



Province of the  
**EASTERN CAPE**  
EDUCATION

**NATIONAL  
SENIOR CERTIFICATE**

**GRADE 11**

**NOVEMBER 2019**

**MECHANICAL TECHNOLOGY:  
FITTING AND TURNING  
MARKING GUIDELINE**

**MARKS: 200**

---

This marking guideline consists of 15 pages.

---

**QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)**

- 1.1 C ✓
- 1.2 B ✓
- 1.3 D ✓
- 1.4 C ✓
- 1.5 A ✓
- 1.6 B ✓
- 1.7 C ✓
- 1.8 A ✓
- 1.9 C ✓
- 1.10 B ✓
- 1.11 B ✓
- 1.12 D ✓
- 1.13 A ✓
- 1.14 A ✓
- 1.15 A ✓
- 1.16 B ✓
- 1.17 D ✓
- 1.18 C ✓
- 1.19 B ✓
- 1.20 B ✓

(20 x 1) [20]

**QUESTION 2: SAFETY (GENERIC)****2.1 Gas welding (PPE)**

- Eye protection ✓
- Overall / leather apron ✓
- Safety boots ✓
- Gloves ✓

(Any 3 x 1) (3)

**2.2 Hydraulic Press**

- The predetermined pressure must not be exceeded ✓
- Pressure gauges must be tested regularly ✓
- The platform on which the work piece rests must be rigid and square ✓
- The platform must rest on the supporting pins ✓
- Place objects to be pressed in or out of the suitable jigs ✓
- Special tools and holding devices must be used to prevent damage to soft material ✓
- Ensure that the direction of pressure is always 90° to the platform. ✓
- Relieve pressure after use by opening the return valve ✓

(Any 3 x 1) (3)

2.3 **Surface Grinder**

- Do not force the work piece into the wheel ✓
- Do not clean or adjust the machine while it is in motion
- Avoid large cuts ✓
- Use coolant ✓
- Know how to use the emergency stop ✓
- Keep an eye on the position of the work piece ✓
- Keep all tools clear of the work table ✓
- Do not leave the machine while it is in operation ✓
- Do not lean on the machine ✓

(Any 3 x 1) (3)

2.4 Switch off the machine. ✓

(1)

2.5 **Bench Grinder**

- Make sure that there are no cracks or chips on the disc. ✓
- Make sure that the emery disc that is fitted is rated above the revolutions at which it is turned by the motor. ✓
- Make sure that the space between the tool rest and the emery disc does not exceed 3 mm. ✓
- Ensure that guards are in place. ✓
- When switching on the machine, do not stand in front of it until it reaches its full speed. ✓
- Do not force or bump the work piece against the emery disc. ✓
- Grind only on the front surface of the wheel, not the sides. ✓
- All grinding machines must have a sign indicating the revolutions at which the spindle rotates. ✓

(Any 3 x 1) (3)

2.6 To protect your eyes from flying sparks ✓

(1)

2.7 **Safety: Hand drill**

- Use a sharp drill of the right size for the type of material to be drilled. ✓
- Remove the key from the chuck. ✓
- Never leave the machine running unattended. ✓
- Clamp the work piece securely on the vice or table. ✓
- Never attempt to stop the machine with your hands if it slips. ✓
- Do not force the drill on the work piece. ✓
- Use a brush to remove chips from the drill. ✓

(Any 3 x 1) (3)

**2.8 Handling of gas bottles**

- Ensure the cylinders are stored in an upright position ✓
- The cylinders should be colour-coded ✓
- Full cylinders should be separated from empty ones ✓
- Keep away from direct sunlight ✓
- Keep protector cap on for protection ✓

(Any 3 x 1) (3)

**2.9 Band saw**

- Ensure there is no oil or grease around the machine ✓
- Ensure that all guides are in place before work commences ✓
- Ensure that the entire blade is guarded except at the point to cut ✓
- Ensure that the machine is switched off when changing blades or guides
- Wear eye protection ✓
- Ensure that the blade is fitted in the correct cutting direction ✓
- Round material must be clamped in a vice or holding device ✓
- Always use pusher against the work piece whenever possible ✓

(Any 3 x 1) (3)

2.10 Clamp the work piece in the vice or holding device ✓

(1)  
**[24]****QUESTION 3: TOOLS AND EQUIPMENT (GENERIC)****3.1 Function of tap and die set**

