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NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2025

MECHANICAL TECHNOLOGY: AUTOMOTIVE MARKING GUIDELINE

MARKS: 200

This marking guideline consists of 15 pages.



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**QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)**

- 1.1 A ✓
- 1.2 C ✓
- 1.3 C ✓
- 1.4 B ✓
- 1.5 A ✓
- 1.6 D ✓

(6 x 1) (6)

QUESTION 2: SAFETY (GENERIC)**2.1 Safety precautions regarding the power saw**

- See that all guards are in place. ✓
- Make sure that no oil, grease or obstacles are around the machine. ✓
- Select the right blade for the material to be cut. ✓
- When changing blades, ensure that the machine is switched off at the main switch. ✓
- Remove or replace the blade carefully. Quick movements, such as pulling off the blade, may result in a badly cut hand. ✓
- Do not adjust guard and guides while the machine is running. ✓
- All materials must be clamped properly before cutting is started. ✓
- Long pieces of material must be supported at the end.
- Always stop the machine when you leave it unattended. ✓ (Any 2 x 1) (2)

2.2 Responsibility of the employee

- Pay attention to their own and other people's health and safety. ✓
- Co-operate with the employer regarding the OHS Act. ✓
- Carry out a lawful order given to them. ✓
- Report any situation that is unsafe or unhealthy. ✓
- Report all incidents and accidents. ✓
- Not to interfere with any safety equipment or misuse such equipment. ✓
- Obey all safety rules. ✓ (Any 2 x 1) (2)

2.3 Safety rules regarding a Bench grinder

- Use safety goggles at all times when grinding metal. ✓
- Do not adjust the tool rest while the wheel is in motion. ✓
- Do not force the work-piece onto or bump it against the emery wheel. ✓
- Keep fingers away from revolving wheel, especially when grinding small pieces. ✓
- Grind only on the front surface and never on the sides of an emery wheel. ✓ (Any 2 x 1) (2)



2.4 Advantages of product layout of machines

- Handling of material is limited to a minimum. ✓
 - Time period of manufacturing cycle is less. ✓
 - Product control is almost automatic. ✓
 - Control over operations is easier. ✓
 - Greater use of unskilled labour is possible. ✓
 - Less total inspection is required. ✓
 - Less total floor space is needed per unit of production. ✓
- (Any 2 x 1) (2)

2.5 Categories of OHS:

- Actions ✓
- Conditions ✓

(2)
[10]

**QUESTION 3: MATERIALS (GENERIC)****3.1 Testing materials**

- Sound test ✓
- Bending test ✓
- Filling test ✓
- Machining test ✓
- Hardness test ✓
- Spark test ✓

(Any 3 x 1) (3)

3.2 Different Carbon groups

- Low carbon steel ✓ 0,15–0,3% ✓
- Medium carbon steel ✓ 0,3–0,75% ✓
- High carbon steel ✓ 0,75–1,7% ✓

(6 x 1) (6)

3.3 Purpose of normalizing steel

- To relieve the internal stresses ✓ produced by machining, forging or welding ✓

(2)

3.4 Tempering process of steel

Heating the steel below its critical temperature. ✓

Soaking it at this temperature for a period. ✓

Quench/cool in an appropriate quenching agent. (water, brine, or oil) ✓

(3 x 1) (3)

[14]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

- 4.1 B ✓
- 4.2 A ✓
- 4.3 D ✓
- 4.4 C ✓
- 4.5 A ✓
- 4.6 C ✓
- 4.7 A ✓
- 4.8 D ✓
- 4.9 B ✓
- 4.10 A ✓
- 4.11 C ✓
- 4.12 C ✓
- 4.13 B ✓
- 4.14 D ✓

(14 x 1) (14)

QUESTION 5: TOOLS AND EQUIPMENT (SPECIFIC)**5.1 Card-type compression tester set-up procedures**

- Remove the spark plug. ✓
- Put a new card in the tester. ✓
- Turn the ignition on, depress the throttle and crank the engine up to four revolutions. ✓
- Activate the tester and move to cylinder 2. ✓
- Do the same with all the cylinders. ✓
- Remove the card. ✓
- Compare with the specifications.

