basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

MECHANICAL TECHNOLOGY: AUTOMOTIVE

2019

MARKING GUIDELINES

MARKS: 200

These marking guidelines consist of 13 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

1.1 B ✓ (1)

1.2 B ✓ (1)

1.3 A ✓ (1)

1.4 A ✓ (1)

1.5 D ✓ (1)

1.6 B ✓ (1)
[6]

QUESTION 2: SAFETY (GENERIC)

2.1 **Angle grinder:**
- Do not use excessive force while grinding ✓
- Ensure that the sparks do not endanger co-workers ✓
- Keep hands clear from grinding disc ✓
- Maintain a firm grip on the angle grinder ✓

(Any 2 x 1) (2)

2.2 **Welding goggles:**
- To protect your eyes from the spatter ✓
- To protect your eyes from the harmful rays ✓
- To ensure proper vision of the process ✓

(Any 2 x 1) (2)

2.3 **PPE – Bench grinder:**
- Overall ✓
- Safety goggles ✓
- Safety shoes ✓

(Any 2 x 1) (2)

2.4 **Process and product workshop layout:**
- The product layout ensures that the machines are arranged in the sequence of the manufacturing process of a product. ✓
- The process layout is based on the type of manufacturing process needed in the making of the product. ✓ (2)

2.5 **Employer's responsibility – equipment:**
- They must provide and maintain equipment ✓
- Ensure that the equipment is safe to use by employees ✓
- Provide safe storage for equipment ✓
- Provide proper training of employees in the use of the equipment ✓
- Enforce safety measures ✓

(Any 2 x 1) (2)
[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 **Tests to distinguish between metals:**

- Bending test: ✓ hit with hammer✓
- Filing test ✓file material(colour and ease) ✓
- Machining test ✓ machine material (type of shaving, ease and colour) ✓
- Sound ✓ drop on floor(high or low frequency) ✓ (8)

3.2 **Heat-treatment:**

3.2.1 **Tempering:**
After hardening, the steel must be tempered

- To relieve ✓ the strains ✓ induced.
- To reduce ✓ brittleness. ✓

(Any 1 x 2) (2)

3.2.2 **Normalising:**

- To relieve ✓ the internal stresses ✓ produced by forging and machining. (2)

3.2.3 **Hardening:**

- To produce extremely hard steel ✓ to enable it to resist wear and tear ✓ or to use as cutting tools. (2)

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QUESTION 4: MULTIPLE-CHOICE (SPECIFIC)

4.1 D ✓ (1)

4.2 A ✓ (1)

4.3 C ✓ (1)

4.4 C ✓ (1)

4.5 B ✓ (1)

4.6 B ✓ (1)

4.7 A ✓ (1)

4.8 C ✓ (1)

4.9 B ✓ (1)

4.10 B ✓ (1)

4.11 C ✓ (1)

4.12 B ✓ (1)

4.13 A ✓ (1)

4.14 D ✓ (1)

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QUESTION 5: TOOLS AND EQUIPMENT (SPECIFIC)

5.1 **Compression test:**

5.1.1
- Wet test ✓
- Dry test ✓ (2)

5.1.2 **Reasons for low compression:**
- Worn cylinders ✓
- Worn piston rings ✓
- Worn piston ✓
- Leaking inlet valve ✓
- Leaking exhaust valve ✓
- Leaking cylinder head gasket ✓

(Any 2 x 1) (2)

5.2 **Static imbalance:**
A small mass or weight ✓ is applied to the wheel rim diametrically opposite the heavy spot until the wheel is in balance. ✓ (2)

5.3 **Cylinder leakage tester:**

5.3.1 **Components of cylinder leakage tester:**
A. Spark plug adapter / connector ✓
B. Meter / gauge ✓
C. Flexible air hose ✓
D. Compressed air coupling ✓
E. Control valve / knob ✓ (5)

5.3.2 **Cylinder leakage test reasons:**
- Loss in power. ✓
- Low compression. ✓
- To determine if the cylinder head gasket has blown. ✓
- Oil consumption due to excessive leakage past the oil piston rings. ✓
- To identify leaking valves as a cause of excessive smoking.✓

(Any 2 x 1) (2)

5.4 **Reasons for a high CO reading:**
- Incorrect idle speed ✓
- Clogged air filter ✓
- Faulty choke ✓
- Faulty injectors ✓

