basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

MECHANICAL TECHNOLOGY: AUTOMOTIVE

NOVEMBER 2018

MARKING GUIDELINES

MARKS: 200

These marking guidelines consist of 18 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

1.1 A ✓ (1)

1.2 C ✓ (1)

1.3 A ✓ (1)

1.4 B ✓ (1)

1.5 D ✓ (1)

1.6 A ✓ (1)

TOTAL QUESTION 1: [6]

QUESTION 2: SAFETY (GENERIC)

2.1 **Angle grinder: (Before using)**

- The safety guard must be in place before starting. ✓
- Protective shields must be placed around the object being grinded to protect the people around. ✓
- Use the correct grinding disc for the job. ✓
- Make sure that there are no cracks in the disc before you start. ✓
- Protective clothing and eye protection are essential. ✓
- Check electrical outlets and cord/plugs for any damages. ✓
- Ensure that lockable switch is disengaged. ✓
- Ensure that the disc and the nut are well secured. ✓
- Ensure that the removable handle is secured. ✓
- Remove all flammable material from the area. ✓
- Secure the work piece. ✓

(Any 2 x 1) (2)

2.2 **Welding goggles:**

- To protect your eyes against sparks ✓
- To protect your eyes against heat ✓
- To be able to see where to weld ✓
- To protect your eyes from UV rays / bright light ✓
- To protect your eyes from smoke ✓

(Any 2 x 1) (2)

2.3 **PPE for Hydraulic press:**

- Overall ✓
- Safety shoes ✓
- Safety goggle ✓
- Leather gloves ✓
- Leather apron ✓
- Face shield ✓

(Any 2 x 1) (2)

2.4 **Workshop layouts:**

- Process layout ✓
- Product layout ✓ (2)

2.5 **Employer's responsibility regarding first-aid:**

- Provision of first-aid equipment ✓
- First aid training ✓
- First-aid services by qualified personnel ✓
- Any first aid procedures ✓
- Display first aid safety signs ✓
- First aid personnel must be identified by means of arm bands or relevant personal signage ✓

(Any 2 x 1) (2)

TOTAL QUESTION 2: [10]

QUESTION 3: MATERIALS (GENERIC)

3.1 **Bending test:**

- Ductility ✓✓
- Malleability ✓✓
- Brittleness ✓✓
- Flexibility ✓✓

(Any 1 x 2) (2)

3.2 **Heat-treatment:**

3.2.1 **Annealing:**

- To relieve internal stresses ✓
- To soften the steel ✓
- To make the steel ductile ✓
- To refine the grain structure of the steel ✓
- To reduce the brittleness of the steel ✓

(Any 2 x 1) (2)

3.2.2 **Case hardening:**

- To produce a wear resistant surface ✓ and it must be tough enough internally ✓ at the core to withstand the applied loads.
- Hard case ✓ and tough core. ✓

(Any 1 x 2) (2)

3.3 **Tempering process:**

- To reduce ✓ the brittleness ✓ caused by the hardening process.
- Relieve ✓ strain ✓ caused during hardening process.
- Increase ✓ the toughness ✓ of the steel.

(Any 1 x 2) (2)

3.4 **Factors for heat-treatment processes:**

- Heating temperature / Carbon content ✓
- Soaking (Time period at temperature) / Size of the work piece ✓
- Cooling rate / Quenching rate ✓ (3)

3.5 **Hardening of steel:**

- Steel is heated to 30 – 50°C above the higher critical temperature. (AC_3) ✓
- It is then kept at that temperature to ensure (soaking) that the whole structure is Austenite. ✓
- The steel is then rapidly cooled by quenching it in clean water, brine or oil. ✓ (3)

TOTAL QUESTION 3: [14]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

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

TOTAL QUESTION 4: [14]

QUESTION 5: TOOLS AND EQUIPMENT (SPECIFIC)

5.1 **Equipment:**

5.1.1 Compression tester ✓ (1)

5.1.2 A – Flexible piping / hose / tubing ✓
B – Adaptor screw / Fitting / Attachment / Connector ✓
C – Gauge ✓
D – Pressure release valve ✓ (4)

5.1.3 **Compression Tester:**
It measures the pressure created, ✓ when the piston is at top dead centre on power stroke. ✓ (2)

