basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

MECHANICAL TECHNOLOGY (AUTOMOTIVE)

TEACHER GUIDELINES FOR ADMINISTERING PRACTICAL ASSESSMENT TASKS

GRADE 12

2025

These guidelines consist of 32 pages.

NOTE:

These Teacher Guidelines for administering the practical assessment tasks:

- Should be distributed to provincial coordinators and teachers of Mechanical Technology – Automotive ONLY
- Should NOT be distributed to candidates
- Are intended to assist teachers in the administering and marking of tasks for the PAT 2025

TABLE OF CONTENTS

TASK 1: COMPRESSION TEST
WORKSHEET 1– PROCEDURE

DRY COMPRESSION TEST			
PROCEDURE			**MARK**
1.1.1	Obtain the compression pressure specification. ✓		1
1.1.2	Test the battery voltage. ✓	REASON: • Strong battery is needed to ensure that the engine swings at the correct speed. ✓ • To ensure maximum amount of pressure is developed. ✓ **(Any 1 x 1)**	2
1.1.3	Start the engine. ✓		1
1.1.4	Check if engine is at operating temperature. ✓	REASON: • So that the piston and compression rings will expand. ✓ • So that the rings could create a good seal. ✓ • Ensure an accurate reading. ✓ **(Any 1 x 1)**	2
1.1.5	Switch off the engine. ✓		1
1.1.6	Mark the spark plug (HT) leads according to the cylinder number. ✓		1
1.1.7	Remove all the spark plug (HT) leads. ✓		1
1.1.8	Clean around the spark plugs before removing them. ✓	REASON: • To create a good seal surface. ✓ • Avoid dirt falling into the cylinder through the spark plug hole. ✓ **(Any 1 x 1)**	2
1.1.9	Remove all the spark plugs. ✓✓✓✓		4
1.1.10	Remove the air filter. ✓	REASON: • Allow maximum amount of air to enter the cylinder. ✓ • Ensure an accurate reading. ✓ **(Any 1 x 1)**	2
1.1.11	Disable the ignition system; if not able to, remove HT lead from coil. ✓		1
1.1.12	Disconnect/Disable the fuel supply. ✓		1
1.1.13	Fit the compression tester to the cylinder. ✓✓✓✓		4
1.1.14	Fully open the throttle valve. ✓✓✓✓		4
1.1.15	Perform the test for each cylinder by cranking the engine until the needle reaches its maximum. ✓✓✓✓		4

1.1.16 Record the readings.	1 …….✓	2. …….✓	4
	3. …….✓	4. …….✓	
1.1.17 Compare the readings. ✓	REASON: • To check if there is a difference in the compression between each cylinder.✓ • To compare the compression in all cylinders to the specification.✓ **(Any 1 x 1)**		2
		TOTAL – Dry Compression test – Procedure	**37**

WET COMPRESSION TEST			
1.2 Conduct a wet compression test on the cylinder/cylinders with the lowest reading(s).			
	PROCEDURE		**MARK**
1.2.1	Squirt oil into cylinder onto piston. ✓		1
1.2.2	Fit compression tester. ✓		1
1.2.3	Open throttle valve fully. ✓		1
1.2.4	Perform test on the cylinder(s) by cranking engine until needle reaches its maximum. ✓		1
1.2.5	Record the reading. ✓		1
1.2.6	Conclusions after the wet compression test.	REASON: • Compression increase ✓, - piston compression rings worn ✓ • Compression remains the same ✓ - leak not at compression rings ✓ **(Any 1 x 2)**	2
1.2.7	Replace all the spark plugs ✓ (initially turn plugs in by hand). ✓		2
1.2.8	Reconnect the electrical connections ✓ and fit air filter. ✓		2
1.2.9	Reconnect the fuel supply. ✓		1
1.2.10	Ensure the engine starts. ✓		1
		TOTAL – Wet Compression Test – Procedure	**13**

TASK 2: CYLINDER LEAKAGE TEST
WORKSHEET 2.1 – QUESTIONS

<table>
<tr><th colspan="2">QUESTIONS</th><th>MARK</th></tr>
<tr><td colspan="2">2.1.1 Describe THREE safety precautions, and the reason for the precautions that must be adhered to, when conducting the cylinder leakage test.</td><td rowspan="4">6</td></tr>
<tr><td>PRECAUTION:</td><td>REASON:</td></tr>
<tr><td>• Use the correct adaptor. ✓</td><td>• Not to damage the spark plug hole thread. ✓</td></tr>
<tr><td>• No tools on the battery. ✓</td><td>• Avoid short-circuiting. ✓</td></tr>
<tr><td>• Do not touch hot engine components. ✓</td><td>• Could cause skin burns. ✓</td></tr>
<tr><td colspan="2">2.1.2 State THREE faults that can develop due to cylinder leakages on an engine.</td><td rowspan="2">3</td></tr>
<tr><td colspan="2">• Loss of engine power. ✓
• Engine misfiring. ✓
• Poor engine starting or non-starting. ✓
• Increased fuel consumption. ✓
(Any 3 x 1)</td></tr>
<tr><td colspan="2">TOTAL – Cylinder leakage tests – Questions</td><td>9</td></tr>
</table>

