Province of the
EASTERN CAPE
EDUCATION

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GRADE 12

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MECHANICAL TECHNOLOGY: AUTOMOTIVE MARKING GUIDELINE

MARKS: 200

This marking guideline consists of 12 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

1.1 B ✓ (1)

1.2 A ✓ (1)

1.3 C ✓ (1)

1.4 C ✓ (1)

1.5 A ✓ (1)

1.6 D ✓ (1)

[6]

QUESTION 2: SAFETY (GENERIC)

2.1 **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)

2.2 **Employers' responsibility regarding safety:**

- 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 2 x 1) (2)

2.3 **Safety precautions before switching on the angle grinder:**

- Make sure that there are no cracks or chips on the disc. ✓
- Make sure that there are no flammable materials nearby. ✓
- Ensure that guards are in place. ✓
- Wear the appropriate PPE especially eye protection. ✓ (Any 2 x 1) (2)

2.4 **Welding goggles:**

- To protect your eyes against sparks. ✓
- To protect your eyes against heat. ✓
- To see where to weld. ✓ (Any 2 x 1) (2)

2.5 **Disadvantages of process layout:**

- Production is not always continuous. ✓
- Transportation costs between process departments may be high. ✓
- Additional time is spent in testing and sorting as the product moves to the different departments. ✓
- Damage to fragile goods may result from extra handling. ✓ (Any 2 x 1) (2)

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QUESTION 3: MATERIALS (GENERIC)

3.1 **Reason to cut from the unmarked end:**

- Marking does not get lost ✓
- Be able to identify the material ✓ (Any 1 x 1) (1)

3.2 **Heat-treatment processes properties:**

	PROCESS	PROPERTY
3.2.1	Hardening	Very hard, high tensile strength and brittle ✓
3.2.2	Tempering	Tough, hard ✓
3.2.3	Annealing	Soft, ductile, low tensile strength ✓
3.2.4	Normalising	Tough and machinable ✓

(4)

3.3 **Heat-treatment process steps:**

- Heat the metal slowly to a temperature below the critical temperature. ✓
- Soak it at that temperature for a period. ✓
- Quench / cool in an appropriate quenching medium. ✓ (3)

3.4 **Quenching media:**

- Water ✓
- Brine ✓
- Oil ✓ (3)

3.5 **Types of tests:**

3.5.1 Filing test ✓ (1)

3.5.2 Spark test ✓ (1)

3.5.3 Bending test ✓ (1)

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QUESTION 4: MULTIPLE-CHOICE (SPECIFIC)

4.1 A ✓ (1)

4.2 B ✓ (1)

4.3 C ✓ (1)

4.4 D ✓ (1)

4.5 B ✓ (1)

4.6 A ✓ (1)

4.7 A ✓ (1)

4.8 C ✓ (1)

4.9 B ✓ (1)

4.10 B ✓ (1)

4.11 D ✓ (1)

4.12 A ✓ (1)

4.13 A ✓ (1)

4.14 A ✓ (1)

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QUESTION 5: TOOLS AND EQUIPMENT (SPECIFIC)

5.1 **Cylinder leakage tester diagram**:

5.1.1 Leakage tester ✓ (1)

5.1.2 **Labelling: A** – Control valve ✓
B – Metre ✓
C – Compressed air coupling ✓
D – Flexible air hose with spark plug adapter ✓ (4)

5.1.3 **Purpose of cylinder leakage tester**:
- To determine the percentage of gas leakage from a cylinder. ✓
- To determine the location of gas leaks from a cylinder. ✓ (2)

5.2 **Reference to gas analyser**:

5.2.1 To analyse the gas coming out of the exhaust of a motor vehicle ✓ and to determine the amount of those gases in percentage. ✓ (2)

5.2.2 **Gases analysed**:
- Carbon monoxide (CO) ✓
- Carbon dioxide (CO_2) ✓
- Hydrocarbon (HC) ✓
- Oxygen (O_2) and particulate matter ✓
- Sulphur dioxide (SO_2)
- Nitrogen oxide (NO_X) (Any 4 x 1) (4)

