THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATION COUNCIL OF TANZANIA

DIPLOMA IN TECHNICAL EDUCATION EXAMINATION

790 **AUTOMOBILE TECHNOLOGY**

Time: 3 Hour. **ANSWERS** **Year: 2002**

Instructions

1. This paper consists of t**en (10)** questions.
2. Answer any **five (5)** questions
3. Each question carries **twenty (20)** marks.
4. Programmable calculators, cellular phones and other unauthorized materials are **not** allowed in the examination room.
5. Write your **Examination Number** on every page of your answer booklet(s).

1. (a) Explain five workshop safety rules a technician must follow before performing repair or service on a vehicle.

A technician must disconnect the battery before beginning any repairs. This prevents accidental electrical shorts and reduces the risk of electrical shock or component damage.

The vehicle should be securely supported using jack stands and wheel chocks. Never rely solely on a hydraulic jack as it can fail unexpectedly, leading to serious injury.

Personal protective equipment (PPE) such as safety goggles, gloves, steel-toe boots, and overalls must be worn at all times to reduce the risk of injury from tools, chemicals, or sharp objects.

Tools and the working area should be kept clean and organized. Spilled fluids and scattered tools can cause slips, trips, or confusion during repairs.

A technician should always follow manufacturer instructions and safety signage. Ignoring guidelines can result in improper repair procedures and potential hazards.

(b) State three types of fire extinguishers used in an automotive workshop and explain the type of fire each is used for.

A carbon dioxide (CO_2) fire extinguisher is suitable for electrical fires such as those involving live wires, batteries, or short circuits. It displaces oxygen and cools the fire source.

A dry chemical powder extinguisher is used for Class B and C fires, including flammable liquids like petrol, diesel, oil, and gas leaks. It interrupts the chemical reaction of the fire.

A foam extinguisher is effective against flammable liquid fires and also suitable for fires involving solid materials like wood or fabric. It forms a blanket over the burning substance, cutting off oxygen.

(c) Describe how to respond in case of a fuel spill in a workshop environment.

Immediately stop all sources of ignition such as welding machines, running engines, or smoking in the area to prevent fire outbreaks.

Use absorbent materials like sand or special absorbent pads to soak up the spilled fuel. Avoid using water as it spreads flammable liquids.

Ventilate the area by opening doors and windows to allow fuel vapors to disperse. This reduces inhalation risks and lowers the chance of explosion.

Collect the soaked material and dispose of it in a designated hazardous waste container according to environmental regulations.

Finally, clean the area thoroughly and report the spill to the supervisor or workshop safety officer to ensure the incident is documented and preventive measures reviewed.

2. (a) Explain the working principle of a four-stroke spark ignition engine.

The intake stroke begins when the piston moves downward with the intake valve open. A fuel-air mixture is drawn into the combustion chamber.

During the compression stroke, the piston moves upward with both valves closed. This compresses the air-fuel mixture, increasing temperature and pressure.

The power stroke occurs when a spark from the spark plug ignites the compressed mixture. The resulting explosion forces the piston downward, generating mechanical power.

The exhaust stroke happens as the piston moves upward again with the exhaust valve open. Combustion gases are expelled from the chamber, completing the cycle.

(b) Outline four functions of a carburetor in petrol engines.

A carburetor mixes the correct proportion of air and fuel for combustion in the engine.

It regulates the engine's air-fuel mixture according to load and speed demands.

It atomizes the fuel into fine droplets to ensure even distribution and efficient burning.

It provides different circuits for starting, idling, acceleration, and cruising to meet varying engine needs.

(c) State three advantages and two disadvantages of electronic fuel injection systems over traditional carburetors.

EFI systems deliver more accurate fuel metering, resulting in better fuel efficiency and reduced emissions.

They improve cold starting performance and eliminate the need for manual choke adjustments.

They provide better throttle response and smoother acceleration.

However, EFI systems are more expensive to manufacture and repair due to their complexity.

They also require specialized diagnostic tools and training for maintenance.

3. (a) Differentiate between the following:

(i) Overhead Valve (OHV) and Overhead Camshaft (OHC) engines

(ii) Naturally Aspirated and Supercharged engines
(iii) Wet and dry liners

OHV engines have the camshaft located inside the engine block, using push rods to actuate the valves, while OHC engines have the camshaft placed above the cylinder head, directly operating the valves.

Naturally aspirated engines rely solely on atmospheric pressure for air intake, whereas supercharged engines use a compressor to force more air into the cylinder, increasing power output.

Wet liners come into direct contact with engine coolant and are removable for service. Dry liners do not touch the coolant and are tightly pressed into the engine block for added strength.

(b) State three advantages of using aluminium in engine block construction.

Aluminium is lightweight, which reduces the overall vehicle weight and improves fuel economy.

It has excellent heat dissipation properties, helping the engine stay cool during operation.

Aluminium resists rust and corrosion better than cast iron, increasing the engine's longevity.

(c) Explain two reasons why cylinder head gaskets fail.

Overheating due to cooling system failure can warp the cylinder head, leading to gasket leaks.

