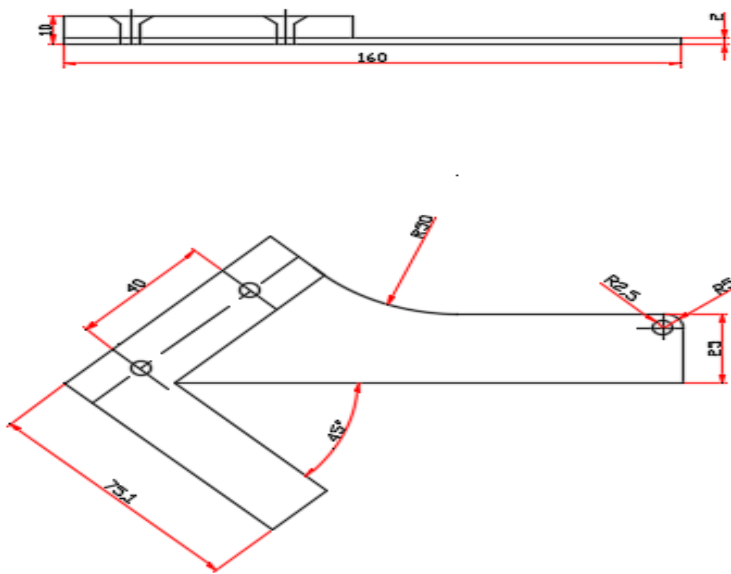


Figure 44 given for operation sheet .6.1

- **Quality Criteria:** the given bench work operation measuring with 0.2 mm accuracy

LAP Test	Practical Demonstration
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Name: _____ Date: _____

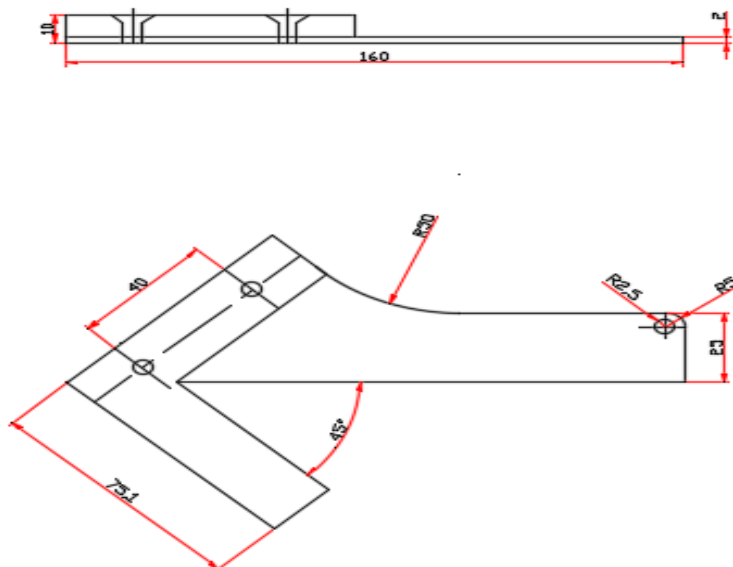
Time started: _____ Time finished: _____

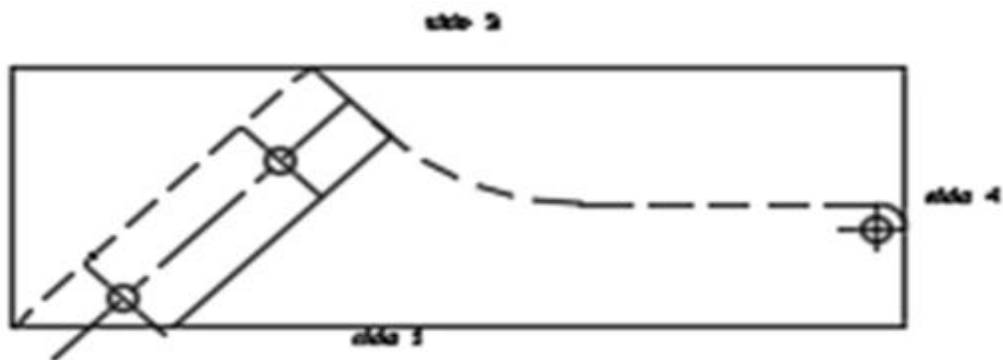
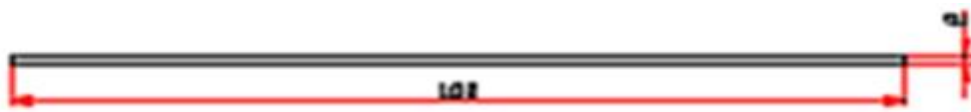
Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **2-5** hours.

