RQF LEVEL 3

MATBO301

MANUFACTURING TECHNOLOGY

Bending Operation

TRAINER'S MANUAL

October, 2024

BENDING OPERATION

KOICA Korea International Cooperation Agency

TQUM TVET Quality Management Project

2024

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TABLE OF CONTENT

ACRONYMS

CBT/A: Competency-Based Training and Assessment
CVD: Chemical Vapour Deposition
MATBO: Manufacturing Technology Bending Operation
PPE: Personal Protective Equipment
PVD: Physical Vapour Deposition
RQF: Rwanda Qualification Framework
RTB: Rwanda TVET Board
TQUM: TVET Quality Management Project

INTRODUCTION

This trainer's manual includes all the methodologies required to effectively deliver the module titled "Bending Operations." Trainees enrolled in this module will engage in practical activities designed to develop and enhance their competencies.

The development of this training manual followed the Competency-Based Training and Assessment (CBT/A) approach, offering ample practical opportunities that mirror real-life situations.

The trainer's manual is organized into Learning Outcomes, which is broken down into indicative content that includes both theoretical and practical activities. It provides detailed information on the key competencies required for each learning outcome, along with the objectives to be achieved.

As a trainer, you will begin by asking questions related to the activities to encourage critical thinking and guide trainees toward real-world applications in the labor market. The manual also outlines essential information such as learning hours, didactic materials, and suggested methodologies.

This manual outlines the procedures and methodologies for guiding trainees through various activities as detailed in their respective trainee manuals. The activities included in this training manual are designed to offer trainees opportunities for both individual and group work. Upon completing all activities, you will assist trainees in conducting a formative assessment known as the end learning outcome assessment. Ensure that trainees review the key reading and the points to remember section.

MODULE CODE AND TITLE: MATBO301 BENDING OPERATIONS

Learning Outcome 1: Prepare for bending operation.
Learning Outcome 2: Carry out bending operation.
Learning Outcome 3: Perform post-operation activities.

Learning Outcome 1: Prepare for Bending Operation.

Indicative contents

1.1 Introduction to bending operation.

1.2 Identification of safety and security measures.

1.3 Identification of material, tools and equipment.

1.4 Pre-operation activities for bending equipment.

Key Competencies for Learning Outcome 1: Prepare for bending operation.

Knowledge	Skills	Attitudes
• Explanation of key concepts of bending operation • Identification of bending equipment safety tips and precautions • Classification of material used in bending operation • Description of properties of materials • Description of tools and equipment used in bending operation • Description of types of bending • Explanation of working principle of bending equipment	• Applying safety and security measures • Cleaning of bending equipment • Selecting tools and equipment used in bending operation • Adjusting the equipment and tools used in bending operation • Lubricating of bending equipment	• Being attentive while applying safety and security measures • Having precision while adjusting bending equipment • Being carefully while selecting materials, tools and equipment • Being task oriented while lubricating

Duration: 8 hrs

Learning outcome 1 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Explain correctly the key concepts used in bending operation
2. Identify correctly bending equipment safety tips and precautions
3. Apply effectively safety precautions in bending operation
4. Describe properly the materials, tools and equipment used in bending operation
5. Select appropriately materials, tools and equipment used in bending operation
6. Describe correctly the types of bending operation
7. Apply properly maintenance techniques on bending equipment

Resources

Equipment	Tools	Materials
• Personal protective equipment • Lifting devices • Air compressor • Grease pump • Bending machines • Shear machine • Cut-off machine	• Vernier calliper • Tape measure • Spanners • Allen key • Cloths rugs • Wire brushes • Spray gun • Centre punch • Steel scriber • Divider • Trammel • T-Square	• Oil and • Grease • Paint • Sheet metal • Pipes • Bars

	• Steel ruler	

Advance Preparation:

Before delivering this learning outcome, you are recommended to:

- Avail a video / photo showing bending process and bent products
- Avail PPEs and other safety equipment at workplace
- Avail bent product with bending tools at work place
- Avail a bending machine with its manual instructions

Indicative content 1.1: Introduction to Bending Operation.

Duration: 2 hrs

Theoretical Activity 1.1.1: Explanation of key concepts of bending operation

Notes to the trainer:

- Trainer may deliver this content by using small groups for describing the keys terms used in bending operation.
- The use of images, videos, and illustrations relating to key concepts of bending operation as didactic materials is required.

Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and request trainees to answer the following question:

i. what do you understand by the following key terms used in bending operation

- Bending
- Flange length
- Bent radius
- K factor
- Bend deduction
- Bend allowance
- Outside set back
- Bend length

ii. What should be the advantages and disadvantages of bending operation?

iii. what should be the applications of bending operation?

Step 2: Ask trainees to write provided answers on flipchart/paper.

Step 3: Facilitate trainees to present their findings.

Step 4: Provide expert view and clarifies ideas by using didactic materials.

Step 5: Ask trainees to read the key reading 1.1.1. in trainee manual

Points to Remember

- The key terms of bending operation should be in line with the operation
- Bending operation should be applied in mechanical innovations and also in: manufacturing, construction and Transportation.

Indicative content 1.2: Identification of Safety and Security Measures

Duration: 1 hr

Theoretical Activity 1.2.1: Description of safety and security measures used in bending operation

Notes to the trainer:

- Trainer may deliver these contents; by using small groups to describe safety and security measures at workplace.
- You can use some tutorial videos or picture to explain more safety and security measures.

Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and request trainees to answer to the following questions.

i. What do you understand by bending equipment safety tips?
ii. What are the safety precautions we can consider during bending?
iii. What should be the safety measures on work place during bending?

Step 2: Ask any trainees to write answers provided on flipchart/paper.

Step 3: Facilitate trainees to present their findings.

Step 4: Provides expert view and clarifies ideas by using didactic materials.

Step 5: Ask trainees to read the key reading 1.2.1 in the trainee manual and address any questions or concerns.

Points to Remember

- Before working any task related to the bending operation make sure that the safety precaution are properly applied.
- For maintaining a safe and healthy work environment at the workplace the safety measures must take into consideration.

Practical Activity 1.2.2: Applying safety and security measures in bending operation

Notes to the trainer

- The trainer may allow individual trainee to go to the workplace and apply safety and security measures required for bending operation.
- Videos, images and illustrations should be used as didactic materials

Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to do the task as described below:
As a metal fabricator, you are requested to go to the workshop and apply safety and security measures required for bending operation based on application criteria.

Step 2: Explain the task and provide clear work instruction (Task, PPE, Time allocated).

Step 3: Demonstrate to trainees how to apply safety and security measures required for bending operation and explains the procedures.

Step 4: Ask trainees to apply safety and security measures required for bending operation and monitor the procedures.

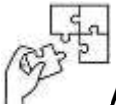
Step 5: Verify whether safety and security measures are correctly applied and provide support where necessary.

Step 6: Ask trainees to read key reading 1.2.2.

Step 7: Ask trainees to perform the task provided in application of learning 1.2.

Points to Remember

- Keep the area organized to avoid accidents
- Always wear protective equipment like gloves, goggles, and safety boots



Application of learning 1.2.

In your school manufacturing workshop, workshop technician is preparing to fabricate window. The technician wants to apply the safety and security measures required for bending window pieces process. Ask trainees to apply the safety and security measures required.

Checklist/solution for application

SN	Criteria	Indicators	Observation	
			Yes	No
1	Safety and security measures are applied	1.1. Equipment safety tip are indicated		
		1.2. Safety equipment are selected		
		1.3. hazardous materials are removed		

Indicative content 1.3: Identification of Material, Tools and Equipment.

Duration: 2 hrs

Theoretical Activity 1.3.1: Description of material, tools and equipment used in bending operation

Notes to the trainer:

- While delivering this contents, small groups can be used to describe materials, tools, equipment as used in bending operation.
- Use pictures or photos and illustrations as didactic materials for more clarification.

Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to provide the answers of questions below, reflecting on tools, materials and equipment used in bending operation.

i. What are the classifications of materials used in bending operation?
ii. What are the classifications of tools used in bending operation?
iii. What are the classifications of equipment used in bending operation?

Step 2: Ask any trainee to write answers provided on flipchart/paper.
Step 3: Facilitate trainees to present their findings.
Step 4: Provide expert view and clarify ideas by using didactic materials.
Step 5: Ask trainees to read the key reading 1.3.1. in the trainee manual and address any questions or concerns.

Points to Remember

- Use appropriate tools for the material type and thickness to avoid overloading or improper bends.
- Check the bending equipment for proper calibration and alignment before starting operations
- The equipment used in bending operations can be classified based on mechanism of action, size or capacity and automation level.

Practical Activity 1.3.2: Selecting material, tools and equipment used in bending operation

Notes to the trainer

- This activity should take place in workshop where you are supposed to demonstrate trainees how to select tools, material and equipment to be used in bending operation.
- Remember to ask trainees to perform this activity and facilitate them individually. You are recommended to:
  ✓ Avail tools, materials and equipment used in bending operation.
  ✓ Have a well-organized workplace.

Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to do the task as described below:
As a metal fabricator, you are requested to go to the workshop and select tools, materials and equipment to be used in bending operation based on selection criteria.

Step 2: Explain the task and provide clear work instruction (Task, PPE, Time allocated).

Step 3: Demonstrate to the trainees how to select tools, materials and equipment used in bending operation and explains the selection criteria.

Step 4: Ask trainees to select tools, materials and equipment used in bending operation and monitor the procedures.

Step 5: Verify whether tools, materials and equipment used in bending operation are correctly selected and provide support where necessary.

Step 6: Ask trainees to read key reading 1.3.3.

Step 7: Ask trainees to perform the task provided in application of learning 1.3.

Points to Remember

- The selection of tools, materials and equipment should depend on the types of bending which is going to be done.
- Pay attention to the selection of materials because any error should make them useless.

Theoretical Activity 1.3.3: Description of types of bending operation

Notes to the trainer:

- While delivering this contents, small groups can be used to describe the types of bending operation.
- Use pictures or photos and illustrations as didactic materials for more clarification.

Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to provide the answers of questions below:

i. What do you understand by the cold bending?

ii. What do you understand by the hot bending?

Step 2: Ask any trainees to write answers provided on flipchart/paper.

Step 3: Facilitate trainees to present their findings.

Step 4: Provide expert view and clarify ideas by using didactic materials.

Step 5: Ask trainees to read the key reading 1.3.1. in trainee manual and address any questions or concerns.

