THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATION COUNCIL OF TANZANIA

DIPLOMA IN TECHNICAL EDUCATION EXAMINATION

790 **AUTOMOBILE TECHNOLOGY**

Time: 3 Hour. **ANSWERS** **Year: 2004**

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) State five workshop safety measures a mechanic must observe when working under a lifted vehicle.

A mechanic must always ensure the vehicle is supported by jack stands or axle stands and not just a hydraulic jack. Hydraulic jacks can fail unexpectedly, leading to a serious risk of injury or death.

The working area around the lifted vehicle should be kept clean and free from tools or spilled fluids to avoid tripping hazards and ensure safe movement.

Before going under the vehicle, the mechanic should verify that the parking brake is engaged and wheel chocks are placed on opposite wheels to prevent the vehicle from rolling.

Personal protective equipment such as a helmet or hard hat, safety glasses, gloves, and steel-toe boots should be worn to protect against falling parts or accidental contact.

The mechanic must inform another person in the workshop before working under a vehicle. This ensures someone is available to assist or raise an alarm in case of an emergency.

(b) Mention three causes of workshop fires and explain how each can be prevented.

Flammable liquids such as petrol, diesel, and solvents can ignite from open flames or sparks. They should be stored in sealed containers and kept away from ignition sources.

Electrical faults like short circuits and exposed wiring can spark fires. Regular inspection and maintenance of electrical tools and wiring help prevent such incidents.

Welding and grinding activities generate high heat and sparks. Fire-resistant blankets or shields should be used, and a fire extinguisher must be kept nearby during such operations.

(c) Outline the procedure for using a fire blanket to extinguish a small engine bay fire.

Immediately cut off the ignition and open the bonnet slightly to reduce air supply to the flames while maintaining a safe distance.

Carefully pull the fire blanket from its container and hold it as a shield between yourself and the fire.

Drape the blanket over the engine bay completely, covering the fire source and blocking oxygen supply to smother the flames.

Leave the blanket in place for several minutes to ensure the fire is fully extinguished and does not reignite.

After confirming the fire is out, remove the blanket cautiously and check for any remaining hot spots or smoldering parts.

2. (a) Describe the operating principle of a turbocharged diesel engine.

In a turbocharged diesel engine, exhaust gases exiting the engine pass through a turbine, causing it to spin. This turbine is connected via a shaft to a compressor wheel.

As the turbine spins, the compressor draws in ambient air and compresses it before sending it into the engine intake manifold.

Compressed air allows more oxygen to enter the combustion chamber, enabling more fuel to burn efficiently, which increases engine power and torque.

This process improves overall engine efficiency without increasing engine size.

(b) State four advantages of turbocharging in modern engines.

Turbocharging increases engine power output without increasing engine displacement, improving performance.

It improves fuel economy by allowing smaller engines to deliver similar power to larger naturally aspirated engines.

Turbocharging enhances high-altitude performance, as the compressor compensates for thinner air at elevation.

It improves emission control by promoting more complete combustion and reducing unburned hydrocarbons.

(c) Highlight three possible faults that may result from a failing turbocharger and their effects on engine performance.

Oil leaks from the turbo seals can result in blue smoke from the exhaust and oil consumption, leading to engine damage if not addressed.

Worn or damaged turbine blades reduce boost pressure, causing loss of power, sluggish acceleration, and poor engine response.

Excessive shaft play or bearing failure may lead to unusual whining or grinding noises and complete turbo failure if ignored.

3. (a) With the aid of labeled sketches, distinguish between inline and V-type engine configurations.

An inline engine has all cylinders arranged in a single straight line. This design is simpler, more compact, and easier to maintain.

A V-type engine arranges cylinders in two separate banks that form a "V" shape when viewed from the front. It allows more cylinders in less space and provides smoother operation.

(b) Explain the function of the following components:
(i) Timing belt
(ii) Flywheel
(iii) Oil sump

The timing belt synchronizes the rotation of the crankshaft and camshaft, ensuring that valves open and close at the correct time during the engine cycles.

The flywheel maintains engine momentum by storing rotational energy. It also smooths out engine vibrations and provides the mounting surface for the clutch in manual transmissions.

The oil sump, located at the bottom of the engine, stores lubricating oil. It also helps in cooling and collecting contaminants before the oil is pumped again through the engine.

(c) List three effects of incorrect valve timing on engine operation.

Incorrect valve timing can lead to poor engine performance due to valves opening or closing at the wrong time, affecting air-fuel intake and exhaust.

It may cause engine misfiring or backfiring, resulting in rough idling and poor acceleration.

In severe cases, incorrect timing can cause piston-to-valve contact, leading to mechanical damage and costly repairs.

4. (a) Differentiate between wet sump and dry sump lubrication systems.

