



**NATIONAL  
SENIOR CERTIFICATE**

**GRADE 11**

**NOVEMBER 2022**

**MECHANICAL TECHNOLOGY: (FITTING AND  
MACHINING)  
MARKING GUIDELINE  
(EXEMPLAR)**

**MARKS: 200**

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This marking guideline consists of 14 pages.

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**SECTION A: COMPULSORY****QUESTION 1: MULTIPLE-CHOICE-QUESTIONS**

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

(20 x 1) [20]

**QUESTION 2: SAFETY****2.1 Accident**

An unplanned hazardous event caused by unsafe conditions or unsafe acts ✓✓

(2)

**2.2 Unsafe act**

- Adjusting machine that is in motion ✓
- Working at unsafe speed ✓
- Working without PPE ✓
- Working without authority
- Working without safety devices/rendering safety devices ineffective ✓
- Teasing fellow employee ✓
- Horse play ✓
- Running in the workshop while carrying a sharp object ✓
- Using the wrong tools for the job ✓

(Any 3 x 1) (3)

**2.3 Workshop safety rules.**

- The workshop must be in a good working condition ✓
- The working area must be condoned off, ensuring maximum protection of other workers ✓
- Solid screens must be erected around workers who are welding, grinding or chipping ✓
- Workers must wear PPE ✓
- Any person assisting a worker who is operating a machine must also wear PPE ✓

(Any 3 x 1) (3)

**2.4 Welding of flame cutting safety rules**

- The operator must have been instructed on how to use the equipment safely ✓
- The workplace must have been effectively partitioned off ✓
- The operator must wear the correct PPE ✓
- The hose pipes must be fitted with flashback arrestor ✓ (Any 3 x 1) (3)

**2.5 Safety precautions when handling gas cylinder**

- Never stack cylinder on top of each other ✓
- Do not bang or work on the cylinder ✓
- Do not allow cylinder to drop ✓
- Do not allow oil or grease to come in contact with oxygen fittings ✓
- All cylinders must conform to the standards set by the South Africa Bureau of Standards (SABS) ✓ (Any 3 x 1) (3)

**2.6 Flashback arrestor**

To prevent the backward movement of gas into the cylinders; this can lead to a gas explosion. ✓✓ (2)

**2.7 Safety precaution of a hydraulic press**

- Ensure safe working pressure is not exceeded ✓
- Pressure gauge must be tested regularly and adjusted or replaced when it malfunctions ✓
- The platform on which the workpiece rest must be rigid ✓
- Platform must rest on supporting pins ✓
- Place object to be pressed in or out on suitable jig ✓
- Relieve the cylinders of all pressure after use ✓
- Special tools should be used to prevent damage to soft materials ✓ (Any 3 x 1) (3)

**2.8 Reason for wearing goggles when using pedestal grinder**

To prevent the eyes from sparks and sharp particles. ✓ (1)

**2.9 Safety precaution post operations**

Switch off machine ✓ (1)

**2.10 Safety precaution before operating power saw**

- Make sure all guards are in place ✓
- Ensure there are no oil or grease around the machine ✓
- Select the correct blade for the job ✓
- Clamp the workpiece properly ✓
- Long workpieces must be supported at the ends ✓ (Any 3 x 1) (3)

**[24]**

**QUESTION 3: TOOLS AND EQUIPMENT****3.1 Machine tool**

3.1.1 Tap wrench ✓ (1)

3.1.2 **Function**

To turn various sizes of taps into drilled hole ✓✓ (2)

**3.2 Types of Taps**

- Taper tap ✓
- Intermediate/second tap ✓
- Plug/bottoming tap ✓ (3)

**3.3 3.3.1 Tool identification**

Manual guillotine ✓ (1)

3.3.2 **Use of tool**

It is used to cut sheet of metals ✓✓ (2)

3.3.3 **Labeling parts**

- A – Adjusting nut ✓
- B – Pressure plate ✓
- C – Base ✓
- D – Spring loaded pedal ✓
- E – Extension bar ✓
- F – Cutting table ✓ (6)

3.3.4 **Specification**

1,2 mm ✓ (1)

**[16]**

**QUESTION 4: MAINTENANCE (GENERIC)****4.1 Factors to consider when selecting drilling speed**

- Type of material ✓
- Diameter of drill bit ✓
- Material of which the drill bit is made ✓
- Firmness with which the work is clamped ✓
- Condition of the machine ✓
- Use of cutting fluid ✓
- Rates of feed ✓

(Any 2 x 1) (2)