Points to Remember

- Use materials that retain ductility and avoid cracking under cold conditions.
- Monitor temperature closely to prevent overheating and weakening the material.

Application of learning 1.3.

Your school workshop assistant before performing bending operation of metallic chair pieces, want to select tools, materials and equipment for making metallic chair. Ask trainees to go to the workshop and select materials, tools and equipment required for bending operation according to the selection criteria.

Checklist/solution for application:

SN	Criteria	Indicators	Observation	
			yes	no
1	Tools are selected	1.1. Clamping tools are selected		
		1.2. Cutting tools are selected		
		1.3. Measuring and marking tools are selected		
		1.4. Miscellaneous tools are selected		
2	Materials are selected	2.1. Metals are selected		
		2.2. Non-metal are selected		
3	Equipment are selected	3.1. Hand held bending machine is selected		
		3.2. Industrial bending machine is selected		

Indicative content 1.4: Pre-operation Activities for Bending Equipment

Duration: 3hrs

Theoretical Activity 1.4.1: Description of pre-operation activities for bending equipment

Notes to the trainer:

- While delivering this content, use small groups can be used for describing pre-operation activities for bending equipment.
- The use of images, videos, and illustrations as didactic materials is required for more clarification

Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and request trainees to respond to the following questions:

i. How can you explain working principle for bending equipment

ii. What do you think about the following maintenance activities?

- Cleaning
- Lubrication
- Adjustment

Step 2: Ask trainees to write answers provided on flipchart/papers.

Step 3: Facilitate trainees to present their findings and choose the correct ones.

Step 4: Provide expert view and clarifies ideas by using didactic materials.

Step 5: Ask trainees to read the key reading 1.4.1. in trainee manual and address any questions or concerns.

Points to Remember

- Familiarize yourself with the machine's operating manual to ensure proper usage.
- Follow the manufacturer's schedule for lubrication and use the specified type of lubricant.

- Use appropriate cleaning solutions to avoid corrosion or damage to surfaces.
- Periodically adjust tools, dies, and settings to ensure proper alignment and accurate performance

Practical Activity 1.4.2: Perform maintenance on bending equipment

Notes to the trainer

- This activity should take place in workshop where you are supposed to demonstrate trainees how to maintain the bending equipment.
- Remember to ask trainees to perform this activity and facilitate them individually. You are recommended to:
  ✓ Avail tools, materials and equipment required for maintenance.
  ✓ Have a well-organized workplace.

Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to perform the task described below: you are requested to go in manufacturing workshop and perform lubrication, cleaning and adjustment as maintenance activities required for bending machine equipment.

Step 2: Explain the task and provide clear work instruction.

Step 3: Demonstrate to trainees how to perform maintenance of bending equipment and explain maintenance procedures.

Step 4: Ask trainees to maintain bending equipment by lubricating, adjustment and cleaning and monitor maintenance procedures.

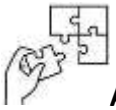
Step 5: Check whether maintenance is properly performed and provide support where necessary.

Step 6: Ask trainees to read key reading 1.4.2

Step 7: Ask trainees to perform the task provided in application of learning 1.4

Points to Remember

- Regularly calibrate the machine to ensure accuracy in bending angles and dimensions.
- Apply the recommended lubricant to moving parts, including joints, pistons, and rollers, to reduce wear and tear.
- Pay special attention to dies, rollers, and moving components to ensure they remain free from residue.



Application of learning 1.4.

In your school manufacturing workshop, there is a technician who is going to bend a required pieces for making a steel chair. He wants to prepare the machine for ready to work the bending operation. Ask trainees to clean, adjust and lubricate the bending machine.

Checklist/solution for application

SN	Criteria	Indicators		
			yes	no
1	Bending equipment are maintained	1.1. Bending equipment are lubricated		
		1.2. Bending equipment are cleaned		
		1.3. Bending equipment are adjusted		

Learning outcome 1 end assessment

Written assessment

Question 1: Complete the following sentences which stating the meaning of common types of metal bending operations. Use the words in bracket **(Cracking, Operation, Formability, Breaking, Plastic)**

a) Material ductility refers to the ability of a metal to undergo **……..plastic….**deformation without fracturing.

b) In metal bending operations, ductility is crucial as it allows the metal to be easily formed into the desired shape without **……cracking……..**or **……breaking……**

Question2 : Write down if this statement is correct or wrong, the sentence is indicating and explaining the concept of bend allowance and how it is calculated.

Answer:

Bend allowance is the amount of material length required for a bend. It compensates for the elongation of the outer surface and compression of the inner surface during bending. It is calculated using formulas based on factors such as bend angle, material thickness, and the type of material being bent. **(True)**

Question 3: Choose the correct answer

1: The followings are the methods of Metal bending except.

a) Press brakes,
b) Roll bending machines,
c) Tube benders,
d) Hot bending.
e) Metal hitting.

