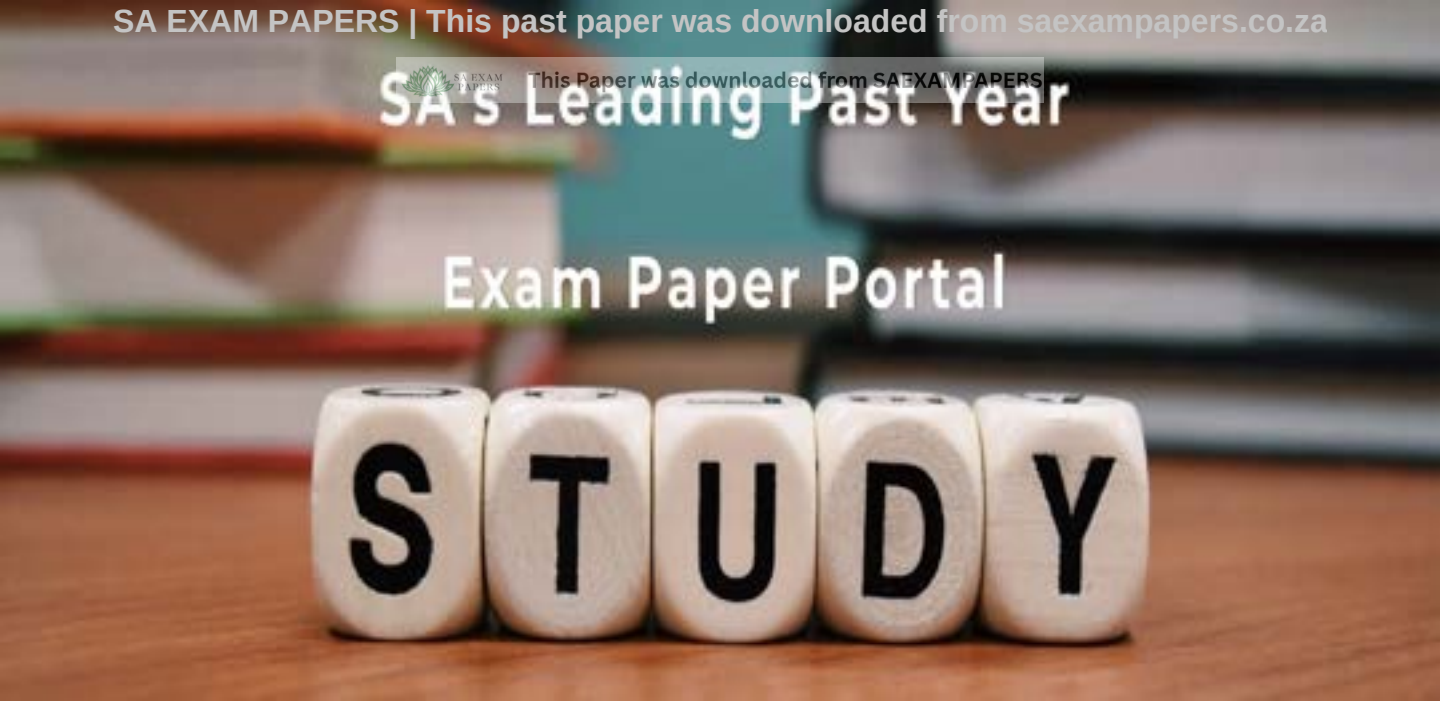


Province of the
EASTERN CAPE
EDUCATION

Iphondo leMpuma Kapa: Isebe leMfundo
Provinsie van die Oos Kaap: Department van Onderwys
Porafensie Ya Kapa Botjahabela: Lefapha la Thuto

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2025

MECHANICAL TECHNOLOGY: AUTOMOTIVE

MARKS: **200**

TIME: **3 hours**

This question paper consists of 16 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 millimeters, 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.

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, for example 1.7 A.