TASK 2: CYLINDER LEAKAGE TEST
WORKSHEET 2.2 – PROCEDURE

CYLINDER LEAKAGE TEST			
2.2	Perform the cylinder leakage test on one cylinder.		
	PROCEDURE		**MARK**
2.2.1	Start the engine. ✓		1
2.2.2	Check if the engine is at operating temperature. ✓	REASON: • So that the piston and compression rings will expand. ✓ • So that the rings could create a good seal. ✓ **(Any 1 x 1)**	2
2.2.3	Switch off the engine. ✓		1
2.2.4	Number the HT spark plug leads according to the cylinders. ✓		1
2.2.5	Remove the HT spark plug leads. ✓		1
2.2.6	Clean around the spark plugs before removing them. ✓	REASON: • To ensure a good seal surface. ✓ • Avoid dirt falling into the cylinder through the spark plug hole. ✓ **(Any 1 x 1)**	2
2.2.7	Remove all the spark plugs. ✓✓✓✓		4
2.2.8	Remove the air filter. ✓	REASON: • To check for leakage at the intake. ✓	2
2.2.9	Turn the engine clockwise at the crank pulley. ✓		1
2.2.10	Turn engine till piston is on compression stroke. ✓	REASON: • The cylinder should have minimal leaks on the compression stroke.✓	2
2.2.11	Turn piston to TDC. ✓		1
2.2.12	Lock the crankshaft. ✓		1
2.2.13	Screw the spark plug hose adapter into the spark plug hole. ✓		1
2.2.14	Ensure compressor pressure is sufficient. ✓		1
2.2.15	Connect the leakage tester to the compressor. ✓		1
2.2.16	Calibrate the leakage tester. ✓	REASON: • To obtain accurate readings ✓	2
2.2.17	Connect leakage tester to spark plug hole adapter. ✓		1
2.2.18	Record the percentage leakage. ……✓	REASON: • If percentage leakage is more than 25%, check for cause of leakages. ✓ • If percentage leakage is less than 25%, engine is in good condition. ✓ **(Any 1 x 1)**	2

2.2.19	Check for causes of leakage(s) (irrespective of the engine condition).	REASON: • Listen for hissing sound at the air intake. ✓ – Leaking inlet valve. ✓ • Listen for hissing sound at the sound at exhaust pipe. ✓ – Leaking exhaust valve. ✓ • Listen for hissing sound at dipstick or oil filler cap. ✓ – Worn or broken piston, cylinder or compression rings. ✓ • Listen for hissing sound at the adjacent spark plug hole. ✓ – Blown head gasket between the cylinders. ✓ • Check for water bubbles in radiator. ✓ – Blown head gasket at water jacket. ✓ **(Any 4 x 2)**	8
2.2.20	Replace spark plugs (initially turn spark plugs in by hand). ✓✓✓✓		4
2.2.21	Reconnect HT leads and air filter. ✓✓		2
		TOTAL – Cylinder Leakage Test – Procedure	**41**

TASK 3: EXHAUST GAS ANALYSIS
WORKSHEET 3.1 – QUESTIONS

QUESTIONS	MARK
3.1.1 What is the purpose of using a gas analyser on an internal combustion engine?	2
• To determine the percentage or number of different gases ✓ found in the exhaust gases. ✓	
3.1.2 State TWO faults that would prompt you to analyse the exhaust gases of an internal combustion engine.	2
• When the vehicle's fuel consumption is high. ✓ • Black gases are continuously emitted from the exhaust. ✓ • General maintenance service. ✓ **(Any 2 x 1)**	
3.1.3 Name FIVE gases that can be analysed by the exhaust gas analyser.	5
• Carbon monoxide ✓ • Hydrocarbons ✓ • Carbon dioxide ✓ • Nitrogen oxides ✓ • Sulphur dioxide ✓ • Oxygen ✓ **(Any 5 x 1)**	
3.1.4 State FOUR safety precautions that must be adhered to when conducting the exhaust gas analysis.	4
• Ensure that there are no persons standing in front or behind the vehicle when the engine is started. ✓ • The exhaust system should not be touched with the bare hand when testing for leaks. ✓ • Always perform the exhaust gas analysis in a well-ventilated area. ✓ • Keep hands and tools clear from moving engine parts. ✓ • Place the analyser from where it won't fall. ✓ **(Any 4 x 1)**	
3.1.5 State FOUR causes of improper and/or incomplete combustion.	4
• Too rich mixture. ✓ • Ignition misfires. ✓ • Dirty or restricted air filter. ✓ • Improper operation of the fuel delivery system. ✓ • Faulty thermostat or coolant sensor. ✓ • Catalytic convertor not working. ✓ **(Any 4 x 1)**	
3.1.6 What is the ideal air-fuel ratio for a spark ignition engine?	1
• 14,7 : 1 ✓	
TOTAL – Exhaust Gas Analysis – Questions	**18**

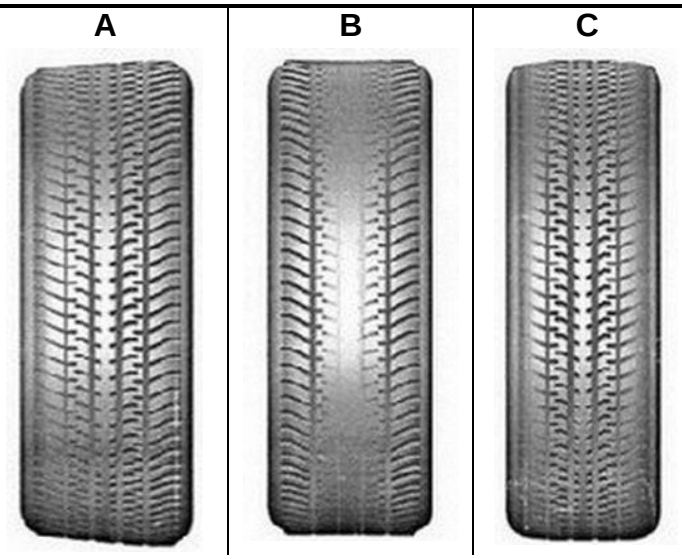
TASK 3: EXHAUST GAS ANALYSIS
WORKSHEET 3.2 – PROCEDURE

EXHAUST GAS ANALYSIS			
3.2	Conduct an exhaust gas analysis on an internal combustion engine, following the correct sequence. Analyse any TWO of the following gases: oxygen (O_2), carbon monoxide (CO) and carbon dioxide (CO_2).		
	PROCEDURE		**MARK**
3.2.1	Obtain the following manufacturers' exhaust gas specifications of the engine to be tested. • Oxygen (O_2) ……..…… ✓ • Carbon monoxide (CO) ……..…… ✓ • Carbon dioxide (CO_2) ……..…… ✓		3
3.2.2	Ensure proper ventilation when conducting test. ✓	REASON: • Toxic exhaust gases are harmful, ✓	2
3.2.3	Bring engine to operating temperature. ✓	REASON: • To ensure proper combustion. ✓	2
3.2.4	Ensure the filters on analyser are clean. ✓✓		2
3.2.5	Check for any exhaust leaks. ✓	EFFECTS OF EXHAUST LEAKS: • Result in inaccurate readings. ✓ • Result in high O_2 reading. ✓ • Leaks cause excessive fuel consumption. ✓	4
3.2.6	Check for any vacuum leaks. ✓	EFFECTS OF VACUUM LEAKS: • Cause a lean mixture. ✓ • May results in high NO_x reading. ✓	3
3.2.7	Switch on the gas analyser. ✓ Connect negative first, then positive to battery terminals. ✓ **(Any 1 x 1)**		1
3.2.8	Calibrate the gas analyser. ✓ Probe not in exhaust. ✓		2
3.2.9	Ensure that the inlet hose is not restricted. ✓		1
3.2.10	Insert probe into exhaust pipe. ✓		1

