



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

MECHANICAL TECHNOLOGY: AUTOMATIVE

EXEMPLAR 2018

MARKING GUIDELINES

MARKS: 200

These marking guidelines consist of 18 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

- | | | |
|-----|-----|------------|
| 1.1 | A ✓ | (1) |
| 1.2 | B ✓ | (1) |
| 1.3 | B ✓ | (1) |
| 1.4 | B ✓ | (1) |
| 1.5 | C ✓ | (1) |
| 1.6 | C ✓ | (1) |
| | | [6] |

QUESTION 2: SAFETY (GENERIC)

- 2.1 **Machine safety rule:**
Switch machine off after use. ✓ (1)
- 2.2 **Drill press safety precautions:**
Clamp the work piece securely to the table and do not hold it by hand. ✓ (1)
- 2.3 **Hydraulic press safety rules:**
- Predetermined pressure must not be exceeded. ✓
 - Pressure gauge must be tested regularly and replaced if malfunction occurs. ✓
 - The platform must be rigid and square to the cylinder. ✓
 - Objects to be pressed must be placed in suitable jigs. ✓
 - Ensure that the direction of pressure is always at 90° to the object. ✓
 - Only prescribed equipment must be used. ✓ (Any 2 x 1) (2)
- 2.4 **Reasons for wearing surgical gloves:**
- To prevent HIV/Aids or any blood related infections. ✓
 - To prevent contamination of the open wounds. ✓ (2)
- 2.5 **Gas cylinder safety precautions:**
- Always store and use gas cylinders in an upright position. ✓
 - Never stack cylinders on top of one another. ✓
 - Do not bang or work on the cylinders. ✓
 - Never allow cylinders to fall. ✓
 - No oil and grease should come into contact with gas cylinders or fittings. ✓
 - Keep the caps on the cylinders for protection. ✓ (Any 2 x 1) (2)
- 2.6 **Responsibility of employer:**
- Provide and maintain working systems, work area, equipment and tools in a safe condition. ✓
 - Eliminate or reduce any hazard or potential hazard. ✓
 - Produce, handle, store and transport goods safely. ✓
 - Ensure that every person employed complies with the requirements of this Act. ✓
 - Enforce measures if necessary in the interest of health and safety. ✓
 - Appoint a person who is trained and who have the authority to ensure that employee take precautionary measures. ✓ (Any 1 x 1) (1)
- 2.7 **Responsibility of employee:**
- Pay attention to his/her own and other people's health and safety. ✓
 - Co-operate with the employer regarding the Act. ✓
 - Carry out a lawful order given to them. ✓
 - Report any situation that is unsafe or unhealthy. ✓
 - Report all incidents and accidents. ✓
 - Do not interfere with any safety equipment or misuse such equipment. ✓
 - Obey all safety rules. ✓ (Any 1 x 1) (1)

[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 Metal tests:

3.1.1 Filing test:

Filing should be done on the tip or near the edge ✓ of the material to establish the relative hardness. ✓ (2)

3.1.2 Machining test:

This test is used on two unknown samples, identical in appearance and size, which is cut with a machine tool at the same speed and feed. ✓ The ease of cutting should be compared and the chips observed for heating colour and curl. ✓ (2)

3.2 Sound test on the steel:

3.2.1 High carbon steel (Hard):

Loud and clear ✓✓ (2)

3.2.2 Low carbon steel (Soft):

Dull sound ✓✓ (2)

3.3 Heat treatment processes on steel:

3.3.2 Case hardening:

To produce a hard case ✓ over a tough core. ✓ (2)

3.3.3 Hardening:

To enable the steel to resist wear ✓ and indentation ✓ (2)

3.3.5 Normalising:

To relieve ✓ the internal stress ✓ produced by machining. (2)

[14]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

4.1	D ✓	(1)
4.2	B ✓	(1)
4.3	D ✓	(1)
4.4	D ✓	(1)
4.5	A ✓	(1)
4.6	C ✓	(1)
4.7	D ✓	(1)
4.8	C ✓	(1)
4.9	C ✓	(1)
4.10	D ✓	(1)
4.11	A ✓	(1)
4.12	C ✓	(1)
4.13	A ✓	(1)
4.14	A ✓	(1)
		[14]

QUESTION 5: TOOLS AND EQUIPMENT (SPECIFIC)