**4.2 Drill speed**

$$S = \pi DN \quad S = \frac{500}{1000} \checkmark$$

$$= 0,5 \text{ m/s } \checkmark$$

$$N = \frac{0,5}{\pi \times 0,012} \checkmark$$

$$= 13,26 \text{ r/sec}$$

$$= 795,77 \text{ r/min } \checkmark \quad (4)$$

**4.3 Effect of excessive friction**

Soften and dull the cutting tip of the drill bit ✓ (1)

**4.4 Cooling method during drilling process**

- Using oil (squadding oil from oil can) ✓
- Use of cutting fluid ✓

(Any 1 x 1) (1)  
**[8]****QUESTION 5: MATERIALS (GENERIC)****5.1 5.1.1 Furnace identification**

Open hearth furnace ✓ (1)

**5.1.2 Parts labeling**

- A – Charging ladle ✓
- B – Funnel ✓
- C – Scrap metals ✓
- D – Steel ✓
- E – Slag thimble ✓
- F – Charging machine ✓
- G – Charging boxes ✓

(7)

**5.1.3 Function**

It is used to convert scraps metals and other alloying elements into different kinds of steel. ✓✓ (2)

**5.2 Steel production flow-chart furnace**

- A – Blast furnace ✓
- B – Open hearth furnace ✓
- Bessemer furnace ✓ **OR**
- Electric furnace ✓

(2)

- 5.3 5.3.1 **Elasticity**  
The ability of material to stretch when a tensile force is applied and return to its original position when the force is removed ✓✓ (2)
- 5.3.2 **Flexibility**  
The ability of material to bend in the direction of applied force but does not return to its original position when the force is removed ✓✓ (2)
- 5.3.3 **Malleability**  
The ability of material to change shape in different directions with little or no cracking ✓✓ (2)
- 5.3.4 **Hardness**  
The ability of material to resist penetration or abrasion ✓✓ (2)
- 5.4 **Advantages of the rotating action of a rotor plant**
  - Prevents the refractory brick lining from being overheated by the flame ✓
  - Decreases the melting time ✓(2)
- 5.5 **Advantages of rotor plant control melting process**
  - 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)
- 5.6 **Role of coke in blast furnace**
  - As a fuel to provide heat for smelting ✓
  - As a reducing agent ✓
  - As a non-clogging support for the charge in the blast furnace ✓(3)
- 5.7 5.7.1 **Function of blast furnace**  
To smelt iron ore, coke and limestone to obtain pig iron. ✓✓ (2)
- 5.7.2 **Electric furnace**  
To produce metals of high specification accuracy such as stainless steel. ✓✓ (2)

**[32]**

**QUESTION 6: TERMINOLOGY (SPECIFIC)****6.1 KEY AND KEYWAY CALCULATIONS**

$$\begin{aligned}
 6.1.1 \quad \text{The width of the key} &= \frac{\text{Diameter}}{4} \quad \checkmark \\
 &= 144 / 4 \\
 &= 36 \text{ mm} \quad \checkmark
 \end{aligned}
 \tag{2}$$

$$\begin{aligned}
 6.1.2 \quad \text{The thickness of the key} &= \frac{\text{Diameter of shaft}}{6} \quad \checkmark \\
 &= 144/6 \\
 &= 24 \text{ mm} \quad \checkmark
 \end{aligned}
 \tag{2}$$

$$\begin{aligned}
 6.1.3 \quad \text{The length of the key} &= 1,5 \times \text{diameter of shaft} \quad \checkmark \\
 &= 1,5 \times 144 \\
 &= 216 \text{ mm} \quad \checkmark
 \end{aligned}
 \tag{2}$$

**6.2 Compound Slide Taper**

$$\text{Compound slide Angle } \tan \frac{\theta}{2} = \frac{D-d}{2 \times l} \quad \checkmark$$

$$\tan \frac{\theta}{2} = 75 - 50 / (2 \times 250) \quad \checkmark \checkmark$$

$$\tan \frac{\theta}{2} = 0,176 \quad \checkmark$$

$$\frac{\theta}{2} = 2,86^\circ \quad \checkmark \tag{5}$$

**6.3 Pitch of a thread.**

$$\text{Pitch} = \frac{\text{Lead}}{\text{Number Starts}}$$

$$= 14/2 \quad \checkmark$$

$$= 7 \text{ mm} \quad \checkmark \tag{2}$$

**6.4 Turning operations**

- Step turning  $\checkmark$
- Taper turning  $\checkmark$
- Thread cutting  $\checkmark$
- Boring  $\checkmark$
- Facing  $\checkmark$
- Straight turning  $\checkmark$
- Parting  $\checkmark$

(Any 4 x 1) (4)