Task 1- Perform center punch grinding operation with its correct point angle following safety regulation.

Task 2- Sharpen 12mm diameter twist drill bit by using bench type grinder with its appropriate angle.

Task 3- Perform the following tasks using necessary bench work operations.





Unit seven : Quality assure finished component

This unit is developed to provide you the necessary information regarding the following content coverage and topics

- Check component for conformance
- Use appropriate techniques, measuring tools and equipment
 - ✓ Vernier caliper
 - ✓ Micro meter
 - ✓ Straight edge
 - ✓ Gages
- Handle deviations .
- routine maintenance and adjustments out.

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Check component for conformance
- Use appropriate techniques, measuring tools and equipment
 - ✓ Steel rule
 - ✓ Vernier caliper
 - ✓ Micro meter
 - ✓ Straight edge
 - ✓ Gages
- Handle deviations appropriately.
- Caring routine maintenance and adjustments out.

Unit seven : Quality assure finished component

7.1. Check component for conformance

Used to ensure that a manufactured product or performed service adheres to a defined set of quality criteria or meets the requirements of the client or customer.

It involves testing of units and determining if they are within the specifications for the final product. The purpose of the testing is to determine any needs for corrective actions in the manufacturing process. Good quality control helps companies meet consumer demands for better products.

The quality of services or products delivered to customers could be checked using the following three methods.

- Visual inspection
- Physical measurements
- Check against specifications/preferences

Quality inspection are measures aimed at checking, measuring, or testing of one or more product characteristics and to relate the results to the requirements to confirm compliance. This task is usually performed by specialized personnel and does not fall within the responsibility of production workers. There are different types of quality checks. The following are the common types:

- Company Quality Check Policy
- Prototype quality testing
- Failure or stress testing
- Manufacturing quality inspections

Company Quality Check Policy:

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One of the best overall quality control methods is to institute a company-wide quality control policy. This policy should make it clear that product quality is a high priority, and should assign employees tasks for checking product quality at all stages, from design to manufacture and finishing. Giving employees a convenient means of reporting quality problems or defects can lead to early detection and can save money in the long term. After all, it is far more inexpensive to fix a problem with a design at the design stage than repairing or fully discarding completed products with a built-in design.

Prototype quality testing: Testing prototypes is a quality checking method that relies on real-world testing by employees and their families, or by potential customers selected from the general public. Prototype products should be as close as possible to production versions, and users should be asked to fill out surveys or report problems with the product.

For example, if you own a shoe company and want to ensure that your shoes will hold up to real world conditions, you can send employees home with pairs for themselves and their families. After a set period, for example, a month or three months, ask them to bring the shoes back in and answer some survey questions about how often they wore them, what activities they performed in them and how comfortable and supportive they found the shoes.

Failure or stress testing: Failure testing, or stress testing, is one of the most common quality check methods for industrial products. Factories often contain a special area for failure testing, where products are subjected to repeated use and misuse until they fail in some way.

This testing can include subjecting the products to extreme temperatures, submerging electronic devices in water, and crushing or dropping products. Mattress testing, for example, involves repeatedly pressing weights on the mattress to see how it will hold up to wear after a long period.

Failure testing not only gives manufacturers an idea of how much a product can endure, but also gives them knowledge about what the form the failure will take and whether or not the broken product will represent a safety risk.

Manufacturing quality inspections: Continuous quality checking should also occur at the point of manufacturing. Employees who perform quality checks in a factory may look for defects at

several stages of production, or check random samplings of products at the end of the process. Measuring tools can serve to check whether products meet certain quality standards in terms of size or shape, and a simple visual inspection can ensure that no severely flawed products leave the factory.

Factors affecting quality of services or products

The quality of a product may be defined as the sum of number of related characteristics, such as shape, dimension composition, strength, workmanship, adjustment, finish and color.

It is sum-total of features of a product which influence its capacity to satisfy a given need.

Quality of a product consists of the following attributes:

- (a) Appearance of the product
- (b) Product design or planned quality
- (c) Suitability from customer's viewpoint
- (d) Reliability
- (e) Durability
- (f) Degree to which it conforms to the product specifications
- (g) Its marketing and service, etc.