3.2.11 Take the readings of the exhaust gases. (**Choose ANY TWO** of the following three gases: CO, O_2 and CO_2.)		
Obtain CO% results.		
Compare CO reading with specifications. ✓	CONCLUSION: • High ✓ – rich ✓ + corrective measure ✓ • Low ✓ – lean ✓ + corrective measure ✓ **(Any 1 x 3)**	4
Obtain O_2% results.		
Compare O_2 reading with specifications. ✓	CONCLUSION: • High ✓ – lean ✓ + corrective measure ✓ • Low ✓ – rich ✓ + corrective measure ✓ **(Any 1 x 3)**	4
Obtain CO_2% results.		
Compare CO_2 reading with specifications. ✓	CONCLUSION: • High ✓ – lean ✓ + corrective measure ✓ • Low ✓ – rich ✓ + corrective measure ✓ **(Any 1 x 3)**	4
3.2.12 Switch off the analyser. ✓ Disconnect negative first, then positive. ✓ **(Any 1 x 1)**		1
3.2.13 Remove the probe from the exhaust pipe. ✓		1
3.2.14 Remove condensate from pipes. ✓		1
TOTAL – Exhaust Gas Analysis – Procedure		**32**

TASK 4: WHEEL BALANCING
WORKSHEET 4.1 – QUESTIONS

	QUESTIONS	MARK
4.1.1	State FOUR advantages of having the motor vehicle's wheels balanced.	4
	• Improve drive comfort ✓ • Eliminate steering wheel vibration ✓ • Prolong tyre life ✓ • Prolong wheel bearing life ✓ • Prevent possible damage to suspension system ✓ • More effective braking ✓ • Less steering effort at speed ✓ • Improved vehicle drive stability ✓ **(Any 4 x 1)**	
4.1.2	Why is it necessary for the wheel balancing machine to be correctly calibrated?	1
	• So that the wheel can be accurately balanced both statically and dynamically. ✓	
4.1.3	State THREE functions of the wheel-weight hammer.	3
	• Remove wheel weights ✓ • Fit wheel weights ✓ • To cut weight if one cannot get correct weight ✓ • Remove foreign matter from treads ✓ **(Any 3 x 1)**	
4.1.4	Define *static balance* of a wheel and tyre assembly.	2
	• Static balance is the equal distribution of all weights ✓ around the axis of rotation in the rotation plane. ✓ • A wheel is statically balanced if it rests ✓ at random points of rotation without turning. ✓ **(Any 1 x 2)**	
4.1.5	Define *dynamic balance* of a wheel and tyre assembly.	2
	• Dynamic balance is the equal distribution of all weights ✓ around the axis of rotation in *all* rotational planes. ✓ • A wheel is dynamically balanced if centrifugal force is equal ✓ in all directions while in rotation. ✓ **(Any 1 x 2)**	

4.1.6	FIGURE 4.1.6 shows different tyre conditions. State the cause of EACH condition (**A**–**C**).  **FIGURE 4.1.6**	3
	A – Misalignment/Incorrect wheel alignment ✓	
	B – Over-inflation/Too high tyre pressure ✓	
	C – Under-inflation/Too low tyre pressure ✓	
4.1.7	State FOUR safety measures that should be observed when performing wheel balancing.	4
	• Make sure that the wheel is tightened properly. ✓ • Make sure the safety cover is in place before balancing wheel. ✓ • Make sure that there is no foreign matter in the tyre tread. ✓ • Be careful not to knock your fingers when fitting wheel weights. ✓ • Make sure there is no sand on the inside of the rim. ✓ **(Any 4 x 1)**	
	TOTAL – Wheel Balancing – Questions	**19**

TASK 4: WHEEL BALANCING
WORKSHEET 4.2 – PROCEDURE

WHEEL BALANCING			
4.2	Balance a wheel and tyre assembly using the correct procedure.		
	PROCEDURE		**MARK**
4.2.1	Choose correct rim adapter (for the rim size) to mount the wheel. ✓		1
4.2.2	Fit wheel to the wheel balancer correctly. ✓		1
4.2.3	Check the tyre for uneven wear. ✓		1
4.2.4	Check the tyre for bruises, cracks and damaged side walls. ✓		1
4.2.5	Check tyre tread wear level at the tyre wear indicators (TWI). ✓		1
4.2.6	Remove foreign matter from the rim and tyre. ✓		1
4.2.7	Check the wheel rim for damaged beads. ✓		1
4.2.8	Obtain the wheel rim diameter from the tyre. ✓		1
4.2.9	Enter wheel rim diameter into the wheel balancer. ✓		1
4.2.10	Obtain tyre pressure specification. ✓		1
4.2.11	Check tyre pressure. ✓		1
4.2.12	Use the calliper to obtain the rim width. ✓		1
4.2.13	Enter wheel rim width into the wheel balancer. ✓		1
4.2.14	Use the off-set arm to measure the distance to the wheel. ✓		1
4.2.15	Enter the off-set measurement into the wheel balancer. ✓		1
4.2.16	Close the safety cover. ✓		1
4.2.17	Start the wheel balancer and allow the wheel to spin. ✓		1
4.2.18	Obtain the imbalance readings on the outer and inner part of the rim. Inner reading: ……✓ Outer reading: ……...✓	REASON: • If less than 5g, the wheel is balanced. ✓ (*At this point, even though the wheel should be removed, the candidate should continue the procedure.*) • If not less than 5g, continue to balance wheel. ✓ **(Any 1 x 1)**	3
4.2.19	Remove the wheel weights. ✓		1
4.2.20	Close the safety cover. ✓		1
4.2.21	Start the wheel balancer and allow wheel to spin. ✓		1

