



Province of the  
**EASTERN CAPE**  
EDUCATION

**NATIONAL  
SENIOR CERTIFICATE**

**GRADE 11**

**NOVEMBER 2018**

**MECHANICAL TECHNOLOGY: AUTOMOTIVE  
MARKING GUIDELINE**

**MARKS: 200**

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This marking guideline consists of 14 pages.

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

- 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 (GENERIC)****2.1 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 General machine safety:**

- 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 Bending press(Box and Pan)**

- 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 Reporting to persons in charge (C3)****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.
- Report accidents immediately.

(Any 1 x 1) (1)

**2.5 Angle 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 machine is plugged in and switched on.

(Any 3 x 1) (3)

**2.6 Drill press safety:**

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

**2.7 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 workpiece. (Any 3 x 1) (3)

**2.8 PPE Gas welding:**

- Overall ✓
- Leather gloves ✓
- Welding goggles ✓
- Welding spats
- Safety boots

(Any 3 x 1) (3)

**2.9 Unsafe conditions in the workshop:**

- Insufficient lighting in the working area to the extent that the worker cannot clearly see what he or she is doing. ✓
  - Insufficient ventilation, especially where welding, grinding, testing of petrol or diesel engines, or work involving chemicals is being carried out. ✓
  - Working in an area where construction is taking place.
  - Working in an area where the floor is unsafe due to its being unstable, cracked, full of holes, weakened by rotten floorboards or wet due to liquid spills, especially oily ones.
  - Badly planned workshop layout.
  - Workshop that is crowded, with piles of materials and / or equipment in passageways and working areas.
  - Blocked or not clearly marked emergency exits.
  - A lack of suitable machine emergency exits.
  - A lack of suitable machine guards and guard rails.
- (Any 2 x 1) (2)

**2.10 Categories of OHS:**

- Conditions ✓
  - Actions ✓
- (2)  
[24]

**QUESTION 3: TOOLS AND EQUIPMENT (GENERIC)**

3.1 3.1.1 Pedestal bench grinder. ✓ (1)

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

3.1.3 Perspex shield is to protect your eyes from the grinding debris. ✓ (1)

**3.2 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 Press machine:**

Manual and hydraulic ✓✓ (2)

**3.4 3.4.1 Function – horizontal band saw:**

It is to cut large metal sections ✓ in a horizontal position. ✓ (2)

**3.4.2 Function – Power saw:**

It is used for rough cuts. ✓✓ (2)

[16]

**QUESTION 4: MAINTENANCE (GENERIC)****4.1 Required drill speed:**

$$\begin{aligned} N &= \frac{S}{\pi \cdot 25} \checkmark \\ &= \frac{700}{78,55} \checkmark \\ &= 8,91 \text{ r/s} \checkmark \end{aligned}$$

(3)

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

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

(1)

**4.3 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)

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

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

(2)

[8]

**QUESTION 5: MATERIALS (GENERIC)****5.1 5.1.1 Plasticity:**

It allows the material to change shape permanently. ✓  
It is the reverse of elasticity. ✓

(2)

**5.1.2 Ductility:**

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

(2)

**5.1.3 Brittleness:**

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

(2)

**5.2 Iron age:**

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

(1)

**5.3 Operational function of 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)

**5.4 5.4.1 Labels: Electric arc furnace:**

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

(7)

**5.4.2 Function-Electric arc furnace:**

It is used for the production of stainless steel. ✓

(2)

**5.5 Cold chisels:**

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. ✓

(Any 4 x 1) (4)

**5.6 Procedure:**

Tempering ✓✓

(2)

**5.7 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)

[32]