2. The following are the definitions of metal bending, except one?

a) Cutting metal into desired shapes

b) Joining metal pieces together

c) Deforming metal to create specific shapes or angles

d) Coating metal surfaces for protection

3. Which industries commonly use metal bending?

a) Food and beverage industry

b) Information technology industry

c) Automotive and manufacturing industry

d) Healthcare and pharmaceuticals industry

4. What factors influence the metal bending process?

a) Type and thickness of the metal

b) Desired bend angle and radius

c) Bending method used

d) All of the above

5. Which of the following is a common method for metal bending?

a) Welding

b) Forging

c) Extrusion

d) Roll bending

6. Why is safety important in metal bending operations?

a) To ensure the quality of the final product

b) To prevent accidents and injuries

c) To increase production speed

d) To reduce material costs

Answers:

1. e) Metal heating

2. c) Deforming metal to create specific shapes or angles

3. c) Automotive and manufacturing

4. d) All of the above

5. d) Roll bending

6. b) To prevent accidents and injuries

Practical assessment

Our school want gate with a top bent frame, the fabricator who is working in school manufacturing workshop want to prepare for bending operation. Ask trainees to go to manufacturing workshop and apply safety measures required for the work, select tools, materials and equipment required and maintain the bending equipment.

ASSESSMENT CHECKLIST

SN	Criteria	Indicators	Observation	
			Yes	No
1	1. Safety and security measures are applied	1.1. Equipment safety tip are indicated		
		1.2. Safety tools and equipment are selected		
		1.3. Hazardous materials are removed		
2	2. Equipment, tools and materials are selected	2.1. Metals are selected		
		2.2. Clamping tools are selected		
		2.3. Cutting tools are selected		
		2.4. Measuring tools are selected		
		2.5. Marking tools are selected		
		2.6. Hand held bending machine is selected		
		2.7. Industrial bending machine is selected		
3	3. Bending Machines are maintained	3.1. Machine is cleaned		
		3.2. Machine is adjusted		
		3.3. Machine is lubricated		

Further information to the trainer

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Indicative contents
2.1 Interpretation of drawing **2.2 Setting up bending equipment** **2.3 Bending the work piece**

Key Competencies for Learning Outcome 2: Carry Out Bending Operation.

Knowledge	Skills	Attitudes
• Identification of Cutting list element • Identification of methods of bending • Description of forms of bends	• Interpreting drawing • Setting up bending equipment • Bending the workpieces	• Having critical thinker while interpreting drawing • Being carefully while setting up bending equipment • Being attentive while bending workpieces

Duration: 15 hrs

Learning outcome 2 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Identify correctly cutting list elements used in bending operation.
2. Interpret correctly the drawing as used in bending operation.
3. Set up properly bending equipment as required in bending operation.
4. Bend correctly the workpiece according to work requirement.

Resources

Equipment	Tools	Materials
• Personal protective equipment • Bench table • Bending machines • Angle grinder • Shearing machine • Air compressor	• Tape measure • Vernier caliper • Try square, • Scriber, • Center punch, • Steel rule, divider • Trammel, • Sliding T-bevel, • Hummer, • Cloths rugs, • Files, • Reamer, • Vice • Spanners, • Wrench, • Allen key • Wire brushes, • Bloom, • Spray gun	• Sheet metal • Tubes/pipe • Bar • Paints, • Oil • Grease

Advance Preparation:

Before delivering this learning outcome, you are recommended to:

- Have all required PPEs ready to be used for safety
- Avail materials, tools and equipment required in bending operation
- Avail prepared workpiece at workplace
- Avail the tutorial video illustrating the process of bending the work piece
- Have a well-organized workplace

Indicative content 2.1: Interpretation of Drawing

Duration: 2 hrs

Theoretical Activity 2.1.1: Description of cutting list elements.

Notes to the trainer:

- While delivering this content, small groups can be used for describing cutting list elements for bending equipment.
- The use of images, videos, and illustrations as didactic materials is required for more clarification

Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and request trainees to respond to the following questions:
  i. What do you understand by cutting list?
  ii. What are the cutting list elements for bending operation?

Step 2: Ask trainees to write answers provided on flipchart/papers.

Step 3: Facilitate trainees to present their findings and choose the correct ones.

Step 4: Provide expert view and clarifies ideas by using didactic materials.

Step 5: Ask trainees to read the key reading 2.1.1. in trainee manual and address any questions or concerns.

Points to Remember

- Cutting list element also known as a material list, should be based during interpretation of drawing.
- Part list format is prepared according to part numbers in sequential order.

Indicative content 2.2: Setting up Bending Equipment

Duration: 5 hrs

Practical Activity 2.2.1: Setting up bending equipment

Notes to the trainer

- This activity should take place in workshop where you are supposed to demonstrate trainees how to set up bending equipment.
- Remember to ask trainees to perform this activity and facilitate them individually. You are recommended to:

  ✓ Avail tools, materials and equipment required for setting up bending equipment.

  ✓ Have a well-organized workplace.

Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to do the task described below:
As a metal fabricator, you requested to go to manufacturing workshop and set up bending equipment by mounting bending tools, positioning work pieces and die based on trainer's instruction.

Step 2: Explain the task and provide clear work instruction (Task, PPE, Time allocated)

Step 3: Demonstrate to trainees how to set up bending equipment by mounting bending tools, positioning work pieces and die based on trainer's instruction. While demonstrating, explain the procedures.

Step 4: Ask trainees to set up bending equipment by mounting bending tools, positioning work pieces and die based on trainer's instruction. While demonstrating, explain the procedures.

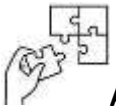
Step 5: Check whether bending equipment is properly set and provide support where necessary.