(6 x 1) (6)

5.2 Purpose of the wheel balancer

- To balance the wheel of a vehicle for static balance ✓ and dynamic balance ✓

(2)

5.3 Set-up procedure for a diagnostic scanner

- Plug the scanner tool into the OBD connector under the dash. ✓
- Turn the key on, but do not start the engine. ✓
- The tool will ask for a number of things such as the VIN, the make and model of the vehicle and the engine type. ✓
- Follow the on-screen instructions. ✓

(4 x 1) (4)

5.4 Camber angle procedure

- Ensure wheels are in a straight-ahead position. ✓
- Remove the protection washer on the bubble gauge ✓end.
- Fit the gauge on the centre of the wheel. ✓
- Level Bubble D. ✓
- Read Bubble A. ✓

(5)

5.5 The Bubble gauge is used to measure caster and kingpin inclination. ✓✓

(2)

**5.6 Factors used to locate the dynamic imbalance of a wheel**

- The plane of imbalance, ✓
- The extent of unbalance forces and ✓
- The sense of direction of these forces (clockwise or anticlockwise) ✓

(3 x 1) (3)

5.7 Tool used for measuring toe-in and toe-out:

Dunlop gauge or Periscope optical alignment gauge

(1)

[23]

QUESTION 6: ENGINES (SPECIFIC)**6.1 FIGURE 6.1 responses**

6.1.1 Friction face-type vibration damper. ✓ (1)

6.1.2 Labelling

A – Secondary flywheel ✓

B – Friction disc ✓

C – Friction spring ✓

D – Spring plate ✓

E – Crankshaft ✓

F – Crankshaft flange ✓

(6 x 1) (6)

6.1.3 Purpose and position of vibration damper

- It smoothens out engine vibrations. ✓
- Usually fitted to the front end of the crankshaft. ✓ (2)

6.1.4 Operation of the vibration damper

- The variable speed of the crankshaft is transmitted to the secondary flywheel ✓
- When a front cylinder fires and the shaft tries to speed up, it tries to spin the secondary flywheel with it, the friction between the secondary flywheel and the flange holds the flywheel back and the crankshaft does not speed up as much ✓
- When the firing pressure is removed from the crankshaft, its unwinding force is retarded because the secondary flywheel has now built-up energy, which keeps it turning. ✓
- The unwinding force of the crankshaft cancels out the twist in the opposite direction, thereby smoothing out the torsional vibration. ✓ (4)

6.1.5 Function of the crankshaft

- Converts the reciprocating movement ✓
- To a rotary movement ✓ (2)

6.1.6 Engine cylinder configurations

- In-line engines ✓
- V-type engines ✓
- Flat engines (Boxer or Horizontally opposed) ✓ (3)

6.2 FIGURE 6.2 responses**6.2.1 Labelling**

A – Exhaust gas flow ✓

B – Engine cylinder ✓

C – Charge air cooler or Intercooler ✓

D – Compressed air flow ✓

E – Turbocharger ✓

(5 x 1) (5)

6.2.2 Component 'C' is responsible to cool the compressed air since it heats up when compressed. ✓ The engine will lose power if it fails, compressed air becomes hot and if the air is hot it loses density and oxygen. ✓ (2)

**6.3 Advantages of turbocharger**

- More power is obtained from the engine with same engine capacity. ✓
- A turbocharger is driven by the exhaust gases of the engine and therefore there is no power loss. ✓
- It gives improved fuel consumption in proportion to engine capacity. ✓
- The effect of height above sea level on power is eliminated.
- The turbocharger is generally cheaper.

(Any 3 x 1) (3)

[28]

QUESTION 7: FORCES (SPECIFIC)**7.1 Definitions of the given terms**

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

7.1.2 Swept volume is a space ✓ between the TDC and BDC which is travelled by the piston. ✓ (2)

7.1.3 Clearance volume is a space ✓ above the piston crown in the combustion chamber, when the piston is at TDC. ✓ (2)

7.2 Methods to lower the compression ratio of an engine

- Fit thicker gasket between the cylinder block and cylinder head. ✓
- Fit piston with suitable lower crown. ✓
- Fit crankshaft with shorter stroke (suitable connecting rods). ✓ (3)

7.3 7.3.1 **Swept volume:** $SV = \frac{\pi D^2}{4} L \checkmark = \frac{\pi(10)^2}{4} \times 13 \checkmark = 1021,02 \text{ cm}^3 \checkmark \checkmark$ (4)

7.3.2 **Compression ratio:** $CR = \frac{SV+CV}{CV} \checkmark = \frac{1021,02+105}{105} \checkmark = 10,72 : 1 \checkmark$ (3)

