basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL
SENIOR CERTIFICATE

GRADE 12

MECHANICAL TECHNOLOGY: AUTOMOTIVE

NOVEMBER 2018

MARKS: 200

TIME: 3 hours

This question paper consists of 14 pages and a 1-page formula sheet.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the spaces provided 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 in managing your time.

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

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

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

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

    A   The Act on safety states 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   The Act 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 has HIV.   (1)

1.2 Which ONE of the following items of personal protective equipment (PPE) is applicable when arc welding is performed on a work piece?

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

1.3 Who is responsible for the provision of safety equipment in the workplace?

    A   Employer
    B   Employee
    C   Customer
    D   Foreman   (1)

1.4 Which ONE of the following properties of solid steel will change if the steel is subjected to a heat treatment process?

    A   Length
    B   Hardness
    C   Size
    D   Shape   (1)

1.5 The purpose of normalising steel is to …

    A   harden.
    B   temper.
    C   harden the core.
    D   relieve internal stresses.   (1)

1.6 If a sound test is applied to high-carbon steel, which ONE of the following sounds will help one to identify the metal?

    A   Loud and clear sound
    B   Dull sound
    C   Soft ringing sound
    D   Low ringing sound   (1)

[6]

QUESTION 2: SAFETY (GENERIC)

2.1 An angle grinder is used to smoothen a welded joint. State TWO safety measures that must be observed before using the angle grinder. (2)

2.2 Give TWO reasons why it is important to wear welding goggles during oxy-acetylene gas welding. (2)

2.3 Name TWO items of personal protective equipment (PPE) that one will use when working with a hydraulic press. (2)

2.4 Name TWO types of workshop layouts. (2)

2.5 Name TWO responsibilities of the employer when applying first aid in the workplace. (2)

[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 Name ONE property of steel that is tested by conducting a bending test on steel. (2)

3.2 Give TWO reasons for conducting EACH of the following heat-treatment processes on steel:

3.2.1 Annealing (2)

3.2.2 Case hardening (2)

3.3 Explain why the tempering of steel is done after the hardening process. (2)

3.4 State the THREE factors that must be considered during all heat-treatment processes. (3)

3.5 Explain the *hardening process* of steel. (3)

[14]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

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

4.1   Which ONE of the following pieces of equipment is used to set the wheel alignment of a motor vehicle?

      A   Pressure tester
      B   Torsion tester
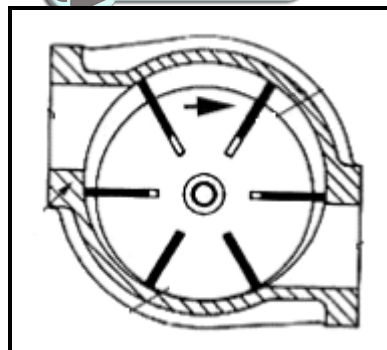   C   Bubble gauge
      D   Wheel gauge   (1)

4.2   What is the purpose of a wheel balancer?

      To balance …

      A   the angles of a motor vehicle
      B   the wheels for static and dynamic balance
      C   the steering control for better road grip
      D   engine torque delivered to the wheels   (1)

4.3   Identify the type of supercharger shown in FIGURE 4.3 below.

FIGURE 4.3

      A   Twin screw supercharger
      B   Roots supercharger
      C   Centrifugal supercharger
      D   Vane type supercharger   (1)

4.4   What is the purpose of a vibration damper on the engine of a motor vehicle?

      A   To check whether the valve lifter is resting on the cam
      B   To obtain static balance of the crankshaft
      C   To balance the crank arms and pistons
      D   To counteract the torsional vibrations of the crankshaft   (1)

Please turn over

4.5   The power of an engine may be defined as …

      A   the rate of doing work within a certain time slot.
      B   a force that overcomes resistance and causes movement.
      C   the twisting effect transmitted by a rotating shaft.
      D   the measure to determine the force developed by burning fuel in a cylinder.   (1)

