



Province of the
EASTERN CAPE
EDUCATION

**NATIONAL
SENIOR CERTIFICATE**

GRADE 11

NOVEMBER 2018

MECHANICAL TECHNOLOGY: AUTOMOTIVE

MARKS: 200

TIME: 3 hours



This question paper consists of 17 pages, including a 1-page formula sheet.

INSTRUCTIONS AND INFORMATION

1. Write your NAME 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. You may use a non-programmable scientific calculator and drawing instruments.
8. The value of gravitational force should be taken as 10 m.s^{-2}
9. All dimensions are in millimetre, unless stated otherwise in the question.
10. A formula sheet is attached to the question paper.
11. Write neatly and legibly.
12. Use the criteria below to assist you in managing your time management.

QUESTION	CONTENT	MARKS	TIME
GENERIC			
1	Multiple-choice questions	20	15 minutes
2	Safety	24	15 minutes
3	Tools and Equipment	16	10 minutes
4	Maintenance	8	10 minutes
5	Materials	32	25 minutes
SPECIFIC			
6	Tools and Equipment (Specific)	9	18 minutes
7	Engines (Specific)	15	10 minutes
8	Systems and Control (Specific)	27	15 minutes
9	Maintenance (Specific)	11	5 minutes
10	Forces (Specific)	30	30 minutes
11	Terminology (Specific)	8	27 minutes
TOTAL:		200	180 minutes

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

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A–D) next to the question number (1.1–1.20) in your ANSWER BOOK, for example 1.21 A.

- 1.1 The legal responsibilities of an employer with regards to health and safety include:
- A Making employees pay for replacing damaged or lost PPE
 - B Providing safe working conditions for all employees
 - C Taking out additional insurance for dangerous work
 - D Ensuring that only one member of staff works on a dangerous job (1)
- 1.2 Which ONE of the following safety procedures applies to the maintenance of a hydraulic press?
- A Do not apply a wrench to a revolving part.
 - B Guards could be removed when pressing soft material.
 - C Pressure gauges must be tested regularly and adjusted or replaced if any malfunction occurs.
 - D Use the machine table as an anvil. (1)
- 1.3 Which of the following is a safety device used in conjunction with guillotines?
- A Fixed guard
 - B Self-adjusting guard
 - C Auto push-away guard
 - D All of the above (1)
- 1.4 Which of the responsibilities of the OHS Act 85 of 1993, are NOT applicable to a person in charge of machines?
- A Installing and properly maintaining machinery
 - B Repairing machinery
 - C Ensuring that safety appliances and guards are in a good condition
 - D Running in the workshop (1)
- 1.5 Welding or flame cutting operations may be undertaken, unless ...
- A an operator has been refused permission to check the equipment.
 - B an operator has been instructed on how to use the equipment safely
 - C a workplace is under surveillance.
 - D an operator is intoxicated. (1)

1.6 The definition for *case hardening*:

- A To produce a wear resistant surface over a tough core
 - B To produce an extremely hard surface over a soft core
 - C To produce a high carbide surface over a hard core
 - D Not one of the above-mentioned
- (1)

1.7 Inside the blast furnace, impurities from the ore become trapped in which element?

- A Cupola
 - B Stove
 - C Molten limestone
 - D Carbon monoxide
- (1)

1.8 Linear motion is the motion along a ...



FIGURE 1.8

- A flywheel.
 - B y-axis.
 - C straight line.
 - D grinding wheel.
- (1)

1.9 The set of taps comprises of the following:

- A The taper tap
 - B The intermediate tap
 - C The plug/bottoming tap
 - D All of the above
- (1)

1.10 Which of the following is NOT a property of metals?

- A Metallurgy
 - B Machinability
 - C Malleability
 - D Ductility
- (1)