- 5.1 **Computerised diagnostic scanner:**
- Easy to retrieve vehicle identification number. ✓
 - High reliability and accurate. ✓
 - Easy to read on its LCD display. ✓
 - The diagnostic terminal fits in one direction only. ✓
- (Any 3 x 1) (3)**
- 5.2 **Reasons for balancing wheels:**
- When a tyre is replaced or repaired. ✓
 - When a balancing weight is moved or falls off. ✓
 - When vibration on the steering wheel is experienced. ✓
- (3)**
- 5.3 **Tools:**
- 5.3.1 **Wheel balancer:**
To balance wheels to eliminate ✓ vibrations ✓ of vehicle wheels. (2)
- 5.3.2 **Gas analyser:**
To analyse exhaust gases ✓ to determine efficiency of the combustion process. ✓ (2)
- 5.3.3 **Compression tester:**
To determine whether the compression ✓ (pressure during compression stroke) in the cylinder is according to specification. ✓ (2)
- 5.3.4 **Pressure tester:**
To test ✓ if there are any leaks ✓ in a system. (2)
- 5.3.5 **Wheel alignment equipment:**
To align the four wheels ✓ of a motor vehicle to ensure maximum tyre life and optimal road holding. ✓ (2)
- 5.4 **Benefits of well-balanced wheels:**
- Reduces tyre wear ✓
 - Improves fuel efficiency ✓
 - Reduces stress in vehicle parts ✓
 - Eliminates vibrations ✓
 - Improves road holding ✓
- (Any 2 x 1) (2)**

5.5 Wheel dimensions:**5.5.1 Offset:**

The distance between the wheel balancer and the inner plane of the wheel rim. ✓

(1)

5.5.2 Width:

Width of the wheel at the wheel flanges, measured with a outside caliper. ✓

(1)

5.5.3 Diameter:

It is the outside diameter of the rim. ✓

(1)

5.6 Static balancing:

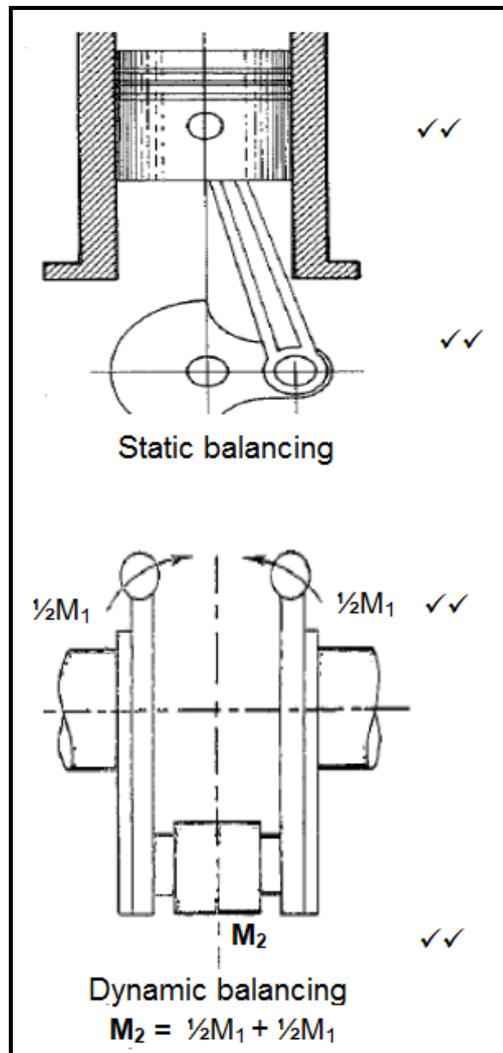
Static balancing is the equal distribution of all weights ✓ around the axis of rotation in the rotation plane. ✓

(2)

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QUESTION 6: ENGINES (SPECIFIC)

- 6.1 **Causes of vibration:**
- Mechanical unbalance because of unbalanced moving parts. ✓
 - Power unbalance because of disproportionate pressure on the pistons and crankshaft. ✓
- (2)
- 6.2 **Angle of balancing weight:**
 180° ✓✓
- (2)
- 6.3 **Dynamic balancing:**
 Balancing in all planes ✓ while the crankshaft is in motion. ✓
- (2)
- 6.4 **Static and dynamic balancing:**



- 6.5 **Mechanical balance:**
 To overcome the differences ✓ that causes unbalance. ✓
- (2)