1.1 Which ONE is the first stage of the basic first aid treatment to apply to an injured person?

A Examination
B Diagnosis
C Treatment
D None of the above (1)

1.2 It contains common guidelines on how employers, employees and trade unions should respond to HIV/Aids in the workplace.

A The Labour Relations Act (LRA No. 66 of 1995).
B The Constitution – Bill of Rights.
C The Code of good practice on HIV/Aids and employment.
D Occupational Health and Safety Act (OHS Act No. 85 of 1993) (1)

1.3 What is the maximum thickness of a sheet metal that the manual guillotine can cut?

A 120 mm
B 12 mm
C 1,2 mm
D 0,12 mm (1)

1.4 Which ONE of the following safety precautions is applicable when using the drill press?

A Always wear tinted safety goggles.
B Do not hold the work piece by hand.
C You may leave the key in the drill chuck.
D You may leave the machine running unattended. (1)

1.5 When mild steel material is tested it produces a … sound.

A medium metallic
B lower ringing
C high ringing
D very dull (1)

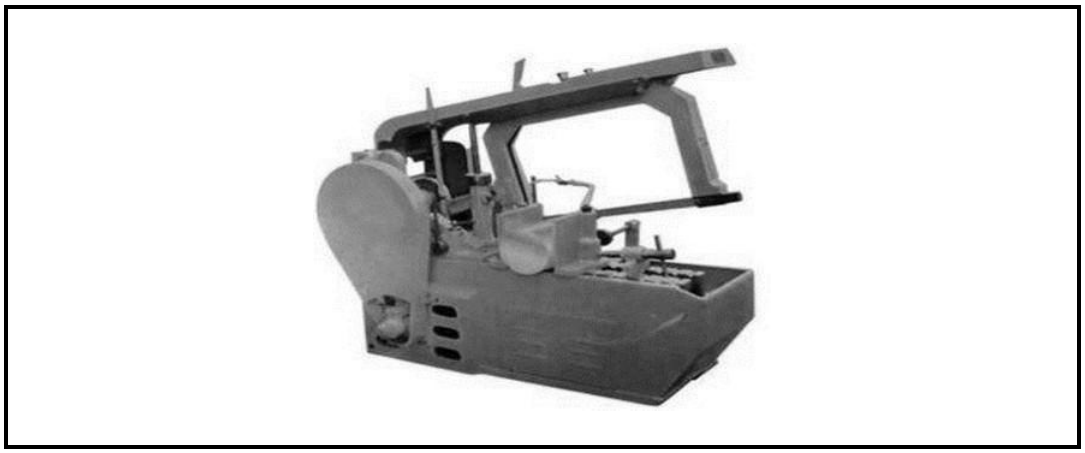
1.6 During the normalising of iron-based alloys, it is heated to approximately … above the upper critical temperature.

A 356°C
B 256°C
C 156°C
D 56°C (1)

[6]

QUESTION 2: SAFETY (GENERIC)

2.1 State TWO safety precautions that must be adhered to when using a power saw.



(2)

2.2 Name TWO responsibilities of an EMPLOYEE regarding safety in the workplace. (2)

2.3 Give TWO safety rules that should be followed while the Bench grinder is in operation. (2)

2.4 State TWO advantages of the product layout. (2)

2.5 Name the TWO main categories into which the causes of accidents can be divided according to the Occupational Health and Safety Act. (2)

[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 Name any THREE tests used to distinguish between the different types of materials. (3)

3.2 Name the THREE groups of carbon steel and state the percentage carbon content range of each. (6)

3.3 What is the purpose of normalising ferrous metals? (2)

3.4 Describe the tempering 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, for example 4.15 D.

4.1 This tool is used to scan all the system on the vehicle and makes adjustments on different sensors. What is the name of this tool?

A Bubble gauge
B Diagnostic scanner
C Leakage tester
D Dunlop gauge (1)

4.2 To correct the static imbalance of a wheel, a small … is applied to the wheel rim, diametrically opposite the 'heavy spot'.