4.2.22	Obtain the imbalance readings and its locations on the rim. Inner reading: ……✓ Outer reading: ……...✓	2
4.2.23	Choose the correct weights. ✓✓	2
4.2.24	Fit the weights correctly. ✓✓	2
4.2.25	Re-check the balancing. ✓	1
4.2.26	Remove the wheel if balanced. ✓	1
	TOTAL – Wheel Balancing – Procedure	**31**

TASK 5: FUEL SYSTEM TEST
WORKSHEET 5.1 – QUESTIONS

<table>
<tr><th colspan="2">QUESTIONS</th><th>MARK</th></tr>
<tr><td colspan="2">5.1.1 State the function of the fuel system tester.</td><td rowspan="2">2</td></tr>
<tr><td colspan="2">• Measures whether the fuel's delivery volume and pressure ✓ are according to manufacturer's specifications. ✓</td></tr>
<tr><td colspan="2">5.1.2 Name TWO methods by which fuel pumps are driven on an internal combustion engine.</td><td rowspan="2">2</td></tr>
<tr><td colspan="2">• Mechanical fuel pump ✓
• Electrical fuel pump ✓</td></tr>
<tr><td colspan="2">5.1.3 State the function of a fuel filter.</td><td rowspan="2">1</td></tr>
<tr><td colspan="2">• Remove dirt particles from the fuel before it enters the engine. ✓</td></tr>
<tr><td colspan="2">5.1.4 State TWO functions of a check valve in the fuel system.</td><td rowspan="2">2</td></tr>
<tr><td colspan="2">• It maintains the pressure in the fuel line to prevent vapour lock. ✓
• It ensures better start ability. ✓</td></tr>
<tr><td colspan="2">5.1.5 State THREE possible faults and their corrective measures for low fuel pressure.</td><td rowspan="8">6</td></tr>
<tr><td>FAULT</td><td>CORRECTIVE MEASURE</td></tr>
<tr><td>Faulty fuel pump ✓</td><td>Repair or replace fuel pump ✓</td></tr>
<tr><td>Restricted fuel filter or fuel line ✓</td><td>Replace fuel filter or repair fuel line ✓</td></tr>
<tr><td>Faulty fuel pressure regulator ✓</td><td>Test and replace ✓</td></tr>
<tr><td>Faulty electrical supply to fuel pump ✓</td><td>Repair fault like fuse, relay, wiring or correct low voltage ✓</td></tr>
<tr><td>Leaks on the fuel system ✓</td><td>Repair fuel leak ✓</td></tr>
<tr><td>Empty fuel tank ✓</td><td>Fill tank with fuel ✓
(Any 3 x 2)</td></tr>
<tr><td colspan="2">TOTAL – Fuel System Test – Questions</td><td>13</td></tr>
</table>

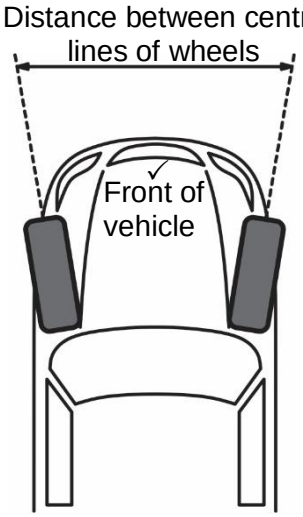
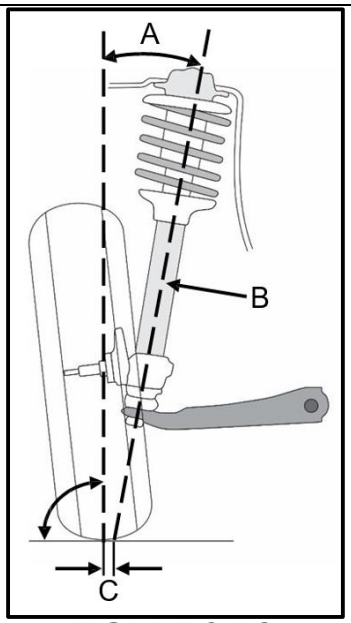
TASK 5: FUEL SYSTEM TEST
WORKSHEET 5.2 – PROCEDURE

5.2 Conduct the Fuel System Test in the correct sequence.			
PROCEDURE			**MARK**
5.2.1	Obtain the fuel pressure specifications: • Fuel pressure after the injector pump or fuel pump ✓ • Fuel pressure when the engine is idling ✓ • Fuel pressure on high revolutions ✓		3
5.2.2	Work in a well-ventilated area. ✓		1
5.2.3	Ensure that there is a fire extinguisher nearby. ✓		1
5.2.4	Obtain the correct adaptor in accordance with the hose size. ✓		1
5.2.5	Ensure that the tester can read the pressure of the fuel system. ✓		1
5.2.6	Ensure that the rubber hose on the tester is not perished. ✓		1
5.2.7	Ensure that the tester's pressure relieve valve is working properly. ✓		1
5.2.8	Fit fuel pressure tester to fuel line between the pump and engine.	• Release the pressure safely. ✓ • Insert the T-piece in the fuel line. ✓ • Secure the T-piece in the fuel line. ✓ **OR** • Locate the Schrader-type valve on the fuel rail. ✓ • Connect tester to the Schrader-type valve on the fuel rail. ✓✓	3
5.2.9	Switch ignition on until maximum fuel pressure is reached. ✓		1
5.2.10	Switch ignition off after the full pressure is reached. ✓		1
5.2.11	Check fuel pressure on gauge. ✓	• If no pressure, ✓ check electrical supply to fuel pump, otherwise fuel pump is faulty. ✓ • If fuel pressure drops, ✓ then the fuel pump check valve is faulty. ✓ **(Any 1 x 2)**	3
5.2.12	Release pressure ✓ and connect to fuel hose on engine side as well. ✓		2
5.2.13	Switch ignition on and off after the full pressure is reached ✓	• Check for leaks ✓	2
5.2.14	Check fuel pressure on gauge. ✓	• If pressure drops, then there is a leak at the engine. ✓	2

