These marking guidelines consist of 16 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. ✓
- Grinding disc fitted will not turn faster than the manufactures recommendation. ✓
- Make sure that there is no cracks or chips on the grinding disc ✓
- Safety guard must be in place. ✓
- PPE must be worn. ✓
- Beware of lockable switches in the on position when the machine is plugged in and switched on. ✓
- Check for defective cables. ✓
- Secure work piece properly. ✓
- Grinding angle to be away from body to prevent sparks directly on clothing. ✓
- Make sure disc does not wobble during cutting. ✓

(Any 2 x 1) (2)

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

(Any 2 x 1) (2)

2.3 PPE – Bench grinder:
- Overall ✓
- Safety goggles / face shield ✓
- 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/ OHS acts and Regulations. ✓
- Employer must provide proper personal protective equipment (PPE) for the specific machines. ✓

(Any 2 x 1) (2)
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) ✓
- Spark test. ✓ Shape and colour of sparks. ✓

(Any 4 x 2) (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. ✓✓

(2)

3.2.3 Hardening:
- To produce extremely hard steel. ✓✓
- To enable it to resist wear and tear. ✓✓

(Any 1 x 2) (2)
### QUESTION 4: MULTIPLE-CHOICE (SPECIFIC)

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Notes</th>
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<tbody>
<tr>
<td>4.1</td>
<td>D ✓</td>
<td>(1)</td>
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<tr>
<td>4.2</td>
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<td>4.3</td>
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<td>4.4</td>
<td>A or C ✓</td>
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<td>4.5</td>
<td>B ✓</td>
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<tr>
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<td>4.9</td>
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<td>4.10</td>
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<tr>
<td>4.12</td>
<td>B ✓</td>
<td>(1)</td>
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<tr>
<td>4.13</td>
<td>A ✓</td>
<td>(1)</td>
</tr>
<tr>
<td>4.14</td>
<td>D ✓</td>
<td>(1)</td>
</tr>
</tbody>
</table>

**[14]**
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 ✓
• Cracked cylinder ✓
• Cracked piston ✓

(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. ✓

(Any 2 x 1) (2)
5.4 Reasons for a high CO reading:
- High idle speed ✓
- Too rich mixture ✓
- Ignition misfire ✓
- Clogged air filter ✓
- Improper operation of the fuel supply system ✓
- Faulty choke (choke stuck in closed position ✓
- Faulty injectors ✓
- Faulty thermostat/coolant sensor ✓
- Non-functioning PCV vale system ✓
- Faulty catalytic converter ✓

(Any 2 x 1) (2)

5.5 Wheel alignment gauge:

5.5.1 Bubble gauge ✓ (1)

5.5.2 Caster reading:
- Ensure that the wheels are straighten and the turntables are on zero. ✓
- Fit the gauge to the centre of the wheel. ✓
- 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)
[23]
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. ✓
- Do not suffer lag. ✓
- Cheaper, easier to install, service and maintain. ✓
- Increases volumetric efficiency. ✓

(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) [28]
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.

\[ CR = \frac{V_{\text{bottom}}}{V_{\text{top}}} \]

\[ CR = \frac{\pi D^2 L}{4} \]

\[ CR = \frac{\pi (8.4)^2}{4} \times 9.0 \]

\[ CR = 498.76 \text{ cm}^3 \]

(2)

7.2 Compression ratio calculations:

7.2.1 Swept Volume
\[ SV = \frac{\pi D^2 L}{4} \]

\[ SV = \frac{\pi (8.4)^2}{4} \times 9.0 \]

\[ SV = 498.76 \text{ cm}^3 \]

(3)

7.2.2 Compression Ratio
\[ CR = \frac{CV}{SV} \]

\[ CV = \frac{SV}{CR - 1} \]

\[ CV = \frac{498.76}{8.5 - 1} \]

\[ CV = 66.50 \text{ cm}^3 \]

(3)

7.2.3 New bore diameter:
\[ CR = \frac{SV + CV}{CV} + 1 \]

\[ 9.5 - 1 = \frac{SV}{66.50} \]

\[ \pi D^2 \times L = 66.50 \times 8.5 \]

\[ D^2 = \frac{66.50 \times 8.5 \times 4}{\pi \times 9} \]

\[ D^2 = 79.97 \text{ cm}^3 \]

(6)
7.3 **Power calculations:**

7.3.1 \[ \text{Force} = (125 \times 10) \]
\[ = 1250 \text{ N} \quad \checkmark \]

\[ \text{Torque} = \text{Force} \times \text{radius} \]
\[ = 1250 \times 0.3 \quad \checkmark \]
\[ = 375 \text{ Nm} \quad \checkmark \quad (3) \]

7.3.2 \[ \text{Indicated Power} = P \times L \times A \times N \times n \]
\[ P = 950 \text{ KPa} \quad \checkmark \]
\[ L = \frac{140}{1000} \]
\[ = 0.14 \text{ m} \quad \checkmark \]
\[ A = \frac{\pi D^2}{4} \quad \checkmark \]
\[ = \frac{\pi 0.12^2}{4} \]
\[ = 11.31 \times 10^{-3} \text{ m} \quad \checkmark \]
\[ N = \frac{2400}{60 \times 2} \quad \checkmark \]
\[ = 20 \text{ power strokes/sec} \quad \checkmark \]
\[ n = 4 \text{ cylinders} \]

\[ \text{Indicated Power} = P \times L \times A \times N \times n \quad \checkmark \]
\[ = 950 \times 0.14 \times 11.31 \times 10^{-3} \times 20 \times 4 \quad \checkmark \]
\[ = 120.34 \text{ kW} \quad \checkmark \quad (9) \]

7.3.3 \[ \text{Brake Power} = 2\pi \times N \times T \]
\[ = 2 \pi 40 \times 375 \text{ W} \quad \checkmark \]
\[ = 94247.78 \text{ W} \quad \text{or} \quad = 94.25 \text{ kW} \quad \checkmark \quad (3) \]

7.3.4 \[ \text{Mechanical Efficiency} = \frac{BP}{IP} \times 100\% \quad \checkmark \]
\[ = \frac{94.25}{120.34} \times 100\% \quad \checkmark \]
\[ = 78.32\% \quad \checkmark \quad (3) \]

[32]
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. ✓
- Decrease in power output. ✓
- Lack of high speed power. ✓
- Poor fuel consumption. ✓
- Overheating. ✓
- A leaking exhaust system. ✓

(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:**
- Fuel pressure before fuel pump. ✓
- Fuel pressure before the carburettor. ✓
- Fuel pressure at idle speed. ✓
- Fuel pressure at high revolutions. ✓
- Fuel pressure before the injectors pump. ✓
- Fuel pressure after the injectors pump. ✓

(Any 4 x 1) (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. ✓
  • To prevent fuel from entering ✓ the cylinders and causing oil dilution. ✓

  (Any 1 x 2) (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)

[23]
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. ✓
- To absorb shocks. ✓

(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) [18]
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 steering principle / geometry. ✓

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 If the centre lines of the steering arms are extended ✓ they will intersect on the longitudinal axis of the vehicle. ✓

(2)

10.10 Alternator:
10.10.1 Rotor assembly ✓

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)

TOTAL: 200

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