basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

MECHANICAL TECHNOLOGY: AUTOMATIVE

EXEMPLAR 2018

MARKS: 200

TIME: 3 hours

This question paper consists of 11 pages and a 1-page formula sheet.

INSTRUCTIONS AND INFORMATION

1. Write your examination number on the ANSWER BOOK.
2. Read ALL the questions carefully.
3. Answer ALL the questions.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Start EACH question on a NEW page.
6. Show ALL calculations and units. Round off final answers to TWO decimal places.
7. Candidates may use non-programmable scientific calculators and drawing instruments.
8. The value of gravitational acceleration should be taken as 10 m/s^2.
9. All dimensions are in millimetres, unless stated otherwise in the question.
10. Write neatly and legibly.
11. A formula sheet is attached to the question paper
12. Use the criteria below to assist you with your time management.

QUESTION	CONTENT	MARKS	TIME
	Generic		
1	Multiple-choice questions	6	6 minutes
2	Safety	10	10 minutes
3	Materials	14	14 minutes
	Specific		
4	Multiple-choice questions	14	10 minutes
5	Tools and Equipment	23	20 minutes
6	Engines	28	25 minutes
7	Forces	32	25 minutes
8	Maintenance	23	20 minutes
9	Systems and Control (Automatic Gearbox)	18	20 minutes
10	Systems and Control (Axles, Steering Geometry and Electronics)	32	30 minutes
	TOTAL	**200**	**180 minutes**

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (1.1 to 1.6) in the ANSWER BOOK, e.g. 1.7 A.

1.1 What is the purpose of the Occupational Health and Safety Act, 1993 (Act 85 of 1993) regarding HIV/Aids awareness?

A The safety laws state that all employers must make sure that the workplace is safe, and that employees are not at risk of becoming infected with HIV at work.
B It contains common guidelines on how employers, employees and trade unions should respond to HIV in the workplace.
C Employers may not demote or promote an employee based on his/her HIV status.
D Employers cannot simply dismiss a person who is infected with HIV. (1)

1.2 Which ONE of the following types of personal protective equipment is applicable when executing oxy-acetylene welding?

A Welding helmet
B Welding goggles
C Hard hat
D Welding mask (1)

1.3 What is the maximum gap allowed between the tool rest and the grinding wheel of a bench grinder?

A 4 mm
B 3 mm
C 5 mm
D 4,5 mm (1)

1.4 Which heat treatment process is used to decrease the brittleness in hardened steel?

A Annealing
B Tempering
C Hardening
D Normalising (1)

1.5 What is the purpose of annealing steel?

A To harden it
B To temper it
C To soften it
D To cool it down (1)

1.6 Which test is used to determine the ductility of a metal?

A Sound test
B Hardness test
C Bending test
D Machining test (1)

[6]

QUESTION 2: SAFETY (GENERIC)

2.1 What safety rule must be adhered to after the work procedures on any machine have been completed? (1)

2.2 Which safety precaution should be adhered to when drilling a small work piece on a drill press? (1)

2.3 State TWO safety rules to be observed when using the hydraulic press. (2)

2.4 Give TWO reasons for wearing surgical gloves when treating a co-worker with open wounds. (2)

2.5 State TWO safety precautions for the handling of gas cylinders. (2)

2.6 Name ONE responsibility of an EMPLOYER regarding safety in the workplace. (1)

2.7 Name ONE responsibility of an EMPLOYEE regarding safety in the workplace. (1)
[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 Explain how you will conduct the following tests to identify various metals:

3.1.1 Filing test (2)

3.1.2 Machining test (2)

3.2 When executing a sound test on steel, what sound is made by the following materials?

3.2.1 High carbon steel (HCS) (2)

3.2.2 Low carbon steel (LCS) (2)

3.3 What is the reason for executing the following heat treatment processes on steel?

3.3.1 Case hardening (2)

3.3.2 Hardening (2)

3.3.3 Normalising (2)
[14]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (4.1 to 4.14) in the ANSWER BOOK, e.g. 4.15 A.

