THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATION COUNCIL OF TANZANIA

DIPLOMA IN TECHNICAL EDUCATION EXAMINATION

790 **AUTOMOBILE TECHNOLOGY**

Time: 3 Hour. **ANSWERS** **Year: 2019**

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) The practice of safety in the workshop goes beyond the knowledge of the proper use of hand tools and equipment. Explain safety precautions to be adhered to by a technician on removal and replacement of worn out brake linings and repair of wheel cylinders in the workshop.

The technician should ensure the vehicle is properly supported on jack stands to avoid accidental falls. Working under an unstable vehicle poses serious injury risks.

Before removing the brake lining, the technician must wear a dust mask or respirator to avoid inhaling brake dust, which may contain harmful asbestos particles.

All brake components should be cleaned using recommended brake cleaning fluids and not with compressed air, as this can disperse harmful dust into the air.

The technician should use appropriate tools and follow the correct sequence for disassembling and assembling brake components to avoid damaging them or causing future malfunctions.

After replacing brake linings or repairing wheel cylinders, the brake system should be properly bled to remove air and ensure full braking performance before allowing the vehicle back on the road.

Finally, the technician should wear appropriate PPE (personal protective equipment) including gloves, safety goggles, and overalls to protect against brake fluid, metal chips, and dirt.

1. (b) What are the safety precautions to be considered when using each of the following hand tools?
(i) A file
(ii) Chisel
(iii) Adjustable wrench

When using a file, ensure the handle is securely fitted to prevent the tang from injuring the hand during use. Always push the file in one direction and avoid using excessive force.

When using a chisel, wear safety goggles to protect eyes from flying metal chips. The chisel head should not be mushroomed, as it may shatter upon striking.

When using an adjustable wrench, ensure the jaws are properly adjusted to the bolt or nut size. Always pull rather than push the wrench to avoid slipping and potential hand injuries.

1. (c) Sketch and label three common frame sections applicable on vehicles.

The three common vehicle frame sections to sketch and label are:

1. Channel section
2. Box section
3. Tubular section

2. (a) (i) Briefly explain the use of reamers.

Reamers are used to finish drilled holes to an accurate diameter and to improve the surface finish by removing a small amount of material.

2. (a) (ii) Outline four types of reamers which are commonly used in a tool workshop.

Hand reamers are manually operated and used for precision work.
Machine reamers are used in drilling machines or lathes for faster and consistent results.
Taper reamers are used to ream holes with taper profiles for parts like cotter pins.
Adjustable reamers can be adjusted for slightly varying hole sizes, providing flexibility in finishing.

2. (a) (iii) What is the use of a feeler gauge in automobile workshops?

A feeler gauge is used to measure and adjust the gap between two parts, such as spark plug gaps, valve clearances, or contact breaker gaps in ignition systems.

2. (b) (i) What is the meaning of popping back as used in fuel system?

Popping back refers to a backfire occurring through the intake manifold or carburetor, usually caused by improper ignition timing, lean fuel mixtures, or intake valve problems.

2. (b) (ii) Mention four causes of popping back in a fuel system.

Incorrect valve timing may cause intake valves to open at the wrong time.
Lean fuel-air mixture can result in incomplete combustion and backfire.
Faulty spark timing such as early ignition can cause combustion to reverse.
Damaged or sticking intake valves may allow ignition pressure to escape through the intake.

2. (c) Explain the purpose of adjusting the steering angles and specifically describe how the following angles are adjusted.
(i) Castor angle
(ii) Camber angle
(iii) Toe-in angle

Steering angle adjustments ensure vehicle stability, straight-line tracking, and tire wear minimization.

The castor angle is adjusted by changing the angle of the suspension strut or the position of the upper and lower control arms to tilt the steering axis forward or backward.

The camber angle is adjusted by altering the angle of the wheel relative to the vertical axis. This is often done by modifying control arm lengths or using cam bolts.

The toe-in angle is adjusted by changing the length of the steering tie rods so the front of the tires point slightly inward or outward, affecting tire wear and tracking.

3. (a) What is meant by the term engine as used in automobile technology?

In automobile technology, an engine refers to the machine that converts chemical energy from fuel into mechanical energy. This energy is used to power the movement of the vehicle by rotating the wheels. Most commonly, internal combustion engines are used in automobiles, where combustion of air-fuel mixture occurs inside the cylinders.

3. (b) Differentiate external combustion engine from internal combustion engine and give two examples in each case.

An external combustion engine is a type of engine where the combustion of fuel takes place outside the cylinder. Heat is transferred to a working fluid such as steam which then performs mechanical work. Examples of external combustion engines include the steam engine and steam turbine.

An internal combustion engine is a type where combustion takes place within the engine cylinder itself. The high-pressure gases from the combustion process directly act on the piston or rotor to produce power. Examples include petrol engines and diesel engines.