Quality characteristics may be directly measurable, e.g., diameter , volt-age, weight, etc. But some quality features are non-measurable, e.g. blow holes, cracks, dents, etc. Quality is of two types :

(a) Quality of design

refers to the manufacturing specification of the product. It consists of appearance, life, safety, maintenance and other features of product design.

(b) Quality of conformance

implies the degree to which the product actually conforms to the design specification. Quality of conformance is measured by the level of defects in the finished product. Usually, higher quality of design means higher cost while higher quality of conformance means lower total cost. Perfection in any type of quality is rarely possible and it may mean infinite cost Moreover,

exceptionally high quality product may not be accepted in the market unless sufficient number of customers can pay for it.

All business concerns exist to provide goods and services to society. They can be profitable and successful only when the products and services are for use and meet the needs of consumers. Such ‘fitness for use’ of product is known as quality. While deciding the quality of his products, a manufacturer has to reconcile two conflicting trends, viz., customer satisfaction and cost of production.

Higher is the quality greater is the satisfaction of customer. But every improvement in quality means additional costs. It is the responsibility management to build a quality level which provides reasonable customer satisfaction at economical cost. The level of quality ultimately depends upon the type of market (level of customer wants and the price he is willing to pay for). Within a certain range quality level is a management decision taken on the basis of costs and profits.

For example, it may be more profitable to supply a medium-quality item at a low price which people can buy rather than to supply a top quality at a price so high that very few people can afford. Thus, the level of quality has direct relation with customer’s purchasing power. This is the economics of quality.

Quality of a product or service depends upon the following factors

- (i) **Market.** Customer demand, his needs and purchasing power are the main determinants of quality level.
- (ii) **Materials.** The availability of right type of materials is essential for maintaining quality level of finished products. A wide variety of materials may be available but material with right specification has to be used.
- (iii) **Technology.** Nature of technology and machinery used has a direct bearing on product quality. Modern technology, methods and equipment have led to improvements in product quality level.

(iv) Labour. The knowledge and experience of people who design and produce products exercise significant influence on quality level. Competent and trained people can design and manufacture better quality products.

(v) Cost. Cost of quality maintenance and improvement has increased significantly. Increasing competition, growing mechanization and decreasing profit margins may not permit greater expenditure on quality improvements. Scrap and rework losses have become serious.

(vi) Management. The attitude and policy of management towards product quality is important. Some managers tend to be more quality conscious than others.

7.2. Use appropriate techniques, measuring tools and equipment

©This topic discussed under lay out and marking Graduated Measuring Devices

7.2.1. Steel rule.

7.2.2. Vernier caliper

7.2.3. Micro meter

7.2.4. Straight edge

7.2.5. Gages

7.4. Handle deviations .

7.4.1. Introduction to Quality Deviation

Quality deviation is departure from an agreed-upon course, design, mean, or method. The act of deviating; a wandering from the way; variation from the common way, from an established rule, etc.; departure, as from the right course or the path of duty.

It is a departure from standard procedures or specifications resulting in non-conforming material and/or processes or where there have been unusual or unexplained events which have the potential to impact on product quality, system integrity or personal safety.

In manufacturing, a deviation is a notable statistical different in the units being produced. It typically means that there is an increase in product defects or a notable change in product quality that is the same throughout several batches but not in accordance with product designs. Deviations typically present serious problems for manufacturers in terms of both profit and safety. Deviation processes help businesses quickly deal with such issues as effectively as possible.

Deviation can quickly ruin batches that the manufacturer creates. Sometimes the product units that have deviated from the planned model can be recycled, but in many cases the products lead directly to profit losses and increased costs. But having deviation processes in place,

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manufacturers can use both software warning systems and planned emergency actions for employees to quickly stop production and examine the problem when it appears that a deviation is occurring.

Some deviations are subtle and manufacturers discover them only after looking carefully at past periods and production results. In this case, it can be very difficult to discover what is causing the deviation. It could be equipment malfunctions or a single part that needs to be oiled or maintained. It could be the quality of new hydraulic fluid, or the quality of the latest shipment of raw materials. By have a deviation process in place, the business can move through steps designed to pinpoint the exact cause quickly and accurately.