4.6   What will be the brake power of an engine if the engine develops torque of 180 N.m at 3 000 r/min?

      A   0,56 kW
      B   5,65 kW
      C   56,55 kW
      D   6,67 kW   (1)

4.7   The relationship between the total volume of a cylinder when the piston is at bottom dead centre to the combustion chamber volume in the cylinder is known as the …

      A   compression ratio.
      B   clearance volume.
      C   swept volume.
      D   clearance ratio.   (1)

4.8   Which device controls the modern electronic automatic transmission of a vehicle?

      A   Electronic control unit
      B   Automatic transmission unit
      C   Electronic automatic transmission
      D   Transmission control unit   (1)

4.9   What is the effect of the gear ratio on the road speed of a motor vehicle?

      A   A lower gear ratio decreases the road speed.
      B   A higher gear ratio decreases the road speed.
      C   A higher gear ratio increases the road speed.
      D   A lower gear ratio increases the road speed.   (1)

4.10 What type of gear train is shown in FIGURE 4.10 below?

FIGURE 4.10

    A   Epicyclic gear train
    B   Ring gear train
    C   Circular gear train
    D   Helical gear train (1)

4.11 What is the effect of a large positive caster angle on the wheels of a vehicle?

    A   The pressure increases.
    B   The pressure decreases.
    C   The wheels will stop rotating.
    D   The wheels will wobble. (1)

4.12 What is the definition of *static balance* of a wheel and tyre assembly?

… around the axis of rotation in the rotation plane.

    A   Equal distribution of less weight
    B   Unequal distribution of little weight
    C   Unequal distribution of all weight
    D   Equal distribution of all weight (1)

4.13 Which exhaust emission control device is used to convert toxic gases and pollutants to less toxic gases from the exhaust gases of an internal combustion engine?

    A   Catalytic converter
    B   Toxic converter
    C   Exhaust converter
    D   Pollution converter (1)

4.14 Which ONE of the following safety measures must be taken into consideration when testing or repairing an alternator?

    A   Always connect the positive and negative cables of the tester to the relevant poles of the battery.
    B   Let the alternator run in an open circuit.
    C   Make sure that all battery cables are connected to the alternator.
    D   Connect the battery and alternator before arc welding is done on the motor vehicle. (1)
[14]

QUESTION 5: TOOLS AND EQUIPMENT (SPECIFIC)

5.1   FIGURE 5.1 below shows equipment that is used in the automotive workshop. Answer the questions that follow.

FIGURE 5.1

     5.1.1   Identify the equipment in FIGURE 5.1.   (1)

     5.1.2   Label parts **A**–**D**.   (4)

     5.1.3   Describe the purpose of the equipment.   (2)

5.2   What is the function of the cylinder leakage tester?   (2)

5.3   A gas analyser is used to analyse the exhaust gases of a motor vehicle. Give ONE reason why it is important to make sure that there are no leakages in the exhaust pipe.   (2)

5.4   State ONE function of a computerised diagnostic scanner.   (1)

5.5   Explain the procedure to follow when checking the camber using a bubble gauge.   (4)

5.6   Name THREE faults that can be established when performing dynamic wheel balancing.   (3)

5.7   What is the purpose of the turn-tables used to adjust the wheel alignment on a motor vehicle?   (4)
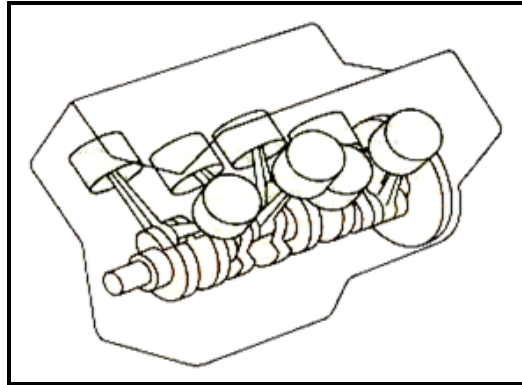
[23]

