GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

REMOTE LEARNING ACTIVITY BOOK

(RELAB)

SUBJECT: FITTING & MACHINING

GRADE: 10

TEACHER GUIDE

INTRODUCTION AND PURPOSE OF THE RELAB

The Covid 19 pandemic has caused serious impact to schooling resulting in major learning loss and instructional time. This scenario has resulted in school implementing rotational timetables-where learners attend school on alternate days or weeks. The Remote Learning Activity Book was conceptualized to engage learners in constructive learning on days they are at home. Hence the RELAB was developed as a strategy to enhance remote learning.

The RELAB is underpinned by the following Legislative demands:

a) Responding to GDE Strategic goal 2 promoting quality education across all classrooms and schools
b) **DBE Circular S13 of 2020** the requires the GDE to support the implementation of the Recovery Annual Teaching Plan (RATP)
c) **GDE Circular 11 of 2020** requiring districts to issue Learning Activity Packs to support schools for lockdown learning. Understanding learning constraints at home as majority of learners do not have access to devices or data to use for online learning. Many households are depending on schools to provide them with learning resources packs

RELAB is designed as workbook with activities based on the Revised Annual Teaching Plan. The exercises are pitched at a standard to expose learners at Grade 10 & 11 to content at different cognitive levels. The NSC diagnostic reports in different subjects have revealed that learners fail to analyse questions and as a result fail to respond accordingly.

The RELAB is intended to ensure that learners work on exercises that consolidate and reinforce topics taught while at school. These exercises are be completed at home and would receive feedback as groups or individually when at school. It is therefore of paramount importance that teachers assess the work with learners in class, as a way of providing constructive feedback. Teacher are also required to diagnose learner responses, remediate where necessary and plan further intervention.

Educators are encouraged to create whatsapp groups to remind learners on what is expected of them in a particular week/ day(s). Effective utiisation of the RELAB activity book would further ensure that all topics in the RATP are covered simultaneously. Feedback from learners at home will confirm usage of the RELAB material and assist to prepare learners for formal assessments.

FITTING & MACHINING - TOPICS

1. **Safety – Generic**
2. **Safety- Generic**
3. **Tools – Generic**
4. **Tools – Generic**
5. **Machining- Specific**
6. **Joining Methods - Generic**
7. **Forces- Generic**
8. **Maintenance – Generic**
9. **Materials- Generic**
10. **Systems and Control - Drive Systems**
11. **Terminology- Machining**

GRADE 10 FITTING AND MACHINING

EXPECTED ANSWERS

SAFETY -Question 1 and 2
Below is a rubric to assess the essay question on HIV and Aids.

Level of Achievement	General Approach	Comprehension
Exemplary **(10 pts)**	•Addresses the question. •States a relevant, justifiable answer. •Presents arguments in a logical order. •Uses acceptable style and grammar (no errors).	•Demonstrates an accurate and complete understanding of the question. •Backs conclusions with data and warrants. •Uses 2 or more ideas, examples and/or arguments that support the answer.
Adequate **(6 pts)**	•Does not address the question explicitly, although does so tangentially. •States a relevant and justifiable answer. •Presents arguments in a logical order. •Uses acceptable style and grammar (one error).	•Demonstrates accurate but only adequate understanding of question because does not back conclusions with warrants and data. •Uses only one idea to support the answer. •Less thorough than above.
Needs Improvement **(3 pts)**	•Does not address the question. •States no relevant answers. •Indicates misconceptions. •Is not clearly or logically organized. •Fails to use acceptable style and grammar (two or more errors).	•Does not demonstrate accurate understanding of the question. •Does not provide evidence to support their answer to the question.
Not Answered well. Poor attempt (1 pts)		

Question 3

Should there be an emergency, that mean somebody got hurt or seriously hurt, that immediate attention can be given to the wound before professional help can be obtained.

Question 4

- Adhesive Plaster Strips
- Bandage
- Cotton Wool
- CPR Resuscitation Barrier Device
- First Aid Dressing
- Gauze Swabs
- Gloves
- Gloves
- Scissors (General)
- Splints
- Tweezers (Metal)
- Wound Cleaner
- Any other that may not appear in this memorandum

Activity 5.1 - Multiple-choice questions

5.1.1. d

5.1.2. a b c

5.1.3. b c

5.1.4. d

5.1.5 a

5.1.6. a

5.1.7. c

5.1.8. b

5.1.9. d

5.1.10. a

5.1.11. b

Activity 5.2 – True or False

5.2.1. True

5.2.2. True

5.2.3. False

5.2.4. True

5.2.5. True

5.2.6. False

5.2.7. True

5.2.8. False

5.2.9. True

5.2.10. False

Activity 5.3.

5.3.1 The Occupational Health and Safety Act aims to provide for the health and safety of persons at work and for the health and safety of persons in connection with the activities of persons at work and to establish an advisory council for occupational health and safety.

5.3.2 Any five of the following:

- the right to life
- freedom from torture and degraded treatment
- freedom from slavery and forced labour
- the right to liberty
- the right to a fair trial
- the right not to be punished for something that wasn't a crime when you did it
- the right to respect for private and family life
- freedom of thought, conscience and religion
- freedom of expression
- freedom of assembly and association

- the right to marry or form a civil partnership and start a family
- the right not to be discriminated against in respect of these rights and freedoms
- the right to own property
- the right to an education
- the right to participate in free elections

5.3.3. Any of the following:

- emails
- internet access
- telephone calls
- data
- images

5.3.4. FIVE responsibilities of the employer:-

- Provide and maintain systems of work, plant and machinery that are safe and without risks to health.
- Take steps to eliminate or reduce any danger or potential hazard to the safety or health of employees.
- Make arrangements to ensure the safety and absence of risks to the health of employees in connection with the production, processing, use, handling, storage or transport of articles or substances.
- Provide training and supervision as may be necessary to ensure the health and safety at work of the employees.
- Ensure that work is performed and that plant or machinery is used under the general supervision of a person trained to understand the hazards associated with it and who has the authority to ensure that precautionary measures taken by the employer are implemented.

FIVE responsibilities of the employee:

- Ensure the health and safety of themselves and of other persons who may be affected by their acts.
- As regards any duty or responsibility imposed on the employer or any other person by this Act, co-operate with such employer or person to enable that duty or responsibility to be performed or complied with.

- Carry out any official order given to them, and obey the health and safety rules and procedures laid down by the employer or by anyone authorised by their employer, in the interest of health or safety.
- If any situation which is unsafe or unhealthy comes to their attention, report such situation to their employer or to the health and safety representative as soon as possible.
- If they are involved in any incident which may affect their health or which has caused an injury to them, report such incident to their employer or to anyone authorised by the employer, or to their health and safety representative, as soon as possible.

5.3.5. Good housekeeping in a workshop simply means an orderly arrangement of tools, equipment, operations, storage facilities and materials. To put it in simpler words, housekeeping can be defined as everything in its place and a place for everything.

5.3.6.

- Equipment and materials are stored in their proper places
- The first aid kit is easily accessible and contains the necessary medical items.
- Fire extinguishers are maintained and in good working order.
- Warning signs are visible and easily understood.
- Areas containing machinery are demarcated and clean
- Walking path are clearly indicated and obstacle free
- Places where mortar, plaster or cement is mixed are thoroughly cleaned after use.
- Poisonous materials are safely stored and used.
- Sharp objects are used with caution.
- Games and jokes are prohibited in the workplace.
- Smoking and drinking are prohibited in the workplace.
- Any materials or liquids that are spilled are immediately cleaned
- Any damaged or broken tools or machinery are immediately repaired.

5.3.7.

- Physical hazards are the most common hazards and are present in most workplaces at some time. Examples include: frayed electrical cords, unguarded machinery, exposed moving parts, constant loud noise, vibrations, working from ladders, scaffolding or heights, spills, tripping hazards.
- Ergonomic hazards occur when the type of work you do, your body position and/or your working conditions put a strain on your body. They are difficult to identify because you don't immediately recognize the harm they are doing to your health. Examples include: poor lighting, improperly adjusted workstations and chairs, frequent lifting, repetitive or awkward movements.
- Chemical hazards are present when you are exposed to any chemical preparation (solid, liquid or gas) in the workplace. Examples include: cleaning products and solvents, vapours and fumes, carbon monoxide or other gases, gasoline or other flammable materials.
- Biological hazards come from working with people, animals or infectious plant material. Examples include: blood or other bodily fluids, bacteria and viruses, insect bites, animal and bird droppings.

5.3.8.

- Plan the arrangement of the machines and worktables to ensure enough space to manoeuvre.
- Calculate the number of machines and workshop accessories.
- Calculate the number of workers (people) in the workshop.
- Are there enough electrical circuits to supply your power needs.
- Plan and design the storage place.

5.3.9. An accident is an unfortunate incident that happens unexpectedly and unintentionally, typically resulting in damage or injury.

5.3.10.

- Defective tools, equipment or supplies.
- Inadequate supports or guards.
- Congestion in the workplace.
- Inadequate warning systems.
- Fire and explosion hazards.
- Poor housekeeping.
- Hazardous atmospheric condition.
- Excessive noise.
- Poor ventilation.
- Rough and slippery floors
- Insufficient light in a workshop
- Badly planned workshop

5.3.11.

- Operating without qualification or authorization.
- Failure to tag out/lockout.
- Operating equipment at unsafe speed.
- Failure to warn.
- Bypass or removal of safety devices.
- Using defective equipment.
- Use of tools for other than their intended purpose.
- Working in hazardous locations without adequate protection or warning.
- Improper repair of equipment.
- Horseplay.
- Wearing unsafe clothing.
- Taking an unsafe position.

5.3.12.

COLOUR	**MEANING OR PURPOSE**	**INSTRUCTION & INFORMATION**
RED	Prohibition/Danger alarm	Dangerous behavior; stop; shutdown; emergency cut-out devices; evacuate
YELLOW or **AMBER**	Warning	Be careful; take precautions; examine
BLUE	Mandatory	Specific behavior or action e.g. wear personal protective equipment
GREEN	Emergency escape; first aid. No danger	Doors; exits; escape routes equipment and facilities Return to normal
RED(fire-fighting signs)	Firefighting equipment	Identification & location

5.3.13.

	SIGN	DESCRIPTION	COLOUR
What the group name of this type of signs: ***Information Signs***		First aid equipment	White on green background
		Eye wash	White on green background
		Emergency telephone	White on green background
		Escape Route Right	White on green background
		Eye wash	White on green background

	SIGN	DESCRIPTION	COLOUR
What is the group name of this type of signs: ***Safety***		Electric shock hazard	Black border with a yellow centre and a black symbol inside
		Warning of fire hazard	Black border with a yellow centre and a black symbol inside

	SIGN	DESCRIPTION	COLOUR
		Warning of slippery surface	Black border with a yellow centre and a black symbol inside
		Ionizing radiation hazard	Black border with a yellow centre and a black symbol inside
		Suspected loads hazard	Black border with a yellow centre and a black symbol inside

	SIGN	DESCRIPTION	COLOUR
What is the group name of this type of signs: **Prohibition Signs**		Proceeding beyond this sign is prohibited	White on red background
		Loose clothing, ties, jewelry and unconfined long hair prohibited	Red sign with black symbol
		Use of compressed air to dust body prohibited	Red sign with black symbol

	SIGN	DESCRIPTION	COLOUR
		Thoroughfare for pedestrians prohibited	Red sign with black symbol
		Drinking of this water prohibited	Red sign with black symbol

	SIGN	DESCRIPTION	COLOUR
What is the group name of this type of signs: ***Fire Safety Signs***		Location of fire blanket	Red on white background
		Location of fire- fighting equipment	Red on white background
		Fire extinguisher	Red on white background
		Fire hose	Red on white background

	SIGN	DESCRIPTION	COLOUR
		Fire hydrant	Red on white background

	SIGN	DESCRIPTION	COLOUR
What is the group name of this type of signs: ***Regulatory Signs***		Eye protection	White on blue background
		Respiratory protection	White on blue background
		Hearing protection	White on blue background
		Hand protection	Hand protection
		Keep area clean	White on blue background

Activity 5.4

5.4.1. All the electrically operated equipment must have a disconnecting device, to make it easy to break the circuit in case of emergency. Where the main switch must be placed on an electrical machine?

The main switch (Double Pole Single Throw Switch - DPST) is on an electrical machine it must be on the front panel of the machine.

5.4.2. All domestic installation must have a disconnecting device, to make it easy to break the circuit in case of emergency. Where the main switch of a domestic installation must be placed?

The main switch (Double Pole Single Throw Switch - DPST) of a domestic installation must be placed at the point of the entry of the main power supply.

5.4.3. Briefly describe what is meant by critical and non-critical emergencies.

- Non Critical Emergencies – It is a condition not in a state of crisis or emergency
- Critical Emergencies – It is a situation in a state of crisis or emergency

5.4.4.

- Class C: electrical fires - Class C fires are contained using Carbon Dioxide (CO2) fire extinguishers and Dry Chemical fire extinguishers

5.4.5.

- Faulty electricity
- Heated surfaces.
- Lightning
- Friction
- Static electricity

5.4.5.

- Class A: wood, paper, etc.
- Class B: flammable liquids such as petrol, oil and paraffin.
- Class C: electrical fires.
- Class D: flammable metals such as magnesium, lithium, etc.

Activity 5.5

5.5.1.

(a) Struck by lightning
(b) Mixing water with electricity
(c) Touching a high voltage source such as a high tension wires fell during storm
(d) Touching a low voltage, current source such as an electric socket or worn or bare electrical wire.

5.5.2.

(a) Look first, do not touch the victim.
(b) Turn the source of electricity at the control panel or fuse box
(c) Pull the victim away from the source by means of non-conductive material such as dry wood if the victim is under immediate danger.
(d) Do not remove the victim unless the he is under immediate danger.
(e) Check for signs of circulation. If absent begin cardiopulmonary resuscitation (CPR) immediately.
(f) Prevent shock by lying the victim down with his feet slightly higher than the head.
(g) Cover the victim with a blanket to maintain body heat.
(h) Call for help.

5.5.3.

- On hearing the evacuation alarm, immediately prepare to leave the building. Secure confidential materials and valuables, collect personal belongings, shut down experiments, and switch off computers, electrical appliances, equipment and machinery.
- If the evacuation alarm sounds, or if instructed to do so, leave the building by the nearest and safest exit route. All doors should be closed (but not locked) on leaving.
- If possible take hand held personal belongings (such as handbags and briefcases) with you when you leave. Do not return to collect belongings.
- Assist any person with a disability to leave the building. Do not attempt to carry people down stairs.

- Walk quickly and calmly to the designated assembly area for your building.
- DO NOT USE THE LIFTS
- Remain at the assembly area (in groups) until instructed to leave by Rescue Services personnel.
- Do not re-enter the building until informed that it is safe to do so by Rescue Services personnel. Do not enter a building in alarm

5.5.4.

Ventilation is one of the most important engineering controls available to the industrial hygienist for improving or maintaining the quality of the air in the occupational work environment.

5.5.5.

- Always wear an apron when working with ferric chloride because it will stain your clothes on contact.
- Protective glasses are essential, as any chemical that comes into contact with your eyes may possibly lead to blindness. Also wear protective glasses during the drilling process.
- Use gloves when doing the etching. The chemical will stain the skin and can cause skin irritations.
- Work in a well-ventilated room.
- Store all used ferric chloride in a big plastic container, with a lid, that can be disposed of by a special waste removal company when full.
- Never work in metal containers; rather use plastic or ceramic. Ferric chloride attacks most metals.