A deviation process will also often include deviation accounts to store a certain expected loss from deviation, which allows the business to keep more accurate books and analyze production more effectively. Of course, sometimes a business also needs to plan for a deviation, if a supplier wants a batch of products with a particular difference. The process will also make room for these plans.

Causes of Quality Deviation

Minor Deviations

When the deviation does not affect any quality attribute, a critical process parameter, or an equipment or instrument critical for process or control, it would be categorized as Minor, and treated as such by the applicable procedure. Possible examples of minor deviations (*) are given below:

- Skip of FEFO principle (first expired-first out) in raw material handling.
- Balance out of tolerance used to determine gross weight of raw materials upon reception.
- Pressure differential out of established limits in class D washing area.
- Inadequately trained personnel to perform warehouse cleaning activities.

Major Deviations

When the deviation affects a quality attribute, a critical process parameter, an equipment or instrument critical for process or control, of which the impact to patients (or

personnel/environment) is unlikely, the deviation is categorized as Major requiring immediate action, investigation, and documented as such by the appropriate SOP. Possible examples of major deviations (*) are given below:

- Use of unapproved reference standard to test an API or drug product.
- Inadequately trained personnel to perform sterility tests.
- Production started without line clearance.
- Filter integrity test has been carried out using equipment with no documented installation qualification completed.
- Gross misbehavior of staff in a critical aseptic process.
- Pressure differential out of established limits in aseptic fill areas.
- Operational parameter out of range for a parameter defined as non-critical.
- Untrained personnel responsible for segregating the approved and rejected raw material in the warehouse

Critical Deviations

When the deviation affects a quality attribute, a critical process parameter, an equipment or instrument critical for process or control, of which the impact to patients (or personnel or environment) is highly probable, including life threatening situation, the deviation is categorized as Critical requiring immediate action, investigated, and documented as such by the appropriate SOP.

Possible examples of critical deviations (*) are given below:

- Expired or rejected API component used.
- Sterilization record of product-contact material used in aseptic filling process not available or unacceptable.
- Incomplete inactivation stage of fermentation.
- Temperature out of control limit during detoxification stage.

Different Levels of Deviation Risks:

For the ease of assessing risk any deviation can be classified into one of the three levels 1, 2 & 3 based on the magnitude and seriousness of a deviation.

Level 1: Critical Deviation

Deviation from Company Standards and/or current regulatory expectations that provide immediate and significant risk to product quality, patient safety or data integrity or a combination/repetition of major deficiencies that indicate a critical failure of systems

Level 2: Serious Deviation

Deviation from Company Standards and/or current regulatory expectations that provide a potentially significant risk to product quality, patient safety or data integrity or could potentially result in significant observations from a regulatory agency or a combination/repetition of "other" deficiencies that indicate a failure of system(s).

Level 3: Standard Deviation

Observations of a less serious or isolated nature that are not deemed Critical or Major, but require correction or suggestions given on how to improve systems or procedures that may be compliant but would benefit from improvement (e.g. incorrect data entry).

Types of Deviations

- Production Deviation - usually raised during the manufacture of a batch production.
- EHS Deviation - raised due to an environmental, health and safety hazards.
- Quality Improvement Deviation - may be raised if a potential weakness has been identified and the implementation will require project approval.
- Audit Deviation - raised to flag non-conformance identified during internal, external, supplier or corporate audits.
- Customer Service Deviation - raised to track implementation measures related to customer complaints.
- Technical Deviation - can be raised for validation discrepancies. For example: changes in Manufacturing Instruction.

- Material Complaint - raised to document any issues with regards to non-conforming, superseded or obsolete raw materials/components, packaging or imported finished goods.
- System Routing Deviation - raised to track changes made to Bill of materials as a result of an Artwork change

Investigation and reporting deviations

Deviation investigations are one of the most important quality activities in any GMP (good manufacturing practice) organization. Clearly, many organizations have room to improve in the writing and managing of **deviation investigations**.

Check During The Deviation Assessment:

QA delegate has to conduct a primary Investigation on the deviation reported and evaluate the following information

1. Scope of the deviation - batch affected (both in-process and previously released)
2. Trends relating to (but limited to) similar products, materials, equipment and testing processes, product complaints, previous deviations, annual product reviews, and /or returned goods etc where appropriate.

- A review of similar causes.
- Potential quality impact.
- Regulatory commitment impact.
- Other batches potentially affected.
- Market actions (i.e. recall etc)

The aim of the reporting process is to establish whether project objectives have been achieved, what resources have been expended, what problems have been encountered, and whether the project is expected to be completed on time and within budget. If performance is sufficient the project will receive payment from the programme for costs incurred, paid and reported.