A weight
B piece
C metal
D matter (1)

4.3 The flywheel is mounted on the crankshaft's …

A main journal.
B crankpin journal.
C crank nose.
D rear flange. (1)

4.4 The five-cylinder inline engine receives a power impulse every …

A 180°
B 120°
C 144°
D 90° (1)

4.5 What is the applied force of an object if the work done is 5 000 J, after it has moved a distance of 10 m on a horizontal plane?

A 500 N
B 50 N
C 5 N
D None of the above. (1)

4.6 What will the indicated power of the engine be if the brake power is 66 kW and the mechanical efficiency is 88%?

A 56 kW
B 46 kW
C 75 kW
D 750 kW (1)

4.7 If the catalytic converter is malfunctioning, the fault may cause a … reading.

A high carbon monoxide (CO)
B low carbon monoxide (CO)
C high carbon dioxide (CO_2)
D low carbon dioxide (CO_2) (1)

4.8 The error code '000' in a gas analyser means …

A switching off and then on again.
B auto zero.
C remove and change element.
D preheat mode. (1)

4.9 The fluid flow pattern characterized by swirling, the rotating motion around the central axis of a torque converter, is called …

A voltage flow.
B vortex flow.
C current flow.
D flow of charge. (1)

4.10 If the annulus is locked and the planet carrier is the driving member with the sun gear as driven component. Which operation is selected to achieve the situation?

A Overdrive forward
B Overdrive reverse
C Reduction forward
D Reduction in reverse (1)

4.11 A provision must be made for toe-out to counteract the camber effect. In which camber angle is toe-out used?

A Zero camber
B Positive camber
C Negative camber
D None of the above (1)

4.12 What is the function of manifold absolute pressure sensor (MAP) in the engine management system?

A It regulates the idle speed by adjusting the volume of air that is allowed to by-pass the closed throttle valve to provide cold-start and fast idle below a certain engine temperature.
B It detects the position of the throttle valve and report it to the ECU so that proper engine adjustments can be made.
C It measures the intake air volume or the engine load.
D It measures the engine load conditions. (1)

4.13 It is used to provide a core that concentrates the magnetic lines of force onto the windings.

A Rotor assembly
B Stator assembly
C Rectifier or diode
D Heat sink (1)

4.14 Which engine component is described as a light, compact design with a low operational noise?

A Injector
B DLI coil
C Common rail
D Electric fuel pump (1)

[14]

QUESTION 5: TOOLS AND EQUIPMENT (SPECIFIC)

5.1 Explain the procedure to perform a card-type compression test on a four-stroke petrol engine. (6)

5.2 What is the purpose of the wheel balancer? (2)

5.3 Briefly explain the set-up procedure of a diagnostic scanner on an engine. (4)

5.4 Explain the procedure to read the camber angle with the use of a bubble gauge. (5)

5.5 The bubble gauge is used to measure three angles during wheel alignment of which one is camber. Name the other TWO angles. (2)

5.6 Name THREE factors that are used to locate the dynamic imbalance of a wheel. (3)

5.7 Name the tool used to measure toe in and toe out. (1)

[23]

QUESTION 6: ENGINES (SPECIFIC)