4.1 What is the function of the cylinder leakage tester?

A To check whether the engine leaks gases from the cylinder during the induction stroke.
B To check whether the engine leaks gases from the cylinder during the power stroke.
C To check whether the engine leaks gases from the cylinder during the exhaust stroke.
D To check whether the engine leaks gases from the cylinder during the compression stroke. (1)

4.2 Which ONE of the following types of equipment is used to test compression in the cylinders of an internal combustion engine?

A Torsion tester
B Pressure tester
C Tensile tester
D Combustion tester (1)

4.3 What is the volumetric efficiency of a blower?

A Its ability to heat intake air
B Its ability to cool exhaust air
C Its ability to drive the blower
D Its ability to fill the cylinder with air above atmospheric pressure (1)

4.4 Which ONE of the following procedures should be applied to determine the extent of the wear on a crankshaft journal?

A Measure the crankshaft journal for taper
B Measure the crankshaft journal to see whether it is oval
C Use an outside micrometer and measure the crankshaft journal at 90°
D Measure around the crankshaft journal and then compare it with the specification (1)

4.5 Which ONE of the following is an important factor that determines the thermal efficiency of an engine?

A Combustion chamber design
B Size of carburettor venturi
C Design of intake manifold
D Valve opening angle (1)

4.6 What does the total volume that the piston will displace refer to when it moves upwards?

A Compression volume
B Clearance volume
C Swept volume
D Piston volume (1)

4.7 What will the mechanical efficiency of the engine be if the engine delivers 50 kW brake power and 60 kW indicated power?

A 83,3 °C
B 1,2%
C 1,2 °C
D 83,3% (1)

4.8 Which ONE of the following safety precautions must be adhered to when a cylinder leakage tester is used?

A Use water to remove dust around the spark plug.
B Make sure the high-tension leads to the spark plugs are connected.
C Do not exceed the prescribed pressure in the cylinder.
D Exceed the prescribed pressure in the cylinder. (1)

4.9 Which ONE of the following is the cause of low fuel pressure in an engine?

A Combustion chamber volume
B Too low acceleration
C Faulty diaphragm
D Too large engine capacity (1)

4.10 Which ONE of the following statements BEST defines *king-pin inclination*?

A The distance between the front and rear of the wheels
B The angle formed between the perpendicular line and the centre line of the king-pin, as seen from the side
C The angle formed between the perpendicular line and the centre line of the wheel, as seen from the front
D The angle formed between the perpendicular line and the centre line of the king pin, as seen from the front (1)

4.11 Which term describes the condition when the impeller of a torque converter rotates at maximum speed and the turbine is almost stationary?

A Torque speed
B Engine speed
C Acceleration speed
D Stall speed (1)

4.12 Which gear is the centre gear in an epicyclical (planetary) gear train?

A Planetary pinion
B Ring gear
C Sun gear
D Planetary gear carrier (1)

4.13 What is the gear ratio of a gear train with a drive gear rotating at 500 r/min and a driven gear rotating at 100 r/min?

A 1 : 5
B 5 : 1
C 1 : 2
D 2 : 1 (1)

4.14 Which ONE of the following is the purpose of brake bands in a three-speed automatic gearbox?

A To hold the secondary sun gear and the planetary gear carrier respectively
B To release the sun gear from the planetary gear carrier
C To activate the smooth transfer of power
D To drive the plates of both clutches to rotate with the turbine (1)

[14]

QUESTION 5: TOOLS AND EQUIPMENT (SPECIFIC)

