THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATION COUNCIL OF TANZANIA

DIPLOMA IN TECHNICAL EDUCATION EXAMINATION

790 **AUTOMOBILE TECHNOLOGY**

Time: 3 Hour. **ANSWERS** **Year: 2006**

Instructions

1. This paper consists of **eight (8)** 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 general safety precautions to be followed before servicing a vehicle engine.

Disconnect the battery to eliminate the risk of electric shock or accidental cranking while working on the engine.

Allow the engine to cool completely before touching components to avoid burns from hot surfaces or fluids.

Wear appropriate personal protective equipment (PPE) such as gloves, goggles, and overalls for protection from chemicals, heat, and debris.

Use wheel chocks and engage the parking brake to prevent the vehicle from moving unexpectedly.

Ensure all tools and equipment are in good condition and use them according to the manufacturer's guidelines to avoid injury.

(b) (i) What is the role of hazard signs in an automotive workshop?

Hazard signs are used to warn technicians and other personnel about potential dangers in the workplace, helping to prevent injuries and accidents.

(ii) Describe three types of hazard signs and give one example for each.

Warning signs are yellow triangles used to indicate potential hazards, such as a lightning bolt for electrical danger.

Mandatory signs are blue circles that indicate required actions, such as wearing safety goggles.

Prohibition signs are red circles with a slash that indicate actions that are not allowed, such as “No Smoking” near flammable materials.

(c) Explain how to safely lift and support a vehicle for underbody repairs.

First, park the vehicle on a flat, stable surface and apply the handbrake firmly.
Use a hydraulic jack to raise the vehicle at the manufacturer’s recommended lifting point.
Place jack stands under strong, designated frame points before working underneath.
Lower the vehicle slowly onto the stands and gently shake it to confirm it’s stable.
Never rely solely on the jack for support while performing underbody work.

2. (a) Differentiate between spark ignition and compression ignition engines.

Spark ignition engines use an electrical spark to ignite an air-fuel mixture, typically in petrol engines.

Compression ignition engines compress air alone until it becomes hot enough to ignite the diesel fuel that is then injected.

Spark ignition relies on spark plugs, while compression ignition uses fuel injectors and high compression.

Spark ignition engines have lower compression ratios, whereas compression ignition engines operate under higher pressures.

(b) List and explain four effects of poor ignition timing in petrol engines.

Poor ignition timing can lead to engine knocking, which causes metallic pinging sounds and damages pistons and valves.

It results in loss of engine power and sluggish acceleration due to inefficient combustion.

Fuel consumption increases because incomplete combustion wastes unburnt fuel.

Excessive emissions are produced, especially unburned hydrocarbons, due to improper burning cycles.

(c) (i) Define the term “scavenging” in two-stroke engines.

Scavenging is the process of removing exhaust gases from the cylinder and replacing them with a fresh air-fuel mixture.

(ii) Describe how scavenging efficiency affects engine performance.

High scavenging efficiency ensures that exhaust gases are fully expelled, allowing complete filling of the cylinder with fresh charge.

This results in better combustion, increased power output, and reduced emissions.

Poor scavenging leads to dilution of the air-fuel mixture, incomplete combustion, and loss of engine performance.

3. (a) State the function of the following parts of an engine lubrication system:

(i) Oil pump

(ii) Pressure relief valve

(iii) Oil strainer

(i) The oil pump circulates lubricating oil throughout the engine under pressure to reduce friction and wear between moving parts.

(ii) The pressure relief valve controls the maximum oil pressure in the system by diverting excess oil back to the sump.

(iii) The oil strainer removes large particles and debris from the oil before it reaches the pump to prevent damage.

(b) Describe how oil circulates in a full-pressure lubrication system.

The oil pump draws oil from the sump through the oil strainer and sends it under pressure to the oil filter.

Filtered oil is then distributed to critical engine parts such as the crankshaft, camshaft, pistons, and

valve train.

After lubricating these components, oil returns to the sump via gravity and is recirculated.