6.1 FIGURE 6.1 below shows an engine component. Study it and answer the questions that follow.

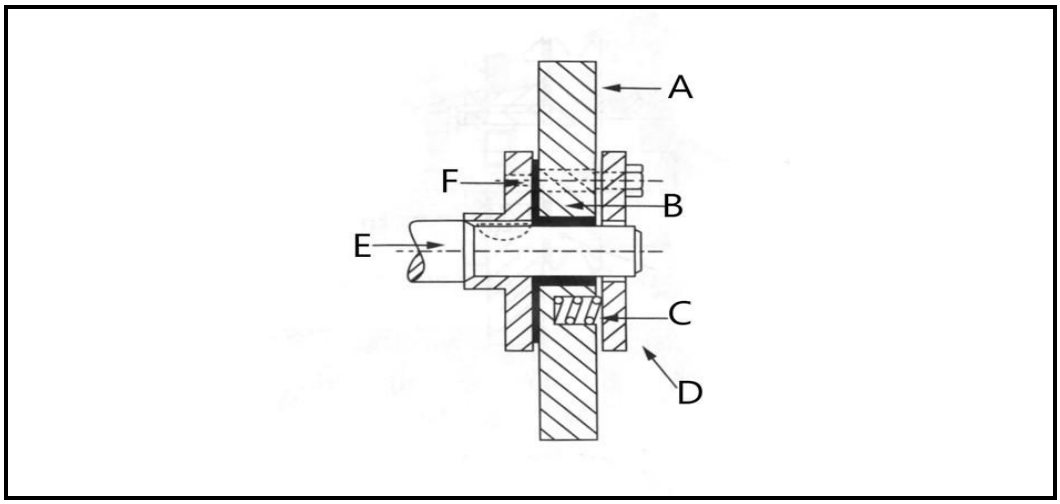


FIGURE 6.1

6.1.1 Give the name of the engine component shown in FIGURE 6.1 above. (1)

6.1.2 Label the parts of the component from **A**–**F** in FIGURE 6.1. (6)

6.1.3 State the purpose and position for adding this component to a crankshaft. (2)

6.1.4 Describe the operation of the engine component shown in FIGURE 6.1. (4)

6.1.5 Describe the main function of a crankshaft. (2)

6.1.6 Name THREE engine cylinder configurations found in vehicles. (3)

6.2 FIGURE 6.2 below shows an engine diagram. Study the diagram and answer the questions that follow.

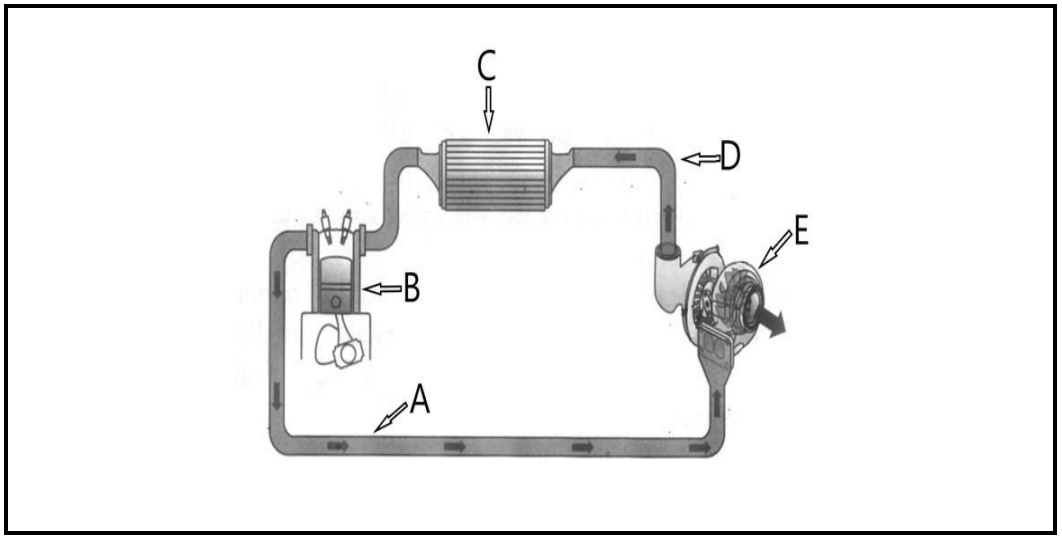


FIGURE 6.2

6.2.1 Label parts **A**–**E** in FIGURE 6.2. (5)

6.2.2 What is component '**C**' responsible for in the system and what would happen if the component fails to perform? (2)

6.3 Name THREE advantages of a turbocharger. (3)
[28]

QUESTION 7: FORCES (SPECIFIC)

