THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

093 MOTOR VEHICLE MECHANICS

Time: 3 Hours **ANSWERS** **Year: 2012**

Instructions

1. This paper consists of section A, B and C.

2. Answer all questions in section A and B and three questions from section C.

1. (i) During the suction stroke of spark ignition engine, the cylinder is charged with
A air only
B diesel/air mixture
C diesel only
D exhaust gas
E petrol/air mixture

Answer: E – In spark ignition (petrol) engines, the air-fuel (petrol/air) mixture is drawn into the cylinder during the suction stroke.

(ii) The component for building up pressure sufficient to atomize the diesel fuel is called
A mechanical fuel pump
B electric fuel pump
C engine pump
D vacuum pump
E injector pump

Answer: E – The injector pump compresses fuel to high pressure and injects it into the cylinder for atomization in diesel engines.

(iii) What does the term 'firing order' stand for?
A Order of pistons arrangements
B Periods of firing point
C Firing sequence of multi-cylinders
D Firing intervals of multi-cylinders
E Rotation of a distributor

Answer: C – Firing order is the sequence in which spark plugs ignite the air-fuel mixture in a multi-cylinder engine.

(iv) The hydrostatic suspension is the combination of
A rubber and fluid under pressure
B plastic and fluid under pressure
C metal and fluid under pressure
D phosphor and fluid under pressure
E zinc/and fluid under pressure

Answer: C – Hydrostatic suspension uses metal springs in combination with fluid under pressure for smooth vehicle support and stability.

(v) The spark ignition engine distributor is driven by
A distributor shaft

B camshaft gear
C rocker shaft
D ignition timing
E camshaft

Answer: E – The distributor in a spark ignition engine is driven by the camshaft, which synchronizes spark timing with valve operation.

(vi) The heating element of the heater plug is located inside the
A cylinder head
B combustion chamber
C sump
D crankcase
E engine block

Answer: B – The heating element of the heater plug (glow plug in diesel engines) is located in the combustion chamber to assist cold starting.

(vii) What is the cause of a low engine oil pressure in motor vehicle?
A Worn engine bearings
B Strong relief valve spring
C High sump speed
D Tight engine bearing
E Dirty pump

Answer: A – Worn engine bearings increase oil clearance, reducing oil pressure in the lubrication system.

(viii) Which of the following drives the pump for lubrication in motor vehicle engine?
A Half shaft
B Distributor
C Camshaft
D Rotor
E Rocker shaft

Answer: C – The camshaft drives the oil pump in most engines through a gear or chain connection.

(ix) Locking devices can be classified as follows:
A Single and double
B Negative and positive
C Flat and round
D Split and stolid
E Frictional and positive

Answer: E – Locking devices are classified into frictional (use resistance) and positive (mechanical locking) types.

(x) Over tightening the water pump drive belt causes the following defect:
A Bearing failure
B Radiator problem
C Engine failure
D Drive belt sleeper
E Thermostat failure

Answer: A – Excessive tension on the drive belt can damage water pump bearings, leading to failure.

2. Write six requirements of a wheel alignment.
– Correct toe-in/toe-out
– Proper camber angle
– Proper caster angle
– Steering axis inclination
– Wheel tracking
– Equal tyre pressure

3. (a) What does the term ‘gear’ means as employed in a motor vehicle?
A gear is a toothed wheel used to transmit torque and change speed or direction of motion between shafts.

(b) What is the function of the sliding joints of a propeller shaft?
They allow for length variation and accommodate movement due to suspension action or road conditions.

(c) State the function of a brake master cylinder.
It converts mechanical force from the brake pedal into hydraulic pressure to activate the braking system.

4. (a) Name three advantages of tubeless tyres.
– Slow air leakage when punctured
– Better heat dissipation
– Lighter weight and improved fuel economy

(b) What are the three functions of a steer’s damper?
– Reduces steering wheel vibration
– Absorbs shocks from road surface
– Enhances vehicle handling and control

5. (a) List two types of engine oil filters.
– Full flow filter

– Bypass filter

(b) List two types of lubrication system in common use on internal combustion engines.
– Wet sump system
– Dry sump system

(c) Enumerate two types of hacksaw frames.
– Fixed frame
– Adjustable frame

6. (a) What is a wheel with regard to motor vehicle?
A wheel is a circular component mounted on the axle that supports the tyre and rotates to move the vehicle.

(b) Why are soft metal caps placed over steel jaws of the bench vice?
To protect soft or delicate components from damage during clamping and prevent scratches.

7. (a) Explain the importance of a frame as a main vehicle layout.
The frame is the backbone of the vehicle, supporting engine, transmission, suspension, and body. It maintains structural integrity and absorbs road shocks.