Step 6: Ask trainees to read key reading 2.2.1

Step 7: Ask trainees to perform the task provided in application of learning 2.2

Points to Remember

- Without bend angle, Material Thickness, Bend Radius, Material Spring back, Tooling Design the die positioning during a bending operation should not be possible
- For mounting the bending tools, you must respect (Mandrel Nose Placement, Direct Pressure Die Setting, Wiper Tip Rake and Pressure Die Assist Setting)
- You must follow the manufacturer's instructions during positioning workpiece for bending as every



Application of learning 2.2.

Your school want to install a pipeline for distributing water in all corners of school but the maintenance technician needs a helper for setting bending equipment to be used for bend pipes where elbows are missing. Ask trainees to set up bending equipment by positioning the bending dies, mounting bending tools and positioning the workpiece correctly to do the required work.

Checklist/solution for application

SN	Criteria	Indicators	Observation	
			yes	No
1	1. Bending equipment are properly set	1.1. Die is positioned		
		1.2. Bending tool is mounted		
		1.3. Workpiece is positioned		

Indicative content 2.3: Bending the Workpiece

Duration: 8 hrs

Theoretical Activity 2.3.1: Description of methods of bending and form of bends

Notes to the trainer:

- While delivering this content, small groups can be used for describing methods of bending and form of bends.
- The use of images, videos, and illustrations as didactic materials is required for more clarification.

Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and request trainees to answer the following questions:
   i. What are the methods of bending in bending operation?
   ii. How do you explain the forms of bends in bending operation?

Step 2: Ask trainees to write answers provided on flipchart/papers.

Step 3: Facilitate trainees to present their findings and choose the correct ones.

Step 4: Provide expert view and clarifies ideas by using didactic materials.

Step 5: Ask trainees to read the key reading 2.3.1. in trainee manual and address any questions or concerns.

Points to Remember

- Bending operation are not done in the same way but performed in different method and in different forms.
- During making elbow you must use the necessary form such curved, elbow and twisted bend

Practical Activity 2.3.2: Bending the workpiece

Notes to the trainer

- This activity should take place in workshop where you are supposed to demonstrate trainees how to bend workpiece.
- Remember to ask trainees to perform this activity and facilitate them individually. You are recommended to:
  ✓ Avail tools, materials and equipment required for bending workpiece.
  ✓ Have a well-organized workplace.

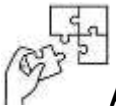
Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to perform the task described below: you are requested to go in manufacturing workshop and bend required workpieces.
Step 2: Explain the task and provide clear work instruction.
Step 3: Demonstrate to trainees how to bend workpiece and explain bending procedures.
Step 4: Ask trainees to bend workpiece and monitor bending procedures.
Step 5: Check whether bending is properly performed and provide support where necessary.
Step 6: Ask trainees to read key reading 2.3.2
Step 7: Ask trainees to perform the task provided in application of learning 2.3

Points to Remember

- Procedures followed when bending workpiece should depend on types bending equipment or bending instruction.
- They are different criteria used for a correct formed bent but they differ from the types of bend.



Application of learning 2.3.

Your school want chairs with curved back, the technician who is work on it want a bended workpiece to assemble those chairs. Ask trainees to bend the required workpieces.

Checklist/solution for application

SN	Criteria	Indicators		
			Yes	Non
1	Workpieces are bent	1.1. Bending machine is used		
		1.2. Bending tools are used		
		1.3. Curved form is produced		

Learning outcome 2 end assessment

Written assessment

A. Read carefully the following statement and choose the correct answer by underline

1. The die positioning in sheet metal bending is?
    a) Die positioning refers to the proper alignment and setup of the die (lower tool) in relation to the punch (upper tool) in a press brake machine.
    b) Determined the final drive bend angle and the overall quality of the steel
    c) The way of meeting wo position of heads of components
    d) All of the above

ANSWER: A

2. How is die positioning determined in sheet metal bending?
    a) Die positioning is determined based on the desired bend angle, material thickness, and other factors.
    b) It can be calculated using formulas or determined through trial and error.
    c) The position of the die affects the amount of spring back, which is the tendency of the material to return to its original shape after bending it also determine the sheet metal bending.
    d) All above determine the positioning in sheet metal bending

    ANSWER: D

3. The following are some common techniques for die positioning in metal bending?
    a) Using reference tables or charts provided by the machine manufacturer or industry standards.
    b) Employing mathematical formulas based on material properties and bending parameters.
    c) Conducting trial and error experiments to fine-tune the die position and achieve the desired bend angle.
    d) Using computer numerical control (CNC) press brake machines that offer automated die positioning based on programmed parameters.

e) All above

f) Only a, b and c

ANSWER: E

4. The following are the factors to be considered when determining die positioning?

a) Material type and thickness: Different materials have different bending properties and require specific die positioning considerations.

b) Bend angle: The desired angle of the bend directly influences the die positioning.

c) Bending method: Different bending methods may have specific die positioning requirements.

d) Punch radius: The radius of the punch tip affects the bend radius and must be considered during die positioning.

e) Spring back: The elastic recovery of the material after bending (springback) must be accounted for when positioning the die to achieve the desired final angle.

f) All above

ANSWER: F

5. The following are the common types of tool mounting systems used in metal bending except one.

a) Tangent or V-style mounting: This involves aligning the punch and die along a tangent line or V-groove to establish the desired bend angle.

b) Wila-style tool clamping: Wila-style clamps are a popular choice for tool mounting. They provide precise tool positioning, easy tool changes, and excellent repeatability.

c) Hot hammering clamp: It is an easy way of heating a metal and clamp it for bending.

d) Hydraulic clamping: Hydraulic clamping systems use hydraulic pressure to secure the tools in place. They offer quick and reliable tool mounting and allow for adjustments during the bending process.