5.2 **Cylinder leakage:**
To check whether the engine leaks gases ✓ from the cylinder during the compression stroke. ✓ (2)

5.3 **Gas Analyser:**
- To ensure ✓ an accurate reading. ✓
- To prevent ✓ a lean reading. ✓

(Any 1 x 2) (2)

5.4 **Function of a computerized diagnostic scanner:**
- Scans all systems ✓ on the vehicle.
- Informs what adjustments can be made after diagnosis ✓

(Any 1 x 1) (1)

5.5 **Bubble gauge camber procedure:**
- Mount the bubble gauge on to the straightened wheel ✓
- Zero the bubble gauge at the gauge zero scale ✓
- Take the reading on the camber scale ✓
- Do the same for the other wheel ✓ (4)

5.6 **Dynamic balance on wheels:**
- The plane of imbalance ✓
- The extent of the unbalancing forces ✓
- The sense of direction of these forces (clockwise or counter-clockwise) ✓
- Determine the location of weight placement ✓
- Magnitude of the weights ✓
- The run-out of the tyre and wheel assembly ✓

(Any 3 x 1) (3)

5.7 **Purpose of turn tables:**
To make it possible to turn ✓ the front wheels in or out ✓ to check ✓ the wheel angles. ✓ (4)

TOTAL QUESTION 5: [23]

QUESTION 6: ENGINES (SPECIFIC)

6.1 **Static balancing of the crankshaft:**
The crankshaft is in static when the mass in all directions ✓ from the centre of rotation is equal while it is at rest. ✓ (2)

6.2 **Cylinder layouts:**

6.2.1 V - engine layout ✓ (1)

6.2.2 In line (straight) engine layout ✓ (1)

6.3 **Firing order in an engine:**

- By removing the tappet cover and determining which are intake valves and which are exhaust valves ✓
- Rotating the engine in the direction in which it turns. ✓
- Watch the order in which one set of valves, inlet or exhaust operates ✓
- This will give the order in which the inlet stroke or exhaust stroke occurs ✓
- The power strokes occur in the same order ✓

OR

- Cylinder 1 must be at TDC on power stroke ✓
- Remove the distributor cap ✓
- Ensure to turn the engine in the correct direction of rotation ✓
- Determine the direction of rotation of the rotor ✓
- Trace the firing order by the HT leads ✓

(Any 1 x 5) (5)

6.4 **Firing order of engines:**

6.4.1 **Four cylinder in-line engine:**

- 1,3,4,2; or ✓
- 1,2,4,3 ✓

(Any 1 x 1) (1)

6.4.2 **V6-cylinder engine:**

- 1,4,2,5,3,6 ✓
- 1,2,3,4,5,6 ✓
- 1,6,5,4,3,2 ✓
- 1,4,5,6,3,2 ✓

(Any 1 x 1) (1)

6.5 **Turbo charger:**

6.5.1 **Turbocharger:**
A – Compressor air inlet ✓
B – Turbine housing ✓
C – Turbine exhaust gas outlet ✓
D – Turbine wheel ✓
E – Turbine exhaust gas inlet ✓
F – Compressed air outlet ✓
G – Compressor wheel ✓ (7)

6.5.2 **Turbocharger advantages:**
- More power / speed / boost is obtained from an engine with the same capacity ✓
- There is no power loss as the turbocharger is driven by exhaust gasses ✓
- Improved fuel consumption ✓
- The effect of height above sea level is eliminated ✓
- Generally, cheaper than superchargers ✓

Any (2 x 1) (2)

6.6 **Terminology:**

6.6.1 **Boost:**
Refers to the increase in manifold pressure ✓ that is generated by the turbocharger in the intake that exceeds the normal atmospheric pressure. ✓ (2)

6.6.2 **Turbo lag:**
- It is a delay ✓ between pushing on the accelerator and feeling turbo kick in. ✓ or
- The time ✓ it takes the turbo charger to reach operating speed. ✓

(Any 1 x 2) (2)

6.7 **Purpose of waste gate:**
It diverts exhaust gases ✓ away from the turbine wheel to regulate the turbine speed ✓ and consequently boost pressure. (2)

6.8 **Oil cooler:**
To cool (prevent overheating) the oil ✓ that lubricates the turbocharger bearings and shaft. ✓ (2)

TOTAL QUESTION 6: [28]