(b) Sketch the following sections of the motor vehicle frame.
(i) Channel section – U-shaped cross-section.
(ii) Box section – Rectangular or square hollow structure.
8. (a) Define the 'ignition intervals' of reciprocating engines.
It refers to the interval or degrees of crankshaft rotation between two successive ignitions in different cylinders.

(b) Name two types of shock absorbers.
– Telescopic shock absorber
– Lever type shock absorber

(c) Define 'viscosity' with regard to motor vehicle mechanics.
Viscosity is the measure of a fluid's resistance to flow. Higher viscosity means thicker oil, essential for engine lubrication.

9. Sketch a diagram of crankshaft and label its three common parts.
Parts to be labeled:
– Main journal
– Crank pin
– Counterweight

10. Identify and briefly explain the following tools in Figure 1, as included in a motor vehicle.
(i) Wheel spanner or cross spanner – Used to tighten or loosen wheel nuts.

(ii) Triangular warning sign – Used as a reflective emergency warning sign to alert other drivers when a vehicle breaks down.

11. Name and define two categories of suspension system.
– Dependent suspension: Both wheels are connected; movement on one side affects the other.
– Independent suspension: Each wheel moves independently, improving ride comfort and handling.

12 (a) (i) What is the 'brake fade' with regard to car braking operations?

Brake fade is a condition where the effectiveness of the braking system reduces or fails temporarily due to overheating of brake components, leading to a loss of braking power.

(ii) Explain briefly how is brake fade in 12 (a)(i) arise?

Brake fade arises due to excessive and continuous braking, especially during long downhill drives. This causes high temperatures which reduce the coefficient of friction between brake linings and drum or disc surfaces, leading to decreased braking efficiency.

(iii) Why brake fade is more prevalent in drum brakes than in disc brakes?

Drum brakes have poor heat dissipation due to their enclosed design, making them prone to overheating.
Disc brakes have better ventilation and exposure to airflow, allowing quicker heat dissipation and reducing brake fade.

(b) (i) Name the parts of the drum brake indicated in Figure 2:

a – Return spring
b – Wheel cylinder
c – Brake shoe
d – Brake drum

(ii) How is leading and trailing shoe brake differ from two leading shoe brake?

In a leading and trailing shoe brake, one shoe is leading and receives more braking force, while the other is trailing and less effective.
In a two leading shoe brake system, both shoes act as leading during forward motion, resulting in better braking force and efficiency.

(iii) Explain briefly three advantages of two leading shoe braking over leading and trailing shoe brake.

Two leading shoe brakes provide greater braking efficiency in forward motion.
Both shoes exert equal force on the drum, reducing uneven wear.
Improved stopping power due to both shoes utilizing self-servo action.

13 (a) (i) What is the mixture strength with regard to vehicle engine operation?

Mixture strength refers to the proportion of air to fuel in the air-fuel mixture supplied to the engine. It determines combustion quality, engine performance, and fuel economy.

(ii) Explain briefly three functions of a carburetor.

Carburetor mixes air and fuel in the correct ratio for combustion.
It regulates engine speed by controlling the amount of air-fuel mixture.
It atomizes the fuel for better combustion efficiency.

(iii) Differentiate between direct and indirect fuel injection in diesel engine.

In direct injection, fuel is sprayed directly into the combustion chamber.
In indirect injection, fuel is injected into a pre-combustion chamber before entering the main chamber.

(b) (i) Label the parts of mechanical fuel pump in Figure 3:

a – Inlet valve
b – Fuel inlet pipe
c – Outlet valve
d – Diaphragm
e – Cam lever

(ii) Explain the operation of the mechanical fuel pump.

As the camshaft rotates, it moves the cam lever up and down, flexing the diaphragm. This creates suction that draws fuel through the inlet valve. On the return stroke, the diaphragm compresses, pushing fuel through the outlet valve toward the carburetor.

(c) (i) What is an ‘air cleaner’ as encountered on carbureted motor vehicle engine?

An air cleaner is a device used to filter dust and debris from incoming air before it enters the carburetor and engine combustion chamber.

(ii) Describe how air cleaner is fitted on carbureted engine.

The air cleaner is mounted on top of the carburetor and sealed with a cover. Air enters through the housing, passes through the filter element, and enters the carburetor.

(d) (i) Define “muffler” and state its function with regards to exhaust system.

A muffler is a component of the exhaust system designed to reduce engine noise and control back pressure. It absorbs sound waves and dissipates exhaust energy.

(ii) Briefly explain how exhaust gas enters and leaves in muffler of reverse flow type with slotted holes.

Exhaust gas enters the muffler chamber through an inlet pipe. It passes through perforated tubes or slotted holes, reflecting and absorbing sound waves. The gas then exits through the outlet pipe after noise reduction.