5.1 State THREE advantages of using a computerised diagnostic scanner on modern vehicles. (3)

5.2 Give THREE reasons for balancing motor vehicle wheels. (3)

5.3 What is the main reason for using the following tools or equipment in an automotive workshop?

5.3.1 Wheel balancer (2)

5.3.2 Gas analyser (2)

5.3.3 Compression tester (2)

5.3.4 Pressure tester (2)

5.3.5 Wheel-alignment equipment (2)

5.4 Name TWO benefits of well-balanced wheels on a motor vehicle. (2)

5.5 Explain the following wheel dimensions one needs to consider before executing the dynamic balancing process:

5.5.1 Off-set (1)

5.5.2 Width (1)

5.5.3 Diameter (1)

5.6 Define *static balancing* of a wheel and tyre assembly. (2)

[23]

QUESTION 6: ENGINES (SPECIFIC)

6.1 Explain TWO factors that cause vibration in an internal combustion engine. (2)

6.2 At what angle to the crank-pin on a crankshaft is the balancing weight placed? (2)

6.3 Define the *dynamic balancing* of a crankshaft. (2)

6.4 Explain, by means of simple line sketches, how a crankshaft is statically and dynamically balanced. (8)

6.5 Explain why it is important to perform mechanical balancing on the crankshaft and flywheel. (2)

6.6 To balance a crankshaft perfectly, metal needs to be removed. Name THREE areas on the crankshaft where this can be done. (3)

6.7 Explain the function of a vibration damper in an internal combustion engine. (2)

6.8 Name FOUR factors that influence a crankshaft layout to obtain a balanced engine. (4)

6.9 State the firing order/sequence of the following engines:

6.9.1 Four-cylinder in-line engine (1)

6.9.2 Horizontally opposed engine (1)

6.9.3 Six-cylinder in-line engine (1)

[28]

QUESTION 7: FORCES (SPECIFIC)

7.1 Define the *compression ratio* of an internal combustion engine. (2)

7.2 The bore and stroke of an engine is 80 mm and 90 mm respectively. The compression ratio is 9,5 : 1.

Determine, by means of calculations:

7.2.1 The swept volume in cm^3 (3)

7.2.2 The original clearance volume in cm^3 (3)

7.2.3 The compression ratio is increased to 10 : 1. What will the new diameter of the bore be if the clearance volume remains unchanged? Answer must be in mm. (6)

7.3 The following data was recorded during a test carried out on a four-stroke, four-cylinder petrol engine:

Brake wheel diameter:	820 mm
Rope diameter:	20 mm
Brake dead weight:	765 N
Spring balance reading:	15 N
Speed during test:	1 200 r/min
Mean effective pressure:	800 kPa
Bore diameter:	110 mm
Stroke:	150 mm

Determine, by means of calculations:

7.3.1 Torque (3)

7.3.2 Indicated power (9)

7.3.3 Brake power in kW (4)

7.3.4 Mechanical efficiency (2)
[32]

QUESTION 8: MAINTENANCE(SPECIFIC)

8.1 Give TWO reasons why it is necessary to perform an oil pressure test on an engine. (2)

8.2 Give TWO reasons for a high carbon monoxide (CO) reading on an internal combustion engine. (2)

8.3 Give THREE reasons for a high hydrocarbon (HC) reading on an internal combustion engine. (3)

8.4 After a compression test had been conducted on an internal combustion engine, the results indicated lost compression in one of the cylinders. Give THREE possible reasons for the lost compression in the engine. (3)

8.5 Explain how a wet compression test is carried out. (2)

8.6 Explain, in point form, the procedure when the cooling-system pressure tester is used to test the pressure in the cooling system. (7)

8.7 As a result of engine power loss in a vehicle the mechanic conducts a compression test according to certain procedures. Why are the following procedures followed?

8.7.1 Remove the high-tension lead. (1)

8.7.2 Unplug the fuel-injection system. (1)

8.7.3 Open the throttle valve fully. (1)

8.7.4 Record the readings. (1)
[23]

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

9.1 What do you understand by the term *transmission* in a motor vehicle? (2)

9.2 FIGURES 9.2.1 and 9.2.2 below show two basic types of layouts of automatic-transmission drives. Identify the TWO types of layouts.