6.1.

6.1.1.

- When using any tool, always wear safety glasses for eye protection.
- Screwdrivers should only be used for their intended purpose—driving or removing screws. Screwdrivers should never be used for prying, punching, chiselling, scoring or scraping.
- While both slotted and cross-slotted screwdrivers will fit many fastener sizes, it is best to use screwdrivers of the proper sizes that fit snugly into the slot or recessed portion of the fastener head.
- Plastic handles should be made of fire and heat resistant materials. If properly designed, they give excellent grip. Rubber or vinyl is often used as a non-slip or insulating cover on plastic handles.
- Typical screwdriver handles will not insulate the user from electric current.
- It is time to discard the tool when the handle of a screwdriver becomes worn or breaks, if the tip is damaged or if the shaft is bent.
- Always keep the screwdriver shank in line with the screw shank. This will avoid damaging the screw slot and pushing the screw out of line.
- Never use pliers for added turning leverage on the shank of a screwdriver. However, a wrench may be used on square-shank drivers.
- Screwdriver slippage can cause injury. Never hold the piece you’re working on in your hand while driving or loosening screws or bolts. Place it on a work surface and use a vice or a clamp to hold the material, whenever possible.
- Never carry a screwdriver in your pocket. The tip of the screwdriver is so sharp and hard that will hurt your body.

6.1.2.

- Always inspect the hammer before use. Loose hammer heads or nails stuck in the claw might fly off and cause injury.
- If a hammer head is loose on the handle, immediately take it to the instructor.
- Never use a hammer to anything but unhardened nails and nail sets; use a ball-peen hammer for still chisels and punches
- Never strike two hammers together. The faces are very hard and a blow might cause a chip to break off and fly out at a high speed.
- Knuckles can be injured if you “choke up” too far on a hammer when striking a blow.
- Unless the blow is truck squarely the hammer ma bounce off the work and cause injury.
- Place a hammer on the bench carefully; a falling hammer can cause serious injury.

6.1.3.

- Never use a file without a handle. Painful injuries may result.
- Use a file card to clean the file, NOT your hand. The chip can penetrate your skin and cause a painful infection.
- Files are very brittle and should never be used as a pry.
- Use a piece of cloth to wipe the surface being filed. Short burrs are formed in filing and can cause serious cuts.
- Never hammer on or with a file, it may shatter and ships fly in all directions.

6.1.4.

- All work being cut must be clamped properly to the table.
- Maintain a margin of safety, keeping your hands and fingers at a safe distance from the blade.
- Always concentrate on your work; becoming distracted can cause injuries.

6.1.5.

- Read and follow the manufacturer’s instructions and warning labels.
- Wear personal protective equipment that is appropriate for the hazards you may be exposed to while performing the required task.
- Ensure the work area is clear of debris.
- Ensure there is adequate lighting in the work area.
- Oil pliers and wire cutters regularly. A drop of oil on the hinge will make the tool easier to use. Pull on pliers; do not push away from you when applying pressure. If the tool slips unexpectedly, you may lose your balance or hit your hand against something.
- Cut material at right angles.
- Do not expose pliers or wire cutters to excessive heat.
- Do not hammer on pliers or wire cutters to cut wires or bolts.

6.1.6.

- Use utility pliers to grip round, square, flat and hexagonal objects.
- Ensure that toothed jaws are clean and sharp.
- Greasy or worn jaws can result in compromised safety.
- Such tools also require increased force to hold the workpiece. Inspect the tool for damage prior to each use.
- Ensure the tool is in good working condition.
- Do not expose pliers or wire cutters to excessive heat.
- Do not use pliers on nuts and bolts; use a wrench.

6.1.7.

- Steel rules are precision measuring instruments.
- Don’t use your steel rule as a scraper, screwdriver or pry bar.
- Don’t drop it or bang it around.
- Keep your steel rule very lightly oiled.
- Inspect your steel rule periodically.
- Be sure that it is not bent or dented.
- Check that the corners are square and sharp.
- Be sure there are no burrs anywhere on the steel rule. If you find any of these problems, replace your steel rule.

6.1.8.

- Take special care with these sharp pointed tools.
- Never use one of these tools in place of the other.
- Each tool has a specific duty, be sure to use the proper tool for the proper activity.

6.2.

- Choose the correctly sharpened drill for the type of work you need to do and the material you are about to drill.
- Do not leave the key in the chuck when you are not at the machine
- Never leave the machine running if unattended
- Clamp the workpiece securely to the table and do not hold it by hand
- Never attempt to stop the workpiece by hand if it slips from the clamp
- A drill should run at the correct speed for the job
- Do not force the drill into the workpiece – this may cause broken or splintered drills and may cause injury
- Use a brush or wooden rod to remove chips from the drill – and not your fingers, waste or rags
- When reaching around a revolving drill, be careful that your clothes do not get caught in the drill or chuck

7.1.1.

- Make sure that all guards are in place.
- Do not use a machine or come close to its moving parts while wearing loose clothing such as ties, unbuttoned sleeves, etc. and keep any cleaning material such as waste and rags away from rotating parts.
- See that there is no oil or grease which can cause slipping on the floor around the machine.
- Spanners or keys must never be left on rotary parts. Always disconnect, remove or stand clear of hand wheels, levers or chuck keys before setting machine or feeds in motion. Never apply a wrench to revolving work or parts.
- Select the correct tool for the job.
- Work pieces and holding devices must always be clamped safely and firmly. Pay special attention when fitting spanners and keys as a loose fit may cause slips, resulting in injury to your arm or hand.
- Do not use your hands to remove cuttings while the machine is in motion. Use a wire hook or a brush.
- Never adjust or attempt to adjust the cutting tool while the machine is running.
- Do not lean on the machine at any time. This is very dangerous habit which one does without thinking and can result in serious injury.
- Do not attempt to stop the machine by placing your hand on the chuck while the machine is slowing down.
- Give attention to cutting-fluid control before switching the machine on.

7.1.2.

- Never use the machine unless the guards are correctly fitted.
- See that there is no oil or grease which can cause slipping on the floor around the machine.
- Check that the tool rest is not more than 3 mm from the grinding wheel.
- When setting the machine in motion, never stand in front of the wheel. Before the grinding operation takes place, let it run idle for a few seconds.
- When the wheel is running out of balance, trim it with an emery-wheel dresser.
- Never grind on the side of a straight wheel, use one the face.
- Use various wheels for the purpose for which they are made.
- Do not grind soft materials such as lead, copper, aluminium, etc., on wheels which are not made for such work.
- Never jab grinding matter onto the wheel, but approach it with care.
- Never force grind, so that it stops the motor or slows it excessively.
- Never adjust the tool rest while the machine is running.
- Work pieces and holding devices must always be clamped on safely and firmly
- Never let the wheel stand in cutting fluid, as this may cause it to become out of balance.

7.1.3.

- Select the correct type of wheel for the job.
- Inspect the wheel for cracks and tap it to apply the “ring test”.
- Make sure that the wheel’s speed does not exceed the manufacturer’s recommendation.
- Never force the wheel onto the spindle.
- Use smooth paper washers on each side of the wheel.
- Use true and correctly recessed flanges of the same size and at least one third the diameter of the wheel.
- Gently tighten the grinding wheel with a spanner only enough to hold the wheel firmly.
- Replace guards correctly.
- Stand aside and set the machine in motion. Let the machine idle before you dress the wheel, using an emery-wheel dresser.
- Finally stop the machine and reset the tool rest within 2 mm of the wheel surface.
- Ensure that the tool rest is parallel to the wheel surface.

7.1.4.

- A fixed guard which prevents hands or fingers reaching through, over, under or around the guard into the point of operation.
- A self-adjusting guard which automatically adjusts itself to the thickness of the material being worked and which prevent hands or fingers reaching through, over, under or around the guard into the point of operation.
- See that there is a supporting guard on the machine that will hold the plate down while it is being bent.
- Another safety device is the automatic sweep-away or push-away that pushes any part of the operator's body out of the danger zone when the working stroke starts.
- Today there are electronic presence-sensing devices which stop the working stroke if the device senses any foreign object in the danger zone.

7.1.5.

- See that all the guards are in place.
- See that no oil, grease or obstacles are around the machine.
- Select the correct blade for the material to be cut.
- When changing blades, ensure that the machine is switched off at the main switch.
- When removing or replacing the blade, do it gently. Quick movements, such as pulling the blade off, may result in a severe cut on your hand.
- Do not adjust guides while the machine is running.
- All material must be clamped properly before cutting is started.
- Long pieces off material must be supported at the end.
- Always stop the machine if you leave it unattended.

TERMINOLOGY

1.1.

A. Reading from the main scale 2.3 cm,
reading from the vernier 0.7 mm,
so the length to the nearest tenth of a mm is
2.3 cm + 0.7 mm = 23 mm + 0.7 mm = 23.7 mm

B. Reading from the main scale 1.0 cm,
reading from the vernier 0.2 mm,
so the length to the nearest tenth of a mm is
1.0 cm + 0.2 mm = 1.0 cm + 0.02 cm = 1.02 cm

C. Reading from the main scale 3.1 cm,
reading from the vernier 0.5 mm,
so the length to the nearest tenth of a mm is
3.1 cm + 0.5 mm = 31 mm + 0.5 mm = 31.5 mm

D. Reading from the main scale 0.9 cm,
reading from the vernier 0.1 mm,
so the length to the nearest tenth of a mm is
0.9 cm + 0.1 mm = 0.9 cm + 0.01 cm = 0.91 cm

E. Reading from the main scale 2.6 cm,
reading from the vernier 0.0 mm,
so the length to the nearest tenth of a mm is
2.6 cm + 0.0 mm = 26 mm + 0.0 mm = 26.0 mm
Note that the trailing zero is a significant figure in this case and so is retained.

1.2.

1.2.1. 8,11 mm

1.2.2. 11,25 mm

1.2.3. 14,19 mm

1.2.4. 8,91 mm

2.1.

- Make sure that all guards are in place. ✓
- Do not use a machine or come close to its moving parts while wearing loose clothing such as ties, unbuttoned sleeves, etc. and keep any cleaning material such as waste and rags away from rotating parts. ✓
- See that there is no oil or grease on the floor around the machine which can cause slipping. ✓
- Spanners or keys must never be left on rotary parts. ✓
- Never apply a wrench to revolving work or parts. ✓
- Select the correct tool for the job. ✓
- Work pieces and holding devices must always be clamped safely and firmly. ✓
- Pay special attention when fitting spanners and keys as a loose fit may cause slips, resulting in injury to your arm or hand. ✓
- Do not use your hands to remove cuttings while the machine is in motion. Use a wire hook or a brush. ✓
- Never adjust or attempt to adjust the cutting tool while the machine is running. ✓
- When filing close to a chuck or lathe carrier, file using your left hand.✓
- Do not lean on a machine at any time. ✓

- Do not attempt to stop the machine by placing your hand on the chuck while the machine is slowing down. ✓
- Give attention to cutting-fluid control before switching the machine on. ✓

2.2.

- Speed lathes
- Engine lathes
- Bench lathes

2.3.

- The centre lathe produces a cutting action by rotating the work piece against the cutting edge of the tool.
- As the cutting tool is moved lengthwise and crosswise to the axis of the work piece, the shape of the work piece is generated.
- The shape produced is basically cylindrical.

2.4.

- Headstock location
- Removable gap piece
- Bed ways

2.5.

2.5.1. V bed

2.5.2. Flat bed

2.5.3. Gap bed

3. This is a practical assessment in the workshop. Great care must be taken that the centre lathe is off and that learners do not fool around, especially if not acquainted with the centre lathe. You must give permission for the learner to switch on the lathe and you must be present at all times.

4. Cutting fluid

4.1. Cutting fluid is used in conjunction with machining processes such as lathe or milling work. It is usually a compound of water-soluble oil and water. The fluid has a milky white appearance and is applied directly to the workpiece by means of a movable spout.

4.2. Advantages

- The workpiece and cutting tool are kept cool.
- The life of the cutting tool is prolonged.
- A better finish is imparted on the workpiece.
- Cuttings are washed away, keeping the cutting tool free from debris.
- The machine is protected because the cutting process is eased.
- The machine operator is protected from very fine metal chips and dust.
- Productivity is increased because the cutting process is faster.
- The soluble oil prevents corrosion.

4.3. Cutting fluid should be applied to the cutting tool in order for them to reach all the areas that needed cooling and lubricating. Care should be taken not to cause the fluid to splash. Splashes of soluble oil on the floor of the workshop are slippery and should be cleaned up immediately.

4.4. The following guidelines should always be followed for safe and effective work with cutting fluid:

- Avoid contamination of the cutting fluid by draining and regularly replacing it.
- Always clean the machine splash tray of metal cuttings after use.
- Regularly wipe cutting fluid splashes off machine parts
- Ensure that the sump is topped up from time to time and check that there is sufficient flow of cutting fluid to the cutting tool.

5. Lathe operations

5.1. The processes include:
Facing
Parallel turning, step turning
Drilling
Tapping
Boring
Taper turning
Screw thread cutting
Parting
Knurling

5.2. Two primary characteristics of a high-quality cutting tool is toughness which permits it to with stands shock and heavy pressure, and hardness which allows it to keep a cutting edge.

5.3. Centre lathe cutting tool can be divided into four groups:
- Solid (one piece) tool of carbon or high-speed steel (HSS), gripped directly in the tool post.
- Tool holder bits of high-speed steel (HSS), which are square or round and held in tool holders.
- Tip tools of different types.
- Special tools, e.g. boring bars which hold tool bits, boring tools, knurling tools and from tools of various kinds.

5.4. The wedge from of the cutting part of a lathe tool involves two components, i.e. the rake angle which is the slope on the face, away from the cutting edge, without which the tool will rub on the work piece and generate heat and damage the work piece.

Whilst clearance angles differ slightly for different purposes, rake angles differ greatly depending on the metal be being cut. The rake angle direction is determined chiefly by the feed direction and the shape of the cutting edge.

6. Cutting tools

6.1. Sharp tools cut faster, more effectively and produce the desired finish.

6.2. The cutting edge must be carefully honed (sharpened) with an oil stone to remove all the burrs to obtain a sharp, smooth cutting edge.

6.3. The efficient cutting action depends on the following:

- The cutting tool must be sharp
- The profile of the cutting tool must be correct.
- The cutting tool must be clamped rigidly in the tool holder.
- The centre lathe must be rigid.
- If used in the centre lathe, the cutting tool must be set at the correct height.
- The cutting tool must not have too much overhang.

6.4. Three common types of chip breakers are available.

- The gullet type has a groove ground onto the rake face of the tool.
- The step type also has an offset ground in the rake face of the tool.
- The screwed-on or clamp type chip breaker has a block of cemented carbide screwed or clamped on the face of the tool

7. Finishing

7.1. When setting the cutting tool square with the work piece, the tip of the cutting tool must fit precisely in the V-groove of the centre gauge. Any error may be perceived by holding a piece of white paper under the centre gauge. Another function of the centre gauge is to check the accuracy of the angle of the point of the screw-cutting tool after it has been ground.

7.2. Chattering during the turning operation may occur because of the following reasons:

- The cutting tool is dull or ground incorrectly.
- The work piece or cutting tool is not rigid enough.
- There is too much overhang of the tool or tool holder.
- A part of the lathe carriage is loose.

7.3. There are two methods of drilling centre holes on the centre lathe.

- The countersink drill can be held in a drill chuck in the tailstock.
- The countersink drill can be held in a drill cuck in the headstock.