Tap is used to cut internal threads ✓ and die cuts external threads ✓ (2)

**3.2 Purpose of extension bar of guillotine**

Lengthens the work surface and supports longer material ✓✓ (2)

3.3 A Pressure gauge ✓

B Handle ✓

C Hydraulic press cylinder ✓

D Supporting pin ✓

E Adjustment holes ✓

F Plunger ✓

**3.4 Functions of equipment**

(6)

3.4.1 Angle grinder - is used for cutting, grinding and polishing ✓✓ (2)

3.4.2 Rolling machine – used to roll sheet metal ✓✓ (2)

3.4.3 Press machine – press fit or remove parts from each other ✓✓ (2)

**[16]**

**QUESTION 4: MAINTENANCE (GENERIC)**

**4.1 Maintenance of pedestal grinder**

**Guards-** always check that they are clamped ✓ before operation and have adequate clearance ✓ from the rotating grinding wheel (6 mm) (2)

**4.2 Reducing friction when cutting holes**

Apply cutting fluid ✓  
Apply oil to the tip of drill bit ✓ (2)

**4.3 Overloading** is when the lubrication bearer of oil is squeezed out of the machine-bearing surfaces ✓✓ (2)

**4.4 Lack of lubrication in a gear system**

- Without lubrication friction between teeth contact surfaces becomes too great, resulting in loss of efficiency ✓
  - Excessive noise ✓
  - Overheating ✓
  - Eventual mechanical failure ✓
- (Any 2 x 1) (2)

**[8]**

**QUESTION 5: MATERIALS (GENERIC)**

**5.1 Raw materials in the production of iron:**

- Iron ore ✓
  - Fuel (coke) ✓
  - Fluxing agent (lime stone) ✓
  - Air ✓
- (Any 3 x 1) (3)

**5.2 Blast furnace product**

Pig Iron ✓ (1)

**5.3 Electric arc furnace**

- It is useful in the production of stainless steel, other high-alloy steels, ✓ or special steels requiring very close metallurgical control ✓ of grain or other structural qualities ✓ (3)

**5.4 Functions of furnaces**

**5.4.1 Blast Furnace:** It is used to convert iron ore to pig iron ✓✓ (2)

**5.4.2 Bessemer converter furnace**  
It is used to convert molten pig iron to steel by the Bessemer process ✓✓ (2)

**5.4.3 Open hearth furnace**  
It is used to convert scrap metal and other alloying elements into different kinds of steel ✓✓ (2)

- 5.5 5.5.1 Blast furnace ✓ (1)
- 5.5.2 A Small bell ✓  
B Stack ✓  
C Melting zone ✓  
D Iron tap hole ✓  
E Hot air supply hole from stove ✓  
F Steel casing ✓  
G Hopper / Load ✓ (7)
- 5.6 **Advantages of rotor plant**
- The molten metal is protected by a layer of slag ✓
  - The oxidation of iron and other elements is minimised ✓
  - The melting loss is lower than that of the cupola furnace ✓
- (3)
- 5.7 **Properties of metals**
- 5.7.1 **Ductility** is the ability of a metal to change shape by stretching it along its length without breaking or drawing it into wire form ✓✓ (2)
- 5.7.2 **Brittleness** is the ability of a metal to break easily and fracture with little or no deformation ✓✓ (2)
- 5.7.3 **Plasticity** is the ability of a metal to change shape permanently. It is the reverse of elasticity ✓✓ (2)
- 5.7.4 **Toughness** is the ability of a metal to resist penetration, cracking, bending, breaking or stretching and remain intact after continual bending in opposite directions ✓✓ (2)
- [32]**

**QUESTION 6: TERMINOLOGY (SPECIFIC)**

**6.1 Functions of the centre lathe components**

6.1.1 **Tool post:** is a tool/holder used for quick change of cutting ✓ tools during different turning operations ✓ (2)

6.1.2 **Tail-stock:** is a device used to apply support to the longitudinal rotary axis of the workpiece being machined ✓ (1)

6.1.3 **Lead screw:** is used as a linkage to translate/convert turning motion into a linear motion ✓ (1)