(c) Mention three effects of using incorrect engine oil viscosity in modern engines.

Using oil with viscosity too low can result in poor film strength, increasing wear on engine parts.

Too high viscosity can cause difficulty in starting during cold weather and reduce oil flow to tight clearances.

Incorrect viscosity may affect hydraulic components like valve lifters and variable valve timing systems, leading to performance issues.

4. (a) (i) What is gear ratio?

(ii) How does gear ratio affect vehicle acceleration and fuel consumption?

(i) Gear ratio is the ratio of the number of teeth on two meshing gears. It indicates how many times the input shaft must turn to rotate the output shaft once.

(ii) A higher gear ratio provides more torque and better acceleration but increases fuel consumption.

A lower gear ratio results in less torque and slower acceleration but improves fuel economy, especially at cruising speeds.

(b) Describe the function of a constant velocity (CV) joint in a front-wheel-drive vehicle.

A CV joint transmits torque from the transmission to the wheels while accommodating the up and down motion of the suspension and the steering angles.

It allows smooth rotation at varying angles without a significant increase in friction or wear.

(c) State three symptoms of a worn-out CV joint.

Clicking or popping noises during turns, especially under acceleration.

Grease leaking from a torn CV boot, which leads to contamination and wear of the joint.

Vibration or shuddering during acceleration due to loss of balance or joint looseness.

5. (a) Explain how the parking brake (hand brake) mechanism operates in a drum brake system.

When the handbrake lever is pulled, it pulls a cable connected to a lever inside the drum brake assembly.

This lever forces the brake shoes outward against the drum surface, creating friction to hold the wheel stationary.

The mechanism remains engaged mechanically, holding the vehicle even without hydraulic pressure.

(b) (i) What is brake fade?

Brake fade is the reduction or loss of braking power due to overheating of the brake components during prolonged or heavy braking.

(ii) List two causes and two effects of brake fade.

Causes include overheating of brake pads and boiling of brake fluid due to repeated braking.

Effects include increased stopping distance and a spongy or unresponsive brake pedal.

(c) Compare ventilated disc brakes and solid disc brakes in terms of construction and performance.

Ventilated disc brakes have an air gap between two friction surfaces to improve cooling and reduce heat buildup.

They perform better under high-stress conditions and resist brake fade more effectively.

Solid disc brakes are simpler with a single disc and are often used in rear wheels or lighter vehicles where cooling demand is lower.

6. (a) Describe three differences between rack-and-pinion and recirculating ball steering mechanisms.

The rack-and-pinion steering system uses a linear gear (rack) and a circular gear (pinion) to directly convert the rotary motion of the steering wheel into linear motion that turns the wheels. This setup allows for more precise and responsive steering, especially in smaller and lighter vehicles like passenger cars.

In contrast, the recirculating ball steering system uses a worm gear mechanism and a series of ball bearings to reduce friction. This system is more complex and typically used in larger vehicles like trucks and SUVs, where durability under heavy load is more important than responsiveness.

Another difference is in weight and design complexity. Rack-and-pinion systems are more compact and lightweight, making them easier to install and maintain. Recirculating ball systems are heavier and require more components, which increases maintenance complexity and cost.

(b) Explain the purpose and operation of a steering damper.

A steering damper is a hydraulic device similar to a shock absorber that is attached between the vehicle's frame and the steering linkage. Its main purpose is to absorb and dampen sudden movements and vibrations in the steering system caused by road irregularities.

The steering damper works by providing resistance to the movement of the steering linkage, especially when hitting bumps or potholes. This helps to stabilize the steering wheel and prevent it from jerking violently in the driver's hands.

By reducing kickback and improving steering stability, the steering damper enhances driving comfort and control, particularly in off-road and high-speed driving conditions.

(c) (i) What is the Ackermann steering principle?

The Ackermann steering principle is a geometric concept used in vehicle design to ensure that all the wheels turn at appropriate angles during a turn. It states that the inside wheels of a turning vehicle must turn at a sharper angle than the outside wheels to follow their correct circular paths.