7.4. Take a trail cut approximately 15mm long and deep enough to;

- True up the work piece.
- Check the diameter of the work piece.

7.5. Good finish details depend on the following:

- Selecting the correct cutting tool.
- A properly ground cutting tool.
- The calculation of the correct speed, feed and RPM. These details are available form charts in the workshop
- The proper setting of the cutting tool in the tool post.
- The finishing tool should be very sharp.

8. Turning

8.1. Facing is to produce a flat surface at the end of the part and perpendicular to its axis, useful for parts that are assembled with other components.

8.2. There are three forces acting on a cutting tool.
Cutting force, Fc: acts downward on the tool tip. This is the force that supplies energy required for cutting operation.
Thrust force, Ft: acts in longitudinal direction. This force is also called the feed force because it is in the feed direction.
Radial force, Fr: acts in radial direction and tends to push the tool away from the workpiece.

8.3. First start by facing the work piece. Insert the tool into the chuck and clamp it securely. Drill centre holes on each of the ends. Bring the tail stock forward so that the centre enters the centre hole. Make sure your work piece is rigid. Bring the cutting tool forward just before the parallel side of the work piece. Give attention now to the cutting fluid controls and make sure the cutting fluid does not spray all over the machine. Start the machine and bring the cutting tool forward as so it just touches the work piece. Engage the automatic feed and when finished, bring the tool back to the starting point. Take your micrometer and get the first reading and then start cutting again until you reach the desired diameter.

9. Taper calculations

9.1. $\text{Tan}\theta = \frac{D-d}{2\ x\ L}$ ✓

$= \frac{75-60}{2\ x\ 150}$ ✓

$= \frac{15}{300}$ ✓

$= 0.05$ ✓

$\theta = 2°52'$ ✓

9.2.

$$\text{Tan}\theta = \frac{D-d}{2\ x\ L} \checkmark$$

$$\text{Tan } 4° \checkmark = \frac{60-d}{2\ x\ 150} \checkmark$$

$$0.0699 \checkmark = \frac{60-d}{300} \checkmark$$

$$300 \text{ x } 0.0699 = 60 - d \checkmark$$

$$20{,}97 \checkmark = 60 - d \checkmark$$

$$d = 60 - 20{,}97 \checkmark$$

$$d = 39.021\text{mm} \checkmark$$

10.1. The compound rest is favourable for turning or boring short, steep tapers, but it can also be used for longer, gradual tapers providing the length of taper does not exceed the distance the compound rest will move upon its slide.

10.2. The compound rest base is graduated in degrees and can be set at the required angle for taper turning or boring.

10.3. First calculate the degrees the compound must be set to. To machine a taper by this method, the tool bit is set on centre with the work piece axis. Turn the compound rest feed handle in a counter clockwise direction to move the compound rest near its rear limit of travel to assure sufficient traverse to complete the taper. Bring the tool bit into position with the work piece by traversing and cross-feeding the carriage. Lock the carriage to the lathe bed when the tool bit is in position. Cut from right to left, adjusting the depth of cut by moving the cross feed handle and reading the calibrated collar located on the cross feed handle. Feed the tool bit by hand-turning the compound rest feed handle in a clockwise direction. The tool bit travels along a line which is parallel with the ways of the lathe. When the lathe centres are aligned and the work piece is machined between these centres, the diameter will remain constant from one end of the piece to the other. If the tailstock is offset, as shown in Figure 3-64, the centreline of the work piece is no longer parallel with the ways; however, the tool bit continues its parallel movement with the ways, resulting in a tapered work piece. The tail stock may be offset either toward or away from the operator. When the offset is toward the operator, the small end of the work piece will be at the tailstock with the diameter increasing toward the headstock end.

11. Tailstock-offset method

11.1. Generally used to cut taper when no taper attachment available

By using graduations on end of the tailstock (visual method)

By means of the graduated collar and feeler gage

By means of a dial indicator

11.2. Lathe centers remain in alignment, preventing distortion of centers on work

Setup is simple and permits changing from taper to parallel turning with no time lost to align centers

Length of workpiece does not matter, since duplicate tapers may be turned on any length of work

Tapers may be produced on work held between centers, in chuck or in collet

Internal tapers can be produced by this method

Metric taper attachments are graduated in millimeters and degrees, while inch attachments are graduated in both degrees and inches of tpf

- Eliminates need for lengthy calculations and setup
- Wider range of tapers may be produced

11.3. Clean and oil guide bar

Loosen lock screws and offset end of guide bar the required amount or, for inch attachments, set bar to required taper in degrees or tpf

Tighten lock screws

With compound rest set at 90º, set up cutting tool on center

Set workpiece in lathe and mark length of taper

Tighten connecting screw on sliding block

Move carriage until center of attachment opposite length to be tapered

Lock anchor bracket to lathe bed

Take cut .060 in. long, stop lathe, check end of taper for size

Set depth of roughing cut to .050 to .060 in. oversize, and machine taper

Readjust taper attachment, if necessary, take light cut, and recheck taper fit

Finish-turn and fit taper to gage

12. Screw thread

12.1. Fastening

- Fasteners such as wood screws, machine screws, nuts and bolts.
- Connecting threaded pipes and hoses to each other and to caps and fixtures.

Gear reduction via worm drives

Moving objects linearly by converting rotary motion to linear motion, as in the leadscrew of a jack.

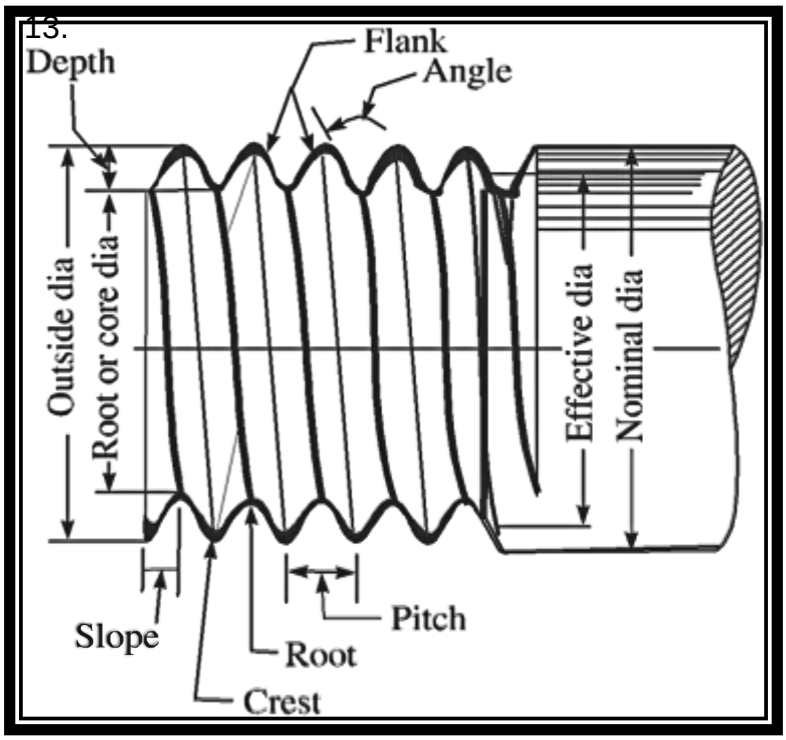
Measuring by correlating linear motion to rotary motion (and simultaneously amplifying it), as in a micrometer.

12.2. It converts rotary motion into linear motion.

It prevents linear motion without the corresponding rotation.

12.3.

13.



12.4. Terms:

a) The distance measured parallel to the axis from a point on a screw thread to a corresponding point on the next thread is called pitch or in other words the distance from crest to crest or root to root is called pitch of the thread.

b) The distance moved by a nut or a bolt in axial direction in one complete revolutions called lead.

c) The outer-most part of the thread is called crest.

d) The inner most part of the thread is called root.

e) The surface between the crest and the root is known as flank of the thread.

f) The angle between the flanks measured on an axial plane is called angle of thread.

g) It is the distance between crest and root measured at right angle to the axis.

h) The diameter of the cylindrical piece on which threads are cut is called nominal diameter.

i) Diameter at the crest of the thread measured at right angle to the axis is called major diameter and is also known as outside diameter.

j) The diameter at the core or root of the thread is called minor diameter. It is also called as core diameter.

k) The threads on the outside surface of the bolt, stud and screw etc., are called external threads.

13. Activity task

Question number	Possible marks	Answers
13.1	10 marks	A screw is a **round** steel bar with a **spiral** groove cut into it. When a screw is turned in a hole or in a nut that also has a thread, then the **rotary** motion of the screw is changed to linear motion as the one thread **meshes** into the other.
	4 marks	13.2.1. V thread
	6 marks	13.2.2. square thread
		13.3.1. vice
		13.3.2. wrench
		13.3.3. G clamp

[20 marks]

TOPIC- TOOLS

1.1. An open-ended spanner can be used for general work where it is impossible to use a ring spanner. It is also used when tightening a bolt to avoid the opening stretching and the spanner slipping.

1.2. Ratchets

Various extensions (short and long)

In places where you cannot get your hands.

Sockets

In places where you cannot get a spanner

Universal joint

In places where you cannot turn a spanner, but if you work at an angle, you can turn the bolt or nut.

2.1. Diagonal pliers

2.2. In hard to reach places where your hand or fingers cannot reach.

3.1.1. Head, shaft and handle.

3.1.2. Shaft must be well-seasoned, straight-grained wood; absorb shock; length of handle should suite size.

3.1.3. The striking face is used for driving, blows and the pein for riveting.

3.1.4. The hole or eye, into which the shaft fits, is tapered. This allows the end of the shaft to expand when a wedge is driven into the shaft. The wedge is made of steel or hard wood.

3.1.5. It is used on finished surfaces which should not be damaged.

4. Four sides will be in contact with the screw. The chances of the screwdriver slipping are very small.

5. With the fastening and loosening of Allen cap screws or in conjunction with sockets.

6.1. Fixed type (frame cannot be adjusted and takes only one length of blade) and adjustable type (frame can adjust and takes blades of various lengths)

6.2. There are two main type of blades – high speed steel blades (used on harder metals) and medium carbon steel blades (used on softer metals such as copper)

6.3. The length is measured between the outside edges of the holes in the blade.

6.4. The teeth are set to saw a wider cut than the blade itself, and this prevents it from binding in the saw-cut and breaking. Blades can be set alternatively or in a wavy pattern. Alternate teeth are set slightly outward to the left and right. This method is used on blades with fine teeth.

7. Files are designed for the different types of filing operations and are graded and classified according to their length, section, cut and degree of coarseness.

8. This file has a second series of parallel teeth cut in the opposite direction. The first set is cut at about 45° and the other set is cut at about 70° to 80° to the axis of the file.

9.1. The flat chisel

The flat chisel, also known as the cold chisel, is the most commonly used for general dressing, chipping and cutting. The cutting edge should be slightly convex as this prevents damage to the outer corners and gives a longer life.

Cross cut chisel

This chisel is used for cutting grooves, slots, recesses and keyways.

Round nose chisel

The straight type is used for drawing over drill centres, in drilling and cutting oil grooves along flat or convex surfaces such as slides, bearings, etc. The curved type is used for cutting oil grooves along the curved surface of a bearing.

Diamond point chisel

The diamond point chisel is used mainly for finishing off and cleaning out corners, and for cutting ‘V’ grooves

9.2. When chipping, watch the cutting edge and not the head of the chisel. Place a suitable guard in front of the work to protect others from injury. Wear goggles to protect your eyes.
Dress the head of the chisel when it becomes mushroomed or ragged, as the chips that may break off are liable to cause serious injury to yourself or anyone else nearby.

9.3. The cutting edge should be slightly convex as this prevents damage to the outer corners and gives a longer life

10.1. Single-cut files, double-cut files and rasps

10.2. There are rough, bastard, second-cut and smooth files

10.3. Uses for files

a) They are used for general purposes
b) They are used for filing corners, slots and square holes.
c) They are used for opening out holes and for filing round corners
d) They are used for filing corners less than 90° and for filing concave surfaces.
e) They have three 60° corners and are used for sharpening saw-teeth and to file corners less than 90°.

10.4. Always ensure that the file tang fits tightly into the handle, as a file with a loose handle is liable to cause serious injury.

11.1. The stock made of steel and the blade is hardened and tempered.

11.2. For correct checking of square-ness, the stock should be held firmly against the true side of the job. The blade is lowered onto the face which is to be checked. This should be done against a bright light.

12.1. The square and blade can be used for:

- Checking and marking-off of external and internal right angles
- as a depth gauge
- checking and marking-off of 45° angles
- the square head may be used alone as a spirit lever

12.2. The protractor head alone can be used to determine the incline of a work piece as follows;

- Release the protractor head on the work piece
- Release the two protractor locknuts
- Turn the protractor until the bubble indicates level
- Tighten the two locknuts and test the level again
- On the protractor, read off the incline in degrees at which the work piece is placed

12.3. Determining of centre on round work piece with a combination set.
When the centre head is fitted to the blade, the side of the blade is exactly in the centre of the V formed by two legs. The purpose of the centre head is to determine the middle point on the face of a round work piece.

13.1. A steel tape is used to measure long lengths.

13.2. The case is made of leather or plastic.

14.1. A rule is made of spring steel, cast steel or stainless steel, the latter being the best as it does not rust.

14.2. Take care so that the edges do not get knocked about, particularly the end where the graduations begin.

15.1. A scriber is used to draw lines on materials.

15.2. A scriber is made of tool steel and is available in various sizes.

16.1. (a) 60 degrees (b) 90 degrees

16.2. The punch is used to mark or “pop” scribed lines to make them prominent. The punch can also be used to indicate the centre of a circle.

16.3. This punch is made of tool steel.

TOPIC- JOINING METHODS

1.1. The table in the learner's book can be used to refer to the relevant formula needed to complete the task. Since a double row lap joint with a chain arrangement is specified, the following formula must be applied.

Bolt diameter =6,05 x $\sqrt{t}$

=6,05 x $\sqrt{25}$

=30,25 mm

(Note that bolt diameter is always rounded up or down to the nearest metric bolt size).

The bolt diameter is therefore 30 mm or M30

Pitch (P) =3 x D (bolt diameter)

=3 x 30

=90 mm

Distance between centre lines

(C) = 0,8 x P (**chain arrangement**)

=0,8 x P

=0,8 x 90mm

=72 mm

Margin (M)=$1\frac{1}{2}$ D

=$1\frac{1}{2}$ D x 30

=45 mm

1.2. The following diagram depicts a scale 1:2 re-presentation of how the joint would be marked out:

2.1. A semi-permanent joining application is a method of joining materials together in a secure manner, which can also be taken apart at a later stage if necessary.

2.2. Head style, drive configuration body, point style and finish.

2.3. Studs are often used to attach the cylinder head of a motor engine to the engine block.

2.4. Friction locking devices:

2.5. Locking devices prevent any unwanted rotation due to shock, movement and vibration of machine parts.

2.6. As can be seen in the diagram below, the rivet shank is cut so that it protrudes from the joint by 1,5 times its own diameter. Once heated, its head is formed by a dolly and set under the pressure of a pneumatic or manual riveter. On cooling, the river contracts and pulls the two plates together.

2.7. The following are three commonly used rivets:
Standard open types are used for general riveting purposes. Sealed types are used for pressure and water tight joints. Grooved types are used where greater grip is required in soft materials. Peel-type rivets are used for brittle material such as glass-fibre.

2.8. Hardened and ground down pins are used to align and locate machine parts such as castings. Taper pins are used to attach wheels and pulleys to shafts. Clevis pins are used to connect yokes and eye members. Cotter pins (split pins) are used in conjunction with other fasteners such as slotted nuts.

