THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

093 MOTOR VEHICLE MECHANICS

Time: 3 Hours **ANSWERS** **Year: 2011**

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) In a four wheel drive, the number of gearboxes are
A Six
B Two
C Four
D Three
E Five

Answer: B – A typical four-wheel-drive system has two gearboxes: the main gearbox and the transfer gearbox for power distribution.

(ii) What is the theoretically quantity of air required for the combustion of 1 kg of fuel?
A 10 kg
B 16.7 kg
C 14.5 kg
D 17.4 kg
E 18.9 kg

Answer: B – Theoretically, about 16.7 kg of air is required to burn 1 kg of fuel completely under stoichiometric conditions.

(iii) The effect of water in lubricating oil is the formation of
A Decomposition
B Oxidation
C Dilution
D Sludge
E Mixing

Answer: D – Water in oil reacts with contaminants and forms sludge, reducing lubrication and causing engine wear.

(iv) In the fuel injection pump of a diesel engine, the fuel injection timing is adjusted by adjusting the
A Delivery valve
B Rotation of plunger
C List of plunger
D Pump cam shaft
E Tappets

Answer: D – Timing in diesel engines is controlled by the fuel pump camshaft, which governs the injection stroke timing.

(v) Which of the following is not a part of alternator?
A Roller
B Rotor

C Voltage regulator
D Rectifier bridge
E Stator

Answer: A – Rollers are not part of an alternator. Alternator parts include rotor, stator, rectifier bridge, and voltage regulator.

(vi) Loss of engine compression can result from
A Defect fan belt
B Loose valves
C Excessive tappet clearance
D Worn out rings
E Wrong timing

Answer: D – Worn out piston rings allow gas leakage past the piston, reducing compression and engine power.

(vii) The capacity of a battery is usually expressed in terms of
A Volts
B Current in amperes
C Weight
D Ampere-hours
E Watts

Answer: D – Battery capacity is measured in ampere-hours, indicating how much current a battery can supply over time.

(viii) Brake shoes of a braking system are made of
A Pressed steel
B Cast aluminium
C Pressed plastic fibre or aluminium
D Pressed steel or cast aluminium
E Pressed steel or plastic fibre

Answer: E – Brake shoes are commonly made of pressed steel for structure and plastic fibre or composite materials for friction lining.

(ix) What happens to the clutch when the pedal is depressed?
A The pressure plate comes closer to the flywheel.
B The pressure plate moves away from the flywheel.
C The driven plate moves towards the flywheel.
D The driven plate slows down to flywheel speed.
E The pressure plate and driven plate move closer to the flywheel.

Answer: B – When the clutch pedal is pressed, the pressure plate is released from the driven plate, moving away from the flywheel, disengaging power.

(x) The purpose of a thermostat in an engine cooling system is to
A Allow the engine to warm up quickly
B Prevent the coolant from boiling
C Pressurise the system to raise the boiling point
D Indicate to the driver the coolant temperature
E Raise the freezing point of the coolant

Answer: A – Thermostat remains closed at startup to help engine warm up faster. It opens later to allow coolant circulation once optimal temperature is reached.

2. (a) Mention two factors which would increase the voltage required to produce a spark at the sparking plug.
– Wider spark plug gap
– Higher cylinder pressure
(b) What happens in piston number 4, when piston number 1 in a four-cylinder in-line four-stroke engine is performing the power stroke?
Piston number 4 is in the exhaust stroke while number 1 is in power stroke. This follows the 1-3-4-2 firing order.

3. Explain briefly three disadvantages of water used as cooling medium in an engine.
– Water causes corrosion to metal parts.
– Water can freeze in cold conditions and cause damage.
– Water evaporates quickly at high temperature, causing coolant loss.

4. State three types of the live axles as referred to motor vehicle.
– Semi-floating axle
– Three-quarter floating axle
– Full floating axle

5. Explain briefly three purposes of the gear box.
– To vary torque and speed depending on road conditions.
– To enable reverse movement.
– To disconnect engine from wheels while idling.

6. Mention three probable causes of lack of engine power.
– Low compression pressure
– Blocked fuel filter or poor fuel supply
– Ignition timing misadjusted

7. Indicate when a driver should use the clutch of a motor vehicle.
– When starting or stopping the engine
– During gear changing
– To control speed in traffic congestion or slope

8. Mention six probable causes of engine overheats.
– Low coolant level
– Faulty radiator
– Clogged cooling system
– Broken fan belt
– Defective water pump
– Faulty thermostat

9. What are the three probable causes of dragging brakes?
– Sticking brake caliper or wheel cylinder
– Weak or broken return spring
– Improper brake pedal free play

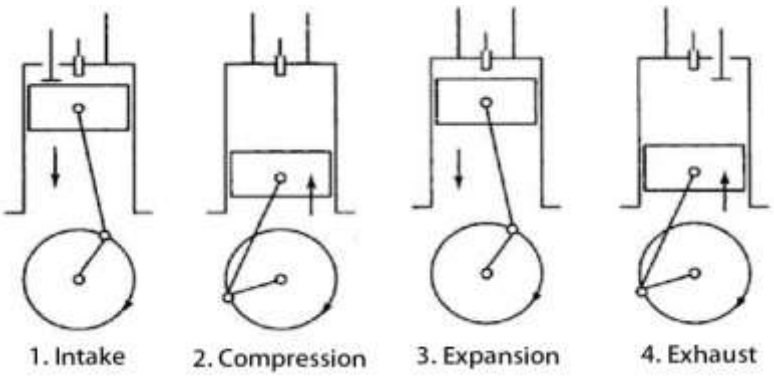
10. (a) Explain briefly two main functions of a carburettor.
– Mix air and fuel in correct ratio
– Deliver the mixture to the engine under varying loads and speeds

(b) Explain briefly why in modern cars the rear wheels are fitted with one ‘leading’ and one ‘trailing’ drum shoes brake.
– Leading shoe increases braking force using self-servo effect.
– Trailing shoe stabilises the braking action.
– This combination improves overall braking efficiency and balance.