(Any 2 x 1) (2)

5.5 **Wheel alignment gauge:**

5.5.1 Bubble gauge ✓ (1)

5.5.2 **Caster reading:**

- Turn the front of the wheel 20° inwards. ✓
- Zero the castor scale. ✓
- Turn the wheel through 40° in the opposite direction.✓
- Take the reading on the castor scale. ✓
- Do the same for the other wheel. ✓ (5)

5.6 **Diagnostic scanner:**

- The vehicle identification number (VIN). ✓
- The make and the model of the vehicle. ✓
- The engine type. ✓

(Any 2 x 1) (2)
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QUESTION 6: ENGINES (SPECIFIC)

6.1 **Balancing of engine**

6.1.1 **Engine crankshaft:**
- Static balance ✓
- Dynamic balance ✓ (2)

6.1.2 **Methods to balance a crankshaft:**
- Static balance: By fitting balance mass pieces to the crank webs or by removing metal from the crank webs. ✓
- Dynamic balance: Vibration is reduced by removing metal from certain parts or from parts of the crank webs. ✓ (2)

6.1.3 **Factors that cause vibration:**
- Mechanical unbalance caused by unbalanced moving parts. ✓
- Power unbalancing caused by uneven pressure on the pistons and crankshaft. ✓
- The crankshaft and flywheel assembly is not statically balanced. ✓
- The crankshaft and flywheel is not dynamically balanced. ✓

(Any 2 x 1) (2)

6.2 **Firing order factors:**
- The position of the cranks on the crankshaft. ✓
- The arrangement of the cams on the camshaft. ✓
- The number of cylinders. ✓

(Any 2 x 1) (2)

6.3 **Vibration damper:**
It is a mass fitted to the crankshaft ✓ on the opposite side of the flywheel to counteract the torsional vibration of the crankshaft. ✓ (2)

6.4 **Supercharger:**

6.4.1 **Type of supercharger:**
Centrifugal type ✓ (1)

6.4.2 **Supercharger parts:**
A. Air inlet port ✓
B. Air outlet port ✓
C. Rotor (impeller) ✓
D. Vane (fins) ✓ (4)

6.5 **Advantages of engine with supercharger:**

- More power is developed compared to a similar engine without a supercharger. ✓
- An engine with a supercharger is more economical per given kilowatt output. ✓
- Less fuel is used compared to engine mass. ✓
- Power loss above sea level is eliminated. ✓

(Any 2 x 1) (2)

6.6 **Operation of the turbocharger:**

- The exhaust gases from the engine are routed to the turbine wheel to enable the turbine wheel to spin at a very high speed. ✓
- The gases are then channelled out of the housing and wheel assembly into the normal exhaust system. ✓
- As the turbine wheel spins, it turns a common shaft, which in turn spins the compressor wheel. ✓
- The compressor draws air in through the compressor inlet. ✓
- It delivers the compressed air through the outlet and the induction port then into the cylinders. ✓
- This boosted pressure delivered to the cylinders increases the volumetric efficiency of the engine. ✓
- Then it also increases the engine's performance. ✓ (7)

6.7 **Turbo charger disadvantage against a super charger:**

- Require lubrication. ✓
- Suffers from lag. ✓
- Tend to heat the air, reducing density. ✓
- Needs to be controlled from over-revving by the waste gate. ✓
- Some turbochargers require a special shut-down procedure before the ignition can be switched off. ✓
- More expensive to install. ✓

(Any 2 x 1) (2)

6.8 **High altitude:**

At high altitude less oxygen is available for combustion ✓ and therefore the performance will be weaker than at sea level. ✓ (2)

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QUESTION 7: FORCES (SPECIFIC)

7.1 **Compression Ratio**
Is the ratio between the total volume of a cylinder when the piston is at bottom dead centre ✓ to the volume of the charge in a cylinder when the piston is at top dead centre. ✓ (2)

7.2 **Compression ratio calculations:**

7.2.1

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

$$= \frac{\pi\,(8{,}4)^2}{4} \times 9{,}0 \quad ✓$$

$$= 498{,}76\ \text{cm}^3 \quad ✓$$

(3)