7.1 Define the following terms in reference to engine cylinders:

7.1.1 *Compression ratio* (2)

7.1.2 *Swept volume* (2)

7.1.3 *Clearance volume* (2)

7.2 Name THREE methods to lower the compression ratio of an engine. (3)

7.3 An engine cylinder bore is 100 mm with the stroke length of 130 mm and a clearance volume of 105 cm^3.

7.3.1 Calculate the swept volume of the engine. (4)

7.3.2 Determine the compression ratio of the engine. (3)

7.4 The following data refers to a four-cylinder, four stroke petrol engine:

Mean effective pressure on the piston:	1 200 kPa
The cylinder volume:	567,057 cm^3
Revolutions per minute:	5 100 rpm
Torque:	240 Nm @ 3 600 rpm
Number of cylinders:	4

Calculate the following:

7.4.1 Indicated power in kW (9)

7.4.2 Brake power in kW (4)

7.4.3 Mechanical efficiency (2)

7.5 Convert 3 000 revolutions per minute into revolutions per second. (1)

[32]

QUESTION 8: MAINTENANCE (SPECIFIC)

8.1 During a cooling system pressure test on an internal combustion engine, the pressure dropped too low in the radiator. Name THREE possible areas of leakage in the cooling system. (3)

8.2 Bubbles inside the radiator expansion bottle were observed during a cylinder leakage test. Name ONE possible cause and also ONE corrective measure for the fault. (2)

8.3 Give FOUR manufacturer's specifications required when a fuel pressure test is conducted. (4)

8.4 An oil pressure drop occurred during an oil pressure test. The table below shows possible causes and corrective measures. Complete the table by writing down only the question numbers (8.4.1–8.4.4) and your answer in the ANSWER BOOK.

POSSIBLE CAUSES	CORRECTIVE MEASURES
Worn oil pump	**8.4.1**
8.4.2	Remove the sump, check and clean the screen
Too little oil in the engine	**8.4.3**
8.4.4	Ensure that the correct oil, according to manufacturer's specifications is used

(4)

8.5 A compression test was conducted on an internal combustion engine. The following results were recorded:

Cylinder 1: 11 bar
Cylinder 2: 10 bar
Cylinder 3: 8,2 bar
Cylinder 4: 9,8 bar

8.5.1 What is an allowable variation, in percentage, between the compression readings? (1)

8.5.2 Calculate the maximum variation between the readings given above. (2)

8.5.3 State TWO possible causes of the low reading in cylinder 3. (2)

8.5.4 Explain TWO corrective measures after a wet test is done and the reading in cylinder 3 remains the same. (2)

8.6 State at least THREE safety requirements while setting up a gas analyser. (3)

[23]