5.3 **Set-up procedure of a compression tester:**
- Remove the fuel pump and injector fuse. Disconnect the main wire to the coil and spark plug wires, then remove the spark plug. ✓
- Insert the compression gauge to the spark plug hole. ✓
- Turn the ignition on, depress the throttle and crank the engine four revolutions. If the readings are not stable, crank the engine at least ten revolutions. Do the same to all cylinders. ✓
- Mark the pressure reading for each cylinder. ✓ (4)

5.4 **Purpose of each given tools**:

5.4.1 Bubble gauge is used to measure ✓ the caster, camber and king pin inclination angles. ✓ (2)

5.4.2 Wheel balancer is used to balance the wheel of a vehicle for static and dynamic balances. (2)

5.4.3 Turntable makes it possible to turn the front wheel 20° in ✓ and zero the bubble gauge and then turn the wheel 20° out to check the caster reading. ✓ (2)

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QUESTION 6: ENGINES (SPECIFIC)

6.1 **Functions of crankshaft:**

6.1.1 The function of the crankshaft is to convert the reciprocal motion of the piston into a rotary motion. ✓✓ (2)

6.1.2 **Labelling:**

A – Crank nose/vibration damper mounting ✓
B – Main journal oil way ✓
C – Main journal ✓
D – Main journal oil hole or crank pin oil hole ✓
E – Flywheel mounting/flange ✓
F – Counterweight/crank web ✓
G – Crankpin journals ✓ (7)

6.1.3 **Factors that determine the firing order:**

- The position of the cranks of the crankshaft. ✓
- The arrangements of the cams of the camshaft. ✓ (2)

6.2 **Explanation of each built in features:**

6.2.1 Connecting rods and pistons are kept as light as possible to reduce reciprocating mass and force. ✓✓ (2)

6.2.2 Flywheels are carefully balanced and are usually fitted to the crankshaft flange in one position only. ✓✓ (2)

6.2.3 Vibration dampers are usually fitted to the front end of the crankshaft to smooth out the engine vibration. ✓✓ (2)

6.3 **Responses based on engine blower:**

6.3.1 Turbocharger ✓ (1)

6.3.2 **Labelling**:

A – Exhaust gas inlet ✓
B – Impeller air outlet/air pump outlet/compressor air outlet ✓
C – Impeller housing/compressor housing ✓
D – Turbine housing ✓
E – Exhaust gas outlet. ✓ (5)

6.4 **Explanation of the turbocharger terms:**

6.4.1 Lag is a turbocharger delay to kick in when the driver depresses the accelerator pedal. ✓✓ (2)

6.4.2 Boost refers to the increase in manifold pressure that is generated by the turbocharger in the intake manifold. ✓✓ (2)

6.5 **Advantages of twin-charging**:

- Outstanding fuel economy. ✓
- Reduced lag in low rpm. ✓
- Increased power across the entire power band, with high torque available at all rpm. ✓ (Any 1 x 1) (1)

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QUESTION 7: FORCES (SPECIFIC)

7.1 Compression ratio of an engine is the relationship between the total volume of a cylinder when the piston is at BDC ✓ to the charge volume of the cylinder when the piston is at TDC. ✓ (2)

7.2 Work done = Force x displacement
= m x g x h ✓
= 560 x 10 x 20 ✓
= 112 000 J ✓
= 112 kJ ✓ (4)

7.3 **Responses based on engine cylinder:**

7.3.1 **Labelling**:
A – Bore diameter ✓
B – Stroke length ✓ (2)

7.3.2 Swept volume = $\frac{\pi D^2}{4}$ x L
= $\frac{\pi(11)^2}{4}$ x 12 ✓✓
1140,40 **OR** 1140,398 cm^3 ✓✓ (4)

7.4 **Methods of raising the compression ratio of an engine:**
- Remove the shims between crankshaft and cylinder block. ✓
- Fit thinner gasket between the cylinder block and cylinder head. ✓
- Machine the metal from the cylinder head. ✓
- Skim the metal from the cylinder. ✓
- Fit pistons with suitable higher crowns. ✓
- Fit crankshaft with longer stroke or longer connecting rods. ✓
- Increase bore of the cylinders. ✓ (Any 4 x 1) (4)