ANSWER: C

6. One among of the following is not included in the process of mounting the bending tools onto a press brake machine.

a) Ensure that the press brake machine is properly set up and powered off.

b) Select the appropriate punch and die for the desired bend.

c) Align the punch and die along the bending axis, taking into account the desired bend angle.

d) Insert the punch into the upper tool holder or tool clamp, and tighten it securely.

e) Place the die into the lower tool holder or tool clamp, ensuring it is aligned with the punch and properly seated.

f) Securely tighten the die clamps or locking mechanisms to hold the die in place.

g) Kick the mounting out of block for fitting the clamp to the bend angle.

h) Double-check the alignment of the punch and die to ensure they are properly positioned for the desired bend.

ANSWER: G

7. What is meant by "bending the work" in metal bending?

a) **"**Bending the work" refers to the process of deforming the metal workpiece using a bending machine or equipment to achieve the desired shape or angle.

b) **"**Bending the work" It involves applying force to the workpiece, causing it to bend along a specific axis.

c) **"**Bending the work" It involves passing the workpiece through a set of rollers to gradually bend it into the desired shape

d) None above

e) Both a and b

ANSWER: E

B. Respond by true if the statement is correct and false if the statement is wrong

a) Press braking is the method uses a press brake machine with a punch and dies to bend the workpiece. **True**

b) Roll bending it involves passing the workpiece through a set of rollers to gradually bend it into the desired shape. **True**

c) Tube bending this is specifically used for bending the squared tubes. **False**

d) The most common method used to bend the work in metal bending is only press braking. **False**

e) The radius of the bend affects the minimum achievable bend radius and the required tooling. **True**

f) Machine limitations is the capacity and capabilities of the bending machine, such as maximum force or bending length, can limit the size or complexity of the bends. **True**

C. Complete the following sentences aided by the words in bracket (Die, Punch, Angle, Powered, Machine, specification and workpieces)

1. Set up the bending machine it ensure the machine is properly adjusted, aligned, and ……..**powered**…… on.
2. Position the workpiece align the ……..**workpiece**…..between the punch and ……**die….,** ensuring it is properly placed for the desired bend.
3. Adjust the bending parameters this set the appropriate bend …….**.angle**….., bending force, and other parameters on the bending ……..**machine**…….

Practical assessment

AB company won a tender of renewing the cooking stoves in schools located in our district, the activity is to fabricate new chimneys and where necessary cooking pans. The company is seeking a qualified technician to carry out required bending activities that includes chimney works. Ask your trainees to perform the following tasks:

- Fabricate the chimney of cylindrical duct with 200mm diameter, 1/100 taper and 4000mm length,
- Where all required materials and tools are available on site

Performance checklist/ Solution

SN	Criteria	Indicators	Observation	
			YES	NO
1	Bending equipment is set	2.1. Die is positioned		
		2.2. Bending tool is mounted		
		2.3. Workpiece is positioned		
2	work piece is bent	3.1. Bending machine is used		
		3.2. Bending tools are used		
		3.3. Curved form is produced		

Further information to the trainer

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Indicative contents
3.1 Finishing bent product. **3.2 Maintaining bending machine.** **3.3 Storing** **3.4 Reporting.**

Key Competencies for Learning Outcome 3: Perform post-operation activities

Knowledge	Skills	Attitudes
• Identification of heat treatment required on bent product • Identification of surface protection of bent product	• Finishing the bent product • Maintaining bending machine • Storing of equipment, tools, product • Preparing technical report of the work done	• Being attentive while finishing bent product • Being task-oriented while maintaining bending machine • Being carefully while preparing technical report. • Being organizer while storing tools, product and equipment
 **Duration: 7 hrs**		

Learning outcome 3 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Identify correctly heat treatment necessary on bent workpiece.
2. Identify properly surface protection required on bent product.
3. Finish correctly the bent product according to surface required.
4. Maintain properly bending machine according to the maintenance manual
5. Store properly tools, equipment and products according to storing techniques
6. Prepare correctly technical report based on reporting template

Resources

Equipment	Tools	Materials
• PPE • Bending machines • Angle grinder • Anvil • Shear machine • Cut-off machine • Material handling equipment • Air compressor • Furnace • Induction furnace	• Dies • Punch • Steel scriber • Try-square • Trammel • Divider • Tap measure • Vernier calper • Micrometre • Chisel • File • Vices • hummer, • screw driver, • Pliers, • Spanners, • Wrench, • Allen key cloths rugs, • Wire brushes, • Bloom, • Spray gun.	• Paints • Oil • Grease

Advance Preparation:

Before delivering this learning outcome, you are recommended to:

- Avail the bent product
- Avail tools, materials and equipment required in bending post-operation activities
- Avail a sample of report for the work done
- Have video/images illustrating bending post operation activities process
- Have a well-organized workshop.