QUESTION 6: ENGINES (SPECIFIC)

6.1   What you understand by *static balancing of a crankshaft*? (2)

6.2   Identify the cylinder layouts as illustrated in FIGURES 6.2.1 and 6.2.2 below.
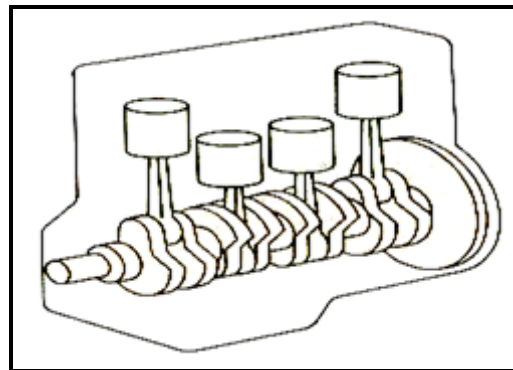
      6.2.1

FIGURE 6.2.1

(1)

   6.2.2

FIGURE 6.2.2

(1)

6.3   Explain how you will determine the firing order of a four-cylinder petrol engine if it is not marked on the crankshaft pulley and the manual is not available. (5)

6.4   State the firing order of the following types of engines:

      6.4.1   Four-cylinder in-line engine (1)

      6.4.2   V6-cylinder engine (1)

6.5   A turbocharger is shown in FIGURE 6.5 below. Answer the questions that follow.
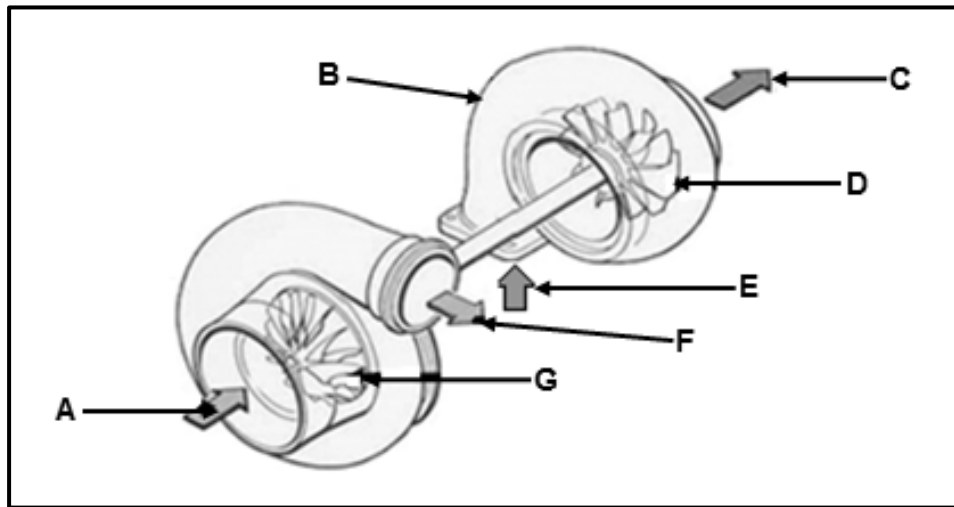
FIGURE 6.5

      6.5.1   Label parts **A**–**G**.   (7)

      6.5.2   State TWO advantages of the turbocharger.   (2)

6.6   Explain the following terms:

      6.6.1   Boost   (2)

      6.6.2   Turbo lag   (2)

6.7   What is the purpose of the waste gate in the turbocharger?   (2)

6.8   What is the purpose of an oil cooler fitted to a turbocharged engine?   (2)

[28]

QUESTION 7: FORCES (SPECIFIC)

