Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 11

NOVEMBER 2022

MECHANICAL TECHNOLOGY: (WELDING AND METALWORK) MARKING GUIDELINE

MARKS: 200

This marking guideline consists of 15 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

1.1 B ✓
1.2 C ✓
1.3 D ✓
1.4 D ✓
1.5 B ✓
1.6 A ✓
1.7 C ✓
1.8 C ✓
1.9 D ✓
1.10 A ✓
1.11 C ✓
1.12 B ✓
1.13 A ✓
1.14 D ✓
1.15 C ✓
1.16 B ✓
1.17 A ✓
1.18 D ✓
1.19 C ✓
1.20 C ✓ (20 x 1) **[20]**

QUESTION 2: SAFETY

2.1 **THREE safety measures to observe when using the arc welding equipment.**

- Wear approved personal protective equipment (PPE). ✓
- Wear PPE that is fire-resistant to protect the welder against sparks, etc. ✓
- Use completely insulated electrode holders. ✓
- At no time strike an arc without protecting your eyes with a helmet or welding shield.
- Always wear safety goggles to protect your eyes from particles of metal and chips of slag.
- Stand and work only in dry surroundings.
- Always keep your hands and clothing dry. (Any 3 x 1) (3)

2.2 **THREE basic rules that apply to machine guards in the workshop.**

- The working area around all machines must be clearly indicated. ✓
- All moving parts must be covered by rigidly constructed guards. ✓
- If access to a machine is necessary, the guard must be able to hinge or slide open while the machine automatically switches off. ✓
- No machine may be operated if any of the guards are missing or broken.

(Any 3 x 1) (3)

2.3 **THREE safety precautions to apply when using a bending press (Box and Pan folder)**

- Before use check if the machine is mounted securely, especially the bench-mounted type. ✓
- Make sure not to exceed the indicated load limit (thickness of the sheet metal) of the machine. ✓
- Use this machine only to bend sheet metal, not rods or angle iron. ✓
- Do not use any extensions on the folding bar levers. (Any 3 x 1) (3)

2.4 **What does the regulation under the OHS Act (clause C3) refers to in terms of reporting to persons in charge of a workshop?**

The worker must report:

- Maintenance requirements of machines or equipment so that the flow of production is not interrupted. ✓
- Progress on work in operation. ✓
- Problems encountered in the manufacturing process. ✓
- Material and equipment requirements.
- Accidents immediately. ✓ (Any 3 x 1) (3)

2.5 **THREE general safety rules one must adhere to before switching on the portable grinder.**

- The safety guard must be in place before you can start the grinding process. ✓
- Protective shields must be placed around the object being ground to protect passers-by. ✓
- Use the correct grinding disc for the job. ✓
- Do not use excessive force while grinding and cutting. ✓
- Make certain that there are no cracks on the disc before you start a job. ✓
- Protective clothing and eye protection are essential when working with an angle grinder.
- Beware of lockable switches in the on position when the machine is plugged in and switched on. (Any 3 x 1) (3)

2.6 **Safety precautions should be adhered to when drilling a flat steel plate on a drill press?**

- Clamp the work piece securely to the table and do not hold it by hand. ✓ (1)

2.7 **THREE safety rules to be observed when using a surface grinder.**

- Protective clothing and eye protection are essential when operating a surface grinder. ✓
- Understand the operating instructions applicable to your machine. ✓
- Do not operate the surface grinder unless all guards and safety devices are in place and working correctly. ✓
- Never clean or adjust the machine while it is in motion.
- Immediately report any dangerous defects of the machine and stop using it until it has been repaired by a qualified person.
- Do not use excessive force when drilling into the work piece. (Any 3 x 1) (3)

2.8 **THREE types of personal protective equipment (PPE) needed when using gas welding equipment.**

Overall. ✓
Leather gloves ✓
Welding goggles ✓
Welding spats
Safety boots (Any 3 x 1) (3)
[24]