QUESTION 7: FORCES (SPECIFIC)

7.1 **Torque:**

- Torque is the twisting effort ✓ transmitted by a rotating shaft or wheel. ✓
- Turning force applied ✓ over a centre of a round object. ✓

(Any 1 x 2) (2)

7.2 **Clearance volume:**

This is the volume of the space ✓ above the crown of the piston at TDC. ✓ (2)

7.3 **Method to increase compression ratio:**

- Remove shims between the cylinder block and cylinder head. ✓
- Fit thinner cylinder head gasket. ✓
- Machine metal from cylinder head. ✓
- Skim metal from cylinder block. ✓
- Fit a piston with a higher crown. ✓
- Fit a crankshaft with a longer stroke. ✓
- Increase the bore of the cylinders. / bigger pistons. ✓

(Any 2 x 1) (2)

7.4 **Calculation of compression ratio:**

7.4.1

$$\text{Swept Volume} = \frac{\pi D^2}{4} \times L \quad ✓$$

$$= \frac{\pi\ (7{,}5)^2}{4}\ 8{,}0 \quad ✓$$

$$= 353{,}43\ \text{cm}^3 \quad ✓$$

(3)

7.4.2

$$\text{Compression Ratio} = \frac{SV + CV}{CV}$$

$$CV = \frac{SV}{CR - 1} \quad ✓$$

$$= \frac{353{,}43}{8{,}5 - 1} \quad ✓$$

$$= \frac{353{,}43}{7{,}5}$$

$$= 47{,}12\ \text{cm}^3 \quad ✓$$

(3)

7.4.3 **New compression ratio:**

$$\text{Swept volume} = \frac{\pi D^2}{4} \times L \quad \checkmark$$

$$= \frac{\pi 7{,}8^2}{4} \times 8 \quad \checkmark$$

$$= 382{,}27\ \text{cm}^3 \quad \checkmark$$

$$\text{New compression Ratio} = \frac{SV}{CV} + 1 \quad \checkmark$$

$$= \frac{382{,}27}{47{,}12} + 1 \quad \checkmark$$

$$= 8{,}11 + 1{:}1$$

$$= 9.11{:}1 \quad \checkmark$$

OR

$$\text{New compression Ratio} = \frac{SV + CV}{CV} \quad \checkmark$$

$$= \frac{382.27 + 47.12}{47.12} \quad \checkmark$$

$$= 9.11{:}1 \quad \checkmark$$

(6)

7.5 Calculations: Power:

7.5.1 $\text{Indicated Power} = P \times L \times A \times N \times n$

$P = 1400 \text{ kPa}$

$$L = \frac{110}{1000}$$
$$= 0,11 \text{ m} \quad ✓$$

$$A = \frac{\pi D^2}{4} \quad ✓$$
$$= \frac{\pi 0,10^2}{4}$$
$$= 7,85 \times 10^{-3} \text{ m}^2 \quad ✓$$

$$N = \frac{3600}{60 \times 2} \quad ✓$$
$$= 30 \text{ r/s} \quad ✓$$

$n = 4$ cylinders

$$\text{Indicated Power} = P \times L \times A \times N \times n \quad ✓$$
$$= \left(1400 \times 10^3\right) \times 0,11 \times \left(7,85 \times 10^{-3}\right) \times 30 \times 4 \quad ✓$$
$$= 145068 \text{ W}$$
$$= 145,07 \text{ kW} \quad ✓$$

(8)

7.5.2 $T = F \times r \quad ✓$
$= (75 \times 10) \times 0,45$
$= 337,5 \text{ N.m} \quad ✓$

$\text{Brake power} = 2 \pi \times N \times T \quad ✓$
$= 2 \pi \times 60 \times 337,5$
$= 127234,5 \text{ W}$
$= 127,23 \text{ kW} \quad ✓$

(4)

7.5.3 $$\text{Mechanical efficiency} = \frac{BP}{IP} 100\%$$

$$= \frac{127,23}{145,07} \times 100\% \quad ✓$$

$$= 87,70\% \quad ✓$$

(2)

TOTAL QUESTION 7: [32]

QUESTION 8: MAINTENANCE (SPECIFIC)

8.1 **Gas analyser:**

- Exhaust gasses ✓
- CO gasses ✓
- CO_2 gasses ✓
- SO_2 gasses ✓
- NO*x* gasses ✓
- HC gasses ✓
- O_2 gasses ✓