### 6.5 TAPER-TURNING PROCEDURE

- The base of the compound slide or top of the cross slide comprises a circular plate that is marked off in degrees. ✓
- Loosen the base screws and set the compound slide to the desired angle.
- Tighten the screws to lock it into position. ✓
- The tool should be set with its cutting point exactly level with the lathe's centre line. ✓
- The carriage should always be locked to the lathe bed when cutting short tapers. ✓
- When the cutting action has started, use the compound slide handle to feed. (Maximum 4 marks) (4)

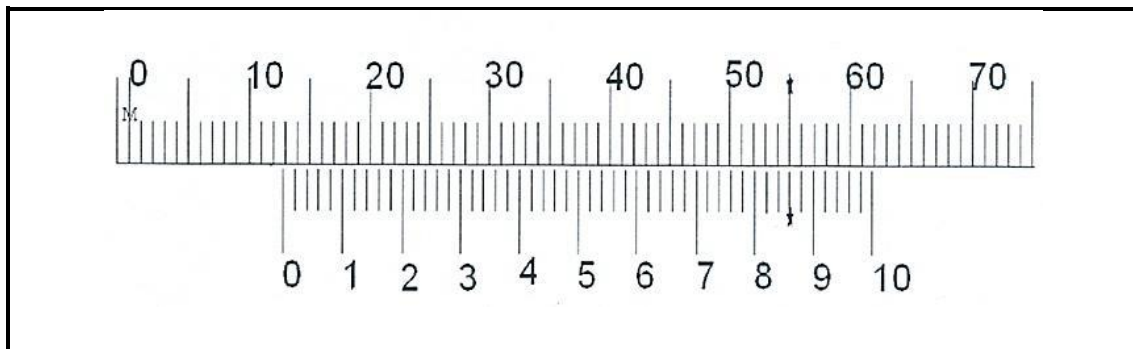
- 6.6 The difference between a horizontal milling machine and a vertical milling machine is that the former can be swivelled about a point ✓ directly below the centre line of the arbor, whilst the table of the plain milling machine cannot be swivelled. Another key difference is that the arbor of the ✓ universal machine can rotate in both the forward and reverse direction. ✓✓ (4)
- [25]**



**QUESTION 7: TOOLS AND EQUIPMENT (SPECIFIC)****7.1 Functions**

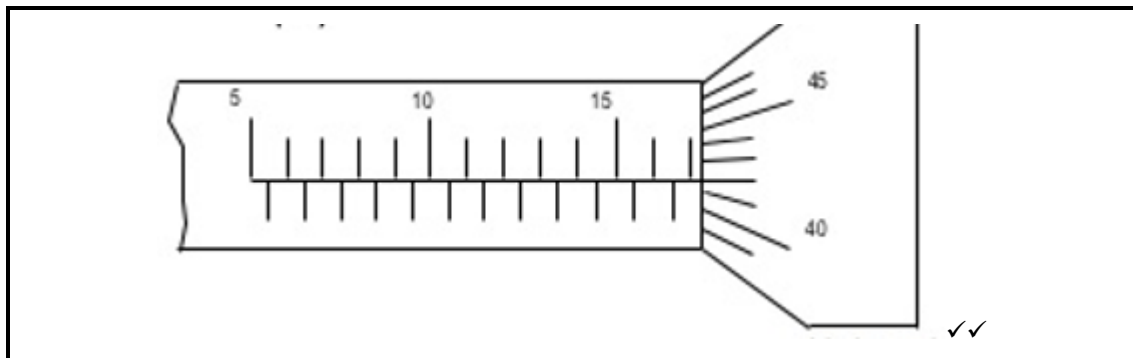
7.1.1 Dial indicator is used in setting up work on machinery, such as centre lathes or milling machines, and to determine the run-out of motor engine parts. ✓✓ (2)

7.1.2 Torque wrench enables tightening of bolts and nuts to a specific clamping force which can be repeated accurately over a number of bolts or nuts. ✓✓ (2)

**7.2 Vernier calliper reading**

7.2.1  $12 + 0,30 = 12,30 \text{ mm}$  ✓✓ (2)