5.2.15	Check regulator vacuum hose for wetness. ✓	• If wet, regulator valve is leaking ✓				2
5.2.16	Check for leaks at injectors.	1. ✓	2. ✓	3. ✓	4. ✓	4
					TOTAL – Fuel System Test – Procedure	**29**

5.3 Check the fuel delivery rate.		
	FUEL DELIVERY RATE – PROCEDURE	**MARK**
5.3.1	Obtain the delivery rate (fuel flow rate) specifications. ✓	1
5.3.2	Release fuel pressure from fuel system. ✓✓	2
5.3.3	Disconnect fuel hose. ✓	1
5.3.4	Insert fuel hose into measuring beaker. ✓	1
5.3.5	Switch ignition on. ✓	1
5.3.6	Measure the fuel delivery volume after ONE minute. ✓✓	2
	TOTAL – Fuel Delivery Rate – Procedure	**8**

TASK 6: WHEEL ALIGNMENT
WORKSHEET 6.1 – QUESTIONS

QUESTIONS	MARK
6.1.1 What is the purpose of toe-out on turns?	2
• Toe-out on turns gives a true rolling motion to the front wheels ✓ in a corner without scuffing. ✓	
6.1.2 Draw a neat, labelled sketch of toe-out on a vehicle.	3
 Sketch ✓	
6.1.3 Label **A** to **C** in FIGURE 6.1.3 below.	3
 **FIGURE 6.1.3**	
A – King pin inclination ✓ **B** – Centre line of steering axis/strut ✓ **C** – Offset/Scrub radius ✓	
TOTAL – Wheel Alignment – Questions	**8**

TASK 6: WHEEL ALIGNMENT
WORKSHEET 6.2 – PROCEDURE

6.2 Conduct the wheel alignment procedure using the bubble gauge in the correct sequence.		
PROCEDURE		**MARK**
6.2.1 Do ANY SEVEN of the pre-checks on the vehicle.	(a) Kerb mass (tank full of petrol, spare wheel and tools) against the manufacturer's specifications. ✓ (b) Kerb height ✓ (c) Tyre pressures ✓ (d) Tyre tread wear ✓ (e) Tyre sizes ✓ (f) Run-out on the wheels; check wheel nuts with torque wrench. ✓ (g) Correct preload on the wheel (hub) bearings (with torque wrench). ✓ (h) Kingpins and bushes for wear. ✓ (i) Condition of ball joints, for wear, locking and lifting. ✓ (j) Suspension bushes for excessive free movement. ✓ (k) Steering box play and whether secure on chassis. ✓ (l) Tie-rod ends. ✓ (m) Sagged springs, which includes riding height. ✓ (n) Ineffective shock absorbers. ✓ (o) Spring U-bolts. ✓ (p) Chassis for possible tears, welding, damage and loose cross-members. ✓ (q) Even wheelbase at front and rear. ✓ **(Any 7 x 1)**	7
6.2.2 Obtain wheel alignment specifications.	(a) Caster …… ✓ (b) Camber …… ✓ (c) KPI …… ✓	3
6.2.3 Place vehicle on turntables.	(a) Safely raise the vehicle. ✓ (b) Place turntables under both front wheels. ✓ (c) Make sure the wheels are straight ahead. ✓ (d) Adjust the turntables' readings to zero. ✓ (e) Safely lower the vehicle onto the turntables. ✓	5

<table>
<tr><td>6.2.4 Take the wheel alignment CAMBER reading.</td><td>(a) Place the bubble gauge on the centre of wheel hub. ✓
(b) Level Bubble D i.e., the gauge scale. ✓
(c) Read the CAMBER angle.

CAMBER …… ✓</td><td>3</td></tr>
<tr><td colspan="2">6.2.5 State if the camber reading is within specifications or not. ✓</td><td>1</td></tr>
<tr><td colspan="2">6.2.6 Advise on how to correct the camber. ✓</td><td>1</td></tr>
<tr><td>6.2.7 Read the wheel alignment CASTER and KPI angles on the LEFT wheel.</td><td>(a) Apply the brake lock. ✓
(b) Turn the front of the wheel 20° inwards. ✓
(c) Level Bubble D. ✓
(d) Level Bubble B i.e. the caster scale (by turning the knob at the bottom of the gauge.) ✓
(e) Level Bubble C i.e. the KPI scale (by turning the knob at the bottom of the gauge.) ✓
(f) Turn the wheel 40° (back to zero + 20°) in the opposite direction. ✓
(g) Level Bubble D. ✓
(h) Read the caster reading on Bubble B. ✓
(i) Read the KPI reading on Bubble C. ✓
<table><tr><td>CASTER …..…… ✓</td><td>KPI …….…… ✓</td></tr></table></td><td>11</td></tr>
<tr><td>6.2.8 Read the wheel alignment CASTER and KPI angles on the RIGHT wheel.</td><td>(a) Apply the brake lock. ✓
(b) Turn the front of the wheel 20° inwards. ✓
(c) Level Bubble D. ✓
(d) Level Bubble B i.e. the caster scale (by turning the knob at the bottom of the gauge.) ✓
(e) Level Bubble C i.e. the KPI scale (by turning the knob at the bottom of the gauge.) ✓
(f) Turn the wheel 40° (back to zero + 20°) in the opposite direction. ✓
(g) Level Bubble D. ✓
(h) Read the caster reading on Bubble B. ✓
(i) Read the KPI reading on Bubble C. ✓
<table><tr><td>CASTER …..…… ✓</td><td>KPI …….…… ✓</td></tr></table></td><td>11</td></tr>
<tr><td colspan="2">TOTAL – Wheel Alignment – Procedure</td><td>42</td></tr>
</table>