14 (a) (i) State the use of thermostat in a motor vehicle.

The thermostat regulates engine temperature by controlling coolant flow between engine and radiator.

(ii) Why the thermostat closes when the cold engine is started?

The thermostat remains closed during cold start to allow the engine to reach optimal operating temperature quickly by preventing coolant flow.

(iii) How water/coolant is cooled in the radiator?

Coolant flows through radiator tubes surrounded by fins. Air passes over the fins, removing heat from coolant and reducing its temperature before returning to the engine.

(b) Explain two types of radiators with regard to the way water flows through it and its water tanks.

Down-flow radiator has top and bottom tanks; coolant flows vertically from top to bottom.
Cross-flow radiator has side tanks; coolant flows horizontally across the core.

(c) (i) What is the purpose of engine fan?

The engine fan increases airflow through the radiator to enhance cooling, especially during low-speed or idling.

(ii) How is the engine fan mounted and driven?

The engine fan is mounted on the front of the engine and driven by a belt connected to the crankshaft pulley or operated electrically in modern vehicles.

(d) (i) State the purpose of tire on motor vehicle.

Tires provide traction, absorb shocks, support vehicle weight, and enable steering and braking.

(ii) Describe two types of the tires commonly employed on motor vehicle.

Tube tire has an inner tube filled with air and fitted inside the tire.
Tubeless tire holds air within the tire casing and does not require an inner tube.

(e) Figure 4 shows types of engine cylinder liners; differentiate them with regards to installation and water jacket.

(i) Dry liner – Press-fitted into cylinder block and does not contact coolant directly.
(ii) Wet liner – Comes in direct contact with coolant and is sealed with rubber rings or gaskets for leak prevention.

15 (a) (i) Briefly state seven possible causes of the oil leak as part of the transmission fault and suggest the remedial to be taken after diagnosis.

Worn oil seals – Replace damaged seals with new ones.
Loose bolts or fasteners – Tighten all bolts to the recommended torque settings.
Cracked or damaged gearbox casing – Repair or replace the casing.
Overfilled transmission fluid – Drain excess fluid and fill to correct level.
Damaged gaskets – Replace with new gaskets to ensure proper sealing.
Blocked breather valve – Clean or replace the breather to allow pressure relief.
Worn or damaged driveshaft oil seal – Replace the seal and inspect shaft for wear.

(ii) Briefly state three causes with their remedial of gears clash in shifting in the transmission system.

Worn or damaged synchronizer rings – Replace synchronizer rings for smooth engagement.
Incorrect clutch adjustment – Adjust clutch linkage or hydraulics for full disengagement.
Low transmission fluid level – Top up transmission fluid to ensure smooth gear shift.

(b) Briefly explain four reasons why the propeller shaft is divided into two pieces and joined by centre bearing.

To reduce vibrations caused by long shafts and improve smoothness.
To allow flexibility and better alignment with moving suspension parts.
To reduce bending stress on the shaft and improve reliability.
To facilitate better torque transmission over long distances with support from center bearing.

(c) Figure 5 shows operations of the four-stroke cycle engine.

(i) Identify the stroke in each figure:

Figure 5 (i) – Intake stroke
Figure 5 (ii) – Compression stroke
Figure 5 (iii) – Power stroke
Figure 5 (iv) – Exhaust stroke

(ii) Explain the operation of each cycle shown in Figure 5.

Intake stroke (i): Piston moves downwards, intake valve opens, and air-fuel mixture enters the cylinder.

Compression stroke (ii): Piston moves upward, compressing the air-fuel mixture with both valves closed.

Power stroke (iii): Spark plug ignites the compressed mixture, causing explosion that pushes piston downwards.

Exhaust stroke (iv): Piston moves upward again, exhaust valve opens, and burnt gases are expelled from the cylinder.

16 (a) Name the parts of the front axle components and steering linkage indicated by the numbers in Figure 6:

1 – Stub axle
2 – Steering arm
3 – Tie rod end
4 – Tie rod
5 – Axle beam
6 – Shock absorber
7 – Leaf spring

(b) (i) What is king pin inclination?

King pin inclination is the inward tilt of the steering axis from vertical, when viewed from the front. It aids in steering stability and self-centering of the wheel.

(ii) State the purpose of king pin inclination.

It reduces steering effort, improves directional control, and helps the wheels return to straight position after turning.

(iii) With the aid of diagram, briefly define and state the function of the following:

Camber angle – Angle between the vertical line and the centerline of the wheel when viewed from front. It affects tire wear and cornering grip.

Caster angle – Angle between the steering axis and vertical axis when viewed from the side. It helps in directional stability and self-centering of steering.