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basic education

Department:
Basic Education
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SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

MECHANICAL TECHNOLOGY: AUTOMOTIVE

2019

MARKING GUIDELINES

MARKS: 200

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)**[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) ✓
- 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)**[14]**

QUESTION 4: MULTIPLE-CHOICE (SPECIFIC)

4.1	D ✓	(1)
4.2	A ✓	(1)
4.3	C ✓	(1)
4.4	A or 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)
		[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 valve 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. ✓

(2)

7.2 Compression ratio calculations:**7.2.1**

$$\begin{aligned}\text{Swept Volume} &= \frac{\pi D^2}{4} \times L && \checkmark \\ &= \frac{\pi (8,4)^2}{4} \times 9,0 && \checkmark \\ &= 498,76 \text{ cm}^3 && \checkmark\end{aligned}$$

(3)

7.2.2

$$\begin{aligned}\text{Compression Ratio} &= \frac{SV + CV}{CV} \\ CV &= \frac{SV}{CR - 1} && \checkmark \\ &= \frac{498,76}{8,5 - 1} && \checkmark \\ &= \frac{498,76}{7,5} \\ &= 66,50 \text{ cm}^3 && \checkmark\end{aligned}$$

(3)

7.2.3 New bore diameter:

$$\begin{aligned}\text{Compression Ratio} &= \frac{SV}{CV} + 1 && \checkmark \\ 9,5 - 1 &= \frac{SV}{66,50} && \checkmark \\ \frac{\pi D^2}{4} \times L &= 66,50 \times 8,5 && \checkmark \\ D^2 &= \frac{66,50 \times 8,5 \times 4}{\pi \times 9} && \checkmark \\ &= 79,97 \text{ cm}^2 \\ D &= \sqrt{79,97} && \checkmark \\ &= 8,94 \text{ cm} \\ &= 89,4 \text{ mm} && \checkmark\end{aligned}$$

(6)

7.3 Power calculations:

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

$$\begin{aligned} \text{Torque} &= \text{Force} \times \text{radius} \\ &= 1250 \times 0,3 \quad \checkmark \\ &= 375 \text{ Nm} \quad \checkmark \end{aligned} \quad (3)$$

$$7.3.2 \quad \text{Indicated Power} = P \times L \times A \times N \times n$$

$$P = 950 \text{ KPa} \quad \checkmark$$

$$\begin{aligned} L &= \frac{140}{1000} \\ &= 0,14 \text{ m} \quad \checkmark \end{aligned}$$

$$\begin{aligned} A &= \frac{\pi D^2}{4} \quad \checkmark \\ &= \frac{\pi 0,12^2}{4} \end{aligned}$$

$$= 11,31 \times 10^{-3} \text{ m} \quad \checkmark$$

$$\begin{aligned} N &= \frac{2400}{60 \times 2} \quad \checkmark \\ &= 20 \text{ power strokes/sec} \quad \checkmark \\ n &= 4 \text{ cylinders} \end{aligned}$$

$$\begin{aligned} \text{Indicated Power} &= P \times L \times A \times N \times n \quad \checkmark \\ &= 950 \times 0,14 \times 11,31 \times 10^{-3} \times 20 \times 4 \quad \checkmark \\ &= 120,34 \text{ kW} \quad \checkmark \end{aligned} \quad (9)$$

$$\begin{aligned} 7.3.3 \quad \text{Brake Power} &= 2\pi \times N \times T \quad \checkmark \\ &= 2\pi \times 40 \times 375 \text{ W} \quad \checkmark \\ &= 94247,78 \text{ W} \quad \text{or} \quad = 94,25 \text{ kW} \quad \checkmark \end{aligned} \quad (3)$$

$$\begin{aligned} 7.3.4 \quad \text{Mechanical Efficiency} &= \frac{BP}{IP} \times 100\% \quad \checkmark \\ &= \frac{94,25}{120,34} \times 100\% \quad \checkmark \\ &= 78,32\% \quad \checkmark \end{aligned} \quad (3)$$

[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. ✓ (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 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 ✓ (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)
- [32]**

TOTAL: 200