## **QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)**

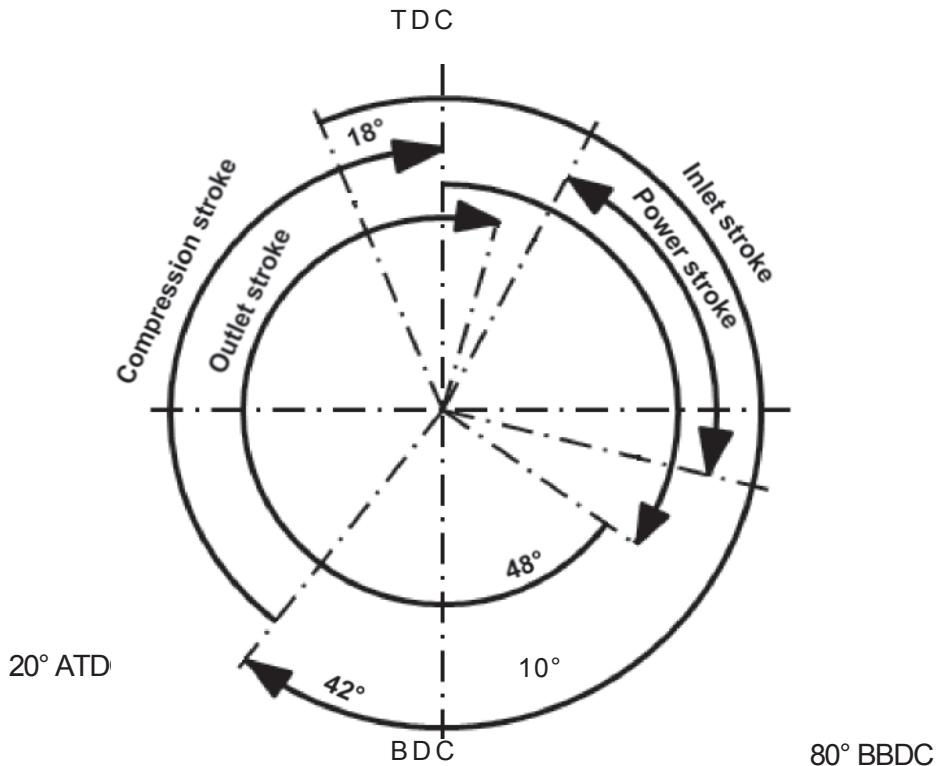
- |     |  |                 |
|-----|--|-----------------|
| 6.1 | <ul style="list-style-type: none"><li>• To measure internal diameters ✓</li><li>• To measure external diameters ✓</li><li>• To measure the depth of a blind hole ✓</li></ul>   | (Any 3 x 1) (3) |
| 6.2 | <ul style="list-style-type: none"><li>• A micrometer should be treated/handled with great care. ✓</li><li>• Rough usage and dropping will soon reduce its accuracy. ✓</li><li>• Do not hold the micrometer by the thimble and swing it around as rapid opening and closing of the instrument wears away the screw thread and causes inaccuracy. ✓</li><li>• Before using a micrometer, test it for accuracy / zero it.</li></ul> | (Any 3 x 1) (3) |
| 6.3 | Outside micrometer ✓   | (1)             |
| 6.4 | <ul style="list-style-type: none"><li>• On cylinder head bolts ✓</li><li>• On the main bearing caps ✓</li><li>• On the big end bearings</li><li>• On the flywheel bolts</li></ul>  | (Any 2 x 1) (2) |

## **QUESTION 7: ENGINES (SPECIFIC)**

- 7.1    7.1.1 Camshaft ✓ (2)

7.1.2    • The cams convert the rotary movement of the camshaft into reciprocating movement of the valves so that each valve opens at the correct moment and remain open for the correct duration. ✓  
• The camshaft serves as a driving mechanism for the oil pump and the distributor. ✓  
• The camshaft in some engines serves as a mechanism to operate the mechanical fuel pump. (Any 2 x 1) (2)

7.2    Draw a valve-timing diagram for a four-stroke engine using the following information:  
**Inlet valve opens:**    18° BTDC  
**Inlet valve closes:**    42° ABDC  
**Exhaust valve opens:** 48° BBDC  
**Exhaust valve closes:** 10° ATDC  
**Injection:**              20° ATDC (3)