3.1. Keys are used in keyways to ensure positive rotation between pulleys, sprockets and wheels to parts such as engines and gearboxes.

3.2. The small head is used to aid removal of the key.

4.

a) $W = \frac{D}{4}$

$W = \frac{80}{4}$

= 20mm

$T = \frac{D}{6}$

$T = \frac{80}{6}$

= 13,33mm

L = 1,5 x D

= 1,5 x 80

= 120mm

$t\ (taper) = T - \left(\frac{L}{100}\right)$

$t\ (taper) = 13{,}33 - \left(\frac{80}{100}\right)$

$t\ (taper) = 13{,}33 - 0{,}8$

$t\ (taper) = 12{,}53mm$

b) $W = \frac{D}{4}$

$W = \frac{100}{4}$

= 25mm

$T = \frac{D}{6}$

$T = \frac{100}{6}$

= 16,66mm

L = 1,5 x D

= 1,5 x 100

= 150mm

$t\ (taper) = T - \left(\frac{L}{100}\right)$

$t\ (taper) = 16{,}66 - \left(\frac{150}{100}\right)$

$t\ (taper) = 16{,}66 - 1{,}5$

$t\ (taper) = 15{,}16mm$

c) $W = \frac{D}{4}$

$W = \frac{95}{4}$

= 23,75mm

$T = \frac{D}{6}$

$T = \frac{95}{6}$

= 15,83mm

L = 1,5 x D

= 1,5 x 95

= 142,5mm

$t\ (taper) = T - \left(\frac{L}{100}\right)$

$t\ (taper) = 15{,}83 - \left(\frac{142{,}5}{100}\right)$

$t\ (taper) = 15{,}83 - 1{,}425$

$t\ (taper) = 14{,}405mm$

d) $W = \frac{D}{4}$

$W = \frac{120}{4}$

= 30mm

$T = \frac{D}{6}$

$T = \frac{120}{6}$

= 20mm

L = 1,5 x D

= 1,5 x 120

= 180mm

$t\ (taper) = T - \left(\frac{L}{100}\right)$

$t\ (taper) = 20 - \left(\frac{180}{100}\right)$

$t\ (taper) = 20 - 1{,}8$

$t\ (taper) = 18{,}20mm$

e) $W = \frac{D}{4}$

$W = \frac{55}{4}$

= 13,75mm

$T = \frac{D}{6}$

$T = \frac{55}{6}$

= 9,17mm

L = 1,5 x D

= 1,5 x 55

= 82,5mm

$t\ (taper) = \ T - \left(\frac{L}{100}\right)$

$t\ (taper) = \ 9{,}17 - \left(\frac{82.5}{100}\right)$

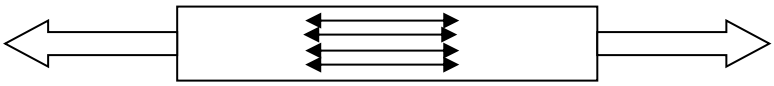
$t\ (taper) = \ 9{,}17 - 0{,}825$

$t\ (taper) = \ 8{,}36mm$

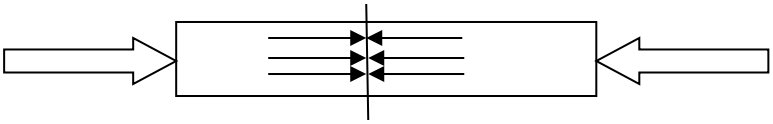
TOPIC- FORCES

Stress

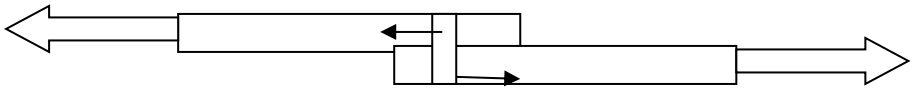
5.1. **Tensile stress** occurs over the full length of a bar which is subjected to a pulling force



Compressive stress occurs over the full length of a bar which is subjected to a pushing force



Shearing stress of this nature exist on a section of a body if, on opposite faces of the section, equal and opposite parallel forces exist.

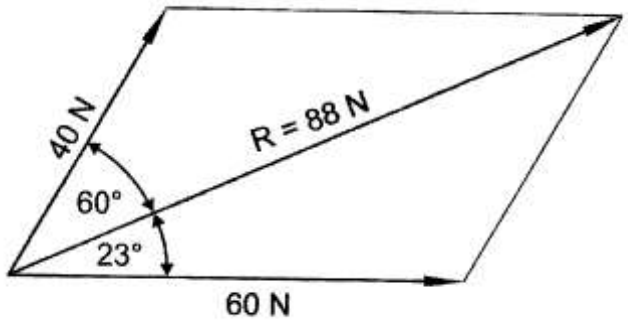


5.2. Shear stress

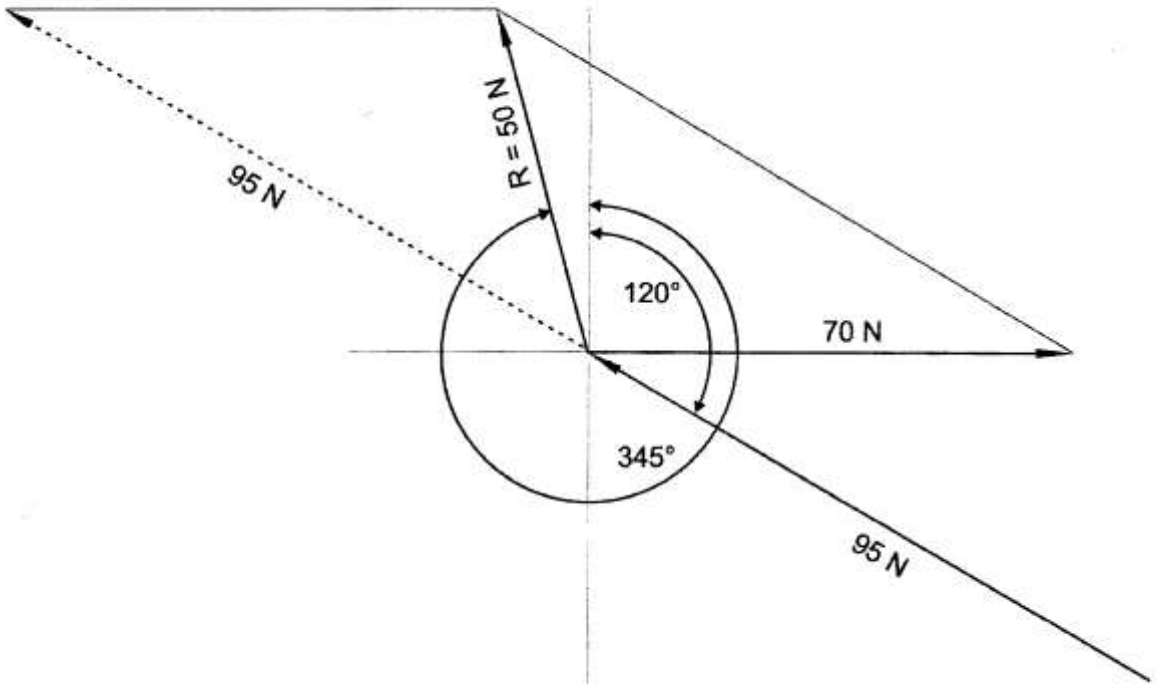
- Cut two pieces of plastic waste pipe.
- Slit one along its length.
- Grip and twist both pieces and compare. The slitted piece will twist easily and show the shear forces that are created.

Components of the forces

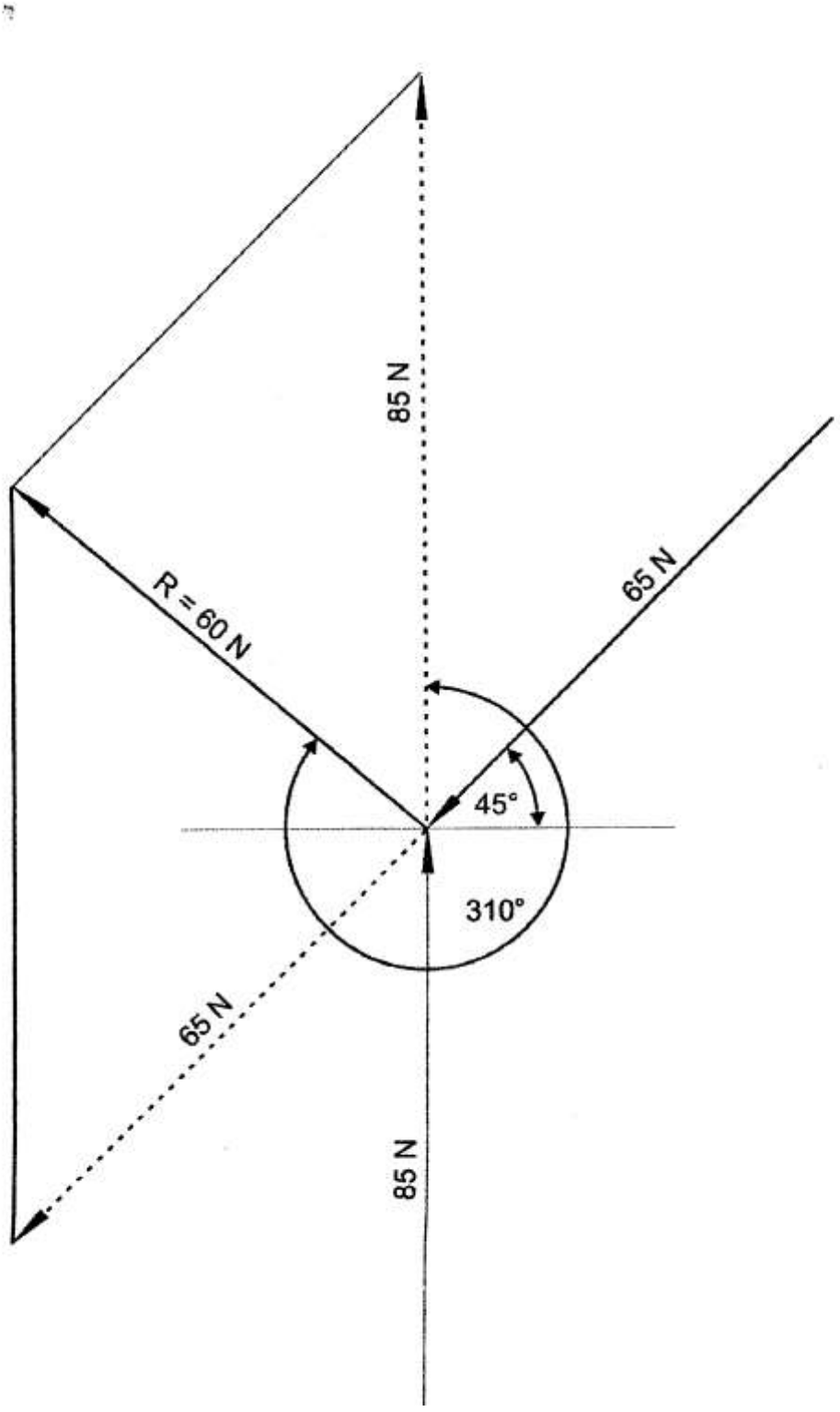
1.1. The resultant of the force on the nail is 88n in a direction of 23° north of east



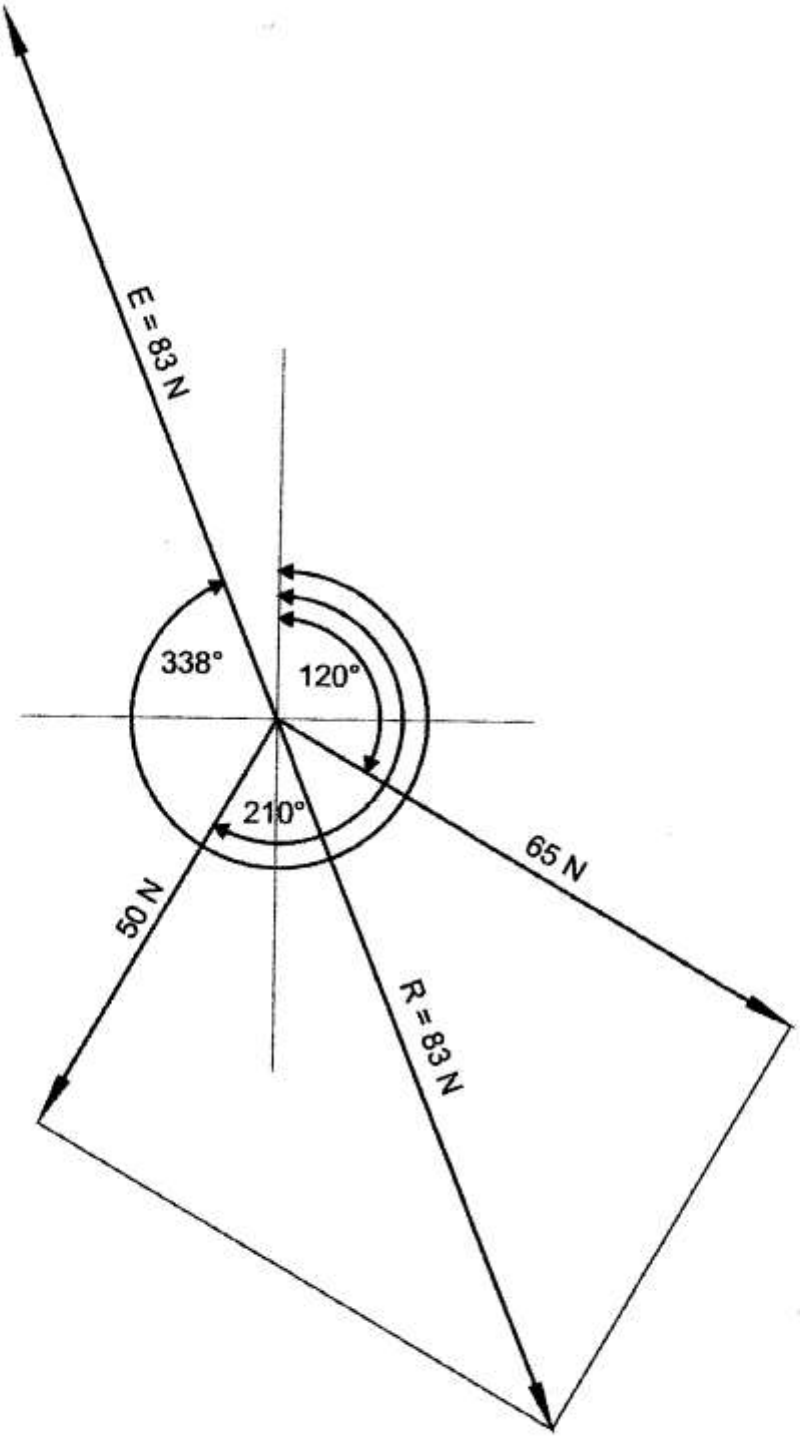
1.2. The resultant force on the pin is 50N on a bearing of 345°