7.5. routine maintenance and adjustments out.

ABRASIVE WHEELS Maintenance

- Handle wheels with care at all times; they break easily.

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- Do not grind on sides or corners of wheel, unless it is impossible to grind the job at hand on the face of the wheel. This rule should be observed, due to the difficulty of dressing the sides of the wheel.
- When mounting wheel on spindle observe the following precautions

Truing: Removal of material from cutting face of a wheel so surface runs true.

Dressing: Restoring sharpness of a wheel face which is "loaded" or dulled

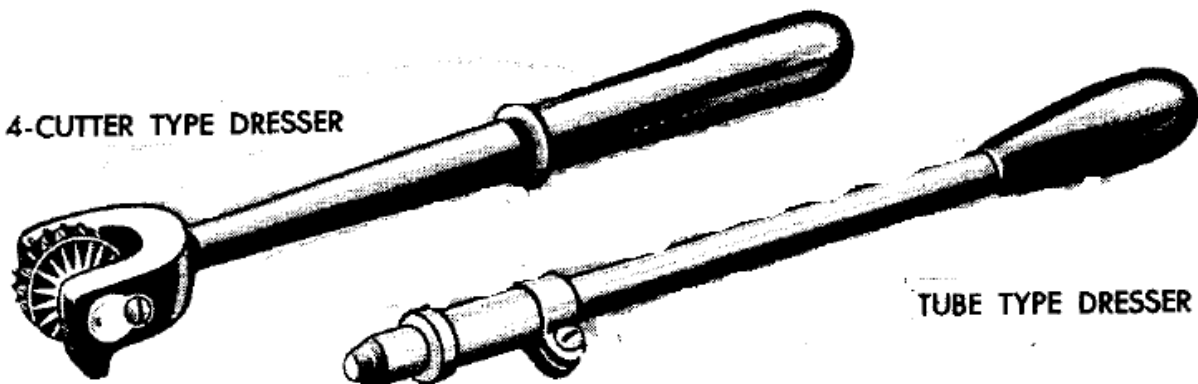


Figure 7.1 Dresser

Measuring Tools Maintenance

the proper care of measuring tools so important? Some of the benefits include the following.

- **Increase accuracy:** If measuring tools don't receive proper care and maintenance, they're more likely to take inaccurate readings. A wide variety of factors can impact the accuracy of a measuring tool, from improper storage temperature to excessive vibrations to physical damage due to dropping it. Because damage or improper maintenance can affect accuracy, it's crucial that you're careful to maintain them properly. A measuring instrument can also fall out of calibration naturally over time, so regular gage calibration is essential.
- **Extend life:** Caring for precision tools properly also helps extend their life. With proper care, many measuring instruments can serve you well for a long time. Without adequate maintenance, however, your tools will break sooner, and you'll have to replace them earlier. Improper care increases the risk of a tool failing in the middle of a job or gradually becoming less effective, reducing the efficiency and accuracy of your work.

- **Lower costs:** Following the right care and maintenance procedures can help you reduce your costs over the long term. It can help you avoid costly breakdowns, more extensive repairs and downtime. It also means you'll have to replace your tools less often, meaning you get more out of your investments in quality instruments.

General MAINTENANCE

Calipers are precision instruments and must be used and handled with care at all times. Wipe perspiration and finger prints from them with a soft cloth; if neglected, this may cause rust. Do not force threaded parts. Use touch measurement. Do not spring or clamp calipers. Keep in case or wrap in soft cloth when not in use.

Lubrication

Oil threaded and moving parts and friction surfaces (firm joint calipers) with preservative lubricating oil (special). Coat non operating surfaces with a film of preservative lubricating oil(special).

Cleaning, Inspection, and Repair

1. Disassemble caliper and wash parts in dry cleaning solvent. Dry with a clean, soft cloth.
2. Inspect all threaded parts to be sure all dirt is removed. Scarcely visible particles may cause uneven thread motion and binding.
3. Inspect parts to see if they are rusted, corroded, burred, bent, or worn. Scour with crocus cloth to remove rust or corrosion. Replace parts which are bent, broken, or worn.
4. Lubricate parts as instructed above, and reassemble caliper.