QUESTION 3: TOOLS

3.1 3.1.1 **Identify the machine in FIGURE 3.1 below.**
Pedestal bench grinder ✓ (1)

3.1.2 **Label A – F**
A – Head / Motor ✓
B – Disc guard ✓
C – Maximum gap (3 mm) ✓
D – Grinding wheel ✓
E – Perspex shield ✓
F – Tool rest ✓ (6)

3.1.3 **What is the purpose of part E?**
Perspex shield is to protect your eyes from the grinding debris. ✓ (1)

3.2 **What is the function of the manual guillotine?**
- A manual guillotine is designed to cut sheet metal that is not thicker than 1,2 mm. ✓
- It is usually able to accommodate sheets not wider than 1,2 mm. ✓ (2)

3.3 **Name the TWO main categories that presses fall into.**
Manual and hydraulic. ✓✓ (2)

3.4 The function of the following equipment?

3.4.1 **Horizontal band saw**
It is to cut large metal sections ✓ in a horizontal position. ✓ (2)

3.4.2 **Power saw**
It is used to rough cut ✓ on large steel profiles. ✓ (2)

3.5 **FOUR processes require oxy-acetylene equipment?**
- Gas welding ✓
- Brazing ✓
- Silver solder ✓
- Heating ✓ (4)

[20]

QUESTION 4: MATERIALS (GENERIC)

4.1 **Distinguish between the following properties of engineering materials:**

4.1.1 **Plasticity**

- It allows the material to change shape permanently. ✓
- It is the reverse of elasticity. ✓ (2)

4.1.2 **Ductility**

It allows the material to change shape by stretching it along its length without breaking it along its length without breaking it or drawing it into wire form. ✓✓ (2)

4.1.3 **Brittleness**

It causes the material to break easily and fractures may occur with little or no deformation. ✓✓ (2)

4.2 **Which era is known as the Iron Age?**

The prehistoric era 1500–1000 BC was known as the Iron Age. ✓ (1)

4.3 **The operational principal of the blast furnace.**

- It is charged with alternative layers of iron ore, coke and limestone. ✓
- The raw materials are supplied at the top of the furnace, through a hopper. ✓
- The hot air from the stoves is blown through the nozzles. ✓
- The nozzles are located near the base of the blast furnace. ✓
- The carbon in the coke and the oxygen in the air combine to form a toxic carbon monoxide gas at a temperature of about 1 648° C. ✓
- This reduces the iron ore to metallic iron. ✓ (6)

4.4 **Describe the function of the electric arc furnace.**

- It is charged with alternative layers of iron ore, coke and limestone. ✓
- The raw materials are supplied at the top of the furnace, through a hopper. ✓
- The hot air from the stoves is blown through the nozzles. ✓
- The nozzles are located near the base of the blast furnace. ✓
- The carbon in the coke and the oxygen in the air combine to form a toxic carbon monoxide gas at a temperature of about 1 648 °C. ✓
- This reduces the iron ore to metallic iron. ✓ (2)

4.5 **Briefly explain how cold chisels are tempered.**

- Heat it to a bright red, about 75 mm from the point, then dip the point of the chisel in water. ✓
- This must be just dipped, and moved up and down slightly to avoid a sharp line of demarcation between the hard and soft, which may, if it occurs, cause the hard end to shear off bodily then the chisel is put to use. ✓
- As soon as the actual edge is quenched to cold, move the chisel rapidly to the anvil, lay the hard end across the edge to support it, and rub both sides with a stone. ✓ This brightens it sufficiently for the operator to see the temper colours as they appear, coming up in straight lines across the shank. ✓ (4)

4.6 **Which procedure will you follow to determine whether steel has been heated to a hardening temperature?**

Tempering ✓✓ (2)

4.7 **Explain the difference between hardening and tempering.**

Hardening is when you dunk red-hot metal into cold water, ✓✓ and tempering is when you take that hardened metal, heat it slightly, and then let it cool slowly. ✓✓ (4)