Indicative content 3.1: Finishing Bent Product

Duration: 3 hrs

Theoretical Activity 3.1.1: Description of finishing process of bent product

Notes to the trainer:

- While delivering this content, small groups can be used for describing finishing process of bent product.
- The use of images, videos, and illustrations as didactic materials is required for more clarification

Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and request trainees to answer the following questions:

i. What do you understand by heat treatment and its types?

ii. What should be the techniques considerations to protect bend product.

Step 2: Ask trainees to write answers provided on flipchart/papers.

Step 3: Facilitate trainees to present their findings and choose the correct ones.

Step 4: Provide expert view and clarifies ideas by using didactic materials.

Step 5: Ask trainees to read the key reading 3.1.1. in trainee manual and address any questions or concerns.

Points to Remember

- Heat treatment on bent workpiece should be done to the proper quality of workpiece.
- Stages of heat treatment on bent workpiece should be based on the types of workpieces
- Workpiece should be protected in the way of preventing rust or corrosion

Practical Activity 3.1.2: Finishing bent product

Notes to the trainer

- This activity should take place in workshop where you are supposed to demonstrate trainees how to finish bent product.
- Remember to ask trainees to perform this activity and facilitate them individually. You are recommended to:

  ✓ Avail tools, materials and equipment required for finishing.

  ✓ Have a well-organized workplace.

Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to perform the task described below: you are requested to go in manufacturing workshop and finish the bent product.

Step 2: Explain the task and provide clear work instruction.

Step 3: Demonstrate to trainees how to finish bent product and explain finishing procedures.

Step 4: Ask trainees to finish bent product and monitor finishing procedures.

Step 5: Check whether bent product is properly finished and provide support where necessary.

Step 6: Ask trainees to read key reading 3.1.2

Step 7: Ask trainees to perform the task provided in application of learning 3.1

Points to Remember

- Procedures for protecting bent metal products should be tailored to the material type, size, and shape of the bent form.
- Use precise temperature control equipment to achieve uniform heating.
- Clean the surface thoroughly before applying protective layers to ensure adhesion and effectiveness.

Application of learning 3.1.

A manufacturing company that carries out sheet metal works, the company needs to finish the fabricated box gutter to replace the damaged one. Ask trainees to finish the product as required.

Check list:

SN	Criteria	Indicators	Observation	
			Yes	No
1	Bent product is finished	1.1. Heat treatment is performed		
		1.2. Surface protection is applied		
		1.3. Required surface finish is obtained		

Indicative content 3.2: Maintaining Bending Machine.

Duration: 2 hrs

Practical Activity 3.2.1: Perform preventive maintenance on bending machine

Notes to the trainer

- The trainer may use demonstration to show how to maintain bending equipment.
- Remember to ask trainees to perform this activity and facilitate them individually. You are recommended to:

  ✓ Avail tools, materials and equipment required for maintenance.

  ✓ Have a well-organized workplace.

Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to perform the task described below: you are requested to go in manufacturing workshop and maintain bending equipment.

Step 2: Explain the task and provide clear work instructions.

Step 3: Demonstrate to trainees how to maintain bending equipment and explain maintenance procedures.

Step 4: Ask trainees to maintain bending equipment by lubricating and cleaning and monitor maintenance procedures.

Step 5: Check whether maintenance is properly performed and provide support where necessary.

Step 6: Ask trainees to read key reading 3.2.1

Step 7: Ask trainees to perform the task provided in application of learning 3.2

Points to Remember

- Before performing a preventive maintenance, you must have the schedule regular inspections.
- Regular cleaning and lubricating must be respected.

Application of learning 3.2.

The A company ltd technician have finished to bend a chairs piece, he wants to maintain bending equipment after work. Ask trainees to perform preventive maintenance on bending equipment as required.

Checklist:

SN	Criteria	Indicators	Observation	
			Yes	No
1	Bending machine is maintained	1.1. Bending machine is cleaned		
		1.2. Bending machine is lubricated		
		1.3. Maintenance tools and materials are used		

Indicative content 3.3: Storing Tools, Equipment and Product.

Duration: .1 hrs

Practical Activity 3.3.1: Storing tools, equipment and product

Notes to the trainer

- This activity should take place in workshop where you are supposed to demonstrate trainees how to store tools, product and equipment.
- Remember to ask trainees to perform this activity and facilitate them individually. You are recommended to:

  ✓ Avail tools, equipment and product for to be stored.

  ✓ Have a well-organized storing room/place.

Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to perform the task described below: you are requested to go in manufacturing workshop and store tools, equipment and product as required in bending operation.

Step 2: Explain the task and provide clear work instruction.

Step 3: Demonstrate to trainees how to store tools, equipment and product and explain storing procedures.

Step 4: Ask trainees to store tools, equipment and product and monitor storing procedures.

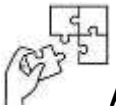
Step 5: Check whether tools, equipment and product are properly storing and provide support where necessary.

Step 6: Ask trainees to read key reading 3.3.1

Step 7: Ask trainees to perform the task provided in application of learning 3.3

Points to Remember

- Criteria for a correct storage of tools, equipment and product should Keep tools and equipment in a cool dry place.
- Techniques used to store tools, equipment and product depend on the quantity of stock, materials stock made for and the size of stock



Application of learning 3.3.

