THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

093 MOTOR VEHICLE MECHANICS

Time: 3 Hours **ANSWERS** **Year: 2004**

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) For the best utilization of fuel, in the engine cylinder, the air supply should be
A about 10% surplus
B about 25% surplus
C chemically correct
D 5 to 10% deficient
E 15 to 20% deficient

Answer: A – About 10% surplus air ensures complete combustion of fuel, preventing unburned fuel loss and reducing emissions, which optimizes fuel utilization.

(ii) In a force feed lubrication system the device used to guard against excessive oil pressure is known as
A release chamber
B balancer
C relief valve
D stop valve
E pressure actuator

Answer: C – A relief valve protects the engine from damage by releasing excess oil back to the sump when oil pressure exceeds safe limits.

(iii) In fuel injection pumps for diesel engines, the effective pressure strokes of the plungers in the fuel injection pump are regulated by means of a
A fuel pump
B control rack
C needle valve
D stop valve
E check valve
Answer: B – The control rack adjusts the amount of fuel delivered by changing the plunger stroke in the fuel injection pump.

(iv) Which one of the following is not a part of the hydraulic braking system?
A Master cylinder
B Wheel cylinder
C Brake pedal
D Hand brake mechanism
E Brake shoe

Answer: D – The hand brake mechanism is mechanical, not hydraulic. It operates via cables, not brake fluid pressure.

(v) To avoid chances of misalignment the bearing generally used is
A radial
B axial

C taper roller
D self aligning
E double row ball

Answer: D – Self-aligning bearings accommodate misalignment between the shaft and housing, reducing stress and wear.

(vi) A two stroke engine is generally preferred to a four stroke engine because
A its fuel consumption is low
B shocks and vibrations are less
C it can be easily controlled
D its size is smaller
E it can be easily started

Answer: D – Two-stroke engines are more compact due to fewer parts and the absence of a valve mechanism, making them suitable for light, portable machines.

(vii) Exhaust gas leakage into the cooling system is most likely due to a defective
A cylinder head gasket
B manifold gasket
C water pump
D radiator
E engine sump

Answer: A – A damaged cylinder head gasket allows combustion gases to leak into the cooling system, causing overheating and pressure build-up.

(viii) A fuse in an electrical circuit "blows" as a result of a high
A voltage caused by a short circuit
B current flow caused by a short circuit
C voltage caused by an open circuit
D current flow caused by an open circuit
E current flow always from an open circuit

Answer: B – Fuses are designed to break the circuit when current exceeds a safe level, usually due to a short circuit which increases current flow rapidly.

(ix) The symptom of "failure of the clutch plates to separate" is
A odour emitted from the clutch
B vibration when the vehicle moves off
C difficulty in obtaining first gear without noise
D noise when the engine is pulling hard
E leakage of the clutch fluid

Answer: C – If clutch plates fail to separate, the transmission cannot disengage from the engine, making gear changes noisy and difficult.

(x) Extra care must be taken when removing a modern radiator cap from a hot engine because
A the seal can be damaged
B the risk of scalding
C the cooling system pressure is lower than that of the atmosphere
D the sudden increase in pressure can damage the radiator
E there can be sudden increase in atmospheric pressure
Answer: B – Removing a radiator cap from a hot engine can release pressurized steam and boiling coolant, causing severe burns.

2. What is the purpose of the capacitor in a coil ignition system?
The capacitor, or condenser, absorbs the surge of current when the contact points open in the ignition coil's primary circuit. This prevents arcing across the contact points, allows quick collapse of the magnetic field, and ensures a strong spark at the plug.

3. When comparing two oils of viscosities SAE 20 and SAE 40, which one has the highest viscosity?
SAE 40 has higher viscosity than SAE 20. Higher viscosity means the oil is thicker and flows slower, offering more resistance but better lubrication at high temperatures.

4. What is happening below the piston of a two-stroke engine at the instant when the spark occurs?
As the spark ignites the fuel-air mixture in the combustion chamber above the piston, below the piston, the fresh air-fuel mixture is being compressed in the crankcase, preparing to be transferred into the combustion chamber during the next cycle.

5. How can you obtain a direct drive in a gearbox?
Direct drive is obtained when the input and output shafts of the gearbox are locked together, usually by engaging a gear where the gear ratio is 1:1. This means the engine and drive shaft rotate at the same speed, common in top gear.

6. What is the function of the differential when a vehicle turns a corner?
The differential allows the drive wheels to rotate at different speeds. During cornering, the outer wheel must cover more distance than the inner wheel, so the differential permits speed variation while still transmitting power.

7. What type of tyres has a slow deflation when punctured and offers a considerable resistance to the side deflection when the vehicle is cornered?
Tubeless radial tyres deflate slowly when punctured because air escapes gradually and they have strong sidewalls that resist lateral deflection, providing better cornering stability.

8. How is the inlet valve opened and closed?
The inlet valve is opened by the action of the camshaft, which pushes the valve open through the cam follower and rocker arm. It is closed by the spring attached to the valve, which pulls it shut once the cam lobe rotates away.

9. In a transmission system, if the reverse gear slips out, what are the three probable causes?
– Worn or damaged gear teeth which fail to lock properly.
– Weak or damaged selector fork or spring.
– Misalignment or incorrect adjustment of gear linkage.
10. What is an independent front suspension system (I.F.S)?
Independent Front Suspension (IFS) is a system where the front wheels move independently of each other. Unlike rigid axle suspension, it provides better ride comfort and handling by reducing unsprung weight and improving tyre contact with the road.