1.3. The resultant force on the pin is 60N on a bearing of 310°

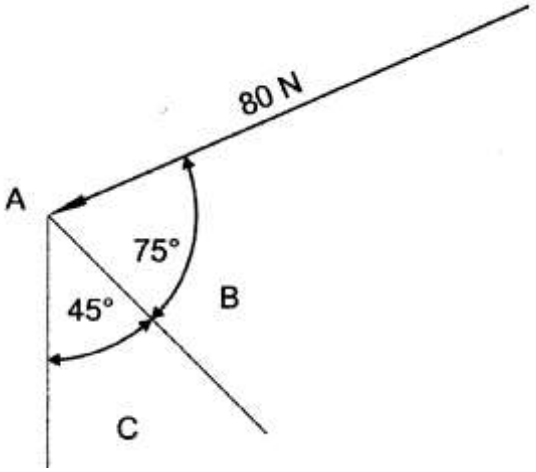


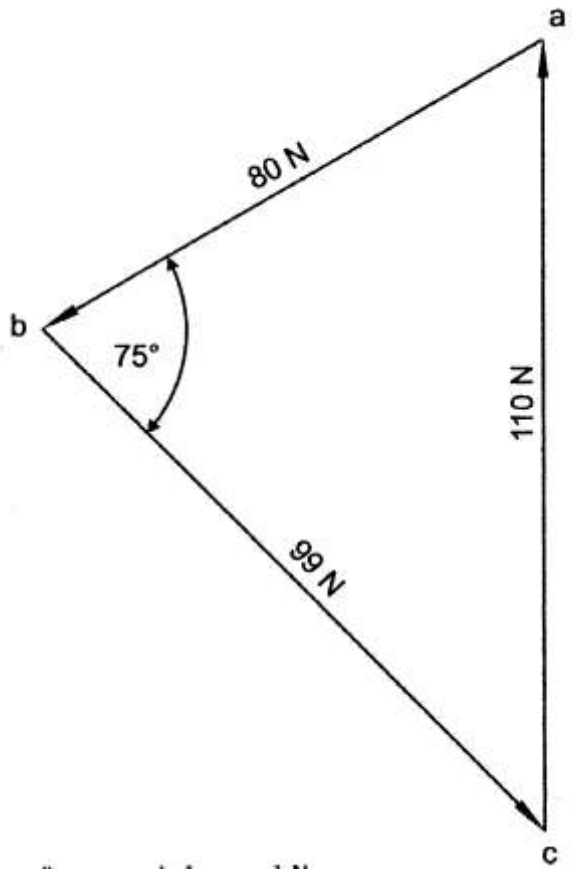
1.4. The equilibrant force has a magnitude of 83N on a bearing of 338°



Triangular forces

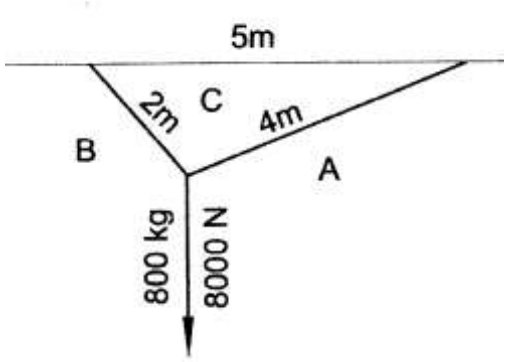
2.1. The scale of the space and force diagram is 1mm = 1N

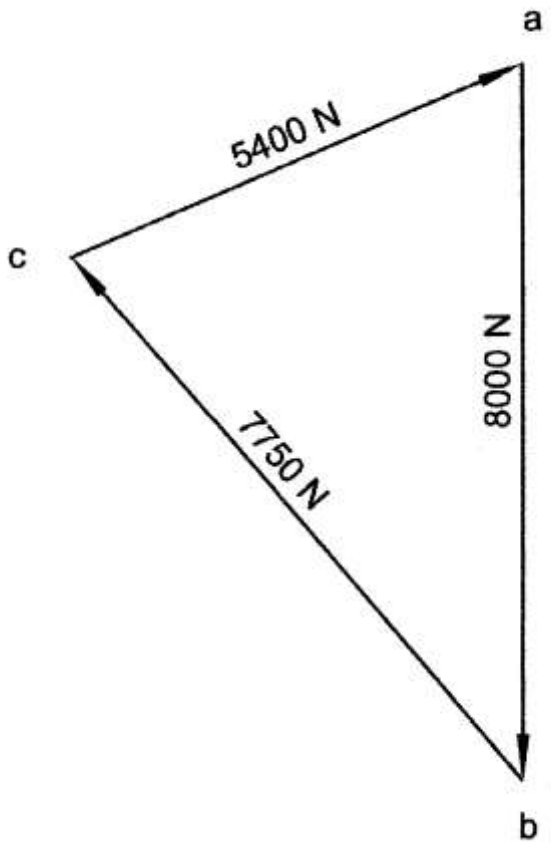




The force in rope **bc** has a magnitude of 99N on a bearing of 135°.
The force in rope **ca** has a magnitude of 110N on bearing of 0°.

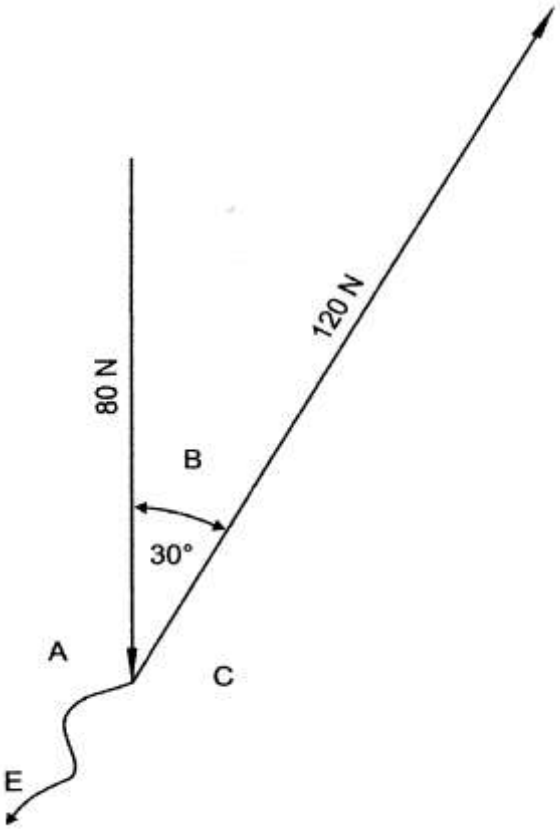
2.2. The scale for the space diagram is 1cm = 1m
The scale for the force diagram is 1mm = 100N

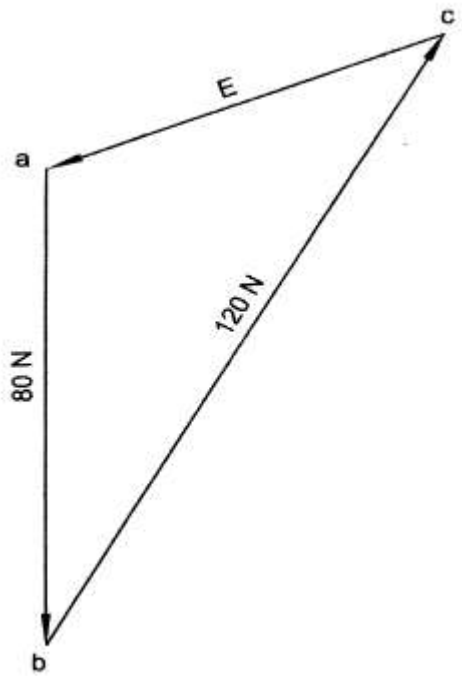




The tension (pulling force) in rope **bc** has a magnitude of 7750N.
The tension in rope **ca** has a magnitude of 5400N.

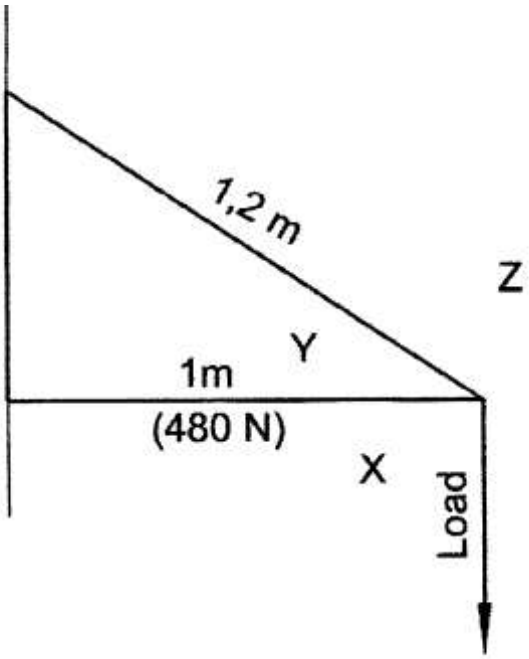
2.3. The scale of the space and force diagram is 1mm = 1N

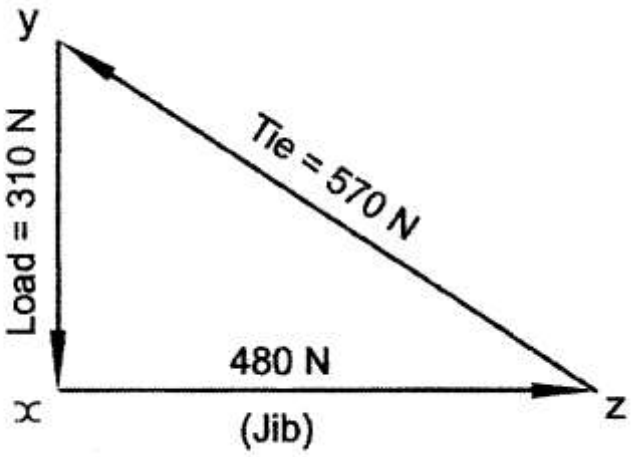




The equilibrant is determined to be 65N on a bearing of 249°. Because the resultant has the same magnitude, but opposite direction to the equilibrant, it has a magnitude of 65N on a bearing of 69°

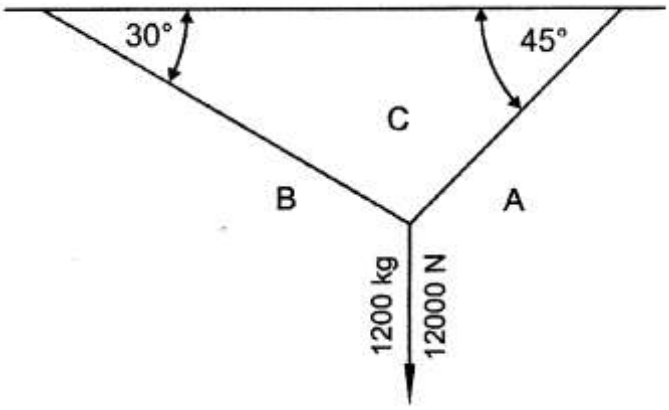
2.4. The space diagram has a scale of 50mm = 1m
The force diagram has a scale of 1mm = 10N

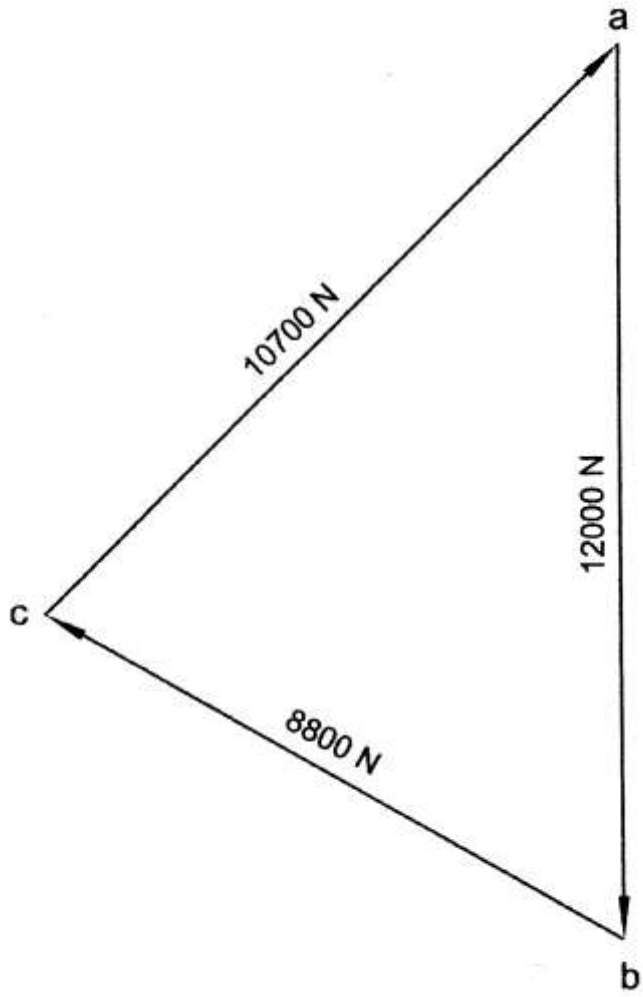




The tension in the tie was determined to be 570N. The load was determined to be 310N. Since the mass was asked for, and not the load, a calculation must be performed to convert force to mass. To calculate mass from load, divide by 9,81 or 10(rounded off). Thus $310N \div 10 = 31kg$

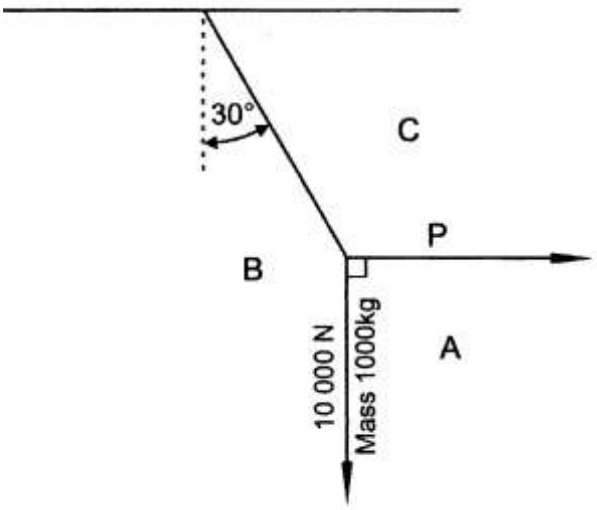
2.5. The space diagram must be constructed by using a protractor
The force diagram scale is 1mm = 100N