**6.2 Taper Turning Calculations**

$$\tan \frac{\theta}{2} = \frac{D-d}{2l} \checkmark$$

$$\tan (8.5/2) \checkmark = (55 -d)/ 2 \times 205 \checkmark \checkmark$$

$$d = 24,53 \text{ mm} \checkmark \quad (5)$$

**6.3 Depth of a Thread**

$$H = 0,866 P$$

$$= 0,866 \times 1$$

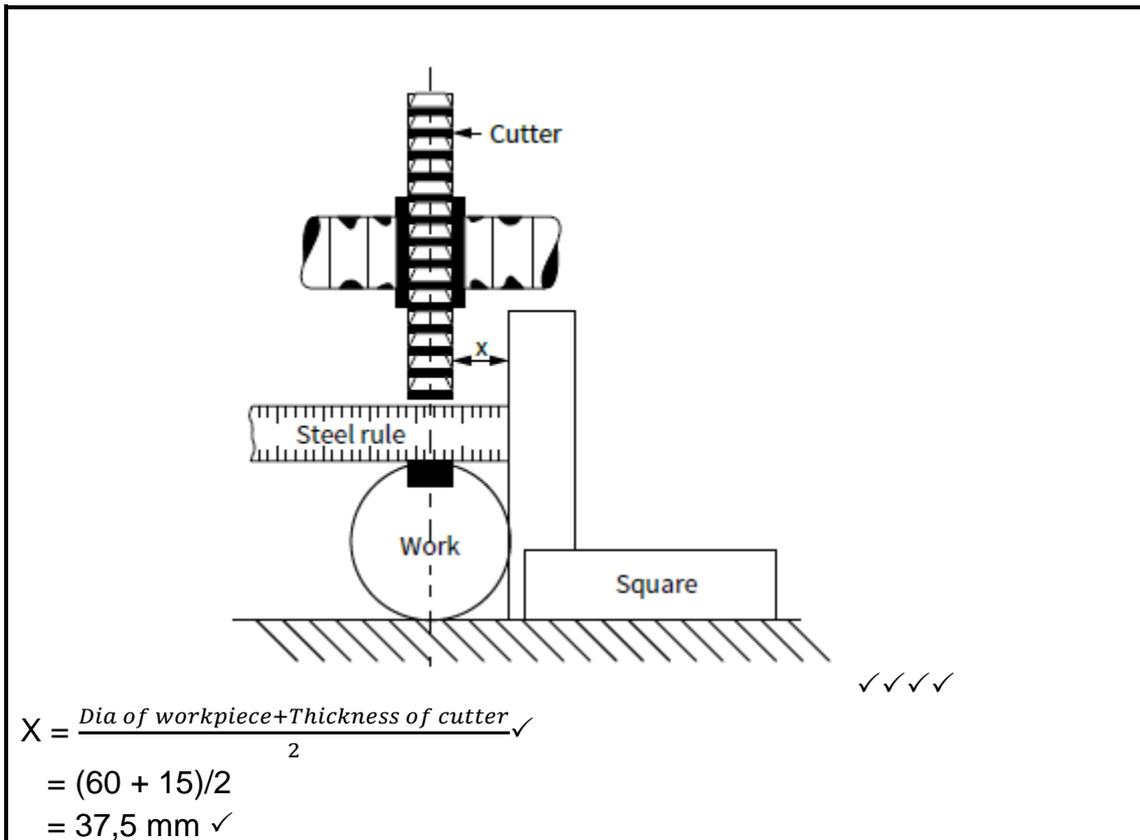
$$= \mathbf{0,866 \text{ mm}} \checkmark \checkmark \quad (2)$$

**6.4 Milling Cutters**

- End mill ✓
- Side and face ✓
- Slot drill ✓
- T-slot ✓
- Helical milling cutter ✓
- Involute tooth gear ✓

(Any 3 x 1) (3)

## 6.5 Centering of the cutting tool



✓✓✓✓

$$X = \frac{\text{Dia of workpiece} + \text{Thickness of cutter}}{2} \checkmark$$

$$= (60 + 15)/2$$

$$= 37,5 \text{ mm} \checkmark$$

(6)

- 6.6 In the vertical machine, the spindle occupies a vertical position relative to the table. The machine head can be swivelled in the vertical plane to an angle of 45°.

In horizontal milling, the table of the universal milling machine can be swivelled about a point directly below the centre line of the arbor, while the table of the plain milling machine cannot be swivelled.