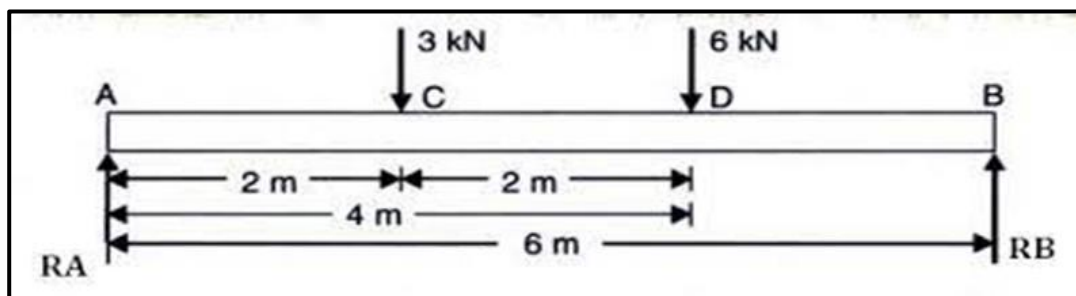
7.3 The sketch showing 17,42 mm



(2)  
[8]

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

- 8.1.1 Moment of force is a force at a given point as being the product of the force and perpendicular distance from the ✓ turning point.
- 8.1.2 Stress is a function of force and cross-sectional area. ✓
- 8.1.3 Component of a force – If two or more forces have the same effect as a single force, these forces are called the component of the single force. ✓

**8.2 BEAM CALCULATIONS**

Take **Moments @ RA**

$$(3 \times 2) + (6 \times 4) = RA \times 6 \quad \checkmark$$

$$RA = 5 \text{ kN} \quad \checkmark$$

Take **Moments at RB**

$$(6 \times 2) + (3 \times 4) = RB \times 6 \quad \checkmark$$

$$RB = 4 \text{ kN} \quad \checkmark$$

(4)

**8.3 STRESS CALCULATIONS**

$$D - d = t$$

$$d = 44 \text{ mm}$$

$$A = \frac{\pi(D^2 - d^2)}{4} \quad \checkmark$$

$$= \pi(0,05^2 - 0,044^2) / 4 \quad \checkmark$$

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

$$\delta = \frac{F}{A} \quad \checkmark$$

$$= 70 \times 10^3 / 0,864 \times 10^{-3} \quad \checkmark$$

$$= 81024334,66 \text{ Pa} \quad \checkmark$$

$$= 81,024 \text{ MPa} \quad \checkmark$$

(6)

#### 8.4 COMPONENTS OF FORCES

$$X_{com} = 10 \cos 30 - 15 \cos 40 - 12 \cos 65 \quad \checkmark$$

$$= 2,24 \text{ N} \quad \checkmark$$

$$Y_{com} = 10 \sin 30 + 15 \sin 40 - 12 \sin 65 \quad \checkmark$$

$$= 3,766 \text{ N} \quad \checkmark$$

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

$$R = \sqrt{2,24^2 + (3,77)^2}$$

$$R = 4,386 \text{ kN} \quad \checkmark$$

##### Direction of Resultant

$$\tan \theta = y/x$$

$$= 3,77/2,23^\circ$$

$$\theta = 59,28^\circ \quad \checkmark$$

(6)  
[19]

#### QUESTION 9: MAINTENANCE (SPECIFIC)

##### 9.1 Definitions:

9.1.1 Dynamic balancing (Stationary Balancing): the principle of dynamic balancing is based on the measurement of the rotating couples that are set up due to off-balance forces.  $\checkmark\checkmark$  (2)

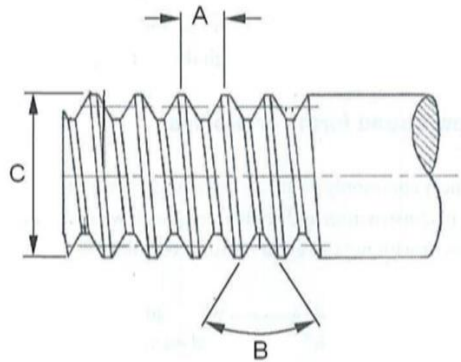
9.1.2 Static balancing or Stationary Balancing: a body or system at rest will stay at rest in any position although it is free to move, it will not turn or rotate due to the influence of gravity.  $\checkmark\checkmark$  (2)

##### 9.2 Effects of lack of maintenance:

- More machine downtime.  $\checkmark$
- Possibly very costly repairs.  $\checkmark$
- Loss of productivity.  $\checkmark$  (Any 2 x 1) (2)

##### 9.3 Definition

*Coefficient of Friction* is the ratio between perpendicular pressure and frictional force on a slide surface, and is also called  $\mu(u)$ .  $\checkmark\checkmark$  (2)  
[8]

**QUESTION 10: JOINING METHODS (SPECIFIC)****10.1 Screw threads:****10.1.1****10.1.1****A Pitch** ✓

A pitch of a screw thread is the distance from any given point on the screw thread to a corresponding point on an adjacent (next) thread. ✓

**B Thread angle** ✓

Is the angle included between the sides (flanks) of the thread measured in an axial plane ✓

**C Crest diameter** ✓

Is the large diameter of the screw thread.