(ii) State its importance in vehicle turning.

This principle is important because it prevents tire scrub during cornering. Tire scrub occurs when the wheels are forced to turn along paths they are not aligned to follow, which increases resistance, wear, and fuel consumption.

By ensuring the wheels are properly aligned during turns, the Ackermann principle improves the efficiency of the vehicle's movement, reduces tire wear, and enhances overall handling stability.

7. (a) List four factors that affect tire wear.

One major factor is incorrect wheel alignment. When the wheels are not aligned to the manufacturer's specifications, it causes uneven contact with the road, leading to abnormal wear on certain parts of the tire.

Another factor is improper tire pressure. Under-inflated tires create more friction with the road, especially on the outer edges, while over-inflated tires wear more quickly in the center. Both conditions reduce tire life.

Worn-out or faulty suspension components such as bushings, shock absorbers, and ball joints also affect tire wear by allowing excessive movement and poor road contact.

Driving habits play a significant role as well. Aggressive driving, frequent hard braking, rapid acceleration, and sharp cornering accelerate the rate of tire wear and reduce overall performance.

(b) Explain the importance of maintaining correct tire inflation pressure.

Maintaining correct tire pressure ensures that the tire makes proper contact with the road surface, which is essential for balanced load distribution and stable vehicle handling.

Correct pressure improves fuel efficiency by reducing rolling resistance, which is the effort required for the tires to move forward. This results in better mileage and lower fuel costs.

It also enhances braking performance by providing consistent grip and reducing stopping distance. This is especially important during emergency braking or wet road conditions.

In addition, proper tire pressure increases tire lifespan by minimizing uneven wear patterns. This reduces the frequency of replacements and saves costs in the long run.

(c) (i) Define wheel run-out.

Wheel run-out is a measure of how much a wheel deviates from a perfectly circular rotation when it spins. It can occur in a lateral direction (side-to-side wobble) or radial direction (up-and-down bounce).

(ii) State two causes and two effects of excessive run-out.

One common cause is a bent or damaged wheel rim, which may result from hitting potholes or curbs. Another cause is improper mounting of the tire on the wheel or debris stuck between the rim and hub.

The effects include vibration in the steering wheel or entire vehicle, especially at high speeds. Another effect is premature and uneven tire wear, which compromises safety and comfort while driving.

8. (a) Outline the steps to test a vehicle battery using a hydrometer.

Begin by ensuring the engine is turned off and the battery is not under load. This gives a more accurate reading of the electrolyte condition.

Carefully remove the vent caps on each battery cell to expose the electrolyte solution. If the battery is sealed, this test cannot be performed.

Insert the hydrometer into each cell, drawing electrolyte into the float chamber until the float rises. Record the specific gravity reading for each cell.

Compare each reading with the standard full-charge value (usually around 1.265 to 1.299 at 25°C). A significantly lower value or large difference between cells indicates a weak or faulty battery.

(b) (i) What is a fusible link in vehicle electrical systems?

A fusible link is a special wire section that acts as a fuse. It is designed to melt and break the circuit when current exceeds a safe limit, protecting important components like the alternator or starter.

(ii) State two advantages of using fusible links over regular fuses.

Fusible links can tolerate short surges of high current without blowing, making them suitable for protecting circuits with temporary spikes, such as during engine cranking.

They are also more reliable in high-current applications because they are physically thicker and more resistant to vibration, heat, and wear than regular plastic fuses.

(c) Describe the operation of an alternator voltage regulator.

The voltage regulator monitors the output voltage of the alternator and adjusts it to maintain a constant level, usually around 13.5 to 14.5 volts, depending on vehicle requirements.

When the battery voltage drops due to high power consumption, the regulator increases the alternator's field current to produce more voltage. When the battery is fully charged, it reduces the field current to avoid overcharging.

This process ensures that all electrical components in the vehicle receive stable voltage for proper operation and prevents battery damage due to overvoltage.