9.2.1

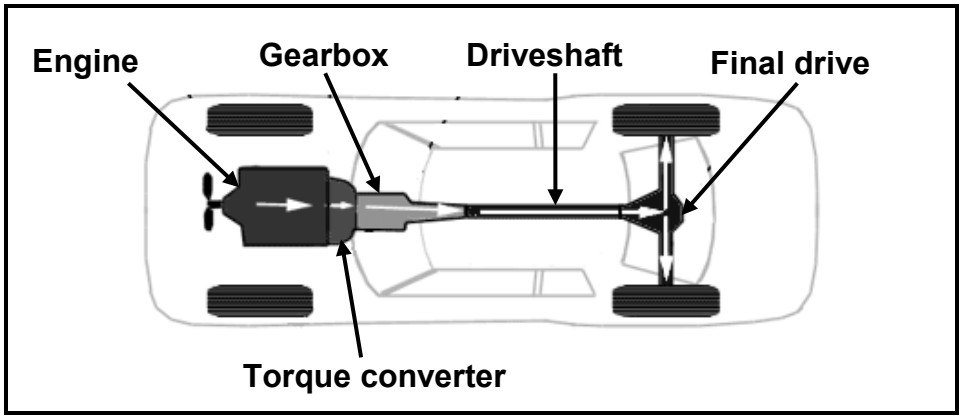

FIGURE 9.2.1 (1)

9.2.2

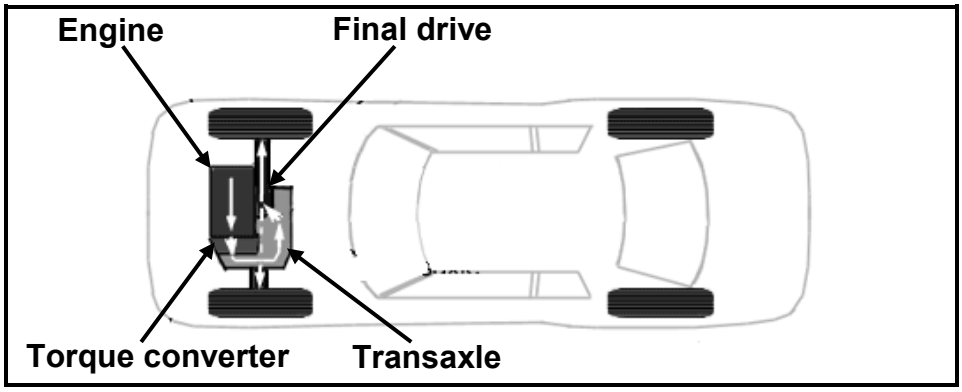

FIGURE 9.2.2 (1)

9.3 State the main function of a torque converter. (2)

9.4 Name THREE main components of the torque converter. (3)

9.5 State THREE advantages of fluid coupling in comparison with friction clutches. (3)

9.6 Which component of a torque converter allows the stator to rotate in the same direction as the pump? (1)

9.7 What is the effect of the gear ratio in relation to the road speed? (1)

9.8 Explain how the locking sequence of the epicyclic gear train is achieved. (2)

9.9 What is the main purpose of kickdown in an automatic gearbox? (1)

9.10 Which mechanical systems in an automatic transmission are able to provide the various forward gear ratios as well as reverse? (1)

