THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

093 MOTOR VEHICLE MECHANICS

Time: 3 Hours **ANSWERS** **Year: 2009**

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 case of four cylinder in-line engine, the number of firing strokes in one revolution of crank is
A One (1)
B Two (2)
C Three (3)
D Four (4)
E Five (5)

Answer: B – In a four-cylinder engine, there are two power strokes per crankshaft revolution because the engine fires once every 180°, and in one revolution two cylinders fire.

(ii) Which part is not common for petrol and diesel engines?
A Air cleaner
B Exhaust silencer
C Battery
D Dynamo
E Spark plug

Answer: E – Spark plug is used only in petrol engines for ignition. Diesel engines use compression for ignition and do not require spark plugs.

(iii) The operation of removing trapped air from hydraulic braking system is known as
A trapping
B pressurization
C bleeding
D deairing
E sieving

Answer: C – Bleeding is the process of removing air bubbles from hydraulic brake lines to restore full braking performance.

(iv) The gears in a constant mesh gearbox which have teeth inclined to the shaft axis are called
A spur
B worm
C bevel
D helical
E epicyclic

Answer: D – Helical gears have teeth cut at an angle to the gear axis, offering smoother and quieter operation compared to spur gears.

(v) The reason why a laminated spring is made up of a series of leaves is to
A lower the artefact friction

B soften the spring action and increase the maximum deflection
C allow sideways flex due to shifting
D increase the stiffness at the centre of a single leaf spring
E overcome friction and power

Answer: B – Multiple leaves allow better flexibility and more uniform stress distribution, increasing spring deflection capacity and improving suspension comfort.

(vi) As applied to steering the abbreviation P.A.S stands for
A pump assisted system
B pump aided steering
C power assisted steering
D power activated system
E pump aided motoring

Answer: C – P.A.S means Power Assisted Steering, a system that reduces driver effort by using hydraulic or electric assistance to steer.

(vii) The track rod is connected to the track arm by a
A ball joint
B king pin
C stub axle
D universal joint
E U-bolt

Answer: A – Ball joints allow rotational movement and connect the track rod to the track arm while allowing steering motion and suspension movement.

(viii) The main purpose of the fan of a liquid cooling system for an engine is to
A disperse engine fumes
B cool the external surface of the engine
C blow hot air over the coil cooling water
D promote air flow when engine speed is low
E push air over the cooling water

Answer: D – The fan helps maintain airflow through the radiator when the engine speed is low or the vehicle is stationary to aid in engine cooling.

(ix) Excess oil consumption in an engine may be due to
A leakage of oil through oil pan gasket
B too high oil pressure
C wrong viscosity of engine oil
D blocked breather pipe

E badly worn piston rings

Answer: E – Worn piston rings allow oil to seep into the combustion chamber, where it burns and increases oil consumption.

(x) Air resistance to a car at 20 kmph is R. The air resistance at 40 kmph would be
A 2R
B 2^2R
C 4R
D R^2
E $4R^2$

Answer: C – Air resistance increases with the square of speed. If speed doubles, resistance becomes four times ($2^2 = 4R$).

2. What does 'piston displacement' mean?
Piston displacement refers to the volume displaced by all pistons in the engine as they move from bottom dead center to top dead center. It is also called engine displacement and determines engine size and capacity.
3. Explain briefly how a thermostat controls the engine temperature.
A thermostat regulates engine temperature by controlling coolant flow. When the engine is cold, it remains closed to allow quick warm-up. As the engine heats up, it opens gradually to allow coolant flow to the radiator, preventing overheating.

4. What is the main difference between the actions of the friction pads on the drum brake and the disk brake?
In a drum brake, friction pads (brake shoes) press outward against the inside of a rotating drum. In a disc brake, brake pads clamp onto a rotating disc from both sides. Disc brakes dissipate heat better and provide more efficient braking.

5. List down three (3) causes of low engine oil pressure in the lubrication system with the sump oil level correct.
– Worn bearings increasing oil clearance
– Faulty or weak oil pump
– Clogged oil filter or strainer

6. State three (3) disadvantages of Compression Ignition (C.I) engine compared to petrol engine.
– Higher initial cost
– Heavier engine construction
– More noise and vibration

7. State six (6) possible causes of external leakage of cooling system of motor vehicle.
– Cracked radiator
– Loose or damaged hose clamps
– Leaking water pump

– Damaged radiator cap seal
– Faulty thermostat housing gasket
– Cracked engine block or cylinder head

8. Describe briefly power steering.
Power steering is a system that uses hydraulic or electric assistance to reduce the effort required to turn the steering wheel. It provides smooth and easier control, especially during low-speed maneuvers.