- 7.3 7.3.1 Inlet-valve period:  
=  $18^\circ + 180^\circ + 42^\circ$   
=  $240^\circ$  (1)

7.3.2 Exhaust-valve period:  
=  $180^\circ + 48^\circ + 10^\circ$   
=  $238^\circ$  (1)

7.3.3 Power period:  
=  $180^\circ - 48^\circ$   
=  $132^\circ$  (1)

7.3.4 Valve overlap:  
=  $18^\circ + 12^\circ$   
=  $30^\circ$  (1)

7.4 Valve timing of the valves is in relation to the position of the crankshaft, ✓  
camshaft rotate at half the speed of the crankshaft. (1)

7.5 Tensioners are always fitted to the slack side of the belt or chain in order to  
take up the slack in the belt or chain due to stretching or wear to prevent the  
belt or chain from jumping a tooth or two which could lead to bent valves. ✓ (1)

7.6 • Reliable ✓  
• Cost effective ✓  
• Physically smaller (Any 2 x 1) (2)  
[15]

## **QUESTION 8: SYSTEMS AND CONTROL (SPECIFIC)**

- 8.1

  - The final drive provides a drive at right angles from the drive shaft to the side shafts of the rear axle assembly. ✓
  - It provides a constant reduction between the speed of the drive wheels and the engine in order to develop the engine revolutions required to drive the vehicle with ease. ✓

(2)

8.2

  - Ability to move a vehicle when only one wheel has traction. ✓
  - Better acceleration on the road (even though one wheel may be airborne). ✓
  - Reduction in shock load on the driving shaft and axles when an airborne wheel returns to the ground. ✓
  - Easier and more effective handling of the vehicle on bumpy roads.

(Any 3 x 1) (3)

8.3

8.3.1

  - To transmit force from the steering centre link or the rack gear to the steering knuckle. ✓
  - This causes the wheel to turn. ✓
  - The outer tie rod end connects with an adjusting sleeve, which allows the length of the tie rod to be adjustable. ✓
  - This adjustment is used to set a vehicle's alignment. (Any 2 x 1) (2)

8.3.2

  - It is used for allowing free movement on two planes at the same time, including rotating in those planes. ✓
  - Combining two such joints with control arms enables motion in all three planes, ✓ allowing the front end of an automobile to be steered and a spring and shock (damper) suspension to make the ride comfortable. ✓

(Any 2 x 1) (2)

8.3.3

  - It changes the rotary motion of a crank or the steering box to a second crank or link in a different plane or axis. ✓
  - It converts the sweeping motion of the steering box to the linear motion ✓ needed to pull the tie rods and ultimately turn the vehicle's wheels. ✓

(Any 2 x 1) (2)

8.4

  - It has no operating arms or links. ✓
  - When mounted diagonally, it helps to reduce body roll. ✓
  - Can be mounted inside coil springs, thus it is more compact. ✓
  - It is relatively cheap to manufacture and reliable. (Any 3 x 1) (3)

8.5

  - They control the up-and-down movement of the body on the springs for the comfort of the passengers. ✓
  - They keep the wheels in full contact with the road for driving control and safety. ✓

(2)

8.6

It is fitted to reduce body roll above the spring and axles ✓ when the vehicle is cornering and thus helps the car on a more even keel. ✓

(2)

- 8.7

  - Smoother engine performance because the torsion of the crankshaft is not concentrated on a specific section, but is distributed evenly over the length of the crankshaft ✓
  - The heat caused by the power strokes is evenly distributed and prevents local overheating or cooling: ✓
    - Causing minimal vibration to improve engine balance ✓
    - Achieving smooth running
    - Achieving longer engine life
    - Causing user comfort ✓

(Any 2 x 1) (2)

8.8    1-5-3-6-2-4    OR    1-4-2-6-3-5 ✓ (1)

8.9    Performs the same tasks as a normal limited slip differentials, often with pressurised hydraulic clutches, only with sophisticated electronics fine-tuned. ✓ (1)

8.10    The spark plug provides a gap in the combustion chamber over which a high-tension spark from the ignition coil may ‘jump’ to ignite the compressed mixture of air and petrol in the cylinder. (1)