Incorrect torque during cylinder head installation can cause uneven pressure and premature gasket failure.

4. (a) Define the term "compression ratio" and explain its importance in engine performance.

Compression ratio is the ratio between the total volume of the cylinder when the piston is at bottom dead center and the volume when at top dead center.

Higher compression ratios result in more efficient combustion, leading to increased engine power and fuel economy. However, they require high-octane fuel to avoid knocking.

(b) A diesel engine has a bore of 85 mm, a stroke of 110 mm, and four cylinders. Calculate the engine displacement in cc.

Bore = 8.5 cm, Stroke = 11 cm, Cylinders = 4
Displacement = $(\pi/4) \times \text{bore}^2 \times \text{stroke} \times \text{number of cylinders}$
$= (3.14/4) \times (8.5 \times 8.5) \times 11 \times 4$
$= 0.785 \times 72.25 \times 11 \times 4$
$= 0.785 \times 3179$
$= 2495.415$ cc

The engine displacement is approximately **2495 cc**.

(c) State four factors that affect the thermal efficiency of an internal combustion engine.

Compression ratio: Higher ratios increase thermal efficiency by extracting more work from the combustion process.

Combustion chamber design: Efficient designs reduce heat losses and improve flame propagation.

Operating temperature: Engines running at optimal temperature reduce friction and improve fuel combustion.

Frictional losses: Lower internal friction within the engine increases overall efficiency by reducing wasted energy.

5. (a) Describe the working of a disc brake system using a labeled sketch.

In a disc brake system, when the driver presses the brake pedal, hydraulic pressure is transmitted through the brake lines to the caliper.

The caliper contains pistons that push the brake pads against both sides of a rotating disc (rotor) attached to the wheel.

The resulting friction between the brake pads and the disc slows down or stops the wheel's rotation, bringing the vehicle to a halt.

When the pedal is released, the hydraulic pressure drops, and the piston retracts slightly, allowing the disc to rotate freely again.

A sketch would typically show a cross-section with the rotor, caliper, brake pads, and hydraulic lines clearly labeled.

(b) Give three reasons why modern vehicles prefer disc brakes over drum brakes.

Disc brakes provide better heat dissipation due to their open design, which reduces brake fade under heavy use.

They offer more consistent braking performance, especially in wet conditions, as water is quickly thrown off the disc surface.

Disc brakes are easier to inspect and maintain, since the components are exposed and more accessible than those inside a drum.

(c) Explain how Anti-lock Braking Systems (ABS) improve safety during braking.

ABS prevents the wheels from locking up during emergency braking by rapidly modulating the brake pressure.

This allows the driver to maintain steering control and avoid skidding, especially on slippery surfaces.

Wheel speed sensors monitor each wheel's rotation, and the ABS control module adjusts pressure through hydraulic valves to prevent loss of traction.

6. (a) Describe the functions of the following suspension components:

(i) Shock absorber

(ii) Coil spring

(iii) Control arm

The shock absorber dampens the oscillations of the suspension springs, improving ride comfort and maintaining tire contact with the road.

The coil spring supports the vehicle's weight and absorbs road shocks by compressing and expanding as the vehicle moves over bumps.

The control arm connects the suspension system to the vehicle frame and allows the wheels to move up and down while keeping them aligned properly.

(b) Differentiate between independent suspension and rigid axle suspension.

Independent suspension allows each wheel to move independently, providing better handling, ride comfort, and road grip.

Rigid axle suspension connects both wheels with a solid axle, so movement of one wheel affects the other. It is durable and commonly used in heavy vehicles.

(c) State three symptoms of worn-out suspension parts and their effects on vehicle performance.

Unusual noises such as knocking or creaking indicate worn bushings or joints, affecting stability and comfort.

Uneven tire wear suggests misalignment caused by worn suspension parts, reducing tire life and road safety.

Excessive body roll or bouncing during turns and braking shows weakened shocks or springs, compromising control and ride quality.

7. (a) Describe the procedure for checking and adjusting wheel alignment.

Start by inspecting the suspension and steering components for wear or damage, as alignment cannot be properly done with faulty parts.

Mount the vehicle on an alignment machine and attach sensors or gauges to all wheels.

Measure the camber, caster, and toe angles using the machine's interface. Compare readings to manufacturer specifications.

Adjust the toe angle by turning the tie rods. Adjust camber and caster if the suspension design allows, often by shifting control arms or rotating struts.

After adjustments, re-check all angles and road-test the vehicle to ensure stable handling and centered steering.

(b) Explain the effects of incorrect camber, caster, and toe on tire wear and steering.

Incorrect camber causes uneven tire wear — negative camber wears the inner edge, while positive camber wears the outer edge.

Incorrect caster affects steering stability. Too much positive caster can make the steering feel heavy, while too little reduces straight-line stability.

Incorrect toe causes tires to scrub against the road. Toe-in causes outer edge wear, while toe-out wears the inner edge and causes instability.

(c) What are the benefits of computerized wheel alignment over manual methods?

Computerized alignment provides precise digital measurements and adjustments, ensuring accuracy and consistency.