- 6.6 **Crankshaft areas:**
- Crank arms ✓
 - Counter weights ✓
 - Flywheel ✓
- (3)
- 6.7 **Vibration damper:**
To counteract the twisting ✓ of the crankshaft during the power stroke. ✓
- (2)
- 6.8 **Crankshaft layout:**
- Number of cylinders ✓
 - Position of cylinders ✓
 - Firing order ✓
 - Firing periods ✓
- (4)
- 6.9 **Firing order:**
- 6.9.1 1, 3, 4, 2 ✓ (1)
- 6.9.2 1, 4, 3, 2 ✓ (1)
- 6.9.3 1, 5, 3, 6, 2, 4 ✓ or 1, 4, 2, 6, 3, 5 ✓ (Any 1 x 1) (1)
- [28]**

QUESTION 7: FORCES (SPECIFIC)**7.1 Compression ratio:**

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)

7.2 Compression ratio:**7.2.1 Swept volume:**

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

(3)

7.2.2 Compression ratio:

$$\begin{aligned}\text{Compression Ratio} &= \frac{SV + CV}{CV} \\ CV &= \frac{SV}{CR - 1} \quad \checkmark \\ &= \frac{452,39}{9,5 - 1} \quad \checkmark \\ &= \frac{452,39}{8,5} \\ &= 53,22 \text{ cm}^3 \quad \checkmark\end{aligned}$$

(3)

7.2.3 New bore diameter:

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

(6)

7.3 **Power:**

7.3.1 **Torque:**
Torque = force × radius

Where :

$$\begin{aligned} \text{Force} &= 765 - 15 \text{ N} \\ &= 750 \text{ N} \quad \checkmark \end{aligned}$$

and

$$\begin{aligned} \text{Radius} &= \frac{820 + 20}{1000 \times 2} \\ &= 0,42 \text{ m} \quad \checkmark \end{aligned}$$

$$\begin{aligned} T &= F \times r \\ &= 750 \times 0,42 \text{ Nm} \\ &= 315 \text{ Nm} \quad \checkmark \end{aligned}$$

(3)

7.3.2 Indicated Power = PLANn

Where :

$$P = 800 \text{ KPa} \quad \checkmark$$

$$\begin{aligned} L &= \frac{150}{1000} \\ &= 0,15 \text{ m} \quad \checkmark \end{aligned}$$

$$\begin{aligned} A &= \frac{\pi D^2}{4} \quad \checkmark \\ &= \frac{\pi 0,11^2}{4} \\ &= 9,5 \times 10^{-3} \text{ m}^2 \quad \checkmark \end{aligned}$$

$$\begin{aligned} N &= \frac{1200}{60 \times 2} \\ &= 10 \text{ r/s} \quad \checkmark \end{aligned}$$

$$n = 4 \text{ cylinders} \quad \checkmark$$

$$\begin{aligned} \text{Indicated Power} &= PLANn \quad \checkmark \\ &= (800) \times (0,15) \times (9,5 \times 10^{-3}) \times (10) \times (4) \quad \checkmark \\ &= 45,6 \text{ kW} \quad \checkmark \end{aligned}$$

(9)

7.3.3 Brake Power = $2\pi \times N \times T$ ✓
= $2\pi \times 20 \times 315$ W ✓
= 39584,07 W ✓
= 39,58 kW ✓ (4)

7.3.4 Mechanical Efficiency = $\frac{BP}{IP} \times 100\%$
= $\frac{39,58}{45,6} \times 100\%$ ✓
= 86,80% ✓ (2)

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QUESTION 8: MAINTENANCE (SPECIFIC)**8.1 Oil pressure test:**

- Because the oil pressure warning light is on. ✓
 - To determine the location of an oil leak. ✓
- (2)

8.2 Reasons for high CO (carbon monoxide) reading:

- Rich air fuel mixture ✓
 - Incorrect idle speed ✓
 - Clogged air filter ✓
 - Faulty choke ✓
- (Any 2 x 1)** (2)

8.3 Reasons for high HC (hydro-carbon) reading:

- Incorrect ignition timing ✓
 - Faulty high-tension leads ✓
 - Low compression ✓
 - Very rich mixture ✓
 - Leaking gasket ✓
 - Worn valves ✓
 - Worn valve lifter ✓
 - Worn rings and piston ✓
- (Any 3 x 1)** (3)