(Any 1 x 1) (1)

8.2 **Specification for gas analysis:**

- % Hydrocarbon / HC ✓
- % Carbon monoxide / CO ✓
- % Carbon dioxide / CO_2 ✓
- % Nitrogen oxide / NO*x* ✓
- % Sulphur dioxide / SO_2 ✓

(Any 3 x 1) (3)

8.3 **Cylinder leakage test: (Results)**

- Hissing noise at air intake ✓
- Hissing noise at exhaust pipe ✓
- Hissing noise in dipstick hole ✓
- Hissing noise under tappet cover ✓
- Bubbles in radiator water ✓
- Hissing noise at adjacent cylinders ✓

(Any 2 x 1) (2)

8.4 **Cylinder Leakage test: (Causes)**

- Worn cylinders ✓
- Worn piston ✓
- Worn piston rings ✓
- Leaking inlet valve ✓
- Leaking exhaust valve ✓
- Leaking cylinder head gasket ✓
- Cracked cylinder head / block ✓

(Any 2 x 1) (2)

8.5 **Compression test procedures:**

- Get the engine to normal operating temperature. ✓
- Disconnect the fuel supply and ignition system. ✓
- Remove spark plugs. ✓
- Fit the compression tester ✓
- Depress the throttle and crank the engine a few revolutions. ✓
- Record and compare the pressure reading for each cylinder with manufacturers specifications. ✓

(6)

8.6 **Reasons for low oil pressure:**

- Worn oil pump ✓
- Blocked oil pump screen/filter/strainer in the sump ✓
- Worn main, big-end and camshaft bearings ✓
- Blocked or restricted oil filter ✓
- Dirty or contaminated oil ✓
- Oil leaks ✓
- Too little oil in engine ✓
- Incorrect grade (viscosity) of oil ✓
- Pressure relief valve spring too weak or damaged ✓
- Plunger / Ball stuck in open position ✓
- Dirt stuck between ball and seat ✓

(Any 2 x 1) (2)

8.7 **Cooling system pressure test:**

- Start engine and allow to heat up. Fit radiator pressure tester to radiator. ✓
- Pressurize the cooling system according to manufacture's specification. ✓
- Watch the pressure for a while, if it drops there is a leak. ✓
- Make a visual check for leaks. ✓
- Install radiator cap to tester and pump tester, the cap should release air at its rated pressure. ✓
- Check the rubber seal for cracks and damage. ✓
- Check the vacuum valve for free movement and operation. ✓ (7)

TOTAL QUESTION 8: [23]

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

9.1 **Differences between an automatic and manual gearbox:**

- There is no clutch pedal in a motor vehicle with an automatic gearbox. / There is a clutch pedal in a motor vehicle with a manual gearbox. ✓
- There is no need to change gears, the shifting of the gears happens automatically. ✓
- Automatic transmission uses thin oil while manual gearbox uses thicker oil. ✓
- Automatic transmission uses torque converter while manual gearbox uses clutch assembly. ✓

(Any 2 x 1) (2)

9.2 **Advantages of automatic gearbox:**

- It reduces driver fatigue ✓
- It ensures great reduction of wheel spin under bad road conditions ✓
- The vehicle can be stopped suddenly without the engine stalling ✓
- The system dampens all engine torsional vibrations ✓
- Easier to drive (e.g. Disabled person with one leg) ✓

(Any 2 x 1) (2)

9.3 **Torque converter:**

9.3.1 **Torque converter function:**

- Transfers engine torque to the transmission. ✓
- It multiplies the engine torque to the transmission. ✓
- Provides a direct-drive, or mechanical link from the engine to the transmission. ✓
- The torque converter dampens all engine torsional vibrations. ✓
- The torque converter acts as a flywheel. ✓

(Any 2 x 1) (2)

9.3.2 **Parts:**

A – One-way clutch / Turbine ✓
B – Turbine / Impeller ✓
C – Pump ✓
D – Turbine shaft ✓
E – Gearbox housing ✓ (5)

9.4 **Single epicyclic gear train:**

- Overdrive forward ✓
- Overdrive reverse ✓
- Gear reduction forward ✓
- Gear reduction reverse ✓
- Direct drive ✓
- Neutral ✓