Repair Bent Firm Joint or Spring Caliper

If leg is bent, place caliper on soft metal block. Straighten bent leg to original shape by tapping with brass hammer. Replace bent adjusting screws.

Adjustment of Micrometer

To compensate for thread wear, screw thimble from barrel. Tighten thread play adjustment nut on fixed nut a fraction of a turn at a time. Test fit of micrometer screw in fixed nut. Repeat tightening and test until operation is free from both binding and play.

NOTE: Some micrometers have an automatic spring-controlled thread play adjustment.

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Testing Micrometer

Clean measuring faces with a soft cloth. Examine faces after cleaning and remove any lint deposited by cleaning cloth. Measure length of micrometer test gage of same length as minimum capacity of micrometer. Micrometer should read its exact minimum capacity. For 0-1 inch micrometer, screw thimble down until spindle contacts anvil. Do not force thimble. Reading should be 0.000 inch.

Measure length of a micrometer test gage of same length as maximum capacity of micrometer. Micrometer should read its exact maximum capacity.

Check inside micrometers against outside micrometers or gage blocks.

If in checking it is found that micrometers do not read correctly refer to proper authority for adjustment. Never use inaccurate micrometers.

Misuses

Never use micrometers with dirty anvil and/or threads. Dirt on micrometer anvil gives incorrect readings. Dirty threads cause excessive wear and eventually inaccurate readings.

Do not carry micrometers in a pocket of work clothes, as dirt from the pocket works into the threads.

Keep micrometers in a covered box on the job and wipe anvil and spindle clean with a soft, slightly oiled rag each time after using and before returning them to their places in the box. Keep cover closed to protect micrometers from dirt and grinding dust.

General-All Clamps

These are relatively heavy-duty but simple tools. Maintenance requirements are few:

Keep screws lubricated with small quantity of preventive lubricating oil (special) or engine oil (SAE 10). Excessive lubricant interferes with use of tool. Keep metal surfaces free of rust. Scour off rust or corrosion with crocus cloth or aluminum oxide abrasive cloth. Coat surfaces with preservative lubricating oil (special) or engine oil (SAE 10).

Varnish hardwood jaws of hand screw clamps whenever finish becomes damaged extensively enough to leave wood without protective coating. Replace all parts broken or damaged beyond repair.

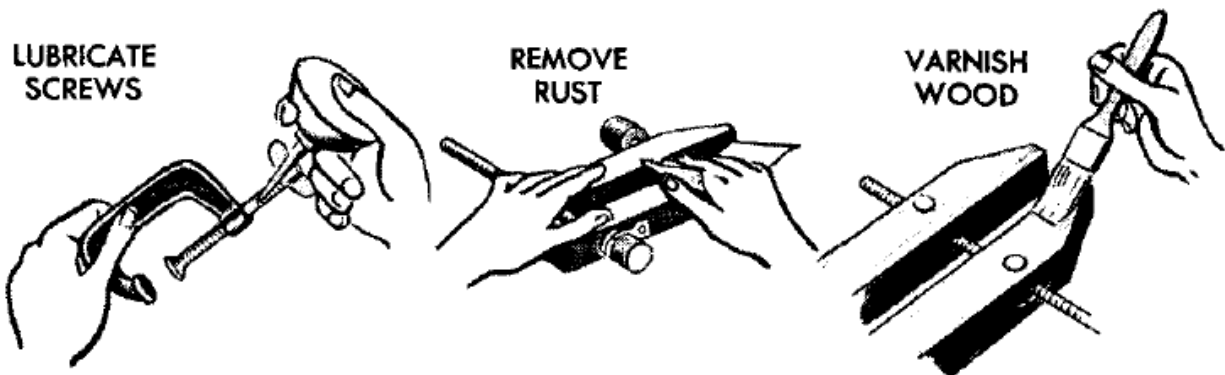


Figure 7.2 lubricate and varnish

Common Misuses and Abuses

Do not use a wrench or bar in tightening clamps. Too much pressure may warp, bend, or break them. Tighten clamps by hand. When applying great pressure, observe clamps for indication of **undue strain**.