Another key difference is that the part arbor of the horizontal can rotate in the forward and reverse direction. ✓✓

(Any 2 x 1) (2)

## 6.7 Simple Indexing Calculations

6.7.1 Indexing =  $\frac{40}{25} \checkmark$

$$= 8/5$$

$$= \frac{8}{5} \times \frac{6}{6}$$

$$= 48/30 \checkmark$$

Indexing is 48 holes in a 30 hole circle ✓

(3)

[25]

**QUESTION 7: TOOLS AND EQUIPMENT (SPECIFIC)**

**7.1 Purpose of Tools**

7.1.1 Dial Test Indicator is used as a precision tool in the setting up of the workpiece on machinery, such as centre lathes or milling machines, and to determine the run-out of motor engine parts ✓ (1)

7.1.2 Tap wrench is used for turning various sizes of taps into a drilled hole ✓ (1)

**7.2 Vernier Reading**

7.2.1 Vernier Calliper ✓ (1)

7.2.2 It is versatile, ✓ that is, one can perform measurements such as inside, outside and depth measuring ✓ (2)

**7.3 External thread cutting process**

- Select the size and pitch of the desired die. ✓
- Secure the workpiece firmly, and perpendicularly on the horizontal to the plane. ✓
- Secure the die in the die wrench and tighten the central spreading screw. ✓
- With an appropriate lubricant (cutting paste) applied, rotate the die through 90° in the clockwise direction applying slight pressure and then turn the die back 45° anticlockwise, to break off the waste spirals and eject them from the die. ✓
- Continue this process until the die has reached the required length. ✓
- Gradually close the aperture of the die ✓ with each successive ✓ pass until the thread diameter is achieved. ✓

(3)  
**[8]**

**QUESTION 8: FORCES (SPECIFIC)****8.1 Definitions**

8.1.1 Torque is twisting or turning force imparted on the drive line by, for example an engine. ✓ (1)

8.1.2 Moment of force: the moment of force at a given point is the product of and the perpendicular distance from the point to the line of action of the force. ✓ (1)

8.1.3 Components of a force: It is where two or more forces have the same effect as a single inclined force, and can be resolved as vertical and horizontal forces. ✓ (1)

**8.2 Beam Calculations**

For RA (Support A) Calculations:

Take Moments @ RB (Support B)

Using Law of Moments

$\Sigma$  of clockwise moments =  $\Sigma$  of anti-clockwise moments

$$(600 \times 4\text{m}) + (250 \times 1,4) = R_A \times 4,7 \quad \checkmark$$

$$R_A = 585,1 \text{ N} \quad \checkmark$$

For RB Take moments RA

$$(600 \times 0,7) + (250 \times 3,3) = R_B \times 4,7 \quad \checkmark$$

$$R_B = 264,89 \text{ N} \quad \checkmark \quad (4)$$

**8.3 Compressive Stress Calculations**

$$\text{Stress} = \frac{\text{Force}}{\text{Area}}$$

$$\text{Area} = D^2 - d^2 \quad \checkmark \text{ (Area for a square tube)}$$

$$= \frac{(65^2 - 59^2)}{10^6} \quad \checkmark$$

$$= 7,44 \times 10^{-4} \text{ m}^2 \quad \checkmark$$

$$\text{Stress} = \frac{25 \times 10^3}{7,44 \times 10^{-4}} \quad \checkmark$$

$$= 33602150,54 \text{ Pa}$$

$$= 33,6 \text{ MPa} \quad \checkmark \quad (5)$$

8.4 System of forces calculations

FORCE	HORIZONTAL COMPONENTS (X)	VERTICAL COMPONENTS (Y)
45 N	45 Cos 0 = 45N ✓	45 Sin 0 = 0
50 N	50Cos 90 = 0	50 Sin 90 = <b>50 N</b> ✓
30 N	30 Cos45 OR 30 Cos135 = <b>-21,21N</b>	30 Sin 45 OR 30 Sin 135 = 17,2 N <b>21,21N</b>
TOTAL	<b>23,79 N</b> ✓	<b>71,21 N</b> ✓

$$X^2 + Y^2 = R^2 \checkmark$$

$$R = 75.079 \text{ N} \checkmark$$

$$\text{Tan } \theta = Y/X =$$

$$\theta = 71,52^\circ \checkmark$$

(7)  
[19]