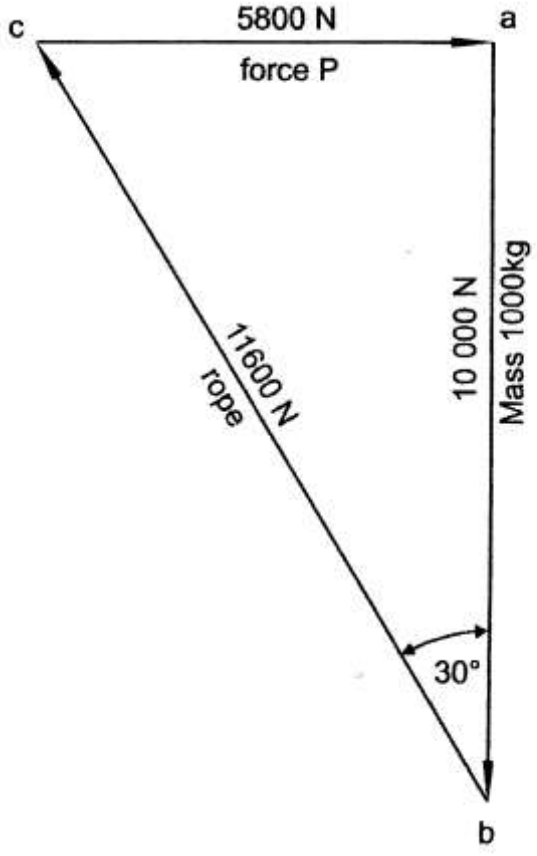




The tensions in rope **bc** and **ca** are 8800N and 10700N respectively

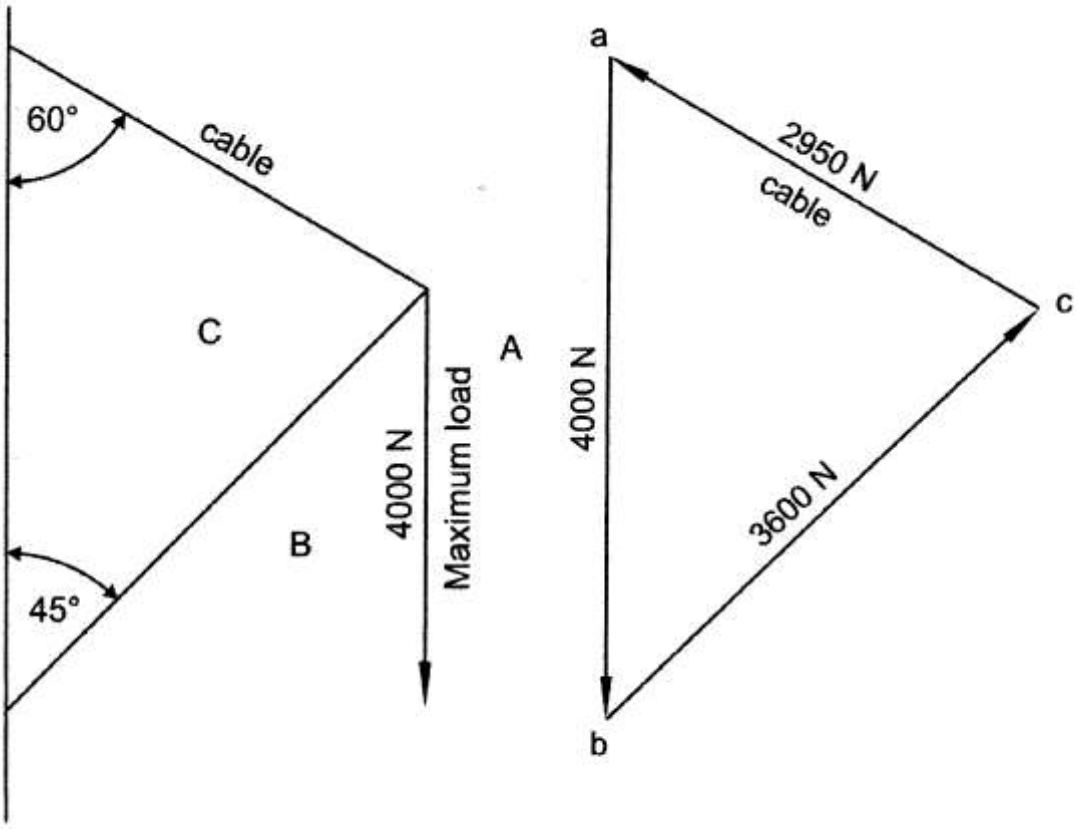
2.6. The scale of the force diagram is 1mm = 100N





The magnitude of the horizontal force P is 5800N. The tension in the rope is measured to be 11600N.

2.7. The scale of the force diagram is 1mm = 50N

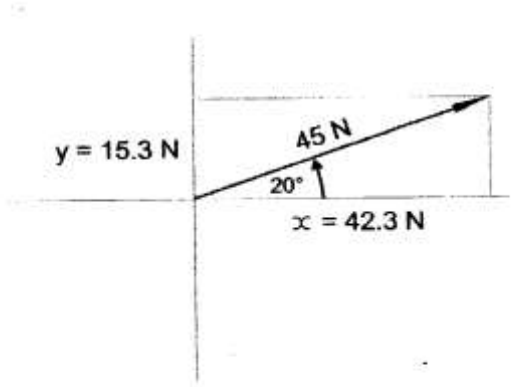


The magnitude of the tensile force in the cable is 2950 N.

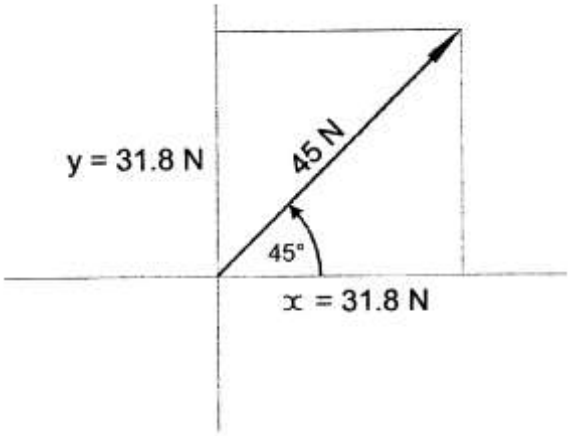
Horizontal and vertical components of a single force

3.1.

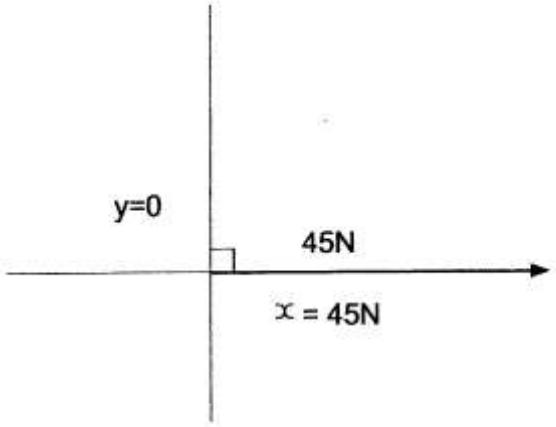
(a)



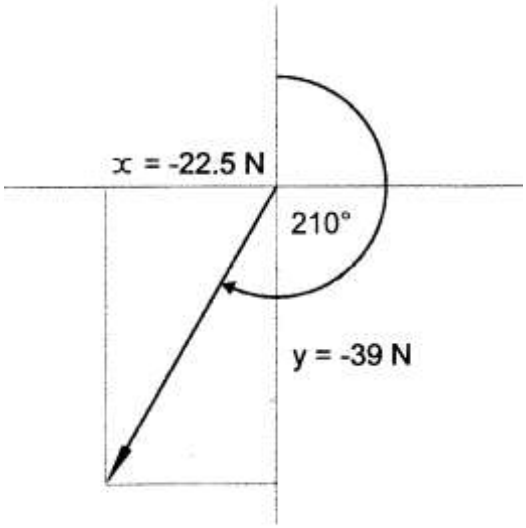
(b)



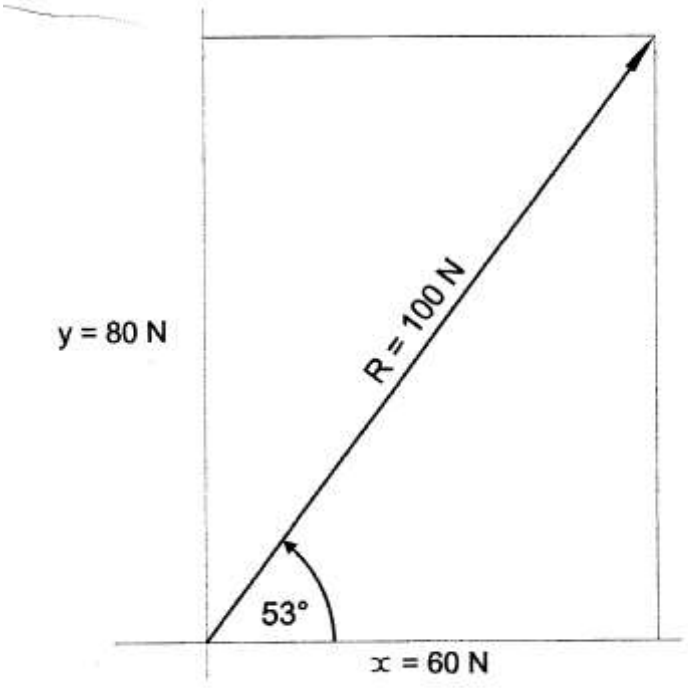
(c)



(d)



3.2. The scale is 1mm = 1N



The magnitude of the force is 100N in the direction of 53° north of east

TOPIC: MAINTENANCE

1) Lubricate
   Increases efficiency, slows wear
   Cool
   Antifreeze only cools the upper engine
   Corrosion Protection
   Stop/hinder oxidation & acid build up
   Clean
   Stop deposit formation & hold particles in suspension

2) The engine starts to heat up
   Friction increase
   Eventually engine failure

3) The SAE designation for multi-grade oils includes two viscosity grades; for example, **10W-30** designates a common multi-grade oil. The first number '**10W**' is the viscosity of the oil at cold temperature and the second number is the viscosity at 100 °C

4) It is the resistance of an oil to flow and is calculated by the time it takes a set quantity of oil to flow through a tube of fixed diameter.
   The longer the oil takes to flow, the higher the oil's viscosity, and the higher the viscosity number which identifies it.

5) There are SAE (Society of Automotive Engineers) grades for gear oils and crankcases (engines)
   International Standards Organization Viscosity Grade, ISO VG for short.

6) **Multigrade oils** are those **oils** that have two numbers on the **grade**, indicating that the **oil** is able to maintain engine performance in high and low temperatures. A **multigrade** lubricant minimises viscosity differences under temperature variations.

7) The first number on a **multigrade oil** is normally followed by a **W**, which **stands for** winter. This number represents the lubricant's viscosity under lower temperatures, giving an indication of how the **oil will** flow in the winter. The lower the first number, the thinner it is at low temperatures.

8) Manufacturers are using thinner and thinner **oils** in **cars**. (5w-30 wt is **recommended** for many **new cars**.)

9) The **American Petroleum Institute** gravity, or API gravity, is a measure of how heavy or light a petroleum liquid is compared to water: if its API gravity is greater than 10, it is lighter and floats on water; if less than 10, it is heavier and sinks.

10) It means that the oil must be changed in the vehicle.

11) Basic - categories are barrier agents axi & chemically **active agents**, sometimes **called** reactive agents.

12)

a) It increases the pour point of oil so it can still be fluid at very low temperatures.
b) Viscosity improvers are primarily used in multigrade engine oils, gear oils, automatic transmission fluids, power steering fluids, greases and various hydraulic fluids. Most of these uses involve an automobile, and this is because automobiles are subjected to tremendous temperature swings.
c) Modifiers for improved fuel economy, Reduces oil burn-off and consumption and conditions seals to prevent leaks.

13) All oil looks pretty black within a couple of days after an oil change, so the only way to avoid running on oil that's so dirty that it becomes a liability is to keep a record of when it was last changed and to change it frequently — as often as every 7500 kilometers.

14) Adverse driving conditions can lead to abnormally high oil temperature or oil consumption. Below are some examples of adverse driving conditions.
Check the oil level more frequently for long journeys:

- towing a caravan or trailer
- in mountainous regions
- at high speeds
- in temperatures colder than -30 °C or hotter than +40 °C.

The above also apply to shorter driving distances at low temperatures.

15) You see this symbol on many quality oils. API is an acronym for the American Petroleum Institute. The institute’s Starburst stamp of approval—it reads “American Petroleum Institute Certified”—was created to help consumers identify engine oils that meet specific performance standards set by vehicle and engine manufacturers.

16) Synthetic base stock lubricant oils are man-made and tailored to have a controlled molecular structure with predictable properties. They are composed of organic and inorganic base stock oils combined with polymer packages to produce synthesised oil compounds (API Groups III, IV & V).

17) The technical advantages of synthetic motor oils include:

- Better low- and high-temperature viscosity performance at service temperature extremes
- Better (higher) Viscosity Index (VI)
- Better chemical and shear stability
- Decreased evaporative loss
- Resistance to oxidation, thermal breakdown, and oil sludge problems
- Possibility to extended drain intervals, with the environmental benefit of less used oil waste generated
- Improved fuel economy in certain engine configurations
- Better lubrication during extreme cold weather starts
- Possibly a longer engine life
- Superior protection against "ash" and other deposit formation in engine hot spots (in particular in turbochargers and superchargers) for less oil burnoff and reduced chances of damaging oil passageway clogging.
- Increased horsepower and torque due to less initial drag on engine[citation needed
- Improved Fuel Economy - from 1.8% to up to 5% has been documented in fleet tests

18) Synthetic oil is used as a substitute for lubricant refined from petroleum when operating in extremes of temperature, because, in general, it provides superior mechanical and chemical properties to those found in traditional mineral oils. Aircraft jet engines, for example, require the use of synthetic oils, whereas aircraft piston engines do not. Synthetic lubricants are also used in metal stamping to provide environmental and other benefits when compared to conventional petroleum and animal fat based products. These products are also referred to as "non-oil" or "oil free.

19) The life cycle for synthetics is typically 11,000 to 16,000 kilometres, a big change from conventional oil.

20) Below SAE 20

21) It is a compound of water-soluble oil and water.

22)

Cutting tool life prolonged
Better finish obtained
Cuttings washed away
Prevents corrosion
Cuttings are washed away, keeping the cutting tool free from debris
The machine is protected because the cutting process is eased
The machine operator is protected from very fine metal chips and dust
Productivity is increased because the cutting process is faster
The soluble oil prevents corrosion

23) Avoid contamination of the cutting fluid by draining and regularly replacing it.
Always clean the machine's splash tray of metal cuttings after use.
Regularly wipe cutting fluid splashes off machine parts.
Ensure that the sump is topped up from time to time and check that there is sufficient flow of cutting fluid to the cutting tool.

24) Friction is a Force that always pushes against an object when it touches another object. When 2 things are in contact with each other, there will be friction acting between them.

25) Reduce the contact area by using rollers/ball-bearings/wheels
Change the surfaces of the materials that are touching by using lubrication eg. Oil
Create a cushion of air eg. Like a hovercraft or air hockey table.

Maintenance

26.

a) It is a set of activities that are performed on plant equipment, machinery, and systems before the occurrence of a failure in order to protect them and to prevent or eliminate any degradation in their operating conditions.
b) Predictive maintenance is a set of activities that detect changes in the physical condition of equipment (signs of failure) in order to carry out the appropriate maintenance work for maximising the service life of equipment without increasing the risk of failure.
c) A process used to determine what must be done to ensure that any physical asset continues to do what its users want it to do in its present operating context

27. The need for an adequate number of staff in the maintenance department in order to perform this type of maintenance.
The right choice of production equipment and machinery that is suitable for the working environment and that can tolerate the workload of this environment.
The required staff qualifications and skills, which can be gained through training.
The support and commitment from executive management to the PM programme.
The proper planning and scheduling of PM programme.
The ability to properly apply the PM programme.

28. The **main difference** between preventive maintenance and predictive maintenance is that predictive maintenance uses monitoring the condition of machines or equipment to determine the actual mean time to failure whereas preventive maintenance depends on industrial average life statistics.

29. Revised maintenance schedules and practices
    Revised Operating procedures
    Recommended Engineering Changes
    Database of maintenance requirements
    Useful to provide documentation for decisions
    Analysis team members gain a deeper understanding of the asset

30. Excessive engine wear is very often caused by improper vehicle operation and subsequent momentary poor lubrication (momentary oil flow discontinuation).
    Momentary poor lubrication may follow during cold engine excessive load, excessive engine load at low RPM, and high RPM (temperature increase causes oil thinning), as well as “aggressive driving”, old pump oil or clogging of oil passages.
31. The pistons start to swell and eventually engine seizure.
32. The most common problems that occur in the master cylinder is wear in the piston bore and piston seal failure. The classic symptom of a failing master cylinder is a brake pedal that slowly sinks while pressure is held against the pedal. The cure is to replace the master cylinder.