7.4 Calculations:**7.4.1 Indicated power:**

$$\text{Volume} = A \times L = 567,057 \text{ cm}^3 \checkmark \checkmark$$

$$= \frac{567,057}{100 \times 100 \times 100} = 0,000567057 \text{ m}^3 \checkmark \checkmark$$

$$N = \frac{5100}{2 \times 60s} = 42,5 \text{ r/s} \checkmark \checkmark$$

$$IP = P L A N n$$

$$IP = 1200000 \times 0,000567057 \times 42,5 \times 4 \checkmark$$

$$IP = 115\,679,628 \text{ W}$$

$$IP = 115,68 \text{ Kw} \checkmark \checkmark \quad (9)$$

7.4.2 Brake power: BP = 2.π.N.T

$$BP = 2 \times \pi \times \frac{3600}{60} \times 240 \checkmark \checkmark$$

$$BP = 90,48 \text{ kW} \checkmark \checkmark \quad (4)$$



7.4.3 **Mechanical efficiency:** $ME = \frac{BP \times 100}{IP} = \frac{90,48 \times 100}{115,68} \checkmark = 78,22 \% \checkmark$ (2)

7.5 **The conversion of 3 000 revolutions per minute to revolutions per second**

$N = \frac{3\,000}{60s} = 50 \text{ revs per second. } \checkmark$ (1)
[32]



QUESTION 8: MAINTENANCE (SPECIFIC)**8.1 Possible areas of cooling system leakage**

- Radiator neck, top and bottom tanks. ✓
- Radiator core. ✓
- Flexible rubber hoses ✓
- Water pump. ✓
- Welch(core) plugs. ✓
- Thermostat housing. ✓
- Cylinder head gasket.
- Interior heater radiator.
- Heater tap.

(Any 3 x 1) (3)

8.2 Possible cause for bubbles inside the radiator neck

- Blown cylinder head gasket or cracked cylinder block. ✓

Corrective measure

- Skim the cylinder head and replace cylinder head gasket or cylinder block. ✓✓

(2)

8.3 Manufacture's specification required when fuel test is conducted

- Fuel pressure before the fuel pump. ✓
- Fuel pressure before and after the injector pump. ✓
- Fuel pressure before the carburettor. ✓
- Fuel pressure when the engine is idling. ✓
- Fuel pressure on high revolutions. ✓

(Any 4 x 1) (4)

8.4 Possible causes and corrective measures for the oil pressure drop

8.4.1 Replace it with a new oil pump. ✓

8.4.2 Blocked oil pump screen in sump. ✓

8.4.3 Top up oil level. ✓

8.4.4 Incorrect grade (viscosity) of the oil (too thin) ✓

(4 x 1) (4)

8.5 8.5.1 10 % ✓

(1)

8.5.2 Variation = $11 - 8,2 = 2,8$ bars ✓✓**OR**

$$\text{Variation} = \frac{(11-8,2) \times 100}{11} = 25,45 \% \checkmark \checkmark$$

(2)



**8.5.3 Possible low readings in cylinder 3**

- Worn piston rings ✓
 - Worn pistons ✓
 - Worn cylinders
 - Leaking inlet valve
 - Leaking outlet/exhaust valve
 - Blown head gasket
 - Cracked cylinder head
 - Cracked piston
 - Cracked cylinder block
- (Any 2 x 1) (2)

8.5.4 Corrective measures

- Remove cylinder head and rework/replace valves. ✓
 - Skim cylinder head.
 - Do a pressure test on cylinder head.
 - Fit a new cylinder head gasket. ✓
- (Any 2 x 1) (2)

8.6 Safety requirements while setting up the gas analyser

- The inlet hose must not be stepped on or restricted in any way. ✓
 - The hose connection must be airtight and the valve on the condenser in the horizontal position (closed). ✓
 - The vehicle tested should have no leaks in the exhaust, manifolds or vacuum system. ✓
 - From time to time, the condensate must be blown out of the hoses and pickup probe with compressed air.
 - The hoses must be disconnected from the analyser or the pump will be damaged.
 - The condenser must be drained after each test, using the valve. When the paper filter becomes light grey, it should be changed.
 - The fuel filter on the condenser stand must be changed regularly. On a 12-volt analyser, the battery clamps must be cleaned.
- (Any 3 x 1) (3)

[23]

QUESTION 9: SYSTEM AND CONTROL (AUTOMATIC GEARBOX)**9.1 Advantages of using an automatic gearbox**

- It reduces driving 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. ✓ (Any 2 x 1) (2)

9.2 Responses based on FIGURE 9.2

9.2.1 Torque converter. ✓ (1)

9.2.2 Labelling

- A – Turbine ✓
- B – Housing ✓
- C – Pump ✓
- D – Stator ✓
- E – Turbine shaft ✓
- F – Gearbox housing ✓
- G – One-way clutch ✓
- H – Crankshaft ✓ (8 x 1) (8)

9.2.3 Advantages of torque converter

- Torque increases automatically. ✓
- Torque is transferred smoothly and shocks to the gearbox, chassis and vehicle's wheels are reduced. ✓
- Minimum servicing is required. (Any 2 x 1) (2)