7.5 Mean effective pressure is an average pressure created by the combustion on a piston crown during the power stroke. ✓✓ (2)

7.6 **Indicator calculations:**

7.6.1 Area of piston crown = $\frac{\pi D^2}{4} = \frac{\pi (0{,}09)^2}{4}$ ✓ = 0,006362 **OR**
0,006361725 m^2 ✓

Number of power stroke per second = $\frac{4200}{2 \times 60s}$ ✓ = 35 r/s ✓

Indicated power = P x L x A x N x n
= 1 200 x 0,086 x 0,006362 x 35 x 4 ✓✓
= 91,92 **OR** 91,91 kW ✓ (7)

7.6.2 Brake power = 2 π N T
= 2 x π x $\frac{4\,200}{60\,s}$ x 180 ✓
= 79 168,13 W ✓
= 79,17 kW ✓ (3)

7.6.3 Mechanical efficiency = $\frac{BP \times 100}{IP} = \frac{79{,}17 \times 100}{91{,}92}$ ✓ = 86,13 % ✓ (2)

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QUESTION 8: MAINTENANCE (SPECIFIC)

8.1 **Safety requirements while setting up radiator tester:**

- A pressure test is used to locate leaks quickly. Do not put more pressure on the system than indicated by the manufacturers. ✓
- Air at low pressure is forced into the system through the radiator filler opening, this usually causes the coolant to pour or drip from the leak. ✓
- Do not open the radiator cap when the engine is hot. You can get burnt. ✓
- The pressure is applied by hand-operated air pump, which is one of the most common system testing devices. ✓
- Do not drop the pump, as you may damage it.
- Do not put more pressure on the radiator cap when tested, as you may damage the valve in the cap. (Any 4 x 1) (4)

8.2 **Causes of the Failure**: (2)

8.2.1 Compression rings are worn. ✓ (1)

8.2.2 Inlet valve not closing properly. ✓ (1)

8.2.3 Blown cylinder head gasket/ cracked cylinder block. ✓ (1)

8.3 **Responses based on gas analyser**:

	FAULTS	POSSIBLE CAUSES	CORRECTIVE MEASURES
8.3.1	Low carbon monoxide (CO) reading.	• Normal reading for CO. ✓	• All systems operating within tolerance. ✓
8.3.2	Low carbon dioxide (CO_2) reading.	• Fuel mixture either too rich or too lean. ✓ • Exhaust system leaks. ✓ (Any ONE)	• Reset fuel mixture. ✓ • Check and repair exhaust system leaks. ✓ (Any ONE)
8.3.3	High hydrocarbon (HC) reading.	• Excessive unburned fuel by incomplete combustion. ✓ • Improper timing. ✓ • Vacuum leak. ✓ • Faulty air management system. ✓ (Any ONE)	• Reset fuel mixture. ✓ • Check and reset the ignition system. ✓ • Check and repair vacuum leaks. ✓ • Check and repair. ✓ (Any ONE)

(3 x 2) (6)

8.4 **Manufacturer's specification for oil pressure testing**:

- Oil pressure when the engine is idling. ✓
- Oil pressure when the engine is cold. ✓
- Oil pressure when the engine is hot. ✓
- Oil pressure on high revolutions. ✓ (4)

8.5 **Causes of low fuel pressure reading:**

- Faulty fuel pump ✓
- Blocked or restricted fuel filter ✓
- Cracked or restricted fuel lines ✓
- Clogged pump inlet strainer ✓
- Low voltage to the fuel pump ✓
- Faulty fuel regulator ✓
- Defective fuel pump relay ✓
- Empty fuel tank ✓ (Any 4 x 1) (4)

8.6 **Manufacturer's specification for fuel testing:**

- Fuel pressure before the pump ✓
- Fuel pressure before and after the injector pump ✓
- Fuel pressure when the engine is idling ✓
- Fuel pressure on high revolutions ✓ (Any 2 x 1) (2)

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

9.1 **Purpose of automatic gearbox:**
- To relieve the driver of clutch and gearshift operation. ✓
- To promote smoother and easier driving of the vehicle. ✓ (2)

