

GENERAL CERTIFICATE OF EDUCATION BOARD

Technical and Vocational Education Examination

MECHANICAL TECHNOLOGY 2

5140

JUNE 2022

INTERMEDIATE LEVEL

Specialty Name and Acronym	AUTOMOBILE REPAIR MECHANICS (ARM)
Subject Title	MECHANICAL TECHNOLOGY
Subject Code No.	5140
Paper No.	2

DURATION: 2 Hours, 30 Mins

INSTRUCTIONS:

This Paper is made up of NINE(9) Questions.

Answer any FIVE (5) by choosing THREE from Section A and TWO from Section B.

All questions carry equal marks.

You are allowed to use non-programmable calculators

You are reminded of the necessity for good English and orderly presentation in your answers.

SECTION A: MECHANICAL TECHNOLOGY
Answer any THREE questions from this section.

1) THE DRIVE AXLE

The figure below represents the cross section of an axle and its assembly

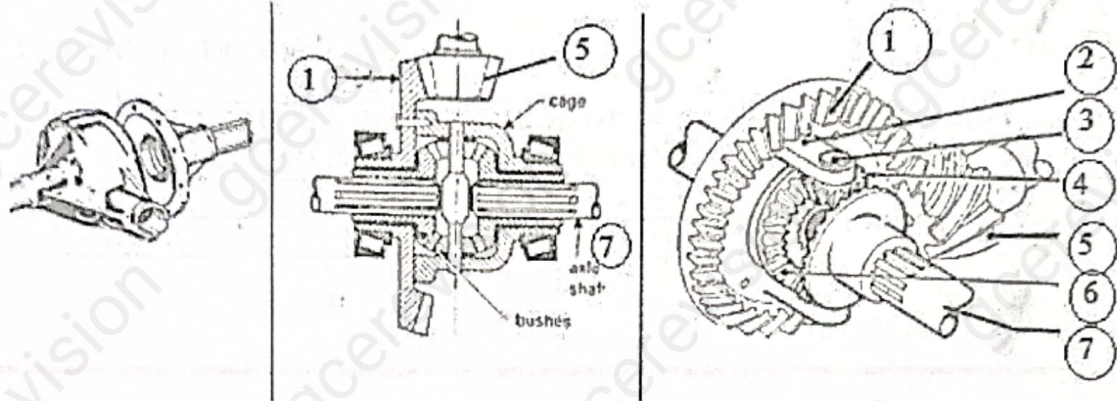


Figure 1: Final drive

- (a) Give TWO functions of the drive axle in a motor vehicle's transmission. (2 marks)
 (b) Name the components labelled 1, 4, 5, and 6. (1x4= 4 marks)
 (c) What type of axle casing is used here? (1 mark)
 (d) Briefly explain how the differential within the axle operates at bends. (2 marks)
 (e) Give TWO probable causes each of the following drive axle problems:
 (i) General axle noise. (0.5 mark)
 (ii) Drive axle noise when cornering. (0.5 mark)

2) THE CLUTCH SYSTEM

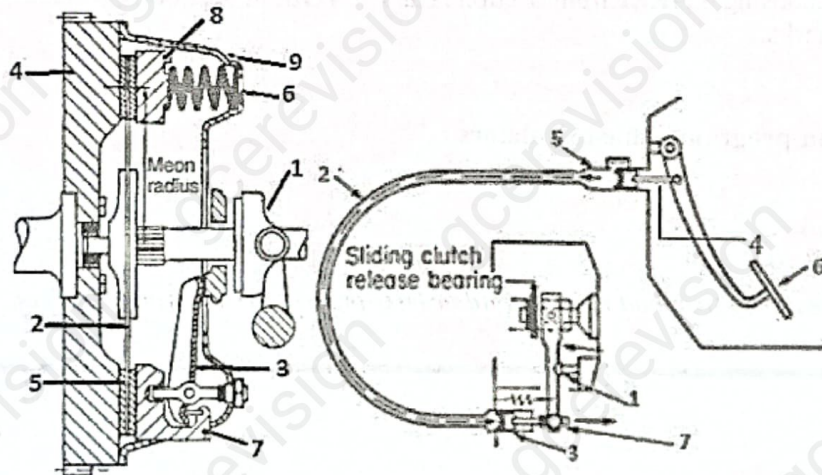


Figure 2a: Clutch system

Figure 2b: Clutch control mechanism

- a) Give the name of the type of clutch represented on figure 2a above. (1 mark)
 b) Name the parts (1, 3, 5 and 8) of fig 2a and their function. (0.5x4= 2 marks)
 c) List TWO checks carried out on a frictional clutch system. (0.5x2= 1 mark)
 d) State the use of the clearance that always exists between the release bearing and the pressure plate? (0.5 mark)
 e) What type of command system is represented on figure 2b? (0.5 mark)
 f) Give two possible faults that can render this command system faulty. (0.5x2 = 1 mark)
 g) Give the names and functions of the parts (2, 3, 4 and 5) in the control system of Figure 2b. (0.5 x 4 = 2 marks)
 h) Explain the operating principle of a clutch control system, when disengaged and engaged. (1 mark x2)

3)ENGINE DRIVE BELT SYSTEM

The diagram in figure 3 shows a drive belt.