8.4 Reasons for compression lost:

- Worn cylinder ✓
 - Cracked cylinder ✓
 - Worn rings ✓
 - Worn piston ✓
 - Cracked piston ✓
 - Leaking inlet valve ✓
 - Leaking exhaust valve ✓
 - Leaking cylinder head gasket ✓
- (Any 3 x 1)** (3)

8.5 Wet compression test-procedure:

- Add a little oil to the cylinder which has a low reading. ✓
 - Execute the compression test as for dry test; if the reading increases it indicates that the piston rings are worn. ✓
- (2)

8.6 Cooling-system pressure tester:

- Run engine to heat up the cooling system. Fit radiator pressure tester to radiator. ✓
 - Pressurise the cooling system. (118 kPa). ✓
 - Watch the pressure, if it drops there is a leak. ✓
 - Make a visual check for leaks. ✓
 - Install radiator cap to tester and pump the tester. The cap should release air at its rated pressure. ✓
 - Check the rubber seal for cracks and damages. ✓
 - Check the vacuum valve for free movement and operation. ✓
- (7)

8.7 Compression test:**8.7.1 High tension lead:**

- The ignition system will be disabled. ✓
- To prevent electrical shock. ✓

(Any 1 x 1) (1)**8.7.2 Fuel injectors disconnected:**

- To prevent unburned fuel entering the exhaust system. ✓
- To prevent fuel entering the tester. ✓

(Any 1 x 1) (1)**8.7.3 Throttle valve fully open:**

To let the correct amount of air into the cylinder to obtain a correct reading. ✓

(1)

8.7.4 Record the readings:

- To compare readings with the specifications. ✓
- To determine the reading differences between the cylinders. ✓

(Any 1 x 1) (1)**[23]**

QUESTION 9: SYSTEMS AND CONTROL (AUTOMATIC GEARBOX) (SPECIFIC)

- 9.1 **Transmission':**
The transmission is a device that is connected to the back of the engine ✓
and it transmits the power from the engine to the drive wheels. ✓ (2)
- 9.2 **Types of transmission layout:**
- 9.2.1 Rear-wheel drive ✓ (1)
- 9.2.2 Front-wheel drive ✓ (1)
- 9.3 **Function of the torque converter:**
To multiply the engine torque automatically ✓ according to road and engine
speeds. ✓ (2)
- 9.4 **Components of the torque converter:**
- Impeller (pump) ✓
 - Reactor (stator) ✓
 - Turbine ✓ (3)
- 9.5 **Advantages of fluid coupling:**
- Acceleration and the transfer of torque is smoother as vehicle pulls
away. ✓
 - It does not require a foot-operated clutch pedal. ✓
 - It serves as a flywheel. ✓
 - It helps to reduce power unbalance. ✓ (Any 3 x 1) (3)
- 9.6 **Rotate in the same direction as the pump:**
One-way clutch ✓ (1)
- 9.7 **Gear ratio in relation to the road speed:**
- Higher gear ratio decreases the engine speed. ✓
 - Low gear ratio increases the engine torque. ✓ (2)
- 9.8 **Locking sequence of the epicyclic gear trains:**
By hydraulic pressure operating brake bands and/or multiplate clutches. ✓ (1)
- 9.9 **Kickdown in automatic gearbox:**
Activates the change down for rapid acceleration. ✓ (1)
- 9.10 **Mechanical systems in automatic transmission:**
Planetary gear system ✓ (1)
- [18]**

QUESTION 10: SYSTEMS AND CONTROL (AXLES, STEERING GEOMETRY AND ELECTRONICS) (SPECIFIC)**10.1 Dynamic balance of a wheel and tyre assembly:**

This is the equal distribution of all weights ✓ around the axis of rotation in all rotation parts ✓