**QUESTION 9: MAINTENANCE (SPECIFIC)****9.1 Terms and Abbreviations**

9.1.1 Viscosity: is the resistance of oil to flow, also referred to as fluid thickness ✓✓ (2)

9.1.2 Static balancing: in static balancing, a body or system at rest ✓ will stay at rest in any position although it is free to move ✓ (2)

9.1.3 Coefficient of friction ( $\mu$ ) also called  $\mu$ , is the ratio between perpendicular pressure and the frictional force on the side surface of an object ✓✓ (2)

**9.2 Cutting speed calculations**

$$\begin{aligned} V &= \pi DN \\ &= \pi \times 0,016 \times 320 \checkmark \\ &= \mathbf{16,08 \text{ m/min}} \checkmark \end{aligned} \quad \begin{array}{l} (2) \\ \mathbf{[8]} \end{array}$$

**QUESTION 10: JOINING METHODS (SPECIFIC)**

**10.1 Calculations**

10.1.1 Length of key = 1,5 x diameter  
 Diameter = 102/1,5 ✓  
 = **68 mm** ✓✓ (3)

10.1.2 Width of key = Diameter/4  
 = 68 /4  
 = **17 mm** ✓✓ (2)

10.1.3 Thickness of key = Diameter /6  
 = 68/6  
 = **11,333 mm** ✓✓ (2)

10.2 Multi-screw thread would be preferred because it offers quick motion or advancement. It is also used where the pitch is small while the lead is big enough to ensure the required quick movement ✓✓ (2)

**10.3 Screw thread applications**

- to hold parts together ✓
  - to transmit motion ✓
  - to transmit power ✓
  - to adjust parts with reference to one another ✓
- (Any 3 x 1) (3)

**[12]**

**QUESTION 11: SYSTEMS AND CONTROLS (SPECIFIC)**

11.1 An air receiver is used as a storage tank for compressed air in large quantities so that when an air tool is switched on, it has plenty of back-up air and will start working at full power immediately ✓✓ (2)

**11.2 Hydraulic System Calculations**

$$\frac{f}{a} = \frac{F}{A} \checkmark$$

$$F = \frac{f \times A}{a} \checkmark = (200 \times 1,5) / 0,1 \checkmark$$

$$F = 3\,000\text{N} \checkmark \quad (4)$$

**11.3 Belt Drive System**

11.3.1  $T_B = ?$

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

$$T_B = (N_A \times T_A) / N_B \checkmark$$

$$T_B = (56 \times 700) / 980 \checkmark$$

$$T_B = 40 \text{ teeth} \checkmark \quad (3)$$

11.3.2 Rotational Speed

$$N_c \times T_c = N_B \times T_B$$

$$N_c = (40 \times 980) / 64 \checkmark$$

$$= 612,5 \text{ rpm} \checkmark \quad (2)$$

11.3.3 Gear C (Driven gear) rotates anti-clockwise ✓ (1)

11.4 Block and tackle is a mechanical device by means of which a small effort will move a larger load ✓✓ (2)

**11.5 Pressures acting on fluid**

- Applied pressure ✓
  - Absolute pressure ✓
  - Atmospheric pressure
- (Any 2 x 1) (2)

**[16]**

**QUESTION 12: PUMPS (SPECIFIC)**

12.1 Volute Pump casing is a shell-like, hollow spiral that increases in area as it approaches the outlet ✓✓ (2)

12.2 **Pump Applications**

- Oil pumping ✓
- Food and drink pumping ✓
- Slurry pumping
- Cement pump
- Sewage sludge pump
- Winery uses (Any 2 x 1) (2)

12.3 **Type of a pump**

12.3.1 Centrifugal Pump ✓ (1)

- 12.3.2 A – Inlet ✓  
 B – Outlet ✓  
 C – Guide vanes ✓  
 D – Impeller/blades ✓ (4)

12.3.3 **Operation of centrifugal pump**

The pump consists of a casing that contains a rotating wheel with blades or vanes. When the pump is filled with fluid and the impeller rotates, it slings the fluid outwards due to centrifugal force, forcing it out at the outlet ✓✓✓ (3)

[12]

**TOTAL: 200**