- 1.11 The hydraulic press is a device that uses a hydraulic cylinder to generate a ... force.
- A tensile
 - B shear
 - C compressive
 - D advance
- (1)
- 1.12 Which ONE of the following fluids can be used to reduce friction in mechanical engineering?
- A Water
 - B Grease
 - C Thinners
 - D Anti-freeze fluid
- (1)
- 1.13 What is understood by the term *viscosity* regarding liquids? It is the resistance to ...
- A flow.
 - B boil.
 - C cool.
 - D foam.
- (1)
- 1.14 Which of the following colours are used with oxygen cylinders?
- A Red
 - B Orange
 - C Green
 - D Black
- (1)
- 1.15 What are the electrodes of an electric-arc furnace made off?
- A Copper
 - B Stainless steel
 - C Carbon
 - D Cast Iron
- (1)
- 1.16 The aim for maintenance of mechanical equipment is ...
- A to stop machinery regularly.
 - B to increase the lifespan of the equipment.
 - C to operate at a higher speed.
 - D to operate at average speed.
- (1)
- 1.17 The most important method of extracting iron from iron ore is ...
- A smelting.
 - B charging.
 - C alloying.
 - D tempering.
- (1)

- 1.18 To determine the drilling speed on a drill press, you need to take into account various factors. Which of the following must be considered?
- A Type of material
 - B Diameter of drill bit
 - C Material that the drill bit is made of
 - D All of the above
- (1)
- 1.19 A 15 mm diameter hole needs to be drilled into a piece of sheet metal, with a cutting speed of 600 mm per second. What will the drill speed be in revolutions per minute?
- A 380 revs/minute
 - B 674 revs/minute
 - C 764 revs/minute
 - D 830 revs/minute
- (1)
- 1.20 What does lockout refer to in machine maintenance?
- A To open the machines
 - B To enlarge the locks on the machines
 - C To isolate the machine completely
 - D To switch off the machine
- (1)
- [20]**

QUESTION 2: SAFETY (GENERIC)

- 2.1 State THREE safety measures to observe when using the arc welding equipment, FIGURE 2.1.

**FIGURE 2.1**

(3)

- 2.2 Give THREE basic rules that apply to machine guards in the workshop. (3)
- 2.3 State THREE safety precautions to apply when using a bending press (Box and Pan folder), FIGURE 2.3.

**FIGURE 2.3**

(3)

- 2.4 What does the regulation under the OHS Act (clause C3) refers to in terms of reporting to persons in charge of a workshop? (1)
- 2.5 Name THREE general safety rules one must adhere to before switching on the portable grinder, FIGURE 2.5.

**FIGURE 2.5**

(3)

- 2.6 What safety precautions should be adhered to when drilling a flat steel plate on a drill press? (1)
- 2.7 State THREE safety rules to be observed when using a surface grinder. (3)
- 2.8 Identify any THREE types of personal protective equipment (PPE) needed when using gas welding equipment. (3)
- 2.9 Give TWO examples of unsafe conditions in the workshop. (2)
- 2.10 Name the TWO main categories that the Occupational Health and Safety regulation can be divided into. (2)

[24]

QUESTION 3: TOOLS AND EQUIPMENT (GENERIC)

3.1 FIGURE 3.1 below shows a type of cutting machine that removes material in which abrasive particles are rotated at high speed against the material being grounded. Answer the questions that follow.

