THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

093 MOTOR VEHICLE MECHANICS

Time: 3 Hours **ANSWERS** **Year: 2001**

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) A square type engine has
A geometrical shape as square
B two horizontal cylinders and two vertical cylinders
C operating speed of 64, 81, 100, 144, 196 rpm or the like
D a cylinder bore equal to stroke length
E row of cylinders which has an angle of 90° between any two consecutive cylinders.

Answer: D – A square type engine is one in which the bore (diameter of the cylinder) is equal to the stroke (distance the piston travels). This design balances power and efficiency.

(ii) Engine dynamo is usually driven by
A chain drive
B gear drive
C flat belt drive
D P.I.V. drive
E V-belt drive

Answer: E – V-belt drive is commonly used to drive engine accessories such as the dynamo or alternator. V-belts provide better grip, higher efficiency, and are easier to maintain.

(iii) When the most economical mixture is supplied in an S.I. engine the colour of exhaust flame is expected to be
A bluish, transparent
B whitish to reddish-yellow
C yellow-red to red
D dark red
E black

Answer: A – A bluish, transparent exhaust flame indicates efficient and complete combustion with a correct air-fuel mixture in spark ignition engines.

(iv) Too rich mixture for an S.I. engine means that the air fuel ratio is about
A 1:17
B 1:15
C 1:14
D 1:13
E 1:10

Answer: E – A rich mixture means more fuel than air. The ideal ratio is 1:15; anything lower, like 1:10, is considered rich, meaning excess fuel is present, which causes incomplete combustion and black smoke.

(v) In a four-stroke S.I. engine the exhaust valve usually opens
A at BDC
B at TDC
C 35° to 60° after BDC
D 35° to 60° before BDC
E 10° to 20° before TDC

Answer: D – In most four-stroke engines, the exhaust valve opens before the piston reaches the bottom dead center (BDC) to begin releasing exhaust gases early and improve efficiency.

(vi) The gas which does not burn and passes out without transformation in a petrol engine is
A nitrogen
B carbon dioxide
C carbon monoxide
D oxygen
E water vapour

Answer: A – Nitrogen is an inert gas that does not participate in combustion and exits the engine unchanged.

(vii) The function of a governor in an automobile is to
A limit the engine speed
B limit the fuel supply
C effect maximum fuel economy
D maintain constant engine speed when the vehicle speeds
E maintain constant engine speed

Answer: D – A governor regulates engine speed by adjusting the fuel supply, maintaining a constant engine speed even as vehicle speed changes.

(viii) The escape of burnt gases from the combustion chamber past the pistons into the crank case is called
A gas loss
B blow by
C by pass
D passed gas
E crank case explosion

Answer: B – Blow-by is when combustion gases escape past the piston rings into the crankcase, causing loss of power and contamination of engine oil.

(ix) Oil pan is attached
A to the outside of the cylinder block
B in a separate unit away from the crankcase
C at the top of the cylinder block

D to the outside of the crank case adjacent to oil filters
E to the bottom of the crankcase

Answer: E – The oil pan is mounted at the bottom of the crankcase to collect and store lubricating oil for circulation in the engine.

(x) Which instrument is used to measure specific gravity?
A Thermometer
B Hygrometer
C Hydrometer
D Anemometer
E Manometer

Answer: C – A hydrometer is specifically used to measure the specific gravity (density) of liquids such as battery electrolytes.

2. Which part of a ball bearing is harder than the other?
The balls in a ball bearing are harder than the races (inner and outer rings). This is because the balls are subjected to constant rolling contact stress and must maintain their shape under high pressure and friction. They are made from high-carbon chromium steel and are heat-treated to achieve maximum hardness and durability.

3. Mention three damages which are likely to occur if the oil level in the oil pan of the engine is maintained above the gauge mark.
Maintaining oil above the gauge mark can lead to several damages: First, excess oil can get aerated by the crankshaft rotation, forming foam that reduces lubrication efficiency. Second, oil may leak through seals and gaskets due to high pressure, causing seal failure. Third, excessive oil can increase drag on moving parts, reducing engine performance and increasing fuel consumption.

4. Name the two shafts and two other components fitted to form the drive line between the engine and wheels.
The two shafts in the drive line are the propeller shaft and the axle shaft. Other components include the clutch, which engages and disengages power from the engine, and the differential, which transmits power to the wheels while allowing them to rotate at different speeds.

5. Explain why petrol flows from the float chamber to the venturi.
Petrol flows from the float chamber to the venturi due to pressure difference. The float chamber is at atmospheric pressure, while the venturi creates a low-pressure area as air passes through it at high speed. This pressure difference causes petrol to be sucked into the airstream, where it mixes with air to form the air-fuel mixture.

6. Define the term viscosity. How do the viscosities of SAE 20 and SAE 40 compare?
Viscosity is the measure of a fluid's resistance to flow. Higher viscosity means thicker fluid. SAE 20 has lower viscosity and flows more easily than SAE 40, which is thicker and flows more slowly. Therefore, SAE 40 provides better protection at high temperatures, while SAE 20 is better for cold starts.