TASK 7: CHARGING SYSTEM
WORKSHEET 7 – PROCEDURE

CHARGING SYSTEM (ALTERNATOR)	**MARK**

7.1 Test the charging system on a vehicle.		
PROCEDURE		**MARK**
7.1.1 Select DC voltage on the multimeter. ✓		1
7.1.2 Obtain the manufacturer's specifications for the vehicle's charging system.	• Voltage at idling ✓ • Voltage with load ✓	2
7.1.3 Check for loose electrical connections.	• Terminals ✓ • Frayed wires ✓ **(Any 1 x 1)**	1
7.1.4 Check the fan belt.	• Tension ✓ • Condition ✓	2
7.1.5 Use the multimeter to measure the battery voltage at idling speed without load.✓	• At least 13,8 volts – good ✓	2
7.1.6 Use the multimeter to measure the battery voltage at idling speed with load.✓	• Switch on accessories, including lights, HVAC, etc. ✓	2
7.1.7 Report on voltage drop between reading at idling speed with and without load.✓	• Acceptable if drop is 5 V and below. ✓	2
	TOTAL – Charging System – Procedure	**12**

7.2 Identify any SEVEN components (**A** to **I**) of the alternator in FIGURE 7.2.	7

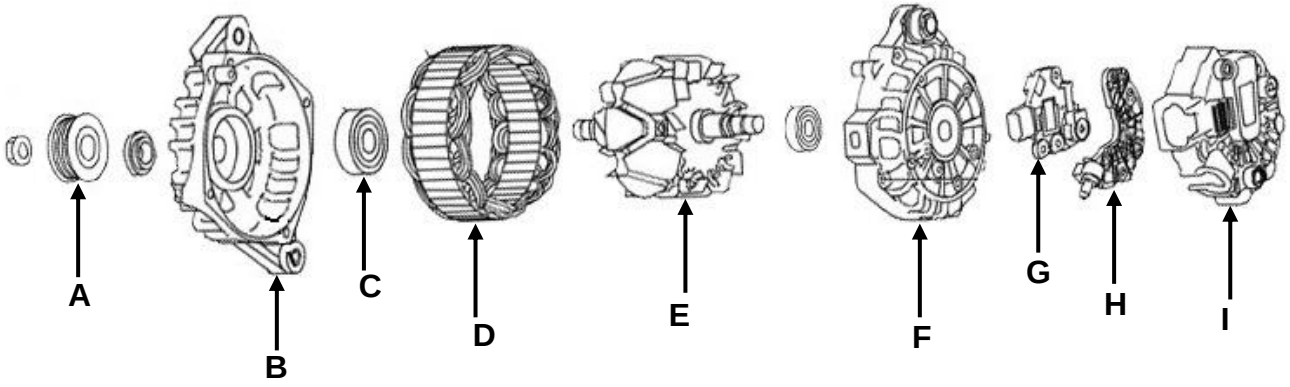


FIGURE 7.2

A - Pulley ✓	**F** - Rear housing ✓
B - Front housing ✓	**G** - Brushes or Brush Holder ✓
C - Bearing ✓	**H** - Rectifier ✓
D - Stator ✓	**I** - Rear cover ✓
E - Rotor ✓	**(Any 7 x 1)**

TOTAL – Alternator Component Identification	**7**	

7.3 Test the following components of a dismantled alternator.			
ALTERNATOR TESTING – PROCEDURE			**MARK**
7.3.1	Select continuity (buzzer) on the multimeter. ✓		1
Check the six diodes on the rectifier.			
7.3.2	Connect the multimeter to both sides of the diodes. ✓✓✓✓✓✓		6
7.3.3	Report condition of diodes. ✓✓✓✓✓✓		6
Check stator for continuity.			
7.3.4	Connect the multimeter to a different pair of each of the three winding ends respectively. ✓✓✓		3
7.3.5	Report continuity of stator windings. ✓✓✓	• If there is no sound, there is a break in the windings. • If there is a sound, there is continuity in the windings.	3
Check stator for earth leakage.			
7.3.6	Connect the multimeter to the stator framework and the other end to any of the three windings ends. ✓		1
7.3.7	Report earth leakage of stator windings.	• If there is no sound, there is no earth leakage. ✓ • If there is a sound, there is earth leakage. ✓ **(Any 1 x 1)**	1
Check rotor for continuity.			
7.3.8	Connect multimeter to both slip rings. ✓		1
7.3.9	Report on continuity of rotor windings.	• If there is no sound, there is a break in the windings. ✓ • If there is a sound, there is continuity in the windings. ✓ **(Any 1 x 1)**	1
7.3.10	Check if slip rings are connected properly to rotor windings. ✓✓		2
7.3.11	Check slip rings for wear. ✓		1
Check rotor for earth leakage.			
7.3.12	Connect multimeter to rotor winding and rotor framework (poles). ✓		1
7.3.13	Report earth leakage of rotor windings.	• If there is no sound, there is no earth leakage. ✓ • If there is a sound, there is earth leakage. ✓ **(Any 1 x 1)**	1
7.3.14	End bracket/Cover for wear. ✓		1
7.3.15	Check front bearing ✓and rear bearing. ✓		2
		TOTAL – Alternator Testing - Procedure	**31**

TASK 8: COMPUTERISED DIAGNOSTIC SCANNER
WORKSHEET 8.1 – QUESTIONS

QUESTIONS		MARK
8.1.1	What do the following abbreviations stand for?	
	(a) ISC	1
	• Idle speed control ✓	
	(b) PCM	1
	• Power control module ✓	
	(c) TCU	1
	• Transmission control unit ✓	
	(d) MAP	1
	• Manifold absolute pressure ✓	
	(e) DIS	1
	• Distributorless ignition system ✓	
8.1.2	Interpret the following fault code: P0304	
	(a) P	1
	• Power train (engine and transmission) ✓	
	(b) 0	1
	• Generic ✓	
	(c) 3	1
	• Ignition system ✓	
	(d) 04	1
	• Misfire (cylinder 4) ✓	
8.1.3	State TWO manufacturer's specifications required to set up an OBD scanner.	2
	• Vehicle Identification Number ✓ • Vehicle Make and Model ✓	
8.1.4	State the FOUR basic functions of an OBD scanner.	4
	• Scan diagnostic trouble codes ✓ • Clear the trouble codes ✓ • Programme ✓ • Retrieve information ✓	