11. Mention three main clutch faults.
– Clutch slipping
– Clutch dragging
– Clutch juddering

12. With the aid of sketches explain the operations of the four-stroke cycle engine.

The four-stroke cycle engine consists of four strokes: intake, compression, power, and exhaust.
Intake stroke: The piston moves down, intake valve opens, and air-fuel mixture enters the cylinder.
Compression stroke: The piston moves up with both valves closed, compressing the mixture.
Power stroke: Spark plug ignites the mixture, pushing the piston downward and generating power.
Exhaust stroke: The piston moves up, exhaust valve opens, and burnt gases are expelled.



13 (a) Explain the operation of a hydraulic braking system of a motor vehicle.

When the driver presses the brake pedal, it pushes a piston inside the master cylinder, which forces brake fluid through hydraulic lines to the wheel cylinders or calipers. The fluid pressure moves pistons in the wheel cylinders, pressing brake shoes or pads against the brake drums or discs. This friction slows down or stops the vehicle. When the pedal is released, return springs bring the brake components back, and fluid returns to the master cylinder.

(b) A simple single plate clutch transmits a torque of 80 Nm. Six springs supply the clamping force. What force must each spring exert if the mean radius of the friction plate is 200 mm? Take the coefficient of friction to be 0.4.

Torque = $\mu \times F \times r$
$80 = 0.4 \times F \times 0.2$
$F = 80 \div (0.4 \times 0.2) = 80 \div 0.08 = 1000$ N
Force per spring = $1000 \div 6 = 166.67$ N

(c) Describe the procedure for bleeding a braking system of a motor vehicle.

Fill the master cylinder reservoir with fresh brake fluid. Attach a clear hose to the bleeder valve on the wheel cylinder or caliper and place the other end in a container. Have an assistant press and hold the brake pedal. Open the bleeder valve to let air and fluid escape. Close the valve and repeat the process until only fluid comes out without air bubbles. Continue for all wheels starting from the furthest from the master cylinder.

14 (a) Explain the safety precautions to be observed in the workshop with regard to:

(i) When using small tools – Use tools for their intended purpose, ensure they are in good condition, and handle them carefully to avoid injury.

(ii) Suitable clothes and footwear – Wear tight-fitting clothes and closed-toe safety shoes to avoid entanglement and foot injuries from falling objects.

(iii) Protective and dark goggles – Use eye protection to guard against flying debris, sparks, or chemical splashes during operations like grinding or welding.

(iv) When working with other persons – Maintain safe distances, communicate clearly, and be aware of each other's tasks to prevent accidents or interference.

(b) Define and explain the function of each of the following:

(i) Flywheel – A rotating mass that stores energy from power strokes and releases it during other strokes, maintaining engine balance and smooth operation.

(ii) Connecting rod – Connects the piston to the crankshaft and transmits reciprocating motion to rotary motion.

(iii) Crankshaft – Converts reciprocating motion of pistons into rotational motion to drive other engine parts or the drivetrain.

(iv) Damper (Shock absorber) – Controls the rebound of suspension springs and dampens vibration, improving ride comfort and handling.

15 (a) Explain four types of steering gearboxes which are commonly used.

Worm and sector gearbox uses a worm gear meshed with a sector gear for transmitting motion to the steering linkage.

Worm and roller gearbox uses a roller moving along a worm gear, reducing friction for smoother steering.

Recirculating ball gearbox uses ball bearings between the worm and nut to minimize wear and provide smooth operation.

Rack and pinion gearbox uses a pinion on the steering shaft that moves a linear rack to steer the wheels directly.

(b) Briefly explain four functions of the engine oil as used in a motor vehicle.

Engine oil reduces friction between moving parts and prevents metal contact.

It cools the engine by carrying away heat from frictional areas.

It acts as a cleaning agent by suspending contaminants and preventing sludge buildup.

It provides a sealing effect between piston rings and cylinder walls to enhance compression.

16 (a) What is a Cam?

A cam is a rotating or sliding mechanical component that converts rotary motion into reciprocating motion. In engines, it controls valve timing by pushing the valve mechanism.

(b) Figure 1 is a view of valve-operating mechanism assembly. Give the name of the parts indicated by number 1 to 9.

1. Camshaft
2. Cam lobe
3. Tappet or valve lifter
4. Push rod
5. Rocker arm
6. Valve spring retainer
7. Valve stem
8. Valve spring
9. Valve head

(c) Describe the operating processes of a valve mechanism assembly in Figure 1.

As the camshaft rotates, the cam lobe pushes the tappet upward, transferring motion through the push rod to the rocker arm. The rocker arm pivots and presses down the valve stem, opening the valve. When the cam lobe rotates away, the spring pushes the valve back to its closed position, completing the cycle.

(d) Explain four methods of securing the piston pin to the piston or connecting rod.

Press-fit method involves pressing the pin tightly into the connecting rod small end.

Fully floating method allows the pin to rotate freely within both piston and connecting rod with locking clips on both ends.

Semi-floating method secures the pin to either the piston or connecting rod, allowing free movement at the other end.

Circlip or snap ring method uses retaining rings in grooves to prevent the pin from moving axially.