7.1 Define the term *torque*. (2)

7.2 What is meant by the term *clearance volume* of an engine? (2)

7.3 State TWO methods to increase the compression ratio of an internal combustion engine. (2)

7.4 The bore and stroke of an engine are 75 mm and 80 mm respectively. It has a compression ratio of 8,5 : 1.

Calculate:

7.4.1 The swept volume in cm^3 (3)

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

7.4.3 The engine has been rebored to 78 mm. What will be the new compression ratio if the clearance volume remains unchanged? (6)

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

Mean effective pressure: 1 400 kPa
Stroke: 110 mm
Bore diameter: 100 mm
Engine revolutions: 3 600 r/min
Brake arm length: 450 mm
Scale reading: 75 kg

Calculate:

7.5.1 Indicated power in kW (8)

7.5.2 Brake power in kW (4)

7.5.3 Mechanical efficiency (2)

[32]

QUESTION 8: MAINTENANCE (SPECIFIC)

8.1   Which gases are analysed with a gas analyser?   (1)

8.2   State THREE manufacturer's specifications that must be obtained for a specific engine when conducting a gas analysing test.   (3)

8.3   State TWO possible results observed when a cylinder leakage test is conducted on an internal combustion engine.   (2)

8.4   State TWO causes of cylinder leakages that can be determined when conducting a cylinder leakage test on an internal combustion engine.   (2)

8.5   Explain the procedures to be followed when conducting a compression test on an internal combustion engine.   (6)

8.6   Give TWO reasons for low oil pressure in an internal combustion engine.   (2)

8.7   Explain in point form how you conduct a *cooling system pressure test*.   (7)
     [23]

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

9.1   State TWO main differences between an *automatic gearbox* and a *manual gearbox*.   (2)

9.2   State TWO advantages of an automatic gearbox.   (2)

9.3   FIGURE 9.3 below shows a torque converter used in an automatic transmission. Answer the questions that follow.
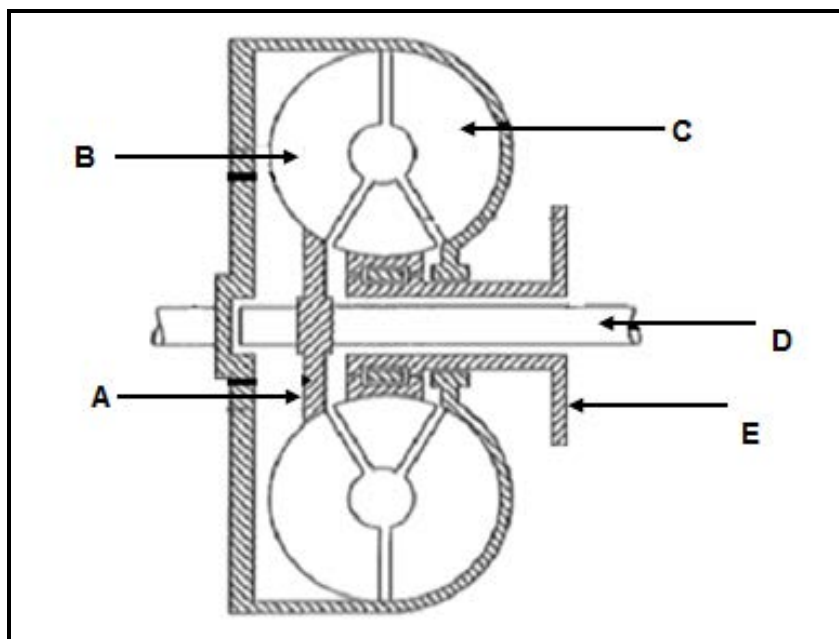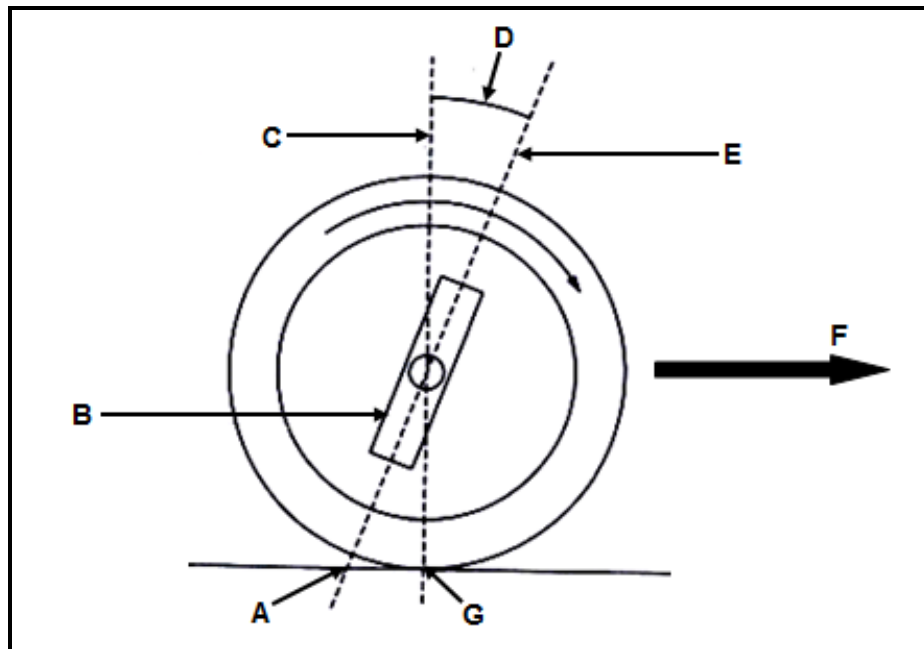