Basic outcome due to the lack of maintenance

Instructions:

33. Enter the workshop – keeping safety in mind – and indentify all the machines in the workshop.
34. Analyse what type of maintenance is needed on the machines.
35. Identify what the outcome may be if there is a lack of maintenance on the machine.

26)

a) The friction that acts on objects that are not moving is called **static friction.**

Because of static friction, you must use extra force to start the motion of stationary objects. For example, think about what happens when you try to push a heavy desk across a floor. If you push on the desk with a force less than the force of static friction between the desk and the floor, the desk will not move. To make the desk move, you must exert a force greater than the force of static friction.

Once the desk is moving, there is no longer any static friction.

b) **Sliding friction** occurs when two solid surfaces slide over each other. Sliding friction can be useful. For example, you can spread sand on an icy path to improve your footing.

Ballet dancers apply a sticky powder to the soles of their ballet slippers so they won't slip on the dance floor. And when you stop a bicycle with hand brakes, rubber pads slide against the tire surfaces, causing the wheels to slow and eventually stop.

c) When an object rolls across a surface, **rolling friction** occurs. Rolling friction is easier to overcome than sliding friction for similar materials. This type of friction is important to engineers who design certain products. For example, skates, skateboards, and bicycles need wheels that move freely.

d) This type of friction is what happens with liquids and gases *(In Physics, liquids and gases are both called "fluids". They behave in similar ways.)* Fluid friction is also known as "**drag**". On aircraft it's also called "**air resistance**".

It depends on:

how thick the fluid is (its " viscosity ")

the shape of the object

the speed of the object

TOPIC: MATERIALS

ACTIVITY 1: POSSIBLE ANSWERS

1.1 Alloy steel is that which contains elements in addition to carbon and iron

1.2 Aluminium

1.3 Chemical; mechanical; physical

1.4 A tough metal possesses very high strength. It also has capacity to deform permanently and resist rupture.

1.5 Coke, limestone or dolomite; air

1.6 Iron ore

1.7 Open heath furnace process; electric (arc) furnace process, basic oxygen furnace process.

1.8 Carbon causes big changes in the nature of the metal, and also determines the hardness of the metal

1.9 Alloys are added to steel to:

- Improve mechanical properties to permit higher tempering temperature while maintaining high strength and improving ductility.
- Improve mechanical properties at low or elevated temperature.
- Increase strength and toughness
- Increase resistance high temperatures
- Secure grater hardness for wear resistance
- Provide high-impact resistance
- Secure better mach inability

1.10 (a) when metal fractures with little or no deformity

(b) Material's ability to change shape or to be drawn into wire form

(c) Materials ability to absorb forces and flex in different directions and return to its original shape when the load is removed

ACTIVITY 2: POSSIBLE ANSWERS

2.1

(a) has a gray fracture surface. Silicon content of (2-3 wt %) promotes graphite precipitation rather than cementite.

(b) has a characteristic of white, crystalline fracture surface: Large amounts of cementite are formed during casting, giving a hard brittle material.

2.2. - historic markers and plaques

- hardware: hinges, latches
- columns, balusters
- stairs
- structural connectors in buildings and monuments
- decorative features
- fences
- tools and utensils
- ordnance
- stoves and firebacks
- piping.

ACTIVITY 3: POSSIBLE ANSWERS

3.1 Characterized by their corrosion resistance, high strength and ductility, and high chromium content. Stainless as a film of chromium oxide protects the metal from corrosion.

3.2 Domestic – cutlery, sinks, saucepans, washing machine drums, microwave oven liners, razor blades

Architectural/Civil Engineering – cladding, handrails, door and window fittings, street furniture, structural sections, reinforcement bar, lighting columns, lintels, masonry supports

Transport – exhaust systems, car trim/grilles, road tankers, ship containers, ships chemical tankers, refuse vehicles

Chemical/Pharmaceutical – pressure vessels, process piping.

Oil and Gas – platform accommodation, cable trays, subsea pipelines.

Medical – Surgical instruments, surgical implants, MRI scanners.

Food and Drink – Catering equipment, brewing, distilling, food processing.

Water – Water and sewage treatment, water tubing, hot water tanks.

General – springs, fasteners (bolts, nuts and washers), wire.

ACTIVITY 4: POSSIBLE ANSWERS

4.1

Metal	Property	Uses
Copper	*Red in colour and is tough, ductile and malleable.*	*Electrical tubing, soldering, irons, electrical wires*
Tin	*Silvery shiny, soft and malleable, poor conductor of electricity.*	*Basis of white metal bearings, canning industry, protective layer for copper wires*
Lead	*Soft, bluish in colour, tough but low tensile strength, malleable, ductile, low melting point*	*Soft solder, plumbing, roof sheeting, bullets, cables, battery plates*
Zinc	*Bluish white in colour and high gloss, hard, brittle malleable*	*Galvanising on sheets, water tanks and wire*
Aluminium	*Bluish in colour, hard and very light, resistant to corrosion, malleable and ductile*	*Cooking utensils, foil, electrical connectors, and long distance high-tension transmission lines*

ACTIVITY 5: POSSIBLE ANSWERS

5.1 Bronze is an alloy of copper and any other metal. As with brasses, there are many formulas for bronzes, depending on the application.

5.2 Aluminum bronzes, tin bronzes, phosphor bronzes, nickel bronzes, and silicon bronzes are all examples of varying alloys

.

5.3 Bronzes are used in applications such as bearings, some limited structural applications, decorative uses, and applications which require them not to spark when struck with another metal.
This makes them useful in the transport and handling of items such as explosives, fuels, and flammable materials.
Bronzes are often used in statues and can be seen to form the familiar green oxidized coating.

5.4 Brass is a metal alloy made of copper and zinc; the proportions of zinc and copper can be varied to create a range of brasses with varying properties. It is a substitutional alloy: atoms of the two constituents may replace each other within the same crystal structure.

5.5 Brass is used for decoration for its bright gold-like appearance;
for applications where low friction is required such as:
Locks, gears, bearings, doorknobs, ammunition casings and valves; for plumbing and electrical applications; and extensively in brass musical instruments such as horns and bells where a combination of high workability (historically with hand tools) and durability is desired. It is also used in zippers. Brass is often used in situations in which it is important that sparks not be struck, such as in fittings and tools around explosive gases.

5.6 White metals include antimony, bismuth, cadmium, lead, tin, and zinc. Of these, lead, tin, and zinc are of primary interest.

5.7 Ball bearings and engine bearings.

5.8 It’s light strong alloy of aluminum, copper, manganese, and Duralumin is soft, ductile, and workable in the normal state; they may be rolled, forged, extruded, or drawn into a variety of shapes and products. Its’ light weight and high strength makes them suitable for something that needs to be strong and light at the same time.
That’s why it is suitable for an airplane.

TOPIC: SYSTEMS AND CONTROL

ACTIVITY 1: POSSIBLE ANSWERS

1.1 Gear B turns in the same direction as gear A

1.2 Gear B turns opposite direction with gear A

1.4 Pulley A turns in the same direction as Pulley B

1.4

Flat belts	V-belts
Mainly used over long distances and where belts are to be twisted e.g. crossed drives.	Used to transmit power over short distances, e.g. between the alternator and fan of a motor vehicle.

1.5 Heavy loads can be carried by using a wide pulley with a number of grooves to accommodate a number of V-belts. An added advantage is that if one of the belts breaks in a multiple drive, the remaining belts can carry on until a replacement is available.

1.6 Gears can be divided into three groups:

(i) Gears and coupling shafts, running parallel to each other and in the same plane, for example spur or straight-tooth gears, helical gears, double helical gears or herringbone gears and internal gears or ring gears.

(ii) Gears and coupling shafts, of which the centrelines intersect at an angle, for example bevel or conical gears. These bevel gears are also known as mitre wheels or mitre gears.

(iii) Gears and coupling shafts, lying at angles to each other but not in the same plane, for example worm and worm wheels and spiral gears.

ACTIVITY 2: POSSIBLE ANSWERS

2.1 $N_1 \times T_1 = N_2 \times T_2$

$$T_2 = \frac{12\ x\ 40}{2}$$

= 240 teeth

2.2 $N_1 \times T_1 = N_2 \times T_2$

$$N_2 = \frac{2\ x\ 40}{70}$$

= 1,14 rev/sec

2.3 $N_1 \times T_1 = N_2 \times T_2$

$$N_1 = \frac{400\ x72}{48}$$

= 600 rpm

2.4 $N_1 \times T_1 = N_2 \times T_2$

$$T_2 = \frac{2000\ x\ 30}{500}$$

= 120 teeth

2.5 $N_1 \times T_1 = N_2 \times T_2$

$$N_1 = \frac{3{,}7\ x\ 290}{170}$$

= 6,31 rev/sec

ACTIVITY 3: POSSIBLE ANSWERS

3.1 $D_1 \times N_1 = D_2 \times N_2$

$$D_1 = \frac{1500\ x\ 230}{1200}$$

= 287,50mm

3.2 $D_1 \times N_1 = D_2 \times N_2$

$$D_2 = \frac{200\ x\ 750}{100}$$

= 1500 rpm

3.3

a) $D_1 \times N_1 = D_2 \times N_2$

$$D_1 = \frac{1500\ x\ 230}{1200}$$

= 8 rev/sec

b) 8 x 60

= 480 rpm

3.4 $D_1 \times N_1 = D_2 \times N_2$

$$N_2 = \frac{50\ x\ 1400}{125}$$

= 560 rpm

3.5 $D_1 \times N_1 = D_2 \times N_2$

$$D_2 = \frac{125\ x\ 1100}{1375}$$

= 100 mm

ACTIVITY 4: POSSIBLE ANSWERS

4.1

$$V = \pi DN$$

$$V = \frac{\pi \; x \; 280 \; x \; 1450}{1000 \; x \; 60}$$

= 21, 26 m/s

4.2

$$V = \pi DN$$

$$V = \frac{\pi \; x \; 125 \; x \; 3000}{1000 \; x \; 60}$$

= 19, 63 m/s

4.3

$$V = \pi DN$$

$$4 = \frac{\pi \; x \; D \; x \; 1775}{1000 \; x \; 60}$$

$$D = \frac{4 \; x \; 1000 \; x \; 60}{\pi \; x \; 1775}$$

= 43, 04 mm

4.4

$$V = \pi DN$$

$$V = \frac{\pi \; x \; 350 \; x \; 750}{1000 \; x \; 60}$$

= 13,74 m/s

4.5

$$V = \pi DN$$

$$4 = \frac{\pi \; x \; 600 \; x \; N}{1000 \; x \; 60}$$

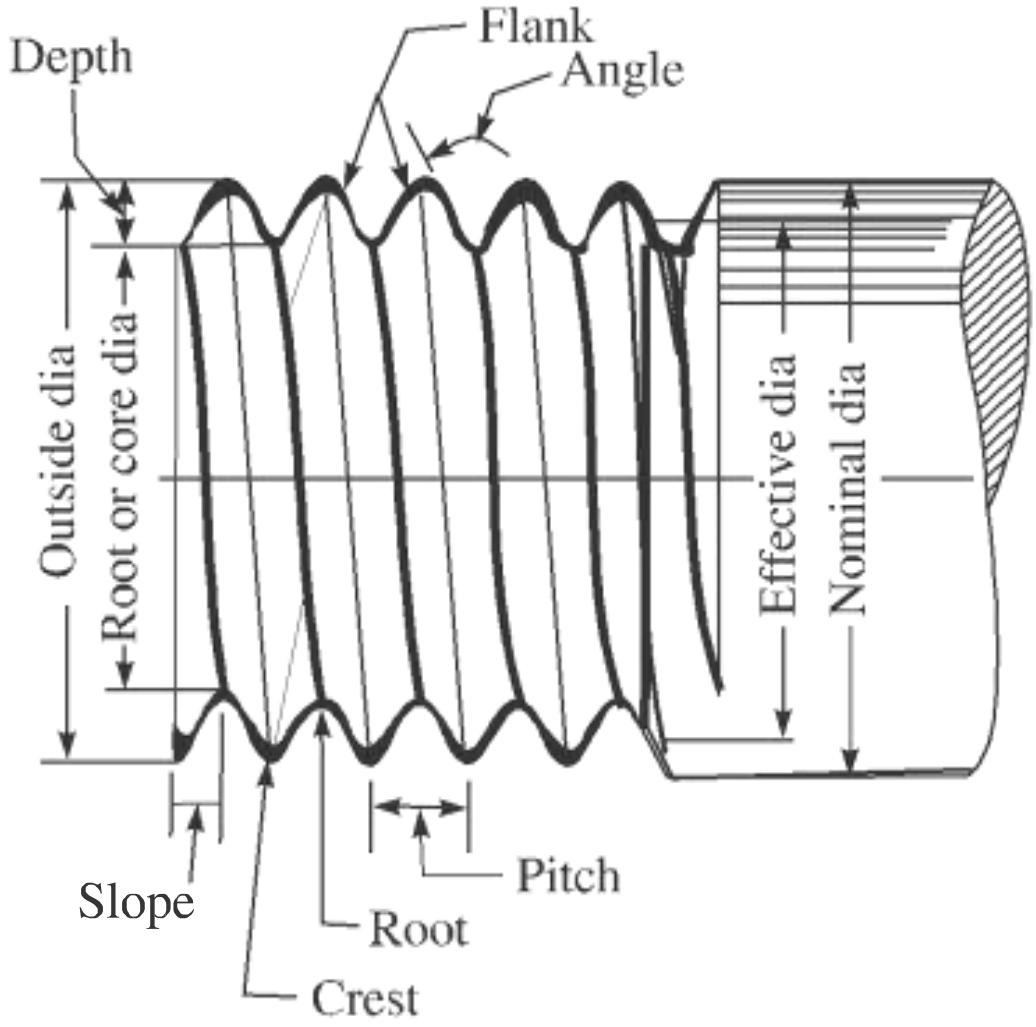
$$N = \frac{4\ x\ 1000\ x\ 60}{\pi\ x\ 600}$$

= 108,23 rpm

ACTIVITY 5: POSSIBLE ANSWERS

5.1 Fastening
Fasteners such as wood screws, machine screws, nuts and bolts.
Connecting threaded pipes and hoses to each other and to caps and fixtures.
Gear reduction via worm drives
Moving objects linearly by converting rotary motion to linear motion, as in the leadscrew of a jack.
Measuring by correlating linear motion to rotary motion (and simultaneously amplifying it), as in a micrometer.
Both moving objects linearly and simultaneously measuring the movement, combining the two aforementioned functions, as in a leadscrew of a lathe.
In all of these applications, the screw thread has two main functions:
It converts rotary motion into linear motion.
It prevents linear motion without the corresponding rotation.