(6)

**10.2 Lead of the screw thread:**

$$\begin{aligned} \text{Lead} &= \text{Number of starts} \times \text{pitch} \quad \checkmark \\ &= 6 \times 3 \quad \checkmark \\ &= 21 \text{ mm} \quad \checkmark \end{aligned}$$

(3)

10.3 Axis of a screw thread is the centre line running longitudinally through the thread. ✓

(1)

**10.4 Basic applications of screw threads.**

- To hold parts together ✓
- To transmit motion ✓
- To transmit power ✓
- To adjust parts with reference to one another. ✓

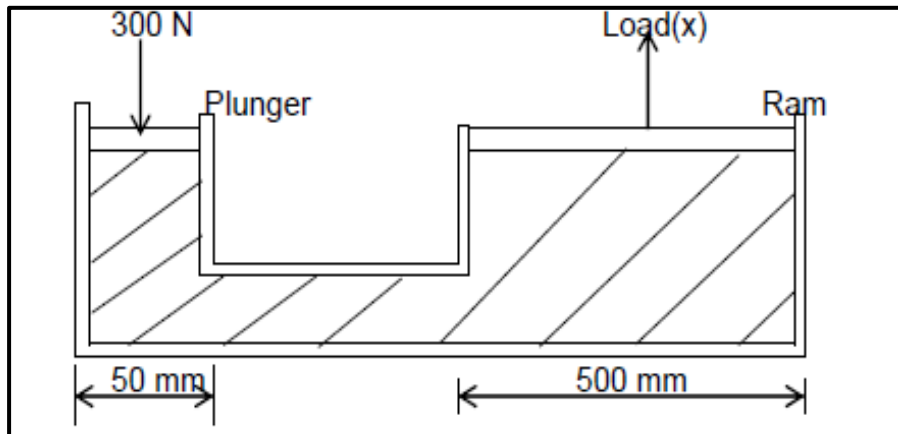
(2)

**[12]**

**QUESTION 11: SYSTEMS AND CONTROL (SPECIFIC)****11.1 Advantages of chain drive.**

- No slippage ✓
- No initial tension ✓
- Chains may travel in either direction. ✓

(Any 2 x 1) (2)

**11.2 A hydraulic system calculation.****11.2.1 Fluid pressure of the system.**

$$\text{Pressure} = \frac{F}{A} \quad \checkmark$$

$$= 300 / (\pi \times 0,025^2) \quad \checkmark \checkmark$$

$$= 152,788 \text{ kPa} \quad \checkmark \quad (4)$$

**11.2.2 Force on the Ram.**

$$\frac{Fa}{Aa} = \frac{Fb}{Ab} \quad \checkmark$$

$$Fb = \frac{Fa \times Ab}{Aa} \quad \checkmark$$

$$Fb = (300 \times 500^2) / 50^2 \quad \checkmark$$

$$Fb = 30 \text{ kN} \quad \checkmark \quad (4)$$

**11.3 Gear drive system**

11.3.1 Gear A is turning clockwise. ✓

(1)

11.3.2 Idler gear is a gear wheel that is inserted between two or more other gear wheels to change the direction of the drive. ✓✓

(2)

**11.4 Belt Drive Calculations**

$$D1 \times N1 = D2 \times N2 \quad \checkmark$$

$$N2 = \frac{900 \times 380}{150} \quad \checkmark$$

$$N2 = 2\,280 \text{ rpm} \quad \checkmark$$

(3)

**[16]**

**QUESTION 12: PUMPS (SPECIFIC)****12.1 Centrifugal pump advantages**

- No valves, NO pistons or plungers. ✓ (1)

**12.2 Pistons pump and Plunger pump main differences**

- The length of the plunger exceeds its stroke length, and the length of the piston is shorter than its stroke length. The piston has packing rings that are inserted on the rim to prevent leakage. ✓✓ (2)

**12.3 Types of pumps:**

- 12.3.1 Gear pump ✓ (1)

- 12.3.2 Operation Gear Pump: A **gear pump** uses the meshing of gears to pump fluid by displacement. As the gears rotate, they separate on the intake side of the pump, creating a void and suction which is filled by fluid. The fluid is carried by the gears to the discharge side of the pump, where the meshing of the gears displaces the fluid. ✓✓✓✓ (4)

**12.4 Types of impellers:**

- 12.4.1 Open impeller: for fluids that contain solids, e.g., sand and grit stone. ✓✓ (2)

- 12.4.2 Encloser impeller: for fluids without materials that can cause obstruction. ✓✓ (2)

**[12]****TOTAL: 200**