Your school technician wants to store the finished products, tools and equipment used to fabricate those products in proper place. Ask trainees to store tools, equipment and products.

Performance check list/ solution

SN	Criteria	Indicators	Observation	
			Yes	No
1	Tools, equipment and product are stored	1.1. Tools are stored		
		1.2. Equipment are stored		
		1.3. Products are stored		

Indicative content 3.4: Reporting the Work Done.

Duration: 1 hr

Practical Activity 3.4.1: Preparing the work report.

Notes to the trainer

- This activity should take place in workshop where you are supposed to demonstrate trainees how to prepare work report.
- Remember to ask trainees to perform this activity and facilitate them individually. You are recommended to:

  ✓ Avail tools, materials and equipment required for report preparation.

  ✓ Have a well-organized workplace.

Key steps:

While delivering this activity, pass through the following steps:

Step 1: Introduce the activity and ask trainees to perform the task described below: you are requested to go in manufacturing workshop and prepare work report.

Step 2: Explain the task and provide clear work instruction.

Step 3: Demonstrate to trainees how to prepare work report and explain reporting procedures.

Step 4: Ask trainees to prepare work report and monitor reporting procedures.

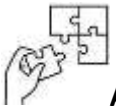
Step 5: Check whether report is properly prepared and provide support where necessary.

Step 6: Ask trainees to read key reading 3.4.1

Step 7: Ask trainees to perform the task provided in application of learning 3.4

Points to Remember

- Procedures of reporting after work done should refer to the activities carried out the product available at workplace
- Reporting after bending operation is an essential part of quality control and project management in manufacturing.



Application of learning 3.4.

Your school manufacturing workshop produces the bend pipe for maintenance pipe line at school, but after the work done, they want to prepare a report of work done. Ask trainees to prepare the report of this work done.

Check list:

SN	Criteria	Indicators	Observation	
			Yes	No
1	Work report is prepared	1.1. Report template is respected		
		1.2. Report template is filled		
		1.3. Work procedures are included		

Learning outcome 3 end assessment

Written assessment

A. Read carefully the following statement and choose the correct answer by encircle.

1. One among of the following is not the reason which indicates that the finishing is important in the metal bending process.
   a) It enhances the aesthetic appearance of the bent product, making it more visually appealing.
   b) Finishing can improve the surface smoothness, removing any rough edges or imperfections caused during the bending process.
   c) It can provide additional protection to the bent product against corrosion or wear.
   d) None of above

   ANSWER: d
2. The followings are the common finishing techniques used in metal bending, except.
   a) Deburring: Removing sharp edges or burrs from the bent product using tools such as files, sandpaper, or deburring machines.
   b) Grinding: Smoothing out the surface of the bent product using grinding tools or abrasives to achieve a consistent finish.
   c) Sanding: Using sandpaper or sanding tools to refine the surface of the bent product, removing any imperfections or roughness.
   d) Slugging: Buffing or polishing the surface of the bent product to achieve a smooth and shiny finish.
   e) Coating: Applying protective coatings such as paint, powder coating, or plating to the bent product to enhance its appearance and durability.

   ANSWER: d
3. The following are some common post-operation maintenance tasks for a bending machine?
   a) Cleaning
   b) Inspection
   c) Lubrication

d) Calibration
e) Documentation
f) All above
g) None above

ANSWER: f

B. Respond by true if the statement is correct and false if the statement is wrong.
a) Can automated or mechanized finishing processes be used in metal bending? **True**
b) Post-operation maintenance of a bending machine, is it important? **True**
c) Regular maintenance of machine helps to identify and address any wear and tear, damage, or abnormalities that may have occurred during the operation. **True**
d) Post-operation activities (maintenance) are done before bending activities start. **False**
e) Are there any specific considerations for post-operation maintenance of a bending machine? **True**
f) Clean and inspect tools before storage to remove debris or residues that can cause damage or deterioration. **True**
g) Secure tools to prevent theft or unauthorized use, using locking mechanisms or storage cabinets are not necessary. T**rue**
h) Proper storage of products depends on their specific characteristics and requirements. However, here are some general guidelines. **True**
i) To ensure proper inventory management during storage is to implement an organized system for tracking and documenting incoming and outgoing products or equipment, such as using barcode systems or inventory management software. True
j) The purpose of **re**porting is to provide all necessary information before bending activities. **False**
k) Financial report is not included in common types of reports. **False**

Practical assessment

The BC company won the tender of replacement of damaged box gutter in the schools located in your district. The BC company is seeking the qualified technician to perform finishing of fabricated products. Ask trainees to finish the product, maintain bending equipment, store tools, equipment and products and prepare the report for the work done.

Checklist:

SN	Criteria	Indicators	Observation	
			Yes	No
1	Product is finished	1.1. Heat treatment is performed		
		1.2. Surface protection is applied		
		1.3. Required surface finish is obtained		
2	Bending equipment is maintained	2.1. Bending machine is cleaned		
		2.2. Bending machine is lubricated		
		2.3. Maintenance tools and materials are used		
3	Product, tools and equipment are stored	3.1. Tools are stored		
		3.2. Equipment are stored		
		3.3. Products are stored		
4	Work report is prepared	4.1. Report template is respected		
		4.2. Report template is filled		
		4.3. Work procedures are included		

Further information to the trainer

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