7.2.2

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

$$CV = \frac{SV}{CR - 1}$$

$$= \frac{498{,}76}{8{,}5 - 1} \quad ✓$$

$$= \frac{498{,}76}{7{,}5}$$

$$= 66{,}50\ \text{cm}^3 \quad ✓$$

(3)

7.2.3 **New bore diameter:**

$$\text{Compression Ratio} = \frac{SV}{CV} + 1 \quad ✓$$

$$9{,}5 - 1 = \frac{SV}{66{,}50} \quad ✓$$

$$\frac{\pi D^2}{4} \times L = 66{,}50 \times 8{,}5 \quad ✓$$

$$D^2 = \frac{66{,}50 \times 8{,}5 \times 4}{\pi \times 9} \quad ✓$$

$$= 79{,}97\ \text{cm}^3$$

$$D = \sqrt{79{,}97} \quad ✓$$

$$= 8{,}94\ \text{cm}$$

$$= 89{,}4\ \text{mm} \quad ✓$$

(6)

7.3 Power calculations

7.3.1

$$\text{Force} = (125 \times 10)$$
$$= 1250\ \text{N} \quad ✓$$

$$\text{Torque} = \text{Force} \times \text{radius} \quad ✓$$
$$= 1250 \times 0,3$$
$$= 375\ \text{Nm} \quad ✓$$

(3)

7.3.2

$$\text{Indicated Power} = P \times L \times A \times N \times n$$
$$P = 950\,\text{KPa} \quad ✓$$
$$L = \frac{140}{1000}$$
$$= 0,14\,\text{m} \quad ✓$$
$$A = \frac{\pi D^2}{4} \quad ✓$$
$$= \frac{\pi 0,12^2}{4}$$
$$= 11,31 \times 10^{-3}\,\text{m} \quad ✓$$
$$N = \frac{2400}{60 \times 2} \quad ✓$$
$$= 20\ \text{power strokes/sec} \quad ✓$$
$$n = 4\ \text{cylinders}$$

$$\text{IndicatedPower} = P \times L \times A \times N \times n \quad ✓$$
$$= 950 \times 0,14 \times 11,31 \times 10^{-3} \times 20 \times 4 \quad ✓$$
$$= 120,34\ \text{kW} \quad ✓$$

(9)

7.3.3

$$\text{Brake Power} = 2\pi \times N \times T \quad ✓$$
$$= 2\pi 40 \times 375\ \text{W} \quad ✓$$
$$= 94247,78\ \text{W}$$
$$= 94,25\ \text{kW} \quad ✓$$

(3)

7.3.4

$$\text{Mechanical Efficiency} = \frac{BP}{IP} \times 100\% \quad ✓$$
$$= \frac{94,25}{120,34} \times 100\,\% \quad ✓$$
$$= 78,32\,\% \quad ✓$$

(3)

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QUESTION 8: MAINTENANCE (SPECIFIC)

8.1 **Oil pressure test - Manufacturers' specification:**

- Oil pressure at engine idle speed. ✓
- Oil pressure when the engine is cold. ✓
- Oil pressure when the engine is hot. ✓
- Oil pressure on high revolutions. ✓

(Any 3 x 1) (3)

8.2 **Exhaust pressure test:**

- Determine if the catalytic converter is blocked. ✓
- Determine if silencer is blocked. ✓ (2)

8.3 **Radiator cap test:**

- Install the cap on the cooling system pressure tester. ✓
- Increase the pressure in the tester while watching the pressure gauge. ✓
- The pressure cap should release air at a rated pressure stamped on the cap. ✓
- Cap should hold pressure for at least one minute. ✓ (4)

8.4 **Fuel-pressure test – manufacturers' specifications need to be obtained:**

- Fuel pressure before fuel pump. ✓
- Fuel pressure before the carburettor. ✓
- Fuel pressure at idle speed. ✓
- Fuel pressure at high revolutions. ✓ (4)

8.5 **Compression test:**

8.5.1 **High tension lead:**
The ignition system will be disabled ✓ to prevent electrical shock. ✓ (2)

8.5.2 **Fuel injectors disconnected:**
To prevent unburned fuel entering the exhaust system ✓ and from entering the tester. ✓ (2)

8.5.3 **Throttle valve fully open:**
To obtain the correct amount of air entering the cylinder ✓ and to obtain a correct reading. ✓ (2)