9.3 Maximum torque multiplication is delivered when the pump has reached the highest velocity ✓ and the turbine is at stall (standing still), i.e. when the vehicle is stationary and just before it starts moving. ✓ (2)

9.4 Advantages of the transmission control unit (TCU)

- Better fuel economy. ✓
- Reduce engine emissions. ✓
- Greater shift system reliability. ✓
- Improved shift feel.
- Improved shift speed.
- Improved vehicle handling. (Any 3 x 1) (3)

[18]

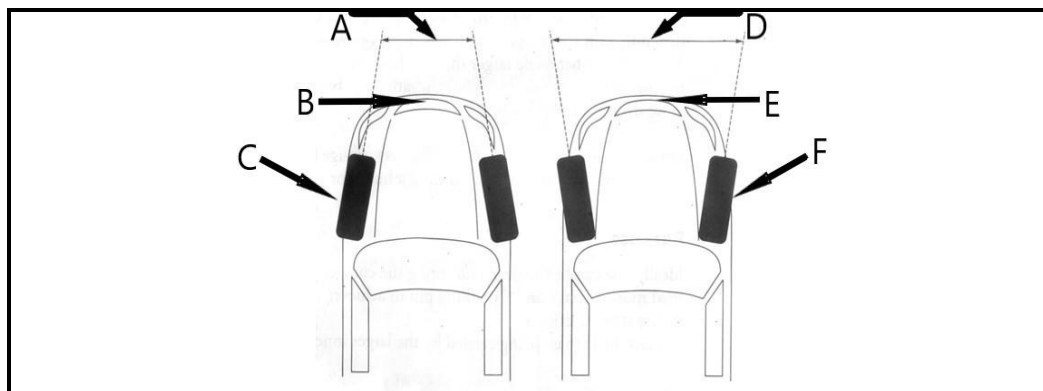
QUESTION 10: SYSTEM AND CONTROL (AXLES, STEERING GEOMETRY AND ELECTRONICS) (SPECIFIC)

10.1 Factors to be taken into account for wheel alignment

- Kerb mass against manufacturer's specifications should be checked. ✓
- Look for uneven tyre wear. ✓
- Check tyre pressures. ✓
- Run-out on wheels, check wheel nuts with torque wrench. ✓
- Correct preload on wheel bearings.
- Kingpins and bushes must be checked for wear.
- 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 free play.
- Sagged springs, which includes ride height.
- Ineffective shock absorbers.
- Spring U-bolts secureness.
- Chassis for possible cracks and loose cross-members. (Any 4 x 1) (4)

10.2 It gives variable toe-out to the front wheels on turns ✓ and automatically increased or decreased toe-out with increased or decreased wheel turning angles. ✓ (2)

10.3 The difference between toe-in and toe-out:



- | | | | |
|---|---|---|-----|
| A | Toe-in | ✓ | |
| B | Front of vehicle (Direction of vehicle) | ✓ | |
| C | Front wheel | ✓ | |
| D | Toe-out | ✓ | |
| E | Front of vehicle (Direction of vehicle) | ✓ | |
| F | Front wheel | ✓ | (6) |

10.4 The camber angle brings the contact point of the tyre on the road more directly under the king pin ✓ to achieve less steering effort and the vehicle mass being carried by the large inner front wheel bearing. ✓ (2)

10.5 **Three criteria for Injector to fulfill its purpose**

- Precise fuel flow rate ✓
- Good linearity ✓
- Wide active range ✓
- Good spray characteristics
- No leakage
- Low noise
- Durability

(Any 3 x 1) (3)

10.6 **FIGURE 10.6 responses**

10.6.1 Distributor less ignition (DLI)-system. ✓ (1)

10.6.2 The purpose of the ignition system is to ignite the air/fuel mixture in the combustion ✓ chamber at the correct time. ✓ (2)

10.6.3 **Labelling**

- A – Throttle position sensor. ✓
- B – Injector. ✓
- C – Distributor less ignition coil ✓
- D – Oxygen sensor ✓
- E – Engine temperature sensor ✓
- F – Crankshaft position sensor ✓
- G – Engine knock sensor ✓

(7 x 1) (7)

10.7 **Catalytic converter output gases**

- H₂O (water) ✓
- N₂ (Nitrogen gas) ✓
- CO₂ (Carbon dioxide) ✓

(Any 3 x 1) (3)

10.8 **Disadvantages of the speed control system**

- The system is expensive. ✓
- High maintenance costs can be incurred if the system becomes faulty. ✓

(2 x 1) (2)

[32]**TOTAL: 200**