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QUESTION 5: MAINTENANCE (SPECIFIC)

5.1 5.1.1 **Consequences of the lack of lubrication:**

- Excessive wear. ✓
- Journals seizing in the bearings/bushes. ✓ (2)

5.1.2 **Machine where friction is not a relative factor**:

- Guillotine ✓
- Punch ✓ (Any 1 x 1) (1)

5.2 **Lack of lubrication on the chuck:**

The moving parts that require lubrication should be oiled regularly to ensure free motion and prevent rust. ✓ (1)

5.3 **Overloading:**

It occurs when the drill bit is forced into the material at a rate that exceeds the rate at which the drill can cut and expel the cuttings. ✓✓ (2)

5.4 **Causes of malfunction – power saw:**

- Failure due to the lack of lubrication. ✓
- Incorrect lubrication to the oil in gearboxes and moving parts. ✓ (2)

5.5 **Importance to keep service records**

- To monitor the condition of the machine. ✓
- To assist in upholding warranties and guarantees, because service requirements form part of these agreements. ✓ (2)

[10]

QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1 **THREE types of welding machines.**

- Arc welding ✓
- Gas welding ✓
- Spot welding ✓ (3)

6.2 **Principle and function of gas welding equipment.**

To enable gas welding by means of the oxy-acetylene flame. ✓ (2)

6.3 **Back firing (back feeding) w.r.t. oxy-acetylene welding** (2)

It is the back flow of one gas ✓

6.4 **Labels of oxy-acetylene apparatus**

a) Oxygen regulator ✓
b) Oxygen flashback arrestor ✓
c) Acetylene regulator ✓
d) Acetylene flashback arrestor ✓
e) Acetylene hose ✓
f) Oxygen hose ✓
g) Acetylene cylinder ✓
h) Parallel hose clips ✓
i) Torch mount flashback arrestors ✓
j) Oxygen cylinder ✓
k) Cylinder's trolley ✓
l) Nozzle ✓
m) Universal cutting torch ✓ (13)

[20]

QUESTION 7: FORCES (SPECIFIC)

7.1 Calculations:

7.1.1 The stress in the material and state your answer in mega pascals.

Stress = $\frac{Load}{Cross\ sectional\ area}$

$= \frac{90\ x\ 10^3}{\frac{\pi\ x\ (70)^2}{4\ x\ 10^6}}$ ✓

$= \frac{4\ x\ 90\ x\ 10^9}{\pi\ x\ (70)^2}$ ✓

= 23386032,45 Pa ✓

OR

= 23 MPa (3)

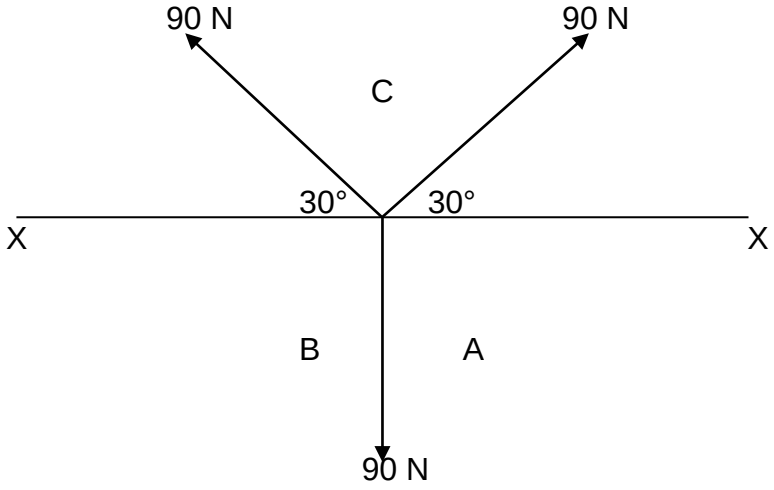
7.1.2 **The strain caused by the force.**