FIGURE 9.3

9.3.1   State TWO functions of a torque converter.   (2)

9.3.2   Label parts **A**–**E** of the torque converter.   (5)

9.4 State FIVE different gear drives that can be obtained with the help of a single epicyclic gear train. (5)

9.5 What is the purpose of gear ratios in the gearbox of a motor vehicle? (2)

[18]

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

10.1 State FIVE factors that need to be taken into account before any wheel alignment adjustments can be done. (5)

10.2 FIGURE 10.2 below shows a wheel alignment angle. Answer the questions that follow.

FIGURE 10.2

10.2.1 Identify the wheel alignment drawing in FIGURE 10.2. (2)

10.2.2 Label **A**–**G**. (7)

10.2.3 Define the *wheel alignment angle*, as indicated in FIGURE 10.2. (3)

10.3 Use a labelled sketch to show toe-out of the front wheels of a vehicle. (3)

10.4 State the purpose of kingpin inclination. (2)

10.5 State TWO chemical processes on which the operating principle of the catalytic converter is based. (1)

10.6 Describe the purpose of the speed-control system fitted to a motor vehicle. (2)

10.7   State TWO advantages of the speed-control system fitted to a motor vehicle.   (2)

10.8   What is the purpose of the pressure regulator in the fuel system of a motor vehicle?   (1)

10.9   State TWO methods to increase the output frequency of an alternator to increase the current output.   (2)

10.10   State ONE function of the stator and stator windings in an alternator.   (1)

10.11   State the function of the rotor assembly in an alternator.   (1)
                                                                              [32]

                                                              TOTAL: **200**

FORMULA SHEET FOR MECHANICAL TECHNOLOGY (AUTOMOTIVE)

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

$a = acceleration$

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

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

$Torque = force \times radius$

$Indicated \ power = P \times L \times A \times N \times n$

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 	$F = force$

$R = length \ of \ brake \ arm$

$N = revolutions \ per \ second$

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

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

where $swept \ volume = \dfrac{\pi \times D^2}{4} \times L$ 		$Clearance \ volume = \dfrac{\pi \times D^2}{4} \times l$

where $L = length \ of \ stroke$ 			where $D = diameter \ of \ bore$

$D = diameter \ of \ bore$ 			$l = clearance$

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