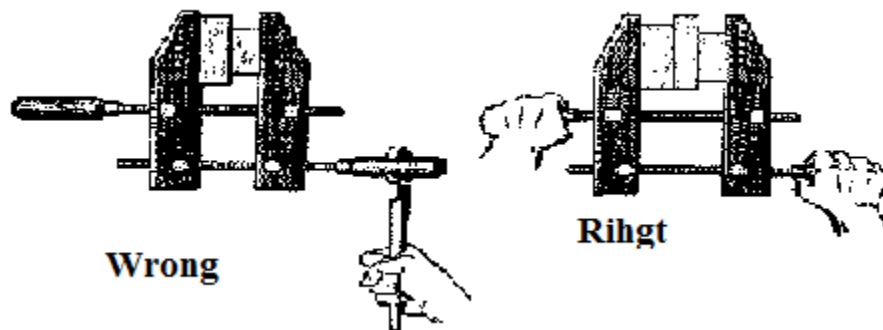


Figure 7.3 Common Misuses and Abuses

Common Misuses and Abuses

Do not strike file against vise or other object to clean it. This practice ruins file teeth and may break file. There is danger from flying particles if file breaks. Clean file with a file card and pin.

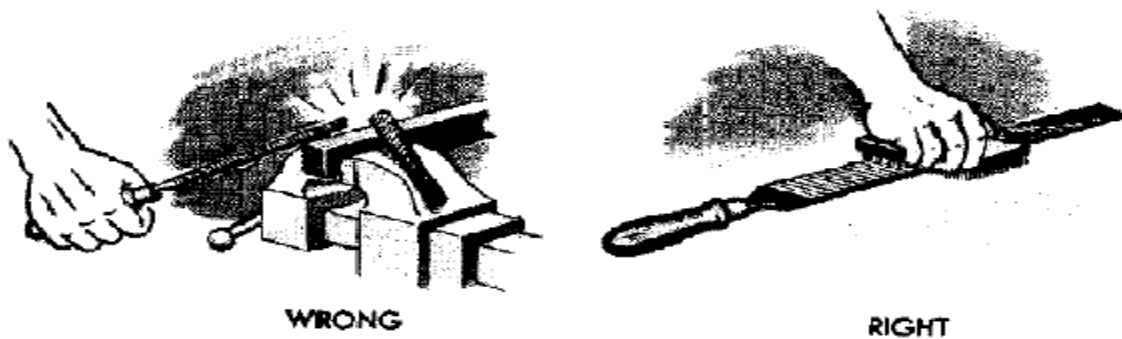


Figure 7.4 Common Misuses and Abuses

Never use a file without a handle. It is dangerous. Install handle before using file for any job, no matter how small.

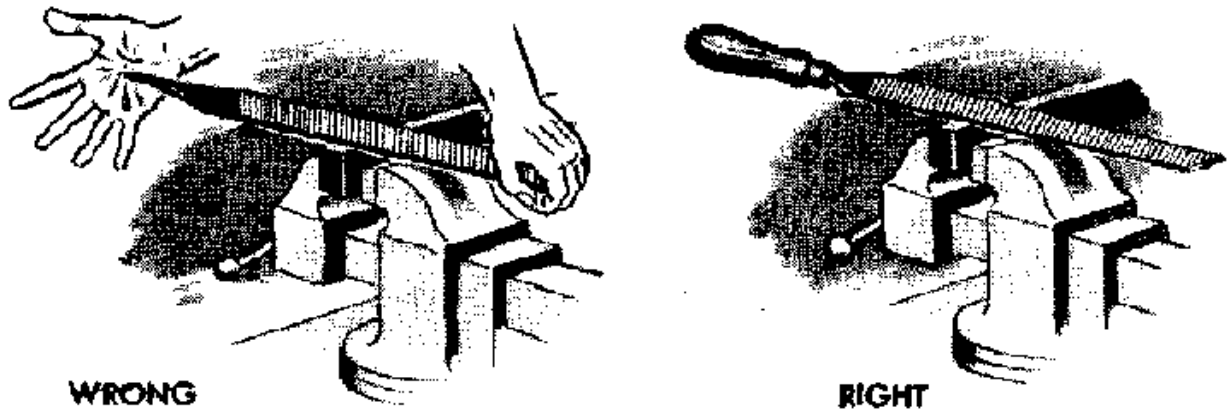


Figure 7.5 Using file with handle and with out

Remove remaining particles from teeth by using a narrow strip of soft metal such as brass or copper. A soft metal will not damage teeth.