A wet sump system stores engine oil in the oil pan beneath the engine. It uses a single pump to circulate oil throughout the engine components.

A dry sump system stores oil in an external reservoir and uses multiple pumps to scavenge and supply oil, keeping the oil pan shallow for better ground clearance and performance.

Wet sump systems are simpler and more common in standard vehicles, while dry sump systems are used in high-performance and racing applications.

(b) Explain how the oil pressure relief valve functions in an engine lubrication system.

The oil pressure relief valve regulates oil pressure by allowing excess oil to bypass the system and return to the sump.

When oil pressure exceeds a preset limit, the valve opens to prevent damage to engine seals, filters, and components.

Once pressure drops to normal, the valve closes, ensuring consistent lubrication without overpressure.

(c) State four signs of insufficient lubrication in an internal combustion engine.

A knocking or ticking noise from the engine indicates metal-to-metal contact due to lack of oil film.

The oil warning light on the dashboard may illuminate, signaling low oil pressure or insufficient oil flow.

Overheating of the engine occurs as friction increases, generating excess heat without enough oil to cool moving parts.

Premature wear of engine components such as camshafts, bearings, and pistons becomes evident due to lack of lubrication.

5. (a) Describe the construction and operation of a master cylinder in a hydraulic brake system.

The master cylinder is a cylindrical component with a piston inside, connected to the brake pedal through a push rod.

It contains one or two chambers filled with brake fluid and connected to the brake lines leading to each wheel.

When the brake pedal is pressed, the piston moves forward, pressurizing the brake fluid and forcing it through the brake lines to activate the brakes.

Upon release, return springs push the piston back, drawing fluid from the reservoir to reset the system.

(b) Explain the importance of brake fluid specifications and compatibility in braking systems.

Brake fluid must meet specific boiling point standards to withstand the heat generated during braking without vaporizing.

Using incompatible or incorrect fluid may lead to rubber seal deterioration, corrosion of brake components, and reduced braking efficiency.

Mixing different types of brake fluid (e.g., DOT 3 with DOT 5) can cause chemical reactions that reduce fluid performance and safety.

(c) State four symptoms of air trapped in the brake system and their implications on safety.

A spongy or soft brake pedal feel is a sign that air is compressing within the lines, reducing braking force.

Increased pedal travel before braking action is felt indicates air in the system delaying pressure buildup.

Brake fade or inconsistent braking response may occur, affecting driver confidence and reaction times.

Complete brake failure in extreme cases can happen if air prevents the fluid from transmitting force to the wheel cylinders.

6. (a) Compare coil spring and leaf spring suspension systems in terms of construction and application.

Coil spring suspensions use helical steel springs that compress and expand to absorb road shocks. They are compact, lighter, and commonly used in front-wheel-drive cars and modern passenger vehicles.

Leaf spring suspensions consist of multiple layers of metal strips (leaves) bound together. They provide greater load-carrying capacity and are commonly used in heavy-duty vehicles and trucks.

Coil springs offer better ride comfort and handling, while leaf springs are simpler, more durable, and effective for load distribution in commercial use.

(b) Explain how a MacPherson strut works and where it is commonly used.

A MacPherson strut combines a shock absorber and coil spring into a single unit, saving space and reducing weight.

When the wheel hits a bump, the strut compresses, absorbing the impact through the shock absorber and allowing controlled spring movement.

It serves both as a suspension component and as a structural link for wheel alignment, maintaining the position of the wheel relative to the body.

MacPherson struts are commonly used in the front suspension of modern front-wheel-drive vehicles due to their simplicity and compactness.

(c) State three reasons why shock absorbers should be replaced in pairs.

Replacing both shock absorbers ensures balanced damping force on both sides of the axle, improving vehicle stability.

Unequal shock performance can cause uneven tire wear and unpredictable handling, especially during cornering and braking.

Pair replacement avoids premature wear of the new shock due to imbalance and extends the life of the suspension system.

7. (a) Define the term “understeer” and explain its causes in a front-wheel-drive vehicle.

Understeer is a handling condition where the vehicle turns less than intended by the driver, causing it to push toward the outside of a corner.

In front-wheel-drive vehicles, understeer commonly occurs due to excessive speed during cornering, where the front tires lose grip before the rear.

Other causes include worn front tires, improper alignment, or overloading the front axle, all of which reduce steering response.

(b) Describe three methods of correcting wheel imbalance.

Static balancing involves adding weights to the wheel to ensure the mass is evenly distributed around the axle, preventing vertical vibration.

Dynamic balancing adjusts the wheel to prevent side-to-side vibrations by adding weights on both inner and outer edges of the rim.

Road force balancing uses a machine that simulates road conditions to identify imbalances caused by tire stiffness or irregularities, providing precise weight placement.