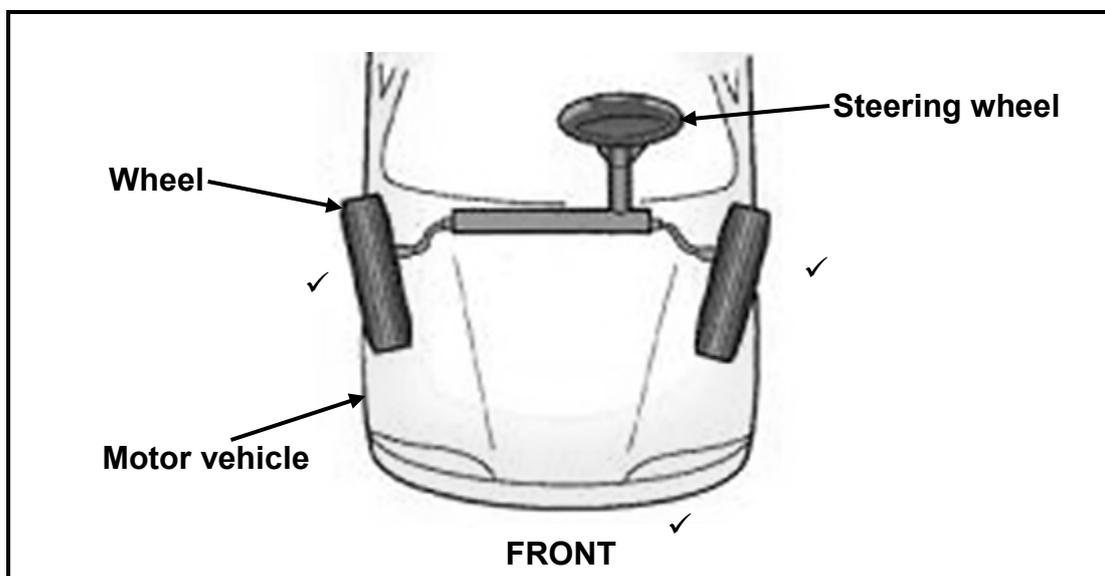
(2)

10.2 Preliminary wheel alignment check:

- Check tyre condition and size. ✓
- Check tyre pressure. ✓
- Check the run out on rim. ✓
- Check wheel bearing for play. ✓
- No spring sag (vehicle must stand level). ✓
- Check suspension rubbers. ✓
- Check shock absorbers. ✓
- Check suspension springs. ✓
- Check if steering gear is in good order and centralised. ✓
- Check steering linkages. ✓
- Check ball-joint or king pin movement. ✓
- Ensure that the wheels are balanced. ✓

(Any 5 x 1)

(5)

10.3 Toe-in:

(3)

- 10.4 **Camber:**
- 10.4.1 **Wheel alignment angle:**
Positive ✓ camber angle ✓ (2)
- 10.4.2 **Camber angle:**
A – Wheel ✓
B – Perpendicular line ✓
C – Centre line of wheel ✓
D – Positive camber angle ✓ (4)
- 10.4.3 **Camber angle definition:**
Positive camber angle is the outward tilt ✓ of the wheel at the top away from the vehicle ✓ when viewed from the front. ✓ (3)
- 10.5 **Purpose of the speed control system:**
To control the throttle and to keep the vehicle speed constant. ✓ (1)
- 10.6 **Advantage of speed control:**
- Driver fatigue is decreased because it is not necessary to control the throttle with his/her foot. ✓
 - The set speed is controlled. ✓
 - Improved fuel consumption. ✓
 - A consistently controlled speed prevents speeding fines. ✓ **(Any 1 x 1)** (1)
- 10.7 **Disadvantage of speed control:**
- The system is expensive. ✓
 - High maintenance costs if the system becomes faulty. ✓ **(Any 1 x 1)** (1)
- 10.8 **Diode:**
To change alternating current to direct current. ✓ (1)
- 10.9 **Stator and stator windings:**
- To provide a core that concentrates the magnetic lines of force onto the stator windings. ✓
 - To provide a coil into which voltage is induced which is used to charge the battery. ✓ **(Any 1 x 1)** (1)

10.10 Operation of electric fuel pump:

- As soon as ignition is switched on, the battery current flows through the electromagnet's coil windings and through the closed contact points to the earth. ✓
- The current flow in the coil windings produces a magnet field which magnetises the soft iron core of the electromagnet. ✓
- The armature on the diaphragm is attracted to the electromagnet moving the diaphragm down against the pressure of its spring. ✓
- This downwards movement of the diaphragm creates a partial vacuum in the float chamber causing the outlet valve to close more tightly. ✓
- Atmospheric pressure outside and inside the fuel tank allows petrol to flow through the inlet valve into the float chamber. ✓
- When the diaphragm is about to complete its downward stroke a trip mechanism opens the contact points and this interrupts the current flow. ✓
- The electromagnet then loses its attraction force and the diaphragm is pushed upwards by the diaphragm spring and the inlet valve closes. ✓
- Fuel is forced out of the float chamber through the outlet valve to the fuel line. ✓

(8)

[32]**TOTAL: 200**