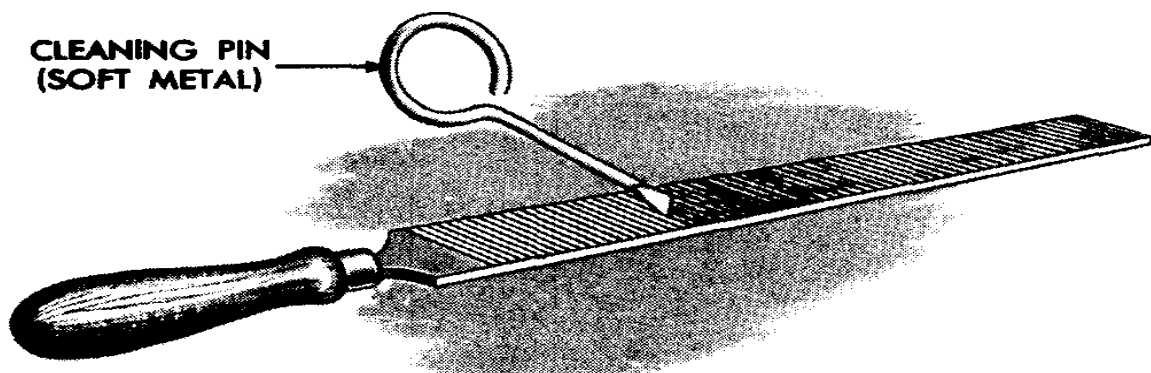


Figure 7.5 File Cleaning

Self-Check -7	Written Test
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Instruction I: Give short answer for the following questions.

1. What are quality checks(2 points).
2. List different types of quality checks(5 points).
3. What are the factors affecting quality of services or products(5 points).

Instruction II filling the blank

1. _____: Removal of material from cutting face of a wheel so surface runs true.
2. _____: Restoring sharpness of a wheel face which is "loaded" or dulled
3. _____ The attitude and policy of management towards product quality is important Some managers tend to be more quality conscious than others

Instruction III Matching

A	B
___1 Modern methods and equipment have led to improvements in product quality level.	A Market
___2 The knowledge and experience of people who design and produce products exercise significant influence on quality level	B Cost
___3 Customer demand, his needs and purchasing power are the main determinants of quality level.	C Technology.
___4 quality maintenance and improvement has increased significantly. Increasing competition, growing mechanization and decreasing profit margins may not permit greater expenditure on quality improvements	D Labour

Reference

CHEA (2001). *Glossary of Key Terms in Quality Assurance and Accreditation*: http://www.chea.org/international/inter_glossary01.html.

4.

5. **ENQA (2005).** *Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG)*: Helsinki, ENQA, originally available at <http://www.enqa.eu/index.php/home/esg/>, accessed 3 January 2017.

6.

7. **Guo, Sheng; Yang, Tao; Gao, Wei; Zhang, Chen (2018).** A Novel Fault Diagnosis Method for Rotating Machinery Based on a Convolution Neural Network". *Sensors*. 18 (5):

1429. doi:10.3390/s18051429. PMC 5982639. PMID 29734704.

8. **Hoang, Duy-Tang; Kang, Hee-Jun (March 2018).** *Rolling element bearing fault diagnosis using convolutional neural network and vibration image; Cognitive Systems Research*. 53: 42–50. doi:10.1016/j.cogsys.2018.03.002.

9.

10. <http://www.businessdictionary.com/definition/activity.html>

11. http://www.simondssaw.com/handfiles/hand%20files%20publications/_simonds-

file%20catalog.pdf

Refer: <https://www.youtube.com/watch?v=KjRyy5lhHZo>

Refer: <https://www.youtube.com/watch?v=-jLcA5z99r8>

Refer: <https://www.youtube.com/watch?v=T5hIXPBGBgw>

Participants of this Module (training material) preparation

N o	Name	Qualifica tion (Level)	Field of Study	Organization/ Institution	Mobile number	E-mail
1	Meseret W/Mariam	A(MSC)	Manufacturing	Wolkite polytechnic college	0912117416	Bmesi2007@gmail.com
2	Solomon Negtu	A(MSC)	Manufacturing	Harer polytechnic college	0912762152	solonnigatu@gmail.com
3	Kibru Getahun	B(BSC)	Manufacturing	M.G.M.B. polytechnic college	0912370975	bmkibru@gmail.com
4	Efrem Kebede	B(BSC)	MAT	Batu polytechnic college	0910410054	Efremkebede27@gmail.com
5						
6						
7						