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

10.1 Define *dynamic balancing* of a wheel and tyre assembly. (2)

10.2 State FIVE factors that need to be taken into account before wheel alignment is adjusted. (5)

10.3 Use a neat labelled sketch to illustrate 'toe-in' of the front wheels of a motor vehicle. (3)

10.4 FIGURE 10.4 below shows an alignment angle. Answer the questions that follow.

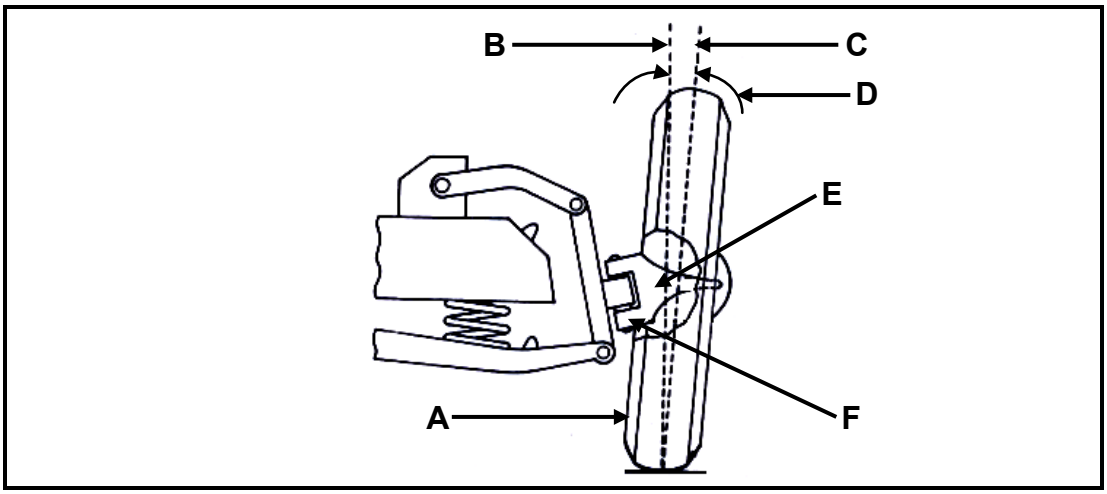

FIGURE 10.4

10.4.1 Identify the alignment angle in FIGURE 10.4. (1)

10.4.2 Identify **A** to **F** in FIGURE 10.4. (6)

10.4.3 Define the *alignment angle* in FIGURE 10.4. (2)

10.5 Describe the purpose of speed control in a motor vehicle. (1)

10.6 Name ONE advantage of speed control in a motor vehicle. (1)

10.7 State ONE disadvantage of speed control in a motor vehicle. (1)

10.8 What is the function of the diode in the alternator of a motor vehicle? (1)

10.9 State ONE function of the stator and stator windings. (1)

10.10 Explain the operation of an electrical fuel pump. (8)

[32]

TOTAL: 200

FORMULA SHEET FOR MECHANICAL TECHNOLOGY (AUTOMOTIVE)

$Force = m \times a$ where $m = mass$
$a = acceleration$

$Work = force \times distance (F \times d)$

$$Power = \frac{force \times distance}{time}$$

$Torque = force \times radius$

$Indicated\ power = P \times L \times A \times N \times n$
where $P = mean\ effective\ pressure$
$L = length\ of\ stroke$
$A = area\ of\ piston\ crown$
$N = number\ of\ power\ strokes\ per\ second$
$n = number\ of\ cylinders$

$Brake\ power = 2\pi N \times T$
where $N = revolutions\ per\ second$
$T = torque$

$Brake\ power (Prony\ brake) = F \times 2 \times \pi \times R \times N$
where $F = force$
$R = length\ of\ brake\ arm$
$N = revolutions\ per\ second$

$$Mechanical\ efficiency = \frac{brake\ power}{indicated\ power} \times 100$$

$$Compression\ ratio = \frac{swept\ volume + clearance\ volume}{clearance\ volume}$$

$$where\ swept\ volume = \frac{\pi \times D^2}{4} \times L$$
where $L = length\ of\ stroke$
$D = diameter\ of\ bore$

$$Clearance\ volume = \frac{\pi \times D^2}{4} \times l$$
where $D = diameter\ of\ bore$
$l = clearance$

$$Gear\ ratio = \frac{product\ of\ the\ number\ of\ teeth\ of\ the\ driven\ gears}{product\ of\ the\ number\ of\ teeth\ of\ the\ driver\ gears}$$