8.1.5 Name FIVE systems that the OBD scanner can detect.	5
• Supplemental Restraint Systems (airbags, seatbelts) (SRS) ✓ • Anti-lock Braking System (ABS) ✓ • Power Control Module (PCM) ✓ • Transmission Control Module (TCM, TCU, GCU) ✓ • Heating, Ventilation and Air-conditioning (HVAC) ✓ • Electronic Control Module (ECM, ECU) ✓ • Diesel Particulate Filter (DPF) ✓ • Speed Assist System (SAS) ✓ • Evaporative Emission System (EVAP) ✓ • Throttle Positioning Management System (TPMS) ✓ • Battery Management System (BMS) ✓ • Electronic Parking Brake (EPB) ✓ • Body Control Module (BCM) ✓ **(Any 5 x 1)**	
TOTAL – Computerised Diagnostic Scanner – Questions	**20**

TASK 8: COMPUTERISED DIAGNOSTIC SCANNER
WORKSHEET 8.2 - PROCEDURE

COMPUTERISED DIAGNOSTIC SCANNER			
8.2	Conduct a Computerised Diagnostic Test on a vehicle using the OBD-II scanner.		
	PROCEDURE		**MARK**
8.2.1	Check for any of the SIX obvious problems listed:	• Fuel leaks and fuel level ✓ • Vacuum hoses that are disconnected ✓ • Corroded connectors ✓ • Unusual noises, smoke, or smell ✓ • Check the air filter ✓ • Check the oil level and condition ✓ • Check the coolant level and condition ✓ • Check the battery voltage ✓ **(Any 6 x 1)**	6
8.2.2	Obtain the VIN of the vehicle. ✓		1
8.2.3	Obtain the make and model of the vehicle. ✓		1
8.2.4	Locate the car's OBD-II port. ✓		1
8.2.5	Gain access to the car's OBD-II port. ✓		1
8.2.6	Plug the diagnostic tool into the OBD-II port. ✓✓		2
8.2.7	Access the diagnostic scanner. ✓✓		2
8.2.8	Enter/Confirm the vehicle's details on the scanner. ✓✓		2
8.2.9	Turn on the vehicle's ignition. ✓✓		2
8.2.10	Select the system to be scanned. ✓✓		2
8.2.11	Perform a diagnostic scan. ✓✓		2
8.2.12	Record any diagnostic trouble codes. ✓✓		2
8.2.13	Clear the trouble codes and restart the diagnostic scan. ✓✓		2
8.2.14	Read the trouble codes. ✓		1
8.2.15	Interpret the trouble codes. ✓		1
8.2.16	Make a diagnosis. ✓✓		2
	TOTAL – Computerised Diagnostic Scanner – Procedure		**30**

TASK 9: ENGINE COMPONENTS MEASUREMENTAND CALCULATIONS (COMPULSORY)
WORKSHEET 9.1 – QUESTIONS

QUESTIONS	MARK
9.1.1 Explain what is meant by *swept volume*.	2
• The volume displaced by the piston ✓ during a stroke (BDC to TDC) ✓	
9.1.2 Define *clearance volume*.	2
• Space above the piston crown ✓ when the piston is at TDC ✓	
9.1.3 What do you understand by the term *compression ratio*?	2
• The relationship between the total volume of a cylinder ✓ and the clearance volume ✓	
9.1.4 Describe THREE methods of raising the compression ratio in an engine.	3
• Remove shims from between crankcase and engine block. ✓ • Fit thinner gasket between engine block and cylinder head. ✓ • Machine metal from cylinder head. ✓ • Skim metal from engine block. ✓ • Fit piston with suitable higher crowns. ✓ • Fit crankshaft with longer stroke (with suitable connecting rods). ✓ • Increase bore diameter of cylinders. ✓ **(Any 3 x 1)**	
9.1.5 Describe THREE methods of lowering the compression ratio in an engine.	3
• Fit thicker gasket between engine block and cylinder head. ✓ • Fit piston with suitable lower crowns. ✓ • Fit crankshaft with shorter stroke (with suitable connecting rods). ✓ • Fit shims between crankcase and engine block. ✓ • Re-line/ re-sleeve engine block. ✓ **(Any 3 x 1)**	

9.1.6	Obtain the stroke length and bore diameter for a given engine from the specification sheet to calculate the compression ratio. Stroke length = …… mm ✓ Bore diameter = …… mm ✓ Clearance volume = 35 cm^3	8
	Below is an example ONLY of a calculation: $d = 80\,mm = 8\,cm$ $L = 90\,mm = 9\,cm$ $SV = \frac{\pi d^2}{4} \times L$ $= \frac{\pi(8)^2}{4} \times 9$ ✓ ✓ $= 452,39\ cm^3$ ✓ $CR = \frac{SV + CV}{CV}$ $= \frac{452,39 + 35}{35}$ ✓ ✓ $= 13,93$ $CR = 14:1$ ✓	

9.1.7 Calculate the total engine capacity in litres of a four-cylinder engine if the clearance volume is 30 mℓ and the swept volume is 230 cm^3.	3
Swept volume = 230cm^3 = 230 mℓ ✓ Total engine volume = Swept volume x No. of cylinders = 230 mℓ x 4 ✓ = 920 mℓ ✓	

9.1.8 What equipment is used to measure the mean effective pressure developed during the power stroke?	1
• Planimeter ✓	
9.1.9 Name TWO types of dynamometers used to measure brake power.	2
• Prony brake ✓ • Electric dynamometer ✓ • Eddy current dynamometer ✓ • Hydraulic dynamometer ✓ • DC dynamometer ✓ • Rope brake ✓ **(Any 2 x 1)**	
TOTAL – Engine Components Measurement and Calculations – Questions	**26**

TASK 9: ENGINE COMPONENTS MEASUREMENT – PROCEDURE
WORKSHEET 9.2 – ENGINE COMPONENTS MEASUREMENT

ENGINE COMPONENTS MEASUREMENT
9.2 Measure the crankshaft main journal, main bearing, cylinder bore, piston diameter and ring gap of an internal combustion engine. Answer the questions that follow.