It saves time by quickly detecting misalignments and offering correction guides.

It stores vehicle data and past alignment records, allowing for easier tracking and diagnostics during maintenance.

8. (a) Define the term "voltage drop" and explain its significance in vehicle electrical circuits.

Voltage drop is the loss of electrical potential across a component or conductor as current flows through it, caused by resistance in the circuit.

In vehicle electrical systems, excessive voltage drop reduces the efficiency of components such as headlights, fuel pumps, and ignition systems.

It can lead to poor performance or malfunction of electronic control modules, sensors, and actuators.

Regular testing for voltage drop helps identify corroded connections, damaged wires, or weak grounds, which are common causes of electrical faults.

(b) Describe how to test an alternator using a digital multimeter.

Start the engine and set the multimeter to DC voltage. Connect the red probe to the positive terminal and the black to the negative terminal of the battery.

At idle, the reading should be between 13.8 and 14.5 volts. This indicates the alternator is charging the battery correctly.

Increase engine speed slightly and observe if the voltage rises slightly and stabilizes. If it goes beyond 15V or drops below 13V, the alternator or regulator may be faulty.

Switch the multimeter to AC voltage mode and test again. Any reading above 0.5V indicates a faulty rectifier diode in the alternator.

(c) List four causes of battery overcharging and explain the consequences if not corrected.

A faulty voltage regulator fails to control output voltage, allowing the alternator to supply excess current continuously.

Incorrect alternator wiring or installation may bypass the regulator circuit, leading to unregulated charging.

A malfunctioning ECU in vehicles with smart charging systems can misinterpret battery data and trigger overcharging.

Poor ground connections or high resistance in the sensing wire can trick the regulator into supplying more voltage than needed.

If not corrected, overcharging leads to battery overheating, electrolyte loss, swelling of the battery case, and damage to onboard electronic systems.

9. (a) Outline the procedure for diagnosing a no-start condition in a petrol engine vehicle.

Check the battery voltage first using a multimeter. It should be at least 12.4 volts for reliable starting. Recharge or replace if below specification.

Inspect the battery terminals and cable connections for corrosion or looseness that may prevent current flow.

Listen for the fuel pump priming sound when the key is turned to the ON position. No sound could indicate a blown fuse or faulty pump.

Check for spark by removing a spark plug, grounding it, and cranking the engine. Absence of spark suggests ignition system failure.

Scan the vehicle with a diagnostic tool for trouble codes, which may point to issues such as a faulty crankshaft position sensor, immobilizer fault, or ECU problem.

(b) What is an OBD-II system? Explain its function in modern automotive diagnostics.

OBD-II (On-Board Diagnostics II) is a standardized system used in modern vehicles to monitor engine and emission performance.

It continuously collects data from sensors and control units and stores diagnostic trouble codes (DTCs) when it detects a fault.

The system helps technicians diagnose issues quickly by providing detailed fault codes and live data via a scan tool.

OBD-II also monitors emissions components to ensure compliance with environmental regulations and triggers the check engine light if limits are exceeded.

(c) Mention three common diagnostic trouble codes (DTCs) and what they indicate.

P0301 indicates a misfire in cylinder 1, often caused by a faulty spark plug, ignition coil, or injector.

P0171 signifies a lean fuel condition on bank 1, typically due to vacuum leaks, a dirty MAF sensor, or low fuel pressure.

P0420 points to catalytic converter efficiency below threshold, which may be caused by a degraded catalyst or faulty oxygen sensor.

10. (a) Describe the working of an electronically controlled fuel injection (EFI) system.

In an EFI system, fuel is supplied under pressure by an electric fuel pump and delivered through injectors mounted on the intake manifold or cylinder head.

The Engine Control Unit (ECU) receives signals from sensors such as the throttle position sensor, oxygen sensor, and crankshaft position sensor.

Using this data, the ECU calculates the precise timing and duration for fuel injection to achieve optimal air-fuel ratio.

Fuel is sprayed into the intake airflow or directly into the combustion chamber, depending on the system type, ensuring better combustion, efficiency, and emission control.

(b) Explain the role of the Mass Air Flow (MAF) sensor and Throttle Position Sensor (TPS) in engine control.

The MAF sensor measures the amount of air entering the engine and sends this data to the ECU for calculating fuel delivery.

It ensures the correct air-fuel ratio by adjusting injection timing according to engine load and environmental conditions.

The TPS monitors the angle of the throttle plate, indicating how much the driver is accelerating.

It helps the ECU manage ignition timing, fuel delivery, and idle control based on driver input.

(c) A vehicle shows poor fuel economy and loss of power. List five possible causes and explain each.

A clogged air filter restricts airflow to the engine, resulting in a rich mixture that wastes fuel and reduces power.

Faulty oxygen sensors send inaccurate data to the ECU, causing incorrect fuel mixture adjustments.

Worn spark plugs create weak sparks, leading to incomplete combustion and reduced engine efficiency.

Dragging brakes increase resistance on the wheels, forcing the engine to work harder and use more fuel.

Low tire pressure increases rolling resistance, lowering fuel economy and making acceleration sluggish.