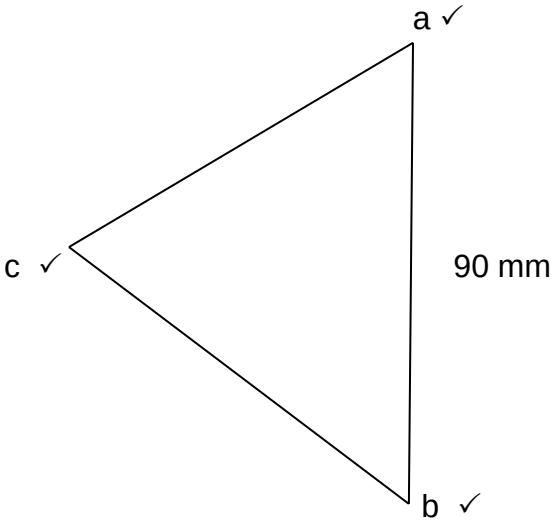
Strain = $\frac{Change\ in\ length}{Original\ length}$

$= \frac{0,5}{200}$ ✓

= 0,0025 ✓ (3)

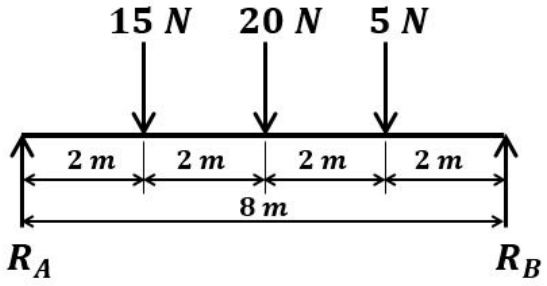
7.2 Bow's notation: 1 mm = 1 N





(3)

7.3 7.3.1 **Calculate the reactions at the supports R_A and R_B.**



Take moments around R_A:

R_A : R_B X 8 = (15 X 2) + (20 X4) + (5 X 6) ✓

R_B X 8 = 30 + 80 + 30 ✓

R_B = 17,5 N ✓

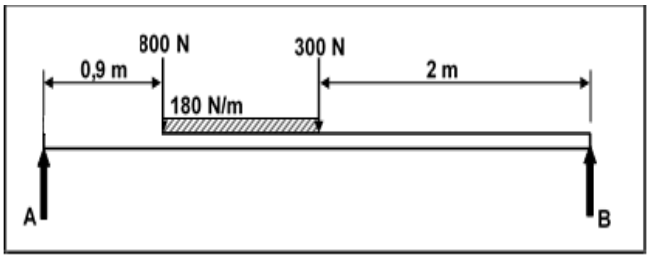
Take moments about R_B:

R_B : R_A X 8 = (5 X 2) + (20 X 4) + (15 X 6) ✓

R_A X 8 = 10 + 80 + 90 ✓

R_A = 22,5 N ✓ (6)

7.4



Calculate A:
Take moments around B.
B: (A X 4) = (300 X 2) ✓ + (198 X 2,55) ✓ + (800 X 3,1) ✓
4A = 3584,9
A = 896,225 N✓
Calculate B:
Take moments around A.
A: (B X 4) = (800 X 0,9) ✓ + (198 X 1,45) ✓ + (300 X 2) ✓
4B = 1607,1
B = 401,775N✓