3.1.1 Identify the machine in FIGURE 3.1 below.

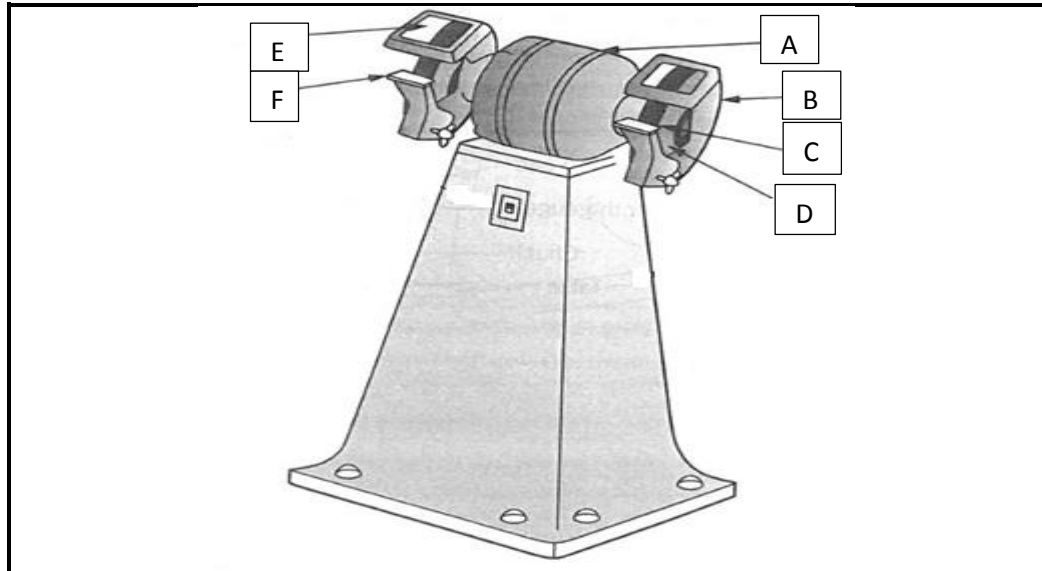


FIGURE 3.1

(1)

3.1.2 Label the parts marked **A–F**.

(6)

3.1.3 What is the purpose of part **E**?

(1)

3.2 What is the function of the manual guillotine?

(2)

3.3 Name the TWO main categories that presses fall into.

(2)

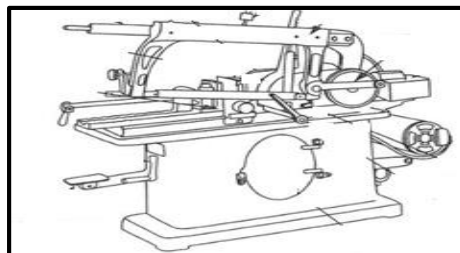
3.4 What is the function of the following equipment?

3.4.1 Horizontal band saw



(2)

3.4.2 Power saw



(2)

[16]

QUESTION 4: MAINTENANCE (GENERIC)

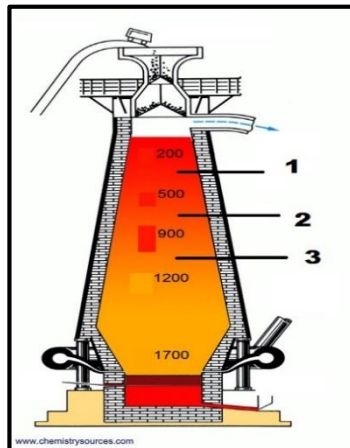
- 4.1 You are requested to drill a 25 mm hole into a mild steel plate, with a cutting speed of 700 mm per second.
Calculate the required cutting speed of the drill in revolutions per minute. (3)
- 4.2 State ONE result of a lack of lubrication on the chuck of a drilling machine. (1)



- 4.3 Define the term *overloading*, with regard to the drilling machine. (2)
- 4.4 What do you understand about the causes of malfunction of power saws (horizontal and band saws)? (2)
- [8]**

QUESTION 5: MATERIALS (GENERIC)

- 5.1 Distinguish between the following properties of engineering materials:
- 5.1.1 Plasticity (2)
 - 5.1.2 Ductility (2)
 - 5.1.3 Brittleness (2)
- 5.2 Which era is known as the Iron Age? (1)
- 5.3 Explain the operational principal of the blast furnace. (6)