9.2.1 Obtain specifications for the following:

COMPONENT	SPECIFICATION	MARK	TOTAL
Main journal size		1	
Big-end journal size		1	
Mains bearing clearance		1	
Big-end journal clearance		1	
Cylinder bore diameter		1	
Stroke length		1	
Piston-to-bore clearance		1	
Ring gap		1	
TOTAL – Engine Specifications		**8**	

9.2.2 **MAINS MEASUREMENT**

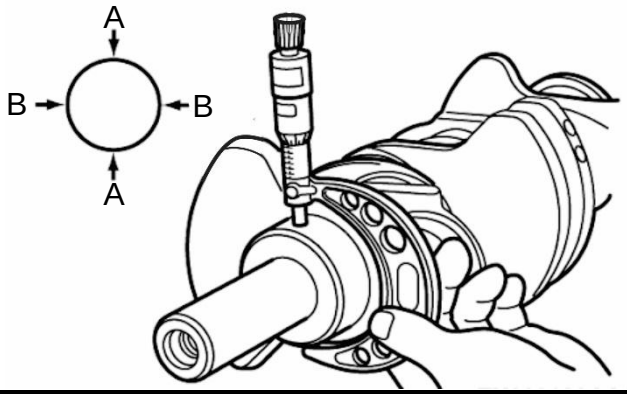


FIGURE 9.2.2: MAIN JOURNAL

9.2.2 (a) Measure the main journal.

DIMENSION	MEASUREMENT	MARK	TOTAL
AA	±0,1 mm tolerance allowed, thereafter, -1 MARK for every 0,1 mm out	5	
BB	±0,1 mm tolerance allowed, thereafter, -1 MARK for every 0,1 mm out	5	

9.2.2 (b) Calculate the ovality.			
AA – BB =		2	

9.2.2 (c) Measure the main bearing.			
DIMENSION	**MEASUREMENT**	**MARK**	**TOTAL**
Measure the main bearing inside diameter.	±0,1 mm tolerance allowed, thereafter, -1 MARK for every 0,1 mm out	5	

9.2.2 (d) Calculate the main bearing clearance.		
	3	
TOTAL – Mains Measurement and Calculation	**20**	

9.2.3 CYLINDER BORE

9.2.3 (a) Measure the cylinder bore.

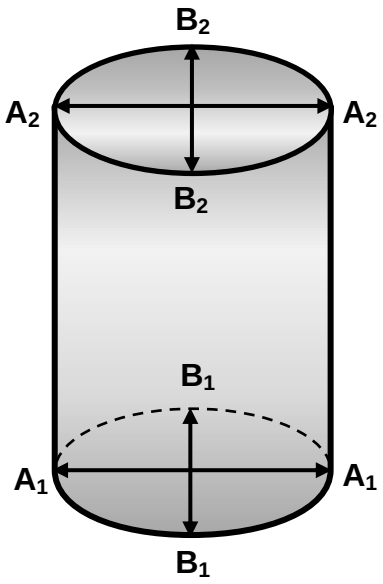


FIGURE 9.2.3 (a): CYLINDER BORE

DIMENSION	MEASUREMENT	MARK	TOTAL
A_1	±0,1 mm tolerance allowed, thereafter, -1 MARK for every 0,1 mm out	5	
A_2	±0,1 mm tolerance allowed, thereafter, -1 MARK for every 0,1 mm out	5	
B_1	±0,1 mm tolerance allowed, thereafter, -1 MARK for every 0,1 mm out	5	
B_2	±0,1 mm tolerance allowed, thereafter, -1 MARK for every 0,1 mm out	5	

9.2.3 (b) Calculate the ovality.			
$A_1 – B_1 =$		2	
$A_2 – B_2 =$		2	
9.2.3 (c) Calculate the taper.			
$A_1 – A_2 =$		2	
$B_1 – B_2 =$		2	
TOTAL – Cylinder Bore Measurement		**28**	

9.2.4 **PISTON MEASUREMENT**

Measure the piston and bore diameters.

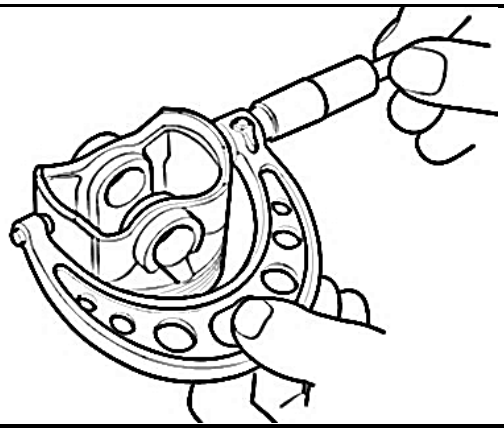


FIGURE 9.2.4.1: MEASURING PISTON DIAMETER

DIMENSION	MEASUREMENT	MARK	TOTAL
Piston diameter	±0,1 mm tolerance allowed, thereafter, -1 MARK for every 0,1 mm out	5	
Piston-to-bore clearance calculation		3	
TOTAL – Piston Measurement		**8**	

9.2.5 **COMPRESSION RING GAP**
Measure the compression ring gap.

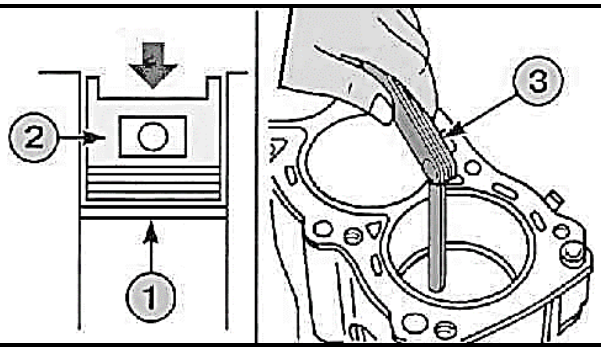



FIGURE 9.2.5: MEASURING RING GAP

MEASURING RING GAP PROCEDURE			**MARK**	**TOTAL**
Insert ring into bore by hand			2	
Use piston to square the ring in bore			2	
Ensure ring is about 25 mm deep in the cylinder			1	
Use feeler gauge to measure ring gap			3	
Record ring gap measurement	……		1	
Is the ring gap within specifications?	Yes	No	1	
TOTAL: Measuring Ring Gap Procedure			**10**	