800 N + 1980 N + 300 N = 401,775 N + 896,225 N
1298 N = 1298 N Beam is in balance **(8)**
[25]

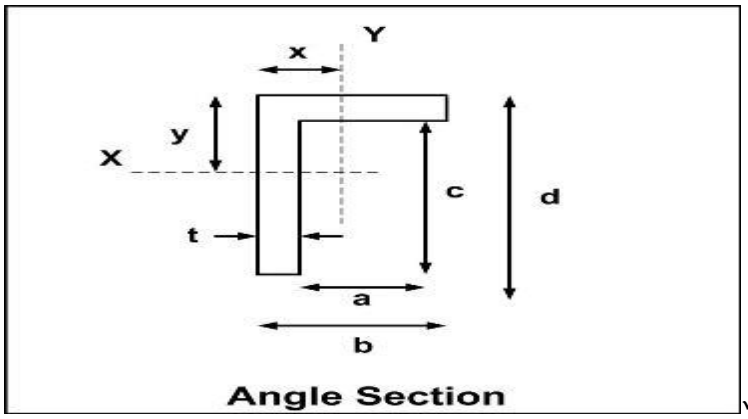
QUESTION 8: JOINING METHODS WELDING & STEEL SECTIONS (SPECIFIC)

8.1 **Conventional template markings:**

8.1.1 This side up ✓ (1)

8.1.2 Other side up ✓ (1)

8.2 Back mark of an angle iron:



✓✓ (2)

8.3 **Calculations of rooftruss:**

8.3.1 **Rafter length of the truss**

Rafter = ✓ $\boldsymbol{Rise^2 + Span^2}$ ✓

= ✓ $\mathbf{3^2 + 9^2}$ ✓

= ✓ 90 ✓

= 9,47 m ✓ (4)

8.3.2 **Rafter angle**

Tan Θ= $\frac{Rise}{Span}$

= $\frac{3}{9}$ ✓

Tan Θ = 0,33 ✓

Θ = 18,4 ˚✓ (3)

8.3.3 **Slope**

Slope = $\frac{Rise}{Span}$

Slope = $\frac{3}{9}$ **or** $\frac{1}{3}$ ✓

= 1 : 3 ✓ (2)

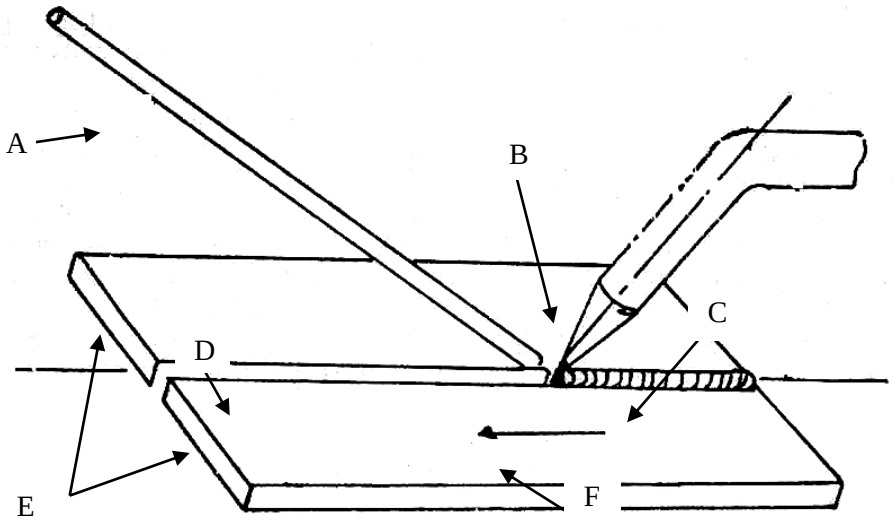
8.4 **Use of flange templates:**

It is positioned over the corner of steel sections ✓ such as angle iron or channel iron. ✓ (2)

[15]

QUESTION 9: JOINING METHODS (SPECIFIC)

9.1 **Leftward welding in the flat position.**



9.1.1 **Label A – F**

A – Filler rod ✓
B – Torch tip ✓
C – Bead ✓
D – Gap in seam ✓
E – Base metal ✓
F – Flow of travel ✓ (6)

9.1.2 **THREE welding joints.**

Butt weld ✓
Lap weld ✓
Fillet weld ✓ (3)

9.2 **THREE fundamentals for a good weld bead.**

Arc length ✓
Speed of electrode ✓
Bead width ✓
Electrode angle and position ✓ (Any 3 x 1) (3)