5.4 FIGURE 5.4 below shows an electric arc furnace.

5.4.1 Label the parts marked **A–G**.

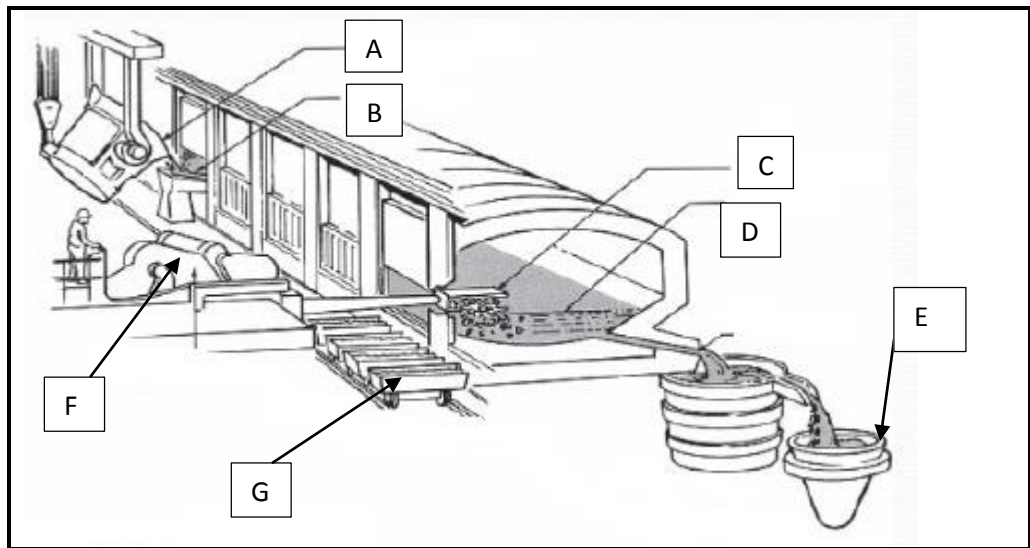
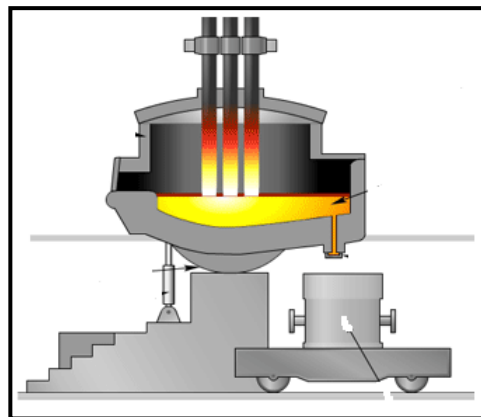


FIGURE 5.4

(7)

5.4.2 Describe the function of the electric arc furnace.



(2)

5.5 Briefly explain how cold chisels are tempered.

(4)

5.6 Which procedure will you follow to determine whether steel has been heated to a hardening temperature?

(2)

5.7 Explain the difference between *hardening* and *tempering*.

(4)

[32]

QUESTION 6: TOOL AND EQUIPMENT (SPECIFIC)

Study FIGURE 6.1 below and answer the questions that follow.