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

9.1 Name TWO advantages of using an automatic gearbox. (2)

9.2 FIGURE 9.2 below shows a cross-sectional view of a gear train part. Study it and answer the following questions:

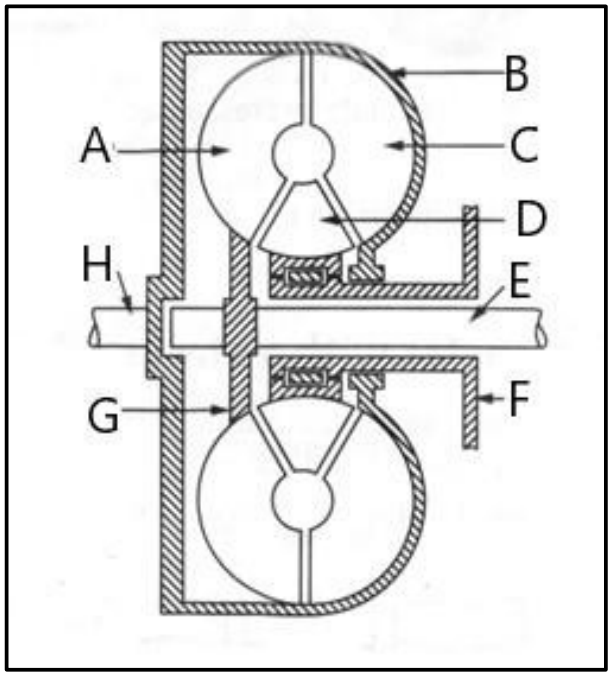


FIGURE 9.2

9.2.1 What is the name given for the gear train part in FIGURE 9.2? (1)

9.2.2 Label the parts **A**–**H**. (8)

9.2.3 Name TWO advantages of the gear train part shown in FIGURE 9.2. (2)

9.3 Explain the meaning of the term 'stall speed' in reference to the gear train part shown in FIGURE 9.2. (2)

9.4 Name THREE advantages of a transmission control unit (TCU). (3)
[18]

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

10.1 State FOUR factors to be taken into account before attempting a wheel alignment adjustment or check. (4)

10.2 State the function of the Ackermann's angle with reference to wheel alignment. (2)

10.3 Use neat drawings to differentiate toe-in from toe-out, labelling must clarify your point. (6)

10.4 What is the purpose of the camber angle on the suspension of a motor vehicle? (2)

10.5 State THREE criteria for an injector to fulfil its purpose. (3)

10.6 FIGURE 10.6 below shows one of the engine management systems. Study it and answer the questions that follow.

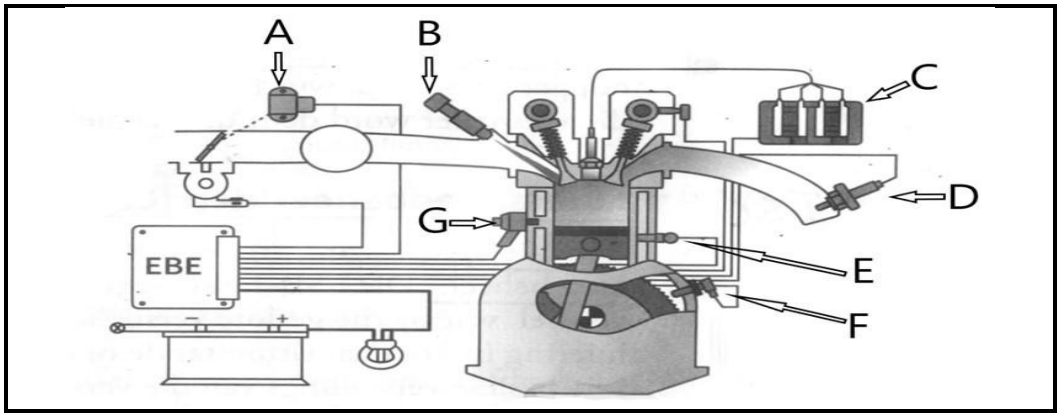


FIGURE 10.6

10.6.1 What type of ignition system is used in FIGURE 10.6? (1)

10.6.2 Briefly describe the purpose of the ignition system shown in FIGURE 10.6. (2)

10.6.3 Label the components **A**–**G** in FIGURE 10.6. (7)

10.7 In a catalytic converter of the engine exhaust gas system, the input gases are Hydrocarbon, Carbon monoxide and Nitrogen oxide. In contrast what would the THREE output gases be? (3)

10.8 Name TWO disadvantages of a speed control system in a motor vehicle. (2)

[32]

TOTAL: 200

FORMULA SHEET FOR MECHANICAL TECHNOLOGY (AUTOMOTIVE)

Force = m x a where m = mass
a = acceleration

Work = force x distance (F x d)

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

Torque = force x radius

Indicated power = P x L x A x N x 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 cyclinders

Brake power = 2π N x T
where N = revolutions per second
T = torque

Brake power (Prony brake) = F x 2 x π x R x N
where F = force
R = length of brake arm
N = revolutions per second

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

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

where swept volume = $\frac{\pi \times D^2}{4} \times L$ clearance volume = $\frac{SV}{CR-1}$

where L = length of stroke
D = diameter of bore

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