8.11    
  - A much higher voltage from the ignition coil is required ✓ to bridge the gap and may cause the ignition coil to overheat. ✓
  - Misfiring occurs at high engine revolutions and at engine load because of insufficient voltage to bridge the gap. ✓
  - The engine will be difficult to start, especially during cold conditions. ✓

(Any 2 x 1) (2)

8.12    The spark duration will be very quick and the spark will be thin and weak. ✓
 
  - The effects of this may be bad starting and high exhaust emission levels.
  - Will result in an increase in fuel consumption. ✓
  - A worn engine will cause carbon deposits to bridge the gap and will result in misfiring. ✓
  - Uneven engine performance will cause loss of power. ✓

(Any 2 x 1) (2)

8.13    The distributor directs the high voltage from the ignition coil to the various spark plugs predetermined firing order. ✓ (1)

## QUESTION 9: MAINTENANCE (SPECIFIC)

- |     |   |                 |
|-----|---|-----------------|
| 9.1 | <ul style="list-style-type: none"><li>• Gear pump ✓</li><li>• Vane pump ✓</li><li>• Rotor pump ✓</li></ul>  | (3)             |
| 9.2 | <ul style="list-style-type: none"><li>• A seal prevents the leakage of water, oil or grease as well as penetration of dust or water in engine parts from the outside. ✓</li><li>• When revolving shafts on the inside of an engine are extended to the outside, it is necessary to seal off the shaft against the casing to prevent oil loss. This is the main function of the seal.</li><li>• The most important position for the application of seals are at the end of the crankshaft.</li></ul> | (Any 1 x 1) (1) |
| 9.3 | <ul style="list-style-type: none"><li>• Gaskets are placed between two surfaces to prevent leakage of the following substances: gases, water, oil and petrol. ✓</li><li>• Gaskets are fitted to obtain gas-tight and oil-tight joints.</li></ul>  | (Any 1 x 1) (1) |
| 9.4 | The oil pump, pumps oil under pressure to different parts of the engine to prevent friction. ✓  | (1)             |
| 9.5 | <ul style="list-style-type: none"><li>• There are no valves or springs ✓</li><li>• All the movements are rotary movements ✓</li><li>• Wear is minimal ✓</li><li>• The operation of the pump is silent</li><li>• Large inlet and outlet ports ensure a steady flow of oil without pulsation. Efficiency is very high, especially at low revolutions</li></ul>  | (Any 3 x 1) (3) |
| 9.6 | Minor service ✓<br>Major service ✓  | (2)             |

**QUESTION 10: FORCES (SPECIFIC)**

10.1 The compression ratio of an internal combustion engine is the ratio of compression of the inlet charge during the compression stroke to the total volume of the cylinder. ✓✓ (2)

10.2 10.2.1 Indicated power =  $P \cdot L \cdot A \cdot n$

Where:

$$P = 800 \text{ kPa}$$

$$L = \frac{150}{1000} \\ = 0,15 \text{ m}$$

$$A = \frac{\pi D^2}{4}$$

$$= \frac{\pi 0,11^2}{4} \\ = 9,5 \times 10^{-3} \text{ m}^2$$

$$N = \frac{1200}{60 \times 2} \\ = 10 \text{ r/s}$$

$n = 4$  cylinders ✓

Indicated Power =  $P \cdot L \cdot A \cdot n$  ✓

$$= (800) \times (0,15) \times (9,5 \times 10^{-3}) \times (10) \times (4) \checkmark \\ = 45,6 \text{ kW} \checkmark$$

(4)

$$\begin{aligned} 10.2.2 \quad \text{Brake Power} &= 2\pi \times N \times T \checkmark \\ &= 2\pi \times 20 \times 315 \checkmark \\ &= 39584,07 \text{ W} \checkmark \\ &= 39,58 \text{ kW} \checkmark \end{aligned}$$