3. (c) The Tanzania Revenue Authority rate vehicle tax payments according to engine size 'cc'. How is the engine size obtained?

Engine size in cubic centimeters (cc) is obtained by calculating the volume of all the engine cylinders. The formula used is: Engine size = $(\pi/4) \times \text{bore}^2 \times \text{stroke} \times$ number of cylinders. This gives the displacement volume swept by all pistons during one cycle.

3. (d) Briefly describe the procedures of testing and adjusting injectors in an automobile for the following job descriptions:
(i) Pressure test
(ii) Leak-off test
(iii) Spray test

In a pressure test, the injector is placed on a testing machine where fuel is pressurized and forced through the injector. The pressure at which the injector opens and sprays fuel is recorded to check if it meets the standard specification.

In a leak-off test, fuel is supplied to the injector without actuating it. If any fuel leaks through the nozzle, it indicates a defective injector which may allow uncontrolled fuel entry into the engine.

In a spray test, the injector is actuated to allow fuel through the nozzle. The spray pattern is observed for uniformity and atomization. A poor or irregular spray pattern suggests blockage or wear.

4. (a) Two common firing order of the four cylinder inline engine are 1342 and 1243. Fill the table given below when the piston move in pairs.

Cylinder Number	**1**	**2**	**3**	**4**
1st Stroke	P	C or E	E or C	I
2nd Stroke	I	P	C or E	E or C
3rd Stroke	C or E	I	P	C or E
4th Stroke	E or C	C or E	I	P

Where: P – Power stroke, C – Compression stroke, E – Exhaust stroke, I – Induction stroke.

4. (b) Explain the induction stroke on a four stroke spark ignition engine (S.I.E).

During the induction stroke, the intake valve opens and the piston moves downward from the top dead center to the bottom dead center. This movement creates a vacuum in the cylinder, drawing in a mixture of air and fuel into the combustion chamber.

4. (c) Briefly explain four distinguishing features between four stroke engine and two stroke engine.

A four stroke engine completes its power cycle in four piston strokes: intake, compression, power, and exhaust. A two stroke engine completes the same cycle in just two strokes.

Four stroke engines have valves operated by a camshaft, while two stroke engines use ports to control intake and exhaust.

Four stroke engines are more fuel-efficient and produce less pollution compared to two stroke engines, which are known to emit more unburned fuel and oil.

Lubrication in a four stroke engine is separate from fuel and uses engine oil. In contrast, two stroke engines mix oil with fuel for lubrication.

5. (a) Briefly explain four basic differences between petrol and diesel engines.

Petrol engines use a spark plug to ignite a pre-mixed air-fuel mixture, while diesel engines compress air to a high pressure and temperature before injecting fuel for combustion.

Petrol engines typically run at higher revolutions per minute (RPM) and are smoother and quieter. Diesel engines operate at lower RPM and are noisier with more vibration.

Petrol engines use lower compression ratios and lighter construction. Diesel engines use high compression ratios and are built stronger to handle higher pressures.

Diesel engines are generally more fuel-efficient and suitable for heavy-duty vehicles, while petrol engines are lighter and more common in small cars.

5. (b) An engine develops a torque of 90 NM at the flywheel at a speed of 1500 rev/min and drives through a gear box which has a low gear ratio of 3:1. If the efficiency of the drive is 90%, what is the torque and speed of the propeller shaft?

Given:
Torque at flywheel = 90 Nm
Speed = 1500 rpm
Gear ratio = 3:1
Efficiency = 90% = 0.9

Speed at propeller shaft = 1500 × 3 = 4500 rpm
Torque at propeller shaft = (90 × 0.9) / 3 = 81 / 3 = 27 Nm

Therefore, the speed of the propeller shaft is 4500 rpm and the torque is 27 Nm.

5. (c) What are the four ideal requirements for an anti-freeze mixture?

The anti-freeze mixture should have a low freezing point to prevent coolant from freezing in cold temperatures.

It should also have a high boiling point to prevent overheating of the engine during high-temperature conditions.

The mixture must provide corrosion protection to internal engine parts like the radiator, water pump, and engine block.

It should be chemically stable and compatible with all materials in the cooling system, including rubber and metal.

6. (a) Why adjustment is provided in the differential for shifting the pinion in or out in the housing, or for shifting the crown wheel right or left to the pinion?

The adjustment allows proper meshing and backlash between the pinion and the crown wheel. This ensures smooth transmission of power, reduces gear noise, and minimizes wear. Improper backlash can cause excessive gear wear or gear damage.

6. (b) (i) What is the release bearing as applied on clutch operation

The release bearing is a component in the clutch system that allows the driver to engage and disengage the clutch. It transmits the force from the clutch pedal to the pressure plate when the pedal is pressed.

6. (b) (ii) Briefly explain how is release bearing engaged when the clutch pedal is pressed?