8.5.4 **Recording the readings:**
The reading obtained during the compression test can be compared to the specification reading ✓ to check if the pressure is correct or not. ✓ (2)

8.6 **Wet test-procedure:**

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

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

9.1 **Methods of cooling the automatic transmission:**

- By using a special oil cooler alongside the engine cooling radiator and circulating transmission fluid through it. ✓
- Circulating transmission fluid through the bottom radiator tank. ✓ (2)

9.2 **Advantages of automatic transmission:**

- It reduces driving fatigue. ✓
- Greater reduction of wheel spin under bad road conditions. ✓
- The vehicle can be stopped suddenly without the engine stalling. ✓
- The system dampers all engine torsional vibrations. ✓

(Any 2 x 1) (2)

9.3 **Purpose of automatic gearbox:**
To relieve the driver of clutch ✓and gear shift operation ✓ (2)

9.4 **Gear ratio on torque:**
The higher the gear ratio the lower the torque transferred ✓ and the lower the gear ratio the higher the torque transferred. ✓ (2)

9.5 **Advantages of torque converter:**

- Torque increases automatically. ✓
- Smooth transfer of torque. ✓
- Minimum servicing is required. ✓

(Any 2 x 1) (2)

9.6 **Automatic gearbox:**

9.6.1 Brake Band ✓ (1)

9.6.2 **Brake band labels:**

A. Lever shaft ✓
B. Lever ✓
C. Strut ✓
D. Brake band ✓
E. Anchor ✓
F. Band adjuster ✓ (6)

9.6.3 **Brake bands function:**
To enable the annulus to come into a stationary position to change to another ratio. ✓ (1)

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

10.1 **Preliminary wheel alignment check:**

- Kerb mass against the manufacturers specifications. ✓
- Uneven wear on the tyres. ✓
- Tyre pressure. ✓
- Run-out on the wheels. ✓
- Correct preload on the wheel 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, which include riding height. ✓
- Ineffective shock absorbers. ✓.
- Spring U-bolts. ✓
- Chassis for possible cracks and loose cross-members. ✓

(Any 5 x 1) (5)

10.2 **Toe-out on turns:**

This toe-out effect in a turn gives a true rolling motion to the front wheels ✓ in a corner without scuffing. ✓ (2)

10.3 **Dynamic balance of the wheel and tyre assembly:**

Dynamic balance of the wheel and tyre assembly refers to the equal distribution of all weights around the axis of rotation in all rotation parts. ✓ (1)

10.4 **Reasons of the speed control system:**

- The speed control system is to control the throttle opening electronically. ✓
- To keep the vehicle speed constant. ✓ (2)

10.5 **Disadvantages of the speed control:**

- The system is expensive. ✓
- High maintenance costs if the system becomes faulty. ✓ (2)

10.6 **Diode:**

The function of the diode is to permit current to flow in only one direction ✓ and to block it from flowing in the opposite direction. ✓ (2)

10.7 **Advantages of an electric fuel pump:**

- Immediate supply of fuel when the ignition switch is turned on.✓
- Low operational noise.✓
- Less discharge pulsation of fuel.✓
- Compact and light design.✓
- Prevents fuel leak and vapour lock.✓

(Any 2 x 1) (2)

10.8 **Aspects that an injector needs to fulfil:**

- Precise fuel flow rate ✓
- Good linearity ✓
- Wide active range ✓
- Good spray characteristics ✓
- No leakage ✓
- Silent operation ✓
- Durability ✓
- To cope with different needs for different engines ✓

(Any 2 x 1) (2)

10.9 **Ackerman principle:**

10.9.1 Ackerman angle ✓ (1)

10.9.2 **Parts:**
A – Rear axis ✓
B – Longitudinal axis ✓
C – Steering arms ✓
D – Front wheels✓
E – Extended centre lines from steering arms ✓
F - Intersection ✓ (6)

10.9.3 Kingpin inclination is designed to bring the front wheels back to the straight-ahead position ✓ after rounding a corner without any driver effort. ✓ (2)

10.10 **Alternator:**

10.10.1 Rotor assembly ✓ (1)

10.10.2 **Parts:**
A – slip ring ✓
B – brushes ✓
C – pole pieces ✓ (3)

10.10.3 The function of the rotor assembly is to provide a rotating electro-magnet to generate current. ✓ (1)
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TOTAL: 200