(4)

$$\begin{aligned} 10.2.3 \quad \text{Mechanical Efficiency} &= \frac{BP}{IP} \times 100\% \checkmark \\ &= \frac{39,58}{45,6} \times 100\% \\ &= 86,80\% \checkmark \end{aligned}$$

(2)

$$\begin{aligned} 10.3 \quad 10.3.1 \quad \text{Swept volume} &= \frac{\pi D^2}{4} \times L \checkmark \\ &= \frac{\pi (0,8)^2}{4} \times 9,0 \checkmark \\ &= 452,39 \text{ cm}^3 \checkmark \end{aligned}$$

(3)

$$\begin{aligned} 10.3.2 \quad \text{Compression ratio} &= \frac{SV + CV}{CV} \\ \text{Clearance Volume} &= \frac{SV}{CR - 1} \checkmark \\ &= \frac{452,39}{9,5 - 1} \checkmark \\ &= 53,22 \text{ cm}^3 \checkmark \end{aligned}$$

(3)

## 10.3.3 New bore diameter:

$$\text{Compression ratio} = \frac{SV+CV}{CV} + 1$$

$$\begin{aligned}
 10 - 1 &= \frac{SV}{53,22} \\
 \frac{\pi D^2}{4} \times L &= 53,22 \times 9 \\
 D^2 &= \frac{53,22 \times 9 \times 4}{\pi \times 9} \quad \checkmark \\
 &= 67,76 \text{ cm}^3 \\
 D &= \sqrt{67,76} \\
 &= 8,23 \text{ cm} \\
 &= 82,3 \text{ mm} \quad \checkmark
 \end{aligned} \tag{2}$$

## 10.4 Indicated Power:

$$IP = 134 \text{ kW}$$

$$\begin{aligned}
 P &= 1400 \text{ kPa} \\
 &= 1400 \times 10^3 \text{ Pa}
 \end{aligned}$$

$$\begin{aligned}
 L &= 80 \text{ mm} \\
 &= 0,08 \text{ m}
 \end{aligned}$$

$$\begin{aligned}
 N &= 4600 \text{ r/min} \\
 &= \frac{4600}{60 \text{ r/sec}} \\
 &= \frac{4600}{60 \times 2} \quad \checkmark \\
 &= 38,33 \text{ r/sec} \quad \checkmark \\
 n &= 4 \quad \checkmark
 \end{aligned}$$

$$\begin{aligned}
 IP &= PLNn \quad \checkmark \\
 A &= \frac{IP}{PLNn} \quad \checkmark
 \end{aligned}$$

$$\begin{aligned}
 &= \frac{134 \times 10^3}{1400 \times 10^3 \times 0.08 \times 38,33 \times 4} \quad \checkmark \\
 &= 7.8 \times 10^{-3} \text{ m}^2 \quad \checkmark
 \end{aligned}$$

$$\begin{aligned}
 A &= \frac{\pi D^2}{4} \quad \checkmark \\
 D &= \frac{\sqrt{4 \times 0.00078}}{\sqrt{\pi}} \quad \checkmark \\
 &= 0.0997 \text{ m}^2 \\
 &= 10 \text{ cm} \quad \checkmark
 \end{aligned}$$

(10)  
[30]

**QUESTION 11: TERMINOLOGY (SPECIFIC)**

- 11.1    • Change the engine oil ✓  
• Check the Transmission oil ✓  
• Check the Differential oil ✓  
• Change the oil filter ✓  
• Labour ✓  
• Lube ✓  
• Parts ✓  
• Wash ✓
- (Any 4 x 1)      (4)

11.2    11.2.1 **Workshop administration:**

The entrepreneur interested in opening a workshop should be sure that he has the ability to manage the business as well as keep the customer and staff happy. ✓

He should apply good interpersonal skills in his dealings with the public and his employees. ✓

(2)

11.2.2 **Employees:**

The number of workers required for each job should be established. ✓

Apart from the general manager, a workshop foreman, office staff, receptionist, motor mechanics, apprentices and labourers. ✓

(2)

[8]

**TOTAL: 200**