(Any 5 x 1) (5)

9.5 **Purpose of gear ratio in the gearbox:**

- It is used in order to utilise the usable torque ✓ developed in a relatively limited speed range of the engine over a greater road speed range. ✓
- Allows different speeds ✓ depending on the different loads. ✓

(Any 1 x 2) (2)

TOTAL QUESTION 9: [18]

QUESTION 10: SYSTEMS AND CONTROL (AXLES, STEERING GEOMETRY AND ELECTRONICS) (SPECIFIC)

10.1 **Preliminary wheel alignment checks:**

- Kerb mass (tank full of petrol, spare wheel and tools) against the manufacturer's specifications. ✓
- Uneven wear on the tyre. ✓
- Tyre pressure. ✓
- Run-out on the wheels; check wheel nuts with torque wrench. ✓
- Correct preload on the wheel (hub) bearings. ✓
- Kingpins and bushes. ✓
- Suspension ball joints for wear, locking and lifting. ✓
- Suspension bushes for excessive free movement. ✓
- Steering box play and whether secure on chassis. ✓
- Tie-rod ends. ✓
- Sagged springs, this includes riding height. ✓
- Ineffective shock absorbers. ✓
- Spring U-bolts. ✓
- Chassis for possible cracks and loose cross-members. ✓
- Wheels must be balanced ✓
- Wheel alignment specifications ✓
- Drive shafts / CV-joints ✓

(Any 5 x 1) (5)

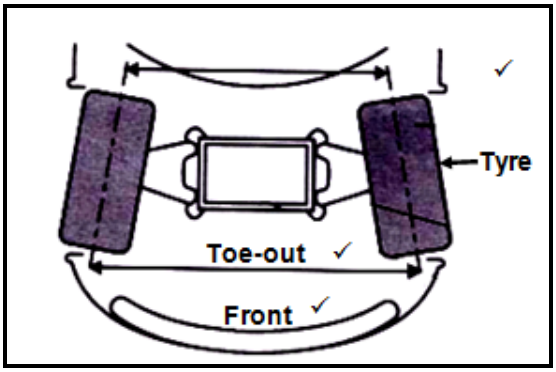
10.2 **Caster**

10.2.1 Negative ✓ Caster ✓ (2)

10.2.2 **Parts:**
A – Contact point of king pin centre line ✓
B – King pin ✓
C – Perpendicular line / vertical line / normal line ✓
D – Negative caster angle ✓
E – Centre line of king pin ✓
F – Front of vehicle / Direction of wheel motion ✓
G – Point of wheel contact / Wheel ✓ (7)

10.2.3 Negative caster angle is the forward tilt ✓ of the kingpin at the top, ✓ viewed from the side. ✓ (3)

10.3 **Toe-out:**



(3)

10.4 **Purpose of the king pin inclination:**

- To bring the front wheels back to the straight-ahead position ✓ after rounding a corner without any driver effort. ✓
- Reduce ✓ the scrub radius. ✓

(Any 1 x 2) (2)

10.5 **Catalytic converter:**

- Oxidation ✓
- Reduction ✓

(Any 1 x 1) (1)

10.6 **Purpose of the speed control system:**

The purpose of the speed control system is to control the throttle opening ✓ and to keep the vehicle speed constant. ✓ (2)

10.7 **Advantage of speed control:**

- Driver fatigue is reduced. ✓
- The set speed is controlled constantly. ✓
- Improved fuel consumption. ✓
- A consistently controlled speed helps to prevent speeding fines. ✓

(Any 2 x 1) (2)

10.8 **Fuel pressure regulator:**

- Fuel pressure regulator regulates the fuel pressure in relation to the manifold pressure. ✓ (1)

10.9 **Output frequency of an alternator:**

- Increase the turns of wire on the stationary coil. ✓
- Increase the magnetic fields. ✓
- Increase the rotational frequency at which the magnet rotates. ✓

(Any 2 x 1) (2)

10.10 **Stator and stator windings:**

- To provide a core which concentrates the magnetic lines of force onto the stator windings ✓
- To provide a coil into which a voltage is induced which is used to charge the battery. ✓

(Any 1 x 1) (1)

10.11 **Function of rotor assembly:**

- Is to provide a rotating electro-magnet. ✓ (1)

TOTAL QUESTION 10: [32]

TOTAL: 200