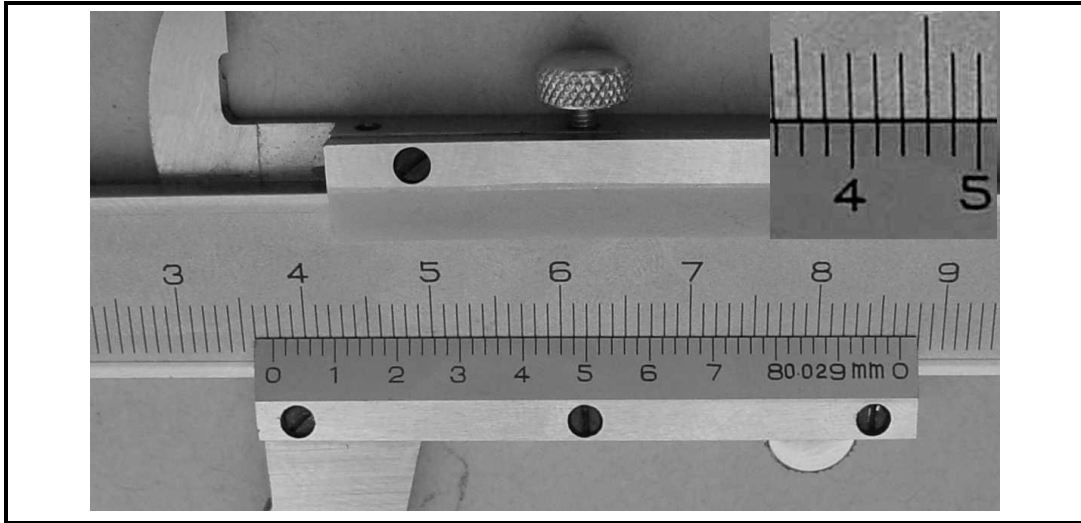


FIGURE 6.1

- 6.1 Give THREE different ways in which a vernier caliper can be used. (3)
- 6.2 How would you care for a micrometer? (3)
- 6.3 A telescopic gauge is used in conjunction with what other precision tool? (1)
- 6.4 State TWO places in a motor car engine where a torque wrench can be used. (2)
- [9]**

QUESTION 7: ENGINES

7.1 The part from the internal combustion engine as illustrated in FIGURE 7.1.



FIGURE 7.1

- 7.1.1 Name the engine part as illustrated in FIGURE 7.1 (1)
- 7.1.2 Mention TWO functions of the engine part in FIGURE 7.1 (2)
- 7.2 Draw a valve-timing diagram for a four-stroke engine using the following information: (3)
- | | |
|-----------------------|----------|
| Inlet valve opens: | 18° BTDC |
| Inlet valve closes: | 42° ABDC |
| Exhaust valve opens: | 48° BBDC |
| Exhaust valve closes: | 10° ATDC |
| Injection: | 20° ATDC |
- 7.3 Use the diagram and calculate the following:
- 7.3.1 Inlet-valve period (1)
- 7.3.2 Exhaust-valve period (1)
- 7.3.3 Power period (1)
- 7.3.4 Valve overlap (1)
- 7.4 What do understand by the term *valve timing*? Explain in your own words. (1)
- 7.5 Describe the function of the tensioner in the timing belt assembly. (1)
- 7.6 Study the diagram in FIGURE 7.2 which illustrates an electromagnet injector.

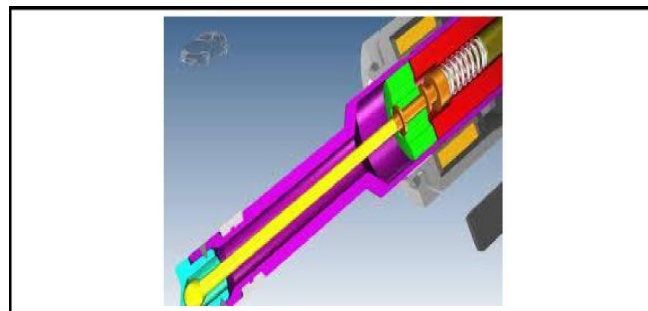


FIGURE 7.2

State TWO advantages of the electromagnetic / solenoid injector.

(2)

[15]

QUESTION 8: SYSTEMS AND CONTROL (SPECIFIC)

- 8.1 Mention TWO functions of the differential in the final drive assembly. (2)
- 8.2 Mention THREE advantages of a limited-slip differential. (3)
- 8.3 State TWO functions of each of the following steering control components:

8.3.1 Tie rod end



FIGURE 8.3.1

(2)

8.3.2 Ball joint



FIGURE 8.3.2

(2)

8.3.3 Drag link



FIGURE 8.3.3

(2)

- 8.4 Give THREE advantages of the telescopic shock absorber. (2)
- 8.5 State the function of the shock absorber as fitted to the motor vehicle. (2)
- 8.6 State the function of a stabiliser bar. (2)
- 8.7 Describe the purpose of predetermined firing order. (2)
- 8.8 What is the firing order for a six cylinder in-line engine? (1)
- 8.9 What is the function of the electronic control limited slip differential? (1)
- 8.10 What is the function of the spark plug in ignition compression engine? (1)
- 8.11 Give TWO consequences of a too big spark plug gap. (2)
- 8.12 Mention any TWO consequences of too small a spark plug gap. (2)
- 8.13 What is the purpose/function of the distributor in the ignition system? (1)