11. What is a dry system finger pump component?
A dry system finger pump component is a mechanical fuel pump that uses flexible fingers or diaphragms to pump fuel without immersing internal parts in liquid fuel. It relies on reciprocating movement and spring-loaded diaphragms or fingers to transfer fuel from the tank to the engine.

12. Name four (4) angles which are often used to describe the steering geometry.

Camber angle refers to the inward or outward tilt of the wheels when viewed from the front of the vehicle. It affects tire contact with the road and influences tire wear and handling performance.

Caster angle is the angle formed by the steering axis when viewed from the side of the vehicle. It affects the self-centering ability of the steering and vehicle stability during motion.

Kingpin inclination is the inward tilt of the steering axis towards the vertical axis of the wheel when viewed from the front. It assists in reducing steering effort and helps in returning the steering wheel to the center position.

Toe angle describes the direction the wheels point relative to the vehicle's centerline when viewed from above. Toe-in or toe-out alignment affects tire wear and steering response.

13. State the names of components which perform each of the following:

(a) The spark plug ignites the petrol-air mixture in the cylinders. It delivers an electric spark to initiate combustion inside the engine.

(b) The cut-out relay or diode prevents the discharge of the battery when the vehicle is at rest by isolating the battery from the rest of the system.

(c) The fuse prevents damage to the cable due to overloading by breaking the circuit in case of excessive current flow.

(d) The alternator supplies current to charge the battery during engine operation, ensuring a continuous power supply.

(e) The ignition coil produces a high voltage required by the spark plugs to generate the spark needed for combustion.

14 (a) An engine cylinder has a bore diameter of 84 mm and stroke of 75 mm, with compression ratio of 8.5:1. Find its clearance volume.

Swept volume = $(\pi \times D^2 \times L) \div 4$
$= (3.142 \times 84^2 \times 75) \div 4$
$= (3.142 \times 7056 \times 75) \div 4$
$= 1661580\ mm^3 \div 4 = 415395\ mm^3 = 415.4\ cm^3$

Compression ratio = (Swept volume + Clearance volume) ÷ Clearance volume
$8.5 = (415.4 + Vc) \div Vc$
$8.5Vc = 415.4 + Vc$
$8.5Vc - Vc = 415.4$
$7.5Vc = 415.4$
$Vc = 55.39\ cm^3$

(b) Diesel engines usually have higher compression ratios because they rely on compression ignition. Higher compression increases the temperature of air inside the cylinder, which is necessary for igniting the diesel fuel without a spark plug. Additionally, higher compression increases thermal efficiency and power output in diesel engines.

(c) (i) If a thicker cylinder head gasket is fitted, the clearance volume increases, leading to a lower compression ratio.

(ii) If the top face of the cylinder block is faced out (machined down), the clearance volume decreases, raising the compression ratio.

(iii) If pistons with a convex crown are fitted instead of flat tops, the clearance volume decreases due to the piston occupying more space, thus increasing the compression ratio.

15 (a) List down four (4) qualities of a good brake fluid.

A good brake fluid must have a high boiling point to withstand the high temperatures generated during braking without vaporizing, which could lead to brake failure.

It must be chemically stable and not degrade over time under varying thermal conditions, ensuring consistent braking performance.

It should have low compressibility to allow effective transmission of hydraulic force from the pedal to the brake pads with minimal loss.

The brake fluid must be non-corrosive to protect the internal components of the braking system such as cylinders, hoses, and seals from damage.

(b) State five (5) defects associated with excessive brake pedal travel.

Worn brake pads can result in increased gap between the pads and brake disc or drum, causing longer pedal travel before the brakes engage.

Air trapped in the hydraulic system reduces the efficiency of force transmission, making the pedal spongy and requiring more travel.

Leaking brake fluid from lines or cylinders lowers system pressure, resulting in weak braking and longer pedal movement.

Faulty brake master cylinder may fail to generate adequate hydraulic pressure, causing delayed brake response and excessive pedal movement.

Incorrect brake pedal adjustment or wear in the linkages can also cause unnecessary travel before engaging the braking system.

(c) Name two (2) advantages of disc brakes over drum brakes for motor vehicles.

Disc brakes offer better heat dissipation, making them less prone to brake fade during continuous braking compared to drum brakes.

They provide more consistent braking performance and quicker response, improving vehicle safety, especially in emergency situations.

16 (a) State five (5) functions performed by engine lubricating oils.

Engine lubricating oil reduces friction between moving engine parts, minimizing wear and enhancing engine efficiency.

It acts as a cooling agent by carrying away heat from engine components, especially from areas where coolant cannot reach.

The oil cleans the engine by suspending and removing dirt, metal particles, and combustion residues, preventing deposit buildup.

It creates a sealing film between piston rings and cylinder walls, reducing blow-by gases and improving compression.

The oil also protects engine components from corrosion and rust by forming a protective film on metal surfaces.

(b) Explain five (5) possible causes for an engine to use an excessive amount of oil.

Worn piston rings allow oil to pass into the combustion chamber where it is burned, leading to high oil consumption and smoke.

Valve stem seals that are worn or damaged can allow oil to leak into the combustion chamber from the valve area.

Oil leaks from external engine parts such as the oil pan, gaskets, or seals may cause a continuous loss of oil.

Incorrect grade or low-quality oil can evaporate quickly or fail to provide adequate lubrication, resulting in frequent top-ups.

Overfilled crankcase may lead to excessive oil being splashed onto cylinder walls, increasing oil burn rate and consumption.