5.2



5.3

a) **Unified threads:** Also called as International organisation threads. India, United Kingdom, U.S.A. and Canada are the members of the International Organisation for Standardization (I.S.O.) and are agreed to have a common form of threads

b) **Metric thread:** These are the threads based on metric system and the Bureau of Indian Standard has recommended to adopt the unified threads on metric system

5.4 Advantages:

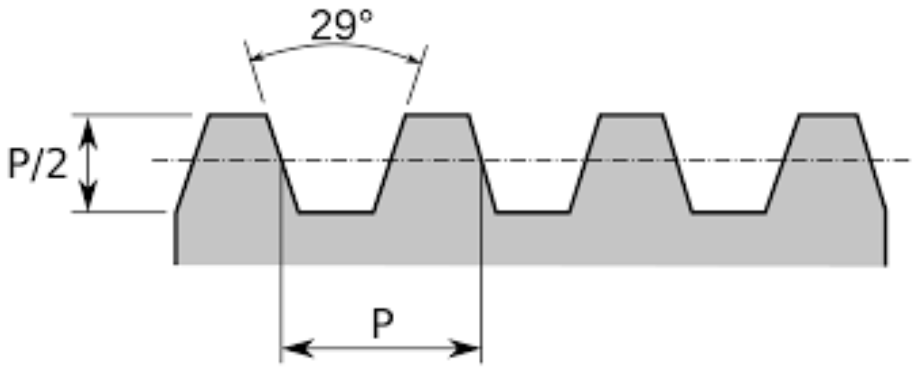
- The greatest advantage of square threads is that they have a much higher intrinsic efficiency than trapezoidal threads (Acme or metric trapezoidal).
- Due to the lack of a thread angle there is no radial pressure, or bursting pressure, on the nut.
- This also increases the nut life

Disadvantages:

- The greatest disadvantage is the difficulty in machining such a thread
- Square threads also cannot carry as much load as a trapezoidal thread, because the root of the square thread is smaller.
- There is no way to compensate for wear on the nut, so it must be replaced when worn out.

5.5 Acme threads have a 29° thread angle, which is easier to machine than square threads. Square thread has a 90° angle to the root of the thread.

5.6



TERM 4

TOPIC: TERMINOLOGY- POSSIBLE ANSWERS

ACTIVITY 1:

1.1 Reading from the main scale 23.00 mm,
reading from the vernier 0.22 mm,
Total reading
23.00mm + 0.12mm = **23.12 mm**

1.2 Reading from the main scale 10.00mm,
reading from the vernier scale 0.2 mm,
so the length to the nearest tenth of a mm is
10.00mm + 0.2 mm = **10.02 mm**

1.3 Reading from the main scale 31.00mm,
reading from the vernier scale 0.10 mm,
Total reading
31.00mm + 0.10 mm = **31.10 mm**

1.4 Reading from the main scale 9.00mm,
reading from the vernier 0.2 mm,
Total reading
9.00mm + 0.2 mm = **9.20mm**

1.5 Reading from the main scale 26.00mm,
reading from the vernier 0.00 mm,
Total reading
26.00mm + 0.0 mm = **26.00 mm**

ACTIVITY 2: POSSIBLE ANSWERS

2.1 8,11mm

2.2 11,25mm

2.3 14,19mm

2.4 8,91mm

ACTIVITY 3: QUESTIONS

3.1 Accept any of the following:

- Make sure that all guards are in place. ✓
- Do not use a machine or come close to its moving parts while wearing loose clothing such as ties, unbuttoned sleeves, etc. and keep any cleaning material such as waste and rags away from rotating parts. ✓
- See that there is no oil or grease on the floor around the machine which can cause slipping. ✓
- Spanners or keys must never be left on rotary parts. ✓
- Never apply a wrench to revolving work or parts. ✓
- Select the correct tool for the job. ✓
- Work pieces and holding devices must always be clamped safely and firmly. ✓
- Pay special attention when fitting spanners and keys as a loose fit may cause slips, resulting in injury to your arm or hand. ✓
- Do not use your hands to remove cuttings while the machine is in motion. Use a wire hook or a brush. ✓
- Never adjust or attempt to adjust the cutting tool while the machine is running. ✓
- When filing close to a chuck or lathe carrier, file using your left hand.✓
- Do not lean on a machine at any time. ✓
- Do not attempt to stop the machine by placing your hand on the chuck while the machine is slowing down. ✓

Give attention to cutting-fluid control before switching the machine on. ✓

3.2

- Speed lathes
- Engine lathes
- Bench lathes

3.3 The centre lathe produces a cutting action by rotating the work piece against the cutting edge of the tool.
As the cutting tool is moved lengthwise and crosswise to the axis of the work piece, the shape of the work piece is generated.
The shape produced is basically cylindrical.
3.4

- Headstock location
- Removable gap piece
- Bed ways
-

3.5
3.5.1 V bed
3.5.2 Flat bed
3.5.3 Gap bed

ACTIVITY 4: POSSIBLE ANSWERS

4.1 Cutting fluid is used in conjunction with machining processes such as lathe or milling work. It is usually a compound of water-soluble oil and water. The fluid has a milky white appearance and is applied directly to the workpiece by means of a movable spout.

4.2 Advantages

- The workpiece and cutting tool are kept cool.
- The life of the cutting tool is prolonged.
- A better finish is imparted on the workpiece.
- Cuttings are washed away, keeping the cutting tool free from debris.
- The machine is protected because the cutting process is eased.
- The machine operator is protected from very fine metal chips and dust.
- Productivity is increased because the cutting process is faster.
- The soluble oil prevents corrosion.

4.3 Cutting fluid should be applied to the cutting tool in order for them to reach all the areas that needed cooling and lubricating. Care should be taken not to cause the fluid to splash. Splashes of soluble oil on the floor of the workshop are slippery and should be cleaned up immediately.

4.4 The following guidelines should always be followed for safe and effective work with cutting fluid:

- Avoid contamination of the cutting fluid by draining and regularly replacing it.
- Always clean the machine splash tray of metal cuttings after use.
- Regularly wipe cutting fluid splashes off machine parts
- Ensure that the sump is topped up from time to time and check that there is sufficient flow of cutting fluid to the cutting tool.

ACTIVITY 5: POSSIBLE ANSWERS

5.1Internal turning.

5.2 Sizing: Boring brings the hole to the proper size and finish. A drill or reamer can only be used if the desired size is "standard" or if special tools are ground. The boring tool can work to any diameter and it will give the required finish by adjusting speed, feed and nose radius. Precision holes can be bored using micro adjustable boring bars.
Straightness: Boring will straighten the original drilled or cast hole. Drills, especially the longer ones, may wander off-center and cut at a slight angle because of eccentric forces on the drill, occasional hard spots in the material, or uneven sharpening of the drill. Cored holes in castings are almost never completely straight. The boring tool being moved straight along the ways with the carriage feed will correct these errors.
Concentricity: Boring will make the hole concentric with the outside diameter within the limits of the accuracy of the chuck or holding device. For best concentricity, the turning of the outside diameter and the boring of the inside diameter is done in one set-up-that is, without moving the work between operations.

5.3 A general rule, which applies to all machining, is to minimize the tool overhang to obtain the best possible stability and thereby accuracy.

5.4 Boring bars are available in steel, solid carbide, and carbide-reinforced steel.

5.5 The following recommendations should be followed to obtain the best possible stability:
• Choose the largest possible bar diameter, but at the same time ensure that there is enough room for chip evacuation.

• Choose the smallest possible overhang but, at the same time, ensure that the length of the bar allows the recommended clamping lengths to be achieved.
• A 0-degree lead angle should be used. The lead angle should, under no circumstances be more than 15 degrees.
• The indexable inserts should be positive rake that results in lower cutting forces.
• The carbide grade should be tougher than for external turning in order to withstand the stresses to which the insert is exposed when chip jamming and vibration occur.
• Choose a nose radius that is smaller than the cutting depth.

ACTIVITY 6: POSSIBLE ANSWERS

6.1 Facing is to produce a flat surface at the end of the part and perpendicular to its axis, useful for parts that are assembled with other components.

6.2 There are three forces acting on a cutting tool.
Cutting force, Fc: acts downward on the tool tip. This is the force that supplies energy required for cutting operation.
Thrust force, Ft: acts in longitudinal direction. This force is also called the feed force because it is in the feed direction.
Radial force, Fr: acts in radial direction and tends to push the tool away from the workpiece

6.3 First start by facing the work piece. Insert the tool into the chuck and clamp it securely. Drill centre holes on each of the ends. Bring the tail stock forward so that the centre enters the centre hole. Make sure your work piece is rigid. Bring the cutting tool forward just before the parallel side of the work piece. Give attention now to the cutting fluid controls and make sure the cutting fluid does not spray all over the machine. Start the machine and bring the cutting tool forward as so it just touches the work piece. Engage the automatic feed and when finished, bring the tool back to the starting point. Take your micrometer and get the first reading and then start cutting again until you reach the desired diameter.

ACTIVITY 7: POSSIBLE ANSWERS

7.1 ANSWER:

$\text{Tan}\theta = \frac{D-d}{2\ x\ L}$ ✓

$= \frac{75-60}{2\ x\ 150}$ ✓

$= \frac{15}{300}$ ✓

$= 0.05$ ✓

θ = 2°52' ✓

7.2 ANSWER:

$\text{Tan}\theta = \frac{D-d}{2\ x\ L}$ ✓

Tan 4°✓ $= \frac{60-d}{2\ x\ 150}$ ✓

0.0699✓ $= \frac{60-d}{300}$ ✓

300 x 0.0699 = 60 – d ✓

20,97✓ = 60 – d ✓

d = 60 – 20,97 ✓

d = 39.021mm ✓

ACTIVITY 8: POSSIBLE ANSWERS

8.1 The compound rest is favourable for turning or boring short, steep tapers, but it can also be used for longer, gradual tapers providing the length of taper does not exceed the distance the compound rest will move upon its slide.

8.2 The compound rest base is graduated in degrees and can be set at the required angle for taper turning or boring.

8.3 First calculate the degrees the compound must be set to. To machine a taper by this method, the tool bit is set on centre with the workpiece axis. Turn the compound rest feed handle in a counter clockwise direction to move the compound rest near its rear limit of travel to assure sufficient traverse to complete the taper. Bring the tool bit into position with the workpiece by traversing and cross-feeding the carriage. Lock the carriage to the lathe bed when the tool bit is in position. Cut from right to left, adjusting the depth of cut by moving the cross feed handle and reading the calibrated collar located on the cross feed handle. Feed the tool bit by hand-turning the compound rest feed handle in a clockwise direction. The tool bit travels along a line which is parallel with the ways of the lathe. When the lathe centres are aligned and the workpiece is machined between these centres, the diameter will remain constant from one end of the piece to the other. If the tailstock is offset, as shown in Figure 3-64, the centreline of the workpiece is no longer parallel with the ways; however, the tool bit continues its parallel movement with the ways, resulting in a tapered workpiece. The tail stock may be offset either toward or away from the operator. When the offset is toward the operator, the small end

of the workpiece will be at the tailstock with the diameter increasing toward the headstock end.

ACTIVITY 9: POSSIBLE ANSWERS

9.1 Generally used to cut taper when no taper attachment available

9.2 By using graduations on end of the tailstock (visual method)
By means of the graduated collar and feeler gage
By means of a dial indicator

9.3Lathe centers remain in alignment, preventing distortion of centers on work
Setup is simple and permits changing from taper to parallel turning with no time lost to align centers
Length of workpiece does not matter, since duplicate tapers may be turned on any length of work
Tapers may be produced on work held between centers, in chuck or in collet
Internal tapers can be produced by this method
Metric taper attachments are graduated in millimeters and degrees, while inch attachments are graduated in both degrees and inches of tpf

- Eliminates need for lengthy calculations and setup

Wider range of tapers may be produced

9.4 Clean and oil guide bar
Loosen lock screws and offset end of guide bar the required amount or, for inch attachments, set bar to required taper in degrees or tpf
Tighten lock screws
With compound rest set at 90º, set up cutting tool on center
Set workpiece in lathe and mark length of taper
Tighten connecting screw on sliding block
Move carriage until center of attachment opposite length to be tapered
Lock anchor bracket to lathe bed
Take cut .060 in. long, stop lathe, check end of taper for size
Set depth of roughing cut to .050 to .060 in. oversize, and machine taper

Readjust taper attachment, if necessary, take light cut, and recheck taper fit
Finish-turn and fit taper to gage

ACTIVITY 10: POSSIBLE ANSWERS

10.1 Fastening

- Fasteners such as wood screws, machine screws, nuts and bolts.
- Connecting threaded pipes and hoses to each other and to caps and fixtures.

Gear reduction via worm drives

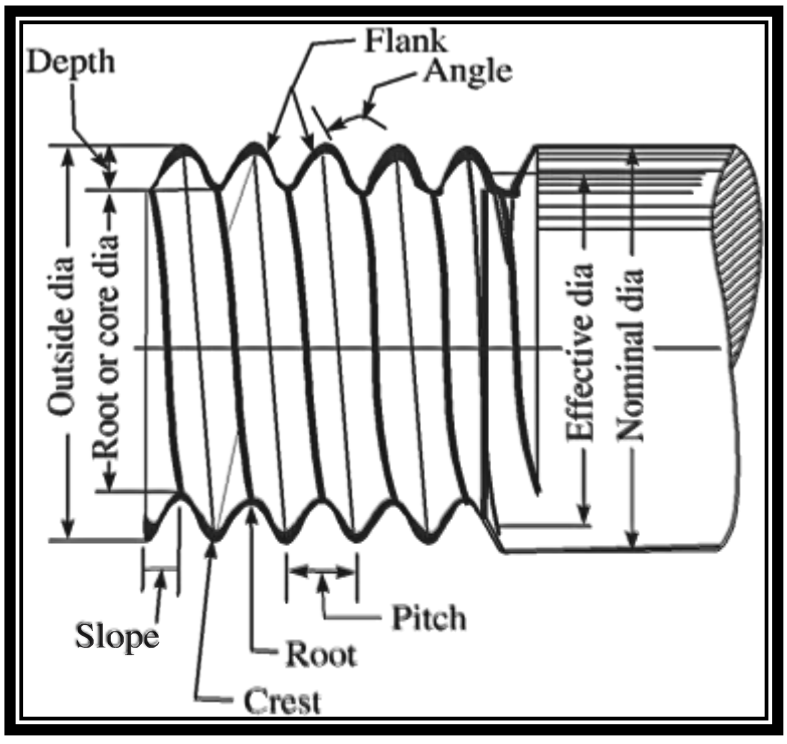
Moving objects linearly by converting rotary motion to linear motion, as in the lead screw of a jack.

Measuring by correlating linear motion to rotary motion (and simultaneously amplifying it), as in a micrometer.

10.2 It converts rotary motion into linear motion.

It prevents linear motion without the corresponding rotation.

10.3



10.4 Terms:

l) The distance measured parallel to the axis from a point on a screw thread to a corresponding point on the next thread is called pitch or in other words the distance from crest to crest or root to root is called pitch of the thread.

m) The distance moved by a nut or a bolt in axial direction in one complete revolutions called lead.

n) The outer-most part of the thread is called crest.

o) The inner most part of the thread is called root.

p) The surface between the crest and the root is known as flank of the thread.

q) The angle between the flanks measured on an axial plane is called angle of thread.

r) It is the distance between crest and root measured at right angle to the axis.

s) The diameter of the cylindrical piece on which threads are cut is called nominal diameter.

t) Diameter at the crest of the thread measured at right angle to the axis is called major diameter and is also known as outside diameter.

u) The diameter at the core or root of the thread is called minor diameter. It is also called as core diameter.

v) The threads on the outside surface of the bolt, stud and screw etc., are called external threads

ACTIVITY 11: POSSIBLE ANSWERS

Question number	Possible marks	Answers
11	10 marks	11.1 A screw is a **round** steel bar with a **spiral** groove cut into it. When a screw is turned in a hole or in a nut that also has a thread, then the **rotary** motion of the screw is changed to linear motion as the one thread **meshes** into the other.
	4 marks	11.2.1 V thread 11.2.2 square thread
	6 marks	11.3.1 vice 11.3.2 wrench 11.3.3 G clamp

[20 marks]