(c) Outline the step-by-step procedure for replacing a worn-out tie rod end.

Lift the vehicle and securely support it with jack stands. Remove the wheel to access the tie rod.

Loosen the lock nut securing the tie rod end to the inner rod. Mark the thread position to maintain alignment.

Remove the cotter pin and loosen the castle nut on the tie rod end ball joint.

Use a tie rod separator or hammer to disconnect the ball joint from the steering knuckle.

Unscrew and remove the tie rod end, then install the new one using the marked thread position.

Reattach the ball joint, tighten the nut to specification, insert a new cotter pin, and tighten the lock nut.

Reinstall the wheel, lower the vehicle, and perform a wheel alignment to ensure proper steering geometry.

8. (a) Explain the purpose and working of a crankshaft position sensor.

The crankshaft position sensor monitors the position and rotational speed of the crankshaft.

It sends signals to the Engine Control Unit (ECU), which uses this data to determine ignition timing and fuel injection timing.

There are magnetic, Hall-effect, and optical types of sensors, each detecting the movement of a toothed wheel on the crankshaft.

Accurate crankshaft position is critical for engine start-up, smooth operation, and misfire detection.

(b) Differentiate between open circuit and short circuit faults in vehicle electronics.

An open circuit fault occurs when the electrical path is broken, preventing current from flowing. This leads to inoperative components such as lights or sensors.

A short circuit fault occurs when current bypasses the intended load due to damaged insulation or wiring. This causes excessive current flow and may blow fuses or damage components.

Open circuits result in no function, while short circuits pose greater risk of fire or component failure.

(c) State three causes of starter motor failure and how each can be diagnosed.

A weak or dead battery results in insufficient power to crank the engine. Diagnosis involves voltage testing with a multimeter.

Worn brushes or damaged armature inside the starter prevent proper contact. This can be diagnosed by tapping the starter and observing if it temporarily engages.

Faulty solenoid may prevent the starter gear from engaging the flywheel. Testing the solenoid terminals while cranking can confirm whether it is functioning properly.

9. (a) List four advantages of using CAN bus systems in modern vehicles.

CAN bus reduces the amount of wiring by allowing multiple control units to communicate over a single network.

It enables faster and more reliable data exchange between systems like engine, transmission, and ABS.

It improves diagnostics by allowing fault codes to be shared across modules and displayed centrally.

It supports system integration, enabling features like traction control, stability systems, and advanced driver-assistance.

(b) Explain the function of an Engine Control Unit (ECU) and how it interacts with sensors and actuators.

The ECU is the brain of the engine management system. It processes input signals from sensors like MAF, oxygen, and throttle position sensors.

Using this data, it calculates the correct amount of fuel to inject, the timing of spark ignition, and operation of actuators such as idle control valves.

It also monitors emissions and can adjust settings for optimal performance and economy. Faults are logged as trouble codes for diagnostics.

(c) What is a multimeter and how is it used to test continuity in a vehicle circuit?

A multimeter is an electronic device used to measure voltage, current, and resistance in a circuit.

To test continuity, set the multimeter to continuity mode. Place one probe on each end of the wire or connection.

If the path is complete, the multimeter beeps or shows near-zero resistance. If no sound or infinite resistance is shown, the circuit is open or broken.

10. (a) A vehicle exhibits frequent overheating. List five possible causes and explain the impact of each on engine health.

A faulty thermostat may remain closed, blocking coolant flow and causing rapid temperature rise, leading to head gasket failure.

A leaking radiator reduces coolant volume, impairing heat dissipation and increasing engine temperature.

A broken water pump fails to circulate coolant, leading to local hotspots and possible engine seizure.

A clogged radiator or blocked coolant passage restricts flow, trapping heat in the engine.

A faulty cooling fan or fan switch causes poor air movement through the radiator, especially at low speeds or idle, leading to overheating.

(b) Describe the function of a radiator cap and how it contributes to pressure regulation.

The radiator cap seals the cooling system and maintains pressure to raise the coolant boiling point.

It contains a spring-loaded valve that opens when pressure exceeds a set limit, allowing excess coolant to flow into the overflow reservoir.

When the engine cools down, the cap allows coolant to return to the radiator, maintaining system balance and preventing air entry.

(c) Outline how to perform a cooling system pressure test.

First, make sure the engine is cool. Remove the radiator cap and attach a pressure tester to the radiator neck.

Pump the tester to the specified system pressure, usually around 15 psi. Observe the gauge for several minutes.

If pressure drops steadily, inspect for external leaks around hoses, radiator, and water pump. If no external leaks are found, perform a cylinder leak-down test to check for internal leaks.

If pressure holds steady, the cooling system is sealed and functioning properly.