When the clutch pedal is pressed, it moves the clutch fork which pushes the release bearing against the diaphragm spring. This action causes the pressure plate to move away from the clutch disc, disengaging the engine from the gearbox.

6. (b) (iii) Briefly explain how is the torque released from the engine to the gearbox?

When the clutch is engaged, the clutch disc is held firmly between the flywheel and the pressure plate. This enables torque from the rotating flywheel to be transferred directly to the clutch disc and then to the gearbox input shaft.

6. (b) (iv) What happen when release bearing is left free as applied on clutch operation?

If the release bearing is left free, it may stay in slight contact with the diaphragm spring, leading to continuous friction and eventual bearing wear. Over time, this can cause bearing failure or clutch disengagement issues.

6. (c) What are the five friction lining property requirements on the clutch plate construction?

The lining must have a high coefficient of friction to effectively transmit torque.

It should be resistant to heat and have good thermal conductivity to dissipate heat.

It should be durable and able to withstand repeated engagement and disengagement.

The lining should resist oil and grease contamination which can reduce friction.

It must provide consistent friction under varying operating conditions and temperatures.

6. (d) (i) Where is the location of the thermostat on a motor car?

The thermostat is usually located in a housing at the engine end of the upper radiator hose, between the engine and the radiator.

6. (d) (ii) Briefly explain how to test the thermostat.

Remove the thermostat from the engine and place it in hot water. Heat the water and observe if the valve begins to open at the rated temperature (usually around 80–90°C). If it does not open, or fails to close when cooled, it is faulty.

7. (a) What are the four functions of the front axle in a vehicle?

The front axle supports the weight of the front part of the vehicle including the engine and cabin.

It enables steering by connecting the steering mechanism to the wheels.

It absorbs shocks and vibrations from road irregularities, improving ride comfort.

It maintains the alignment and stability of the front wheels for better handling.

7. (b) (i) Explain the operation and construction of rack and pinion steering.

In rack and pinion steering, the circular motion of the steering wheel rotates a small gear called the pinion. This pinion meshes with a flat toothed bar called the rack. As the pinion turns, it moves the rack side to side, which turns the vehicle's wheels left or right. It is compact and offers precise control.

7. (b) (ii) Outline three main functions of delivery valve.

The delivery valve prevents fuel from returning to the pump once injected, ensuring one-way flow.

It helps maintain pressure in the injector line for consistent fuel delivery.

It reduces pressure waves and ensures precise fuel timing during engine operation.

7. (c) Counter check and compute by tabulation the cost estimates of engine parts upon dismantling 5V2 – FE engine model, four cylinder inline engine from some of the selected parts as follows:

Part Description	Unit Cost (Tsh)	Quantity	Total (Tsh)
Engine overhaul kit	250,000	1	250,000

Main bearing set	25,000	1	25,000
Connecting rod bearing set	22,500	1	22,500
Piston rings set	65,000	1	65,000
Camshaft bearing	12,000	1	12,000
Valve inlet	15,000	2	30,000
Valve exhaust	16,000	2	32,000
Rocker shaft	21,000	1	21,000
Sleeve	51,400	1	51,400
Thrust bearing (pair)	25,000	2 pairs	50,000
Total			**559,900**

8. (a) What is the effect of the following parts on the leaf spring?
(i) Worn out bushes
(ii) Broken centre bolt
(iii) Loose eye of spring
(iv) Broken shackle

Worn out bushes result in increased noise and vibration during movement and poor suspension performance.

A broken centre bolt allows the leaf spring leaves to shift out of alignment, causing instability and rough handling.

A loose spring eye leads to excessive lateral movement, reducing vehicle control and affecting alignment.

A broken shackle prevents the spring from flexing properly, causing poor ride comfort and possible suspension failure.

8. (b) (i) Outline five causes of pre-ignition in an engine.

Overheated spark plugs can ignite the air-fuel mixture before the spark occurs.

Carbon build-up in the combustion chamber retains heat and causes early ignition.

Incorrect ignition timing leads to early combustion of the mixture.

Using low-octane fuel causes detonation under compression.

Overheating of the engine raises cylinder temperatures and triggers pre-ignition.

8. (b) (ii) Explain how a condenser is tested.

A condenser is tested using a multimeter or condenser tester. Disconnect the condenser and measure its resistance. A good condenser will show a rising resistance and then drop. If the meter shows constant zero or infinite resistance, the condenser is faulty.

8. (c) Describe the procedure for ignition timing in an automobile.

Start the engine and let it reach normal operating temperature. Connect a timing light to the number one spark plug wire. Shine the timing light on the timing marks on the crankshaft pulley while the engine is idling. Observe whether the mark aligns with the specified timing degree. If it does not, loosen the distributor and rotate it slightly to adjust the timing. Once aligned, retighten the distributor and recheck to confirm correct timing.