9.2 **Advantages of automatic gearbox:**
- It reduces driver fatigue. ✓
- It reduces wheel spin under bad road conditions.
- The vehicle can be stopped suddenly without the engine stalling.
- The system dampens all engine torsional vibration.
- It is easier to drive. (Any 1 x 1) (1)

9.3 **Methods of cooling oil of an automatic gearbox:**
- Special oil cooler alongside the engine cooling radiator is used. ✓
- Oil circulates through a tank built into the bottom of a radiator tank. ✓ (2)

9.4 Hydraulic pistons control the brake bands or multidisc clutches which allow the gear change. ✓✓ (2)

9.5 **Automatic gearbox**:

9.5.1 **Labelling**:
A – Sun gear shaft ✓
B – Brake band ✓
C – Anulus or ring gear ✓
D – Planet gear carrier ✓
E – Sun gear ✓
F – Planet gear ✓ (6)

9.5.2 **Operation of double epicyclic gear train in low gear**:
- The turbine shaft and primary sun gear are coupled by the front clutch. ✓
- The planet gear carrier is held stationary by the rear brake band. ✓
- The rear clutch is dis-engaged and the front brake band is free, leaving the secondary sun gear free. ✓
- The drive is from the primary sun gear to the primary and secondary planet gears, which rotate around their own axis, to the anulus that is part of the output shaft. ✓
- The secondary sun gear is also driven but performs no driving function. ✓ (5)

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

10.1 **Responses based on a diagram:**

10.1.1 **Labelling:**

A – King pin inclination angle ✓
B – Centre line of king pin ✓
C – 90º Perpendicular line **OR** Offset ✓ (3)

10.1.2 King pin inclination angle is an inward tilt ✓ of the top ✓ of king pin. (2)

10.2 **Properties of a good steering mechanism:**

- Light and easy to control ✓
- Free from vibrations and road shocks ✓
- As direct as possible without needing too much driver's effort ✓
- Self-centring ✓
- Able to operate without being affected by the action of the suspension or braking system ✓ (Any 3 x 1) (3)

10.3 **Pre-checks of wheel balancing:**

- The tyres for bruises, cracks and damage side walls. ✓
- The wheel rims for damaged beads. ✓
- For foreign matter on the rim and tyre. ✓
- Tyre pressure.
- Tyre thread wear. (Any 3 x 1) (3)

10.4 The catalytic convertor converts the pollutants in the exhaust gases of the engine ✓ into non-poisonous substances making it environmentally friendly. ✓ (2)

10.5 **Requirement for the catalytic convertor:**

- It must be at a temperature of at least 250 °C, preferable between 400 °C–600 °C. ✓
- Unleaded petrol must be used in a vehicle equipped with catalytic convertor. ✓
- The ignition system must be accurately controlled for full effectiveness. ✓
- A persistent misfire will melt the ceramic monolith. ✓
- Burnt engine oil in the exhaust gases will also destroy the monolith. ✓
- The lambda probe exhaust gas sensor must function correctly. ✓

(Any 2 x 1) (2)

10.6 **Diesel particulate filters**:

- Cordierite wall flow filters ✓
- Silicon carbide wall flow filters ✓
- Ceramic fibre filters ✓
- Metal fibre flow through filters ✓ (Any 2 x 1) (2)

10.7 **Engine management system:**

10.7.1 Air induction system ✓ (1)

10.7.2 **Labelling**:

A – Mass air flow meter (MAF) or (MAP) sensor ✓
B – Air filter or air cleaner ✓
C – Throttle valve ✓
D – Inlet valve or Intake valve ✓ (4)

10.7.3 The system measures ✓ and controls the air required for the combustion in the engine cylinder. ✓ (2)

10.8 **Adaptive speed control main aim**:

- To maintain a speed as set by the driver. ✓
- To adapt this speed and maintain a safe distance from the vehicle in front. ✓
- To provide a warning if there is a risk of a collision. ✓ (3)

10.9 **Rotor of alternator:**

10.9.1 **Labelling:**

A – Slip ring ✓
B – Brushes ✓
C – Pole pieces or North and South poles. ✓ (3)

10.9.2 **Methods of increasing output frequency of alternator:**

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

(Any 2 x 1) (2)

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TOTAL: 200