7. State the purpose of the interlocking plungers fitted between the gear box selectors rods.
The interlocking plungers ensure that only one gear is selected at a time. They prevent simultaneous engagement of two gears, which would cause gear damage or transmission failure. The plungers lock the movement of other selector rods when one is already in motion.

8. What is the action of the differential when a vehicle turns a corner?
When a vehicle turns a corner, the differential allows the outer wheel to rotate faster than the inner wheel. This is necessary because the outer wheel covers a greater distance. The differential splits engine torque and transmits it to both wheels while allowing them to turn at different speeds.

9. How is an axle located on the leaf spring?
The axle is located on the leaf spring using a center bolt that passes through the spring leaves and aligns with a locating hole on the axle. U-bolts are then used to clamp the axle tightly to the leaf spring, securing the position and ensuring stability.

10. What type of a tyre has a slow deflation when punctured, offers considerable resistance to side deflection and the vehicle is covered?
A tubeless radial tyre has these properties. When punctured, it deflates slowly because the air is retained between the rim and tyre bead. Its construction resists side deflection due to reinforced sidewalls, and it continues to support the vehicle for a limited distance even when losing air.

11. What does the abbreviation P.S. mean as applied to steering?
P.S. stands for Power Steering. Power steering uses hydraulic or electric assistance to reduce the effort needed by the driver to steer the vehicle, especially at low speeds or during parking. It enhances vehicle handling and driver comfort.

Now continuing with Section C. Each question is copied exactly as it appears and answered with full detailed explanation.

12. (a) The input torque of a gearbox is 125 Nm. The transmission ratio in the second gear is 2.053:1. If the efficiency of the gearbox is 95%, find the output torque of gears.
Input torque = 125 Nm
Transmission ratio = 2.053:1
Efficiency = 95% = 0.95

Output torque = Input torque × Transmission ratio × Efficiency
Output torque = 125 × 2.053 × 0.95

Output torque = 125 × 1.95035
Output torque = 243.79375 Nm

Therefore, the output torque is approximately 243.79 Nm.

(b) Briefly explain why in modern cars the rear wheels are fitted with one “leading” and one “trailing” shoe drum arrangement.
Modern cars use one leading and one trailing shoe in rear wheel drum brakes for balanced braking force and smooth operation. The leading shoe rotates in the direction of drum rotation and produces a stronger braking force due to self-servo action. The trailing shoe, which opposes the direction of drum rotation, provides a stabilizing force. This combination ensures effective braking under both forward and reverse motion, reduces uneven wear, and enhances safety.

13. Explain the changes which take place during the discharge process of a battery. Support your answer with a chemical equation.
During the discharge of a lead-acid battery, chemical energy is converted into electrical energy. The lead dioxide (PbO_2) at the positive plate and the sponge lead (Pb) at the negative plate react with sulfuric acid (H_2SO_4), forming lead sulfate ($PbSO_4$) on both plates and releasing water (H_2O), which reduces the acidity of the electrolyte.

Chemical reactions:
At positive plate: $PbO_2 + H_2SO_4 + 2H^+ + 2e^- \rightarrow PbSO_4 + 2H_2O$
At negative plate: $Pb + SO_4^{2-} \rightarrow PbSO_4$
Overall: $Pb + PbO_2 + 2H_2SO_4 \rightarrow 2PbSO_4 + 2H_2O$

14 (a) Name four advantages of the independent front suspension system (IFS) over the beam axle.

Independent front suspension system offers the following advantages over the beam axle:
The ride comfort is improved since each wheel can move independently, reducing road shock transmission.
Better handling and steering response due to reduced unsprung weight and improved wheel alignment.
Improved road holding and traction, especially on uneven surfaces, because each wheel maintains better contact with the ground.
Reduces tire wear since wheel alignment is better maintained and less affected by road irregularities.

(b) State two purposes of stabilizers as fitted to independent front suspension system.

Stabilizers (anti-roll bars) serve the following purposes:
They reduce body roll or leaning of the vehicle during cornering by distributing the load between the wheels.
They improve vehicle stability by keeping both wheels level on uneven road surfaces.

15 What is the purpose of
(a) camber angle

The purpose of camber angle is to improve cornering performance and ensure even tire wear. Positive or negative camber helps the tire tread to maintain full contact with the road surface during driving and turning.

(b) caster angle
Caster angle enhances directional stability and steering returnability. A positive caster assists in straight-line stability and helps the wheels to return to the center position after turning.

(c) king-pin inclination in automobile steering system?
King-pin inclination improves steering stability and helps reduce the effort required to steer. It also aids in self-centering of the wheels and contributes to reducing tire scrub.

16 What is the use a thermostat?

A thermostat is used in an engine cooling system to regulate the engine temperature. It controls the flow of coolant between the engine and radiator, ensuring the engine warms up quickly and then maintains an optimal operating temperature to enhance efficiency and reduce wear.