9.3 **THREE arc/gas welding defects.**

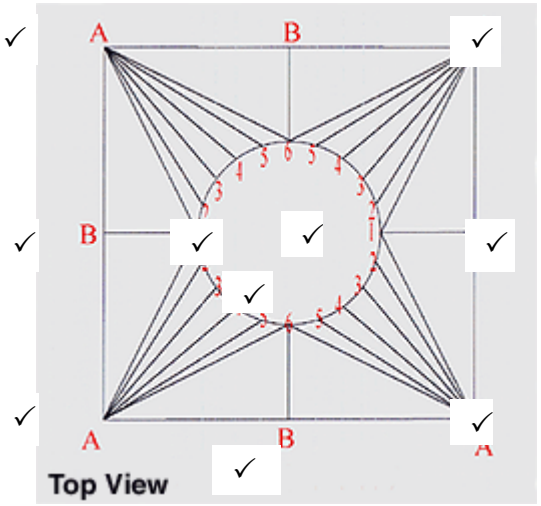
Incomplete penetration ✓
Lack of fusion ✓
Porosity ✓
Undercutting ✓ (Any 3 x 1) (3)

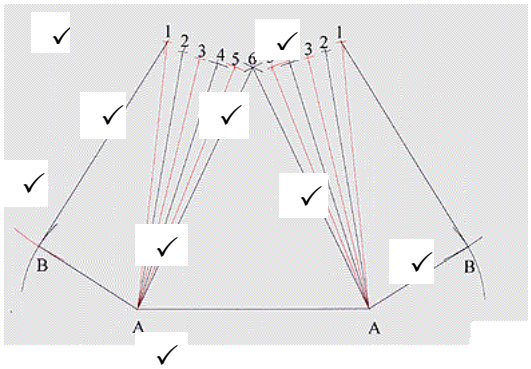
[15]

QUESTION 10 TERMINOLOGY (DEVELOPMENT) (SPECIFIC)

10.1 Development of square to round transition piece

10.1.1





Development (20)

[20]

QUESTION 11: TERMINOLOGY (STEEL SECTIONS)

11.1 11.1.1

✓✓ (2)

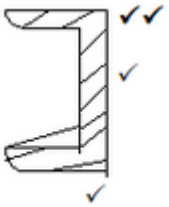
11.1.2

✓✓ (2)

11.2 **Purpose of an assembly jig:**

To hold parts in position ✓ so that a number of identical items can be tack welded and easily removed before final welding is done. ✓ (2)

11.3 **Channel Iron**



(4)
[10]

TOTAL: 200

FORMULA SHEET FOR MECHANICAL TECHNOLOGY (WELDING AND METALWORK)

1. TERMINOLOGY

Depth of cutter = $\frac{Diameter - x}{2}$

Sin θ = $\frac{x}{Dia}$

Where x = depth of cut.

2. FORCES

Clockwise moments = Anti clockwise moments

Upward forces = Downward forces

Stress = $\frac{Force\ /Load}{Area}$

Cross Sectional Area = $\frac{\theta D^2}{4}$ for Round objects.

Cross Sectional Area = s x s for Square objects

Cross Sectional Area = l x b for Rectangular objects

3. SYSTEMS AND CONTROL

$\pi D_{A\ X\ N_A} = \pi D_B \times N_B$

$T_A \times N_A = T_B \times N_B = T_C \times N_C$

Pressure = $\frac{FORCE}{AREA}$

QUESTION 1 ANSWER SHEET

NAME: ……..

	Example: 1.21 A B ~~C~~ D			
1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D
11	A	B	C	D
12	A	B	C	D
13	A	B	C	D
14	A	B	C	D
15	A	B	C	D
16	A	B	C	D
17	A	B	C	D
18	A	B	C	D
19	A	B	C	D
20	A	B	C	D
TOTAL MARKS FOR QUESTION 1				