9. Write suitable ratio of fuel to air in order to obtain:
(a) Maximum economy – 1:18 (lean mixture)
(b) Maximum power – 1:12.5 (rich mixture)
(c) Starting at cold – 1:9 to 1:10 (very rich mixture)

10. (a) Mention two (2) functions of a tyre.
– To support the vehicle load
– To provide traction and absorb shocks from the road

(b) State three (3) causes of excessive tyre wear.
– Incorrect wheel alignment
– Over or under inflation
– Worn suspension or steering parts

11. What is meant by sprung weight and unsprung weight?

Sprung weight refers to the portion of a vehicle's weight that is supported by the suspension system, such as the chassis, body, engine, passengers, and cargo. It is the mass that rests on top of the suspension springs and is isolated from road irregularities by the suspension system.

Unsprung weight is the mass of the components not supported by the suspension system, including the wheels, tires, brake assemblies, and part of the suspension linkages. This weight directly contacts the road surface and affects ride quality and handling performance.

12 (a) What is the name of this type (Figure 1) of oil filtration system?

The oil filtration system shown in Figure 1 is called a full-flow oil filtration system.

(b) Describe fully the sequence of operation of this type (Figure 1) of oil filtration system.

In a full-flow oil filtration system, oil is drawn from the sump by the oil pump. The pump pressurizes the oil and forces it through a coarse filter that removes large contaminants. The filtered oil then passes through a fine filter, which removes smaller particles before reaching the engine bearings and moving parts. A filter relief valve is included to bypass the filter in case it becomes clogged, ensuring continuous oil supply. After lubricating the engine components, the oil returns to the sump to complete the cycle.

13. (a) Explain the two (2) purposes of a radiator in a car.

The primary purpose of a radiator is to dissipate heat from the engine coolant into the atmosphere, preventing the engine from overheating. It maintains the engine's optimal operating temperature.

The radiator also helps maintain thermal stability in the engine system by regulating coolant temperature, which improves fuel efficiency and prevents engine damage due to excessive heat.

(b) Describe briefly two (2) types of radiators.

Tube and fin radiators consist of tubes that carry coolant and fins attached to the tubes to increase surface area for better heat dissipation.

Cross-flow radiators have the coolant flow horizontally from one side to the other, allowing more efficient cooling by increasing the contact time and cooling surface area.

14. Explain four (4) types of steering gear boxes in common use.

The worm and sector gearbox uses a worm gear on the steering shaft meshing with a sector gear to convert rotary motion into linear motion for wheel turning.

The worm and roller gearbox has a roller that rotates and moves along the worm gear, reducing friction and providing smoother steering.

The recirculating ball gearbox uses ball bearings between the worm and nut to reduce friction and improve efficiency and durability.

The rack and pinion gearbox consists of a pinion gear on the steering shaft that meshes with a linear rack, offering direct steering response and compact design.

15. Elaborate four (4) probable causes of a noisy gear box in neutral.

Worn bearings inside the gearbox can produce humming or rumbling sounds even when in neutral due to internal movement of shafts.

Loose or damaged gear teeth may create clattering or knocking noises as gears rotate loosely without engaging.

Lack of lubrication or degraded gear oil increases friction between components, leading to whining or grinding noise.

Worn input shaft or countershaft bearings may cause vibrations and noise transmission through the gearbox while idling in neutral.

16. An engine has a bore diameter of 80 mm, stroke of 140 mm, and a hemispherical combustion chamber as shown in Figure 2.

(b) Swept volume of the cylinder
Swept volume = $(\pi \times D^2 \times L) \div 4$
$= (3.142 \times 80^2 \times 140) \div 4$
$= (3.142 \times 6400 \times 140) \div 4$
$= 2817920 \div 4 = 704480\ mm^3 = 704.48\ cm^3$

(c) Clearance volume (hemispherical chamber)
Clearance volume = $(2/3)\pi r^3$
Radius r = 40 mm
$= (2/3) \times 3.142 \times 40^3$
$= (2/3) \times 3.142 \times 64000 = 133734.4\ mm^3 = 133.73\ cm^3$

(d) Compression ratio
Compression ratio = (Swept volume + Clearance volume) ÷ Clearance volume
$= (704.48 + 133.73) \div 133.73 = 838.21 \div 133.73 \approx 6.27:1$