[27]

QUESTION 9: MAINTENANCE (SPECIFIC)

- 9.1 List THREE types of oil pumps. (3)
- 9.2 Give ONE function of a seal in an engine. (1)
- 9.3 Give ONE function of a gasket in an engine. (1)
- 9.4 State the function of the oil pump in the engine. (1)
- 9.5 Give THREE advantages of a rotor type oil pump. (3)
- 9.6 Name TWO types of services carried out on motor vehicles. (2)

[11]**QUESTION 10: FORCES (SPECIFIC)**

- 10.1 Define the *compression ratio* of an internal combustion engine. (2)
- 10.2 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
Torque:	315 Nm

Determine, by means of calculations:

- 10.2.1 Indicated power (4)
- 10.2.2 Brake power in kW (4)
- 10.2.3 Mechanical efficiency (2)
- 10.3 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:
- 10.3.1 The swept volume in cm³ (3)
- 10.3.2 The original clearance volume in cm³ (3)
- 10.3.3 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. (2)

- 10.4 As a mechanical technician you are given a task to come up with the size of a piston i.e. a piston diameter that would be used to produce the indicated power of 90,432 kW. This will be a four-stroke petrol engine. When it runs at 5 100 rpm with a mean effective pressure of 1 200 kPa on the piston, that has a stroke length of 80 mm, it should produce a torque of 240 Nm at 3 600 rpm.

Calculate the diameter of the piston required for this engine. Your answer must be in millimetres

(10)
[30]

QUESTION 11: TERMINOLOGY (SPECIFIC)

- 11.1 You are requested to do a minor service on the lubrication system of a vehicle. Use the job card shown in TABLE 11.1 below. **Write down** at least **4 things** you will attend to listed on the job card. (**Change only the engine oil**). Do NOT include personal details.

Mr Phillips		Date: 3 Nov 2018		Cash	
				Account	
		Account No.:			
Code					
Cell: 0835557500		Lube chassis			
Reg. No.	FYV012EC	Change engine oil			
Make	Toyota	Change TR oil			
Model	Corolla 2017	Change diff. oil			
Odometer	15 000	Change air filter			
Chassis No.		Change oil filter			
Engine No.		Wash engine			
Colour	Red	Balance wheels			
Parts	Order No.	Requested by:			
Requisition No.	Description			Amount	
I agree to the terms and conditions set out on the reverse side of the job card.					
Order No.	Outwork	Amount	Internal	Amount	
			Labour		
			Oil		
			Lube		
			Parts		
Comment:			Outwork		
			Wash		
			Sundries		
			Subtotal		
			VAT		
			Total		

TABLE 11.1

(4)

11.2 Explain the following terminologies and give an example of each:

11.2.1 Workshop administration (2)

11.2.2 Employees (2)

[8]

TOTAL: 200

FORMULA SHEET FOR MECHANICAL TECHNOLOGY (AUTOMOTIVE)

$$\text{Force} = m \times a \quad \text{where } m = \text{mass}$$

$$a = \text{acceleration}$$

$$\text{Work} = \text{force} \times \text{distance} (F \times d)$$

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

$$\text{Torque} = \text{force} \times \text{radius}$$

$$\text{Indicated power} = P \times L \times A \times N \times n$$

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

$$\text{Brake power} = 2 \pi N \times T$$

where $N = \text{revolutions per second}$
 $T = \text{torque}$

$$\text{Brake power (Prony brake)} = F \times 2 \times \pi \times R \times N$$

where $F = \text{force}$
 $R = \text{length of brake arm}$
 $N = \text{revolutions per second}$

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

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

$$\text{where swept volume} = \frac{\pi \times D^2}{4} \times L$$

where $L = \text{length of stroke}$
 $D = \text{diameter of bore}$

$$\text{Clearance volume} = \frac{\pi \times D^2}{4} \times l$$

where $D = \text{diameter of bore}$
 $l = \text{clearance}$

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