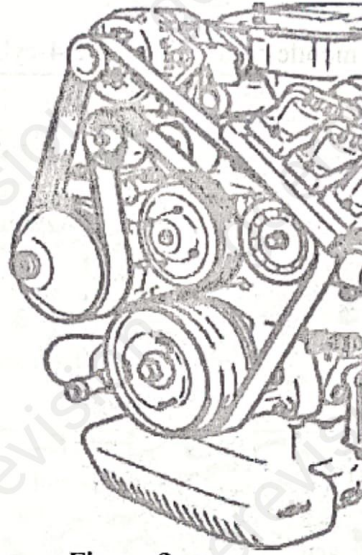


Figure 3:

- Name the type of drive belt shown in the diagram. (2marks)
- Name the components that are usually driven by this belt. (3marks)
- A whining noise is heard when the engine is running. You suspect a faulty bearing in one of the driven components. Outline the procedure that should be carried out to isolate which component is at fault. (4marks)
- Give one effect on engine performance with the use of this type of belt drive (1mark)

4)BRAKING SYSTEM

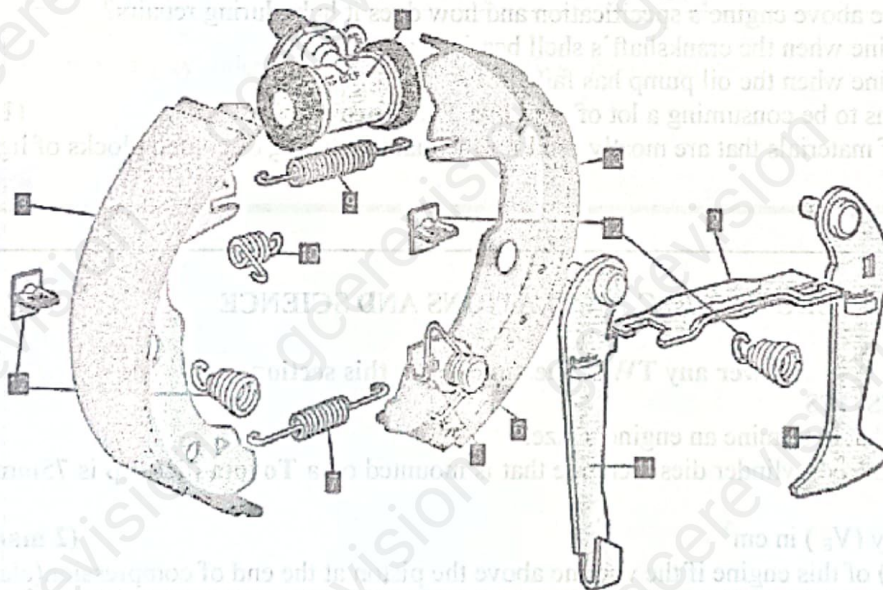


Figure 4

- Give the names of the following components of the above brakes: 1, 3, 9, 11 and 12. (0.5 x 5 = 2.5 marks)
- From what material are brake shoe linings made? (0.5mark)
- What are the consequences of letting grease or oil onto the surfaces of the brake shoes during repairs? (1mark)
- Give the symptom of the presence of air in the hydraulic circuit of the above system. (1mark)
- Give TWO causes each of the following braking problems: (0.5 x 6 = 3 marks)
 - Noisy brakes.
 - Hard braking.
 - Vehicle pulling to one side during brake application.
- Briefly explain how you would bleed the braking system during repairs on it. (2marks)

5) ENGINE CONSTRUCTION

The exploded diagram below shows the mobile organs of a 2.4L, 4-cylinder 3AE TOYOTA CAMRY petrol injection engine block.

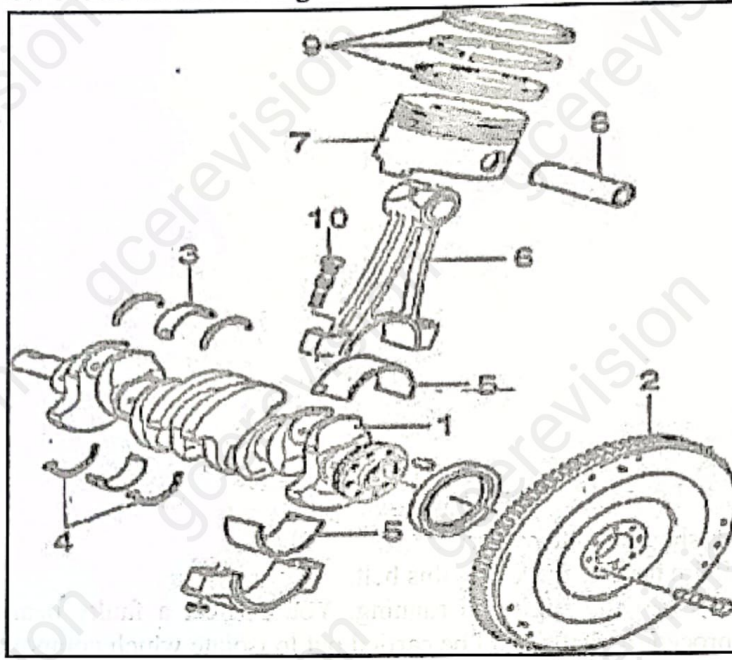


Figure 5

- g) Give the names of the following engine mobile components: 3, 4, 6, 8, 9 and 10. (0.5 x 6 = 3 marks)
- h) Give TWO reasons (advantages) of petrol injection engines over carburettor operated types. (1 mark)
- i) What signifies 3AE in the above engine's specification and how does it help during repairs? (1 mark)
- j) What happens to the engine when the crankshaft's shell bearings are worn? (1 mark)
- k) What happens to the engine when the oil pump has failed? (1.5 mark)
- l) The above engine happens to be consuming a lot of oil. Give TWO probable causes. (1x2 = 2 marks)
- m) Name the TWO types of materials that are mostly used for the manufacturing of engine blocks of light cars. (0.5 mark)

SECTION B: CALCULATIONS AND SCIENCE

Answer any TWO questions from this section.

6) ENGINE CHARACTERISTICS

- a) List THREE parameters that determine an engine's size. (3 marks)
- b) The cylinder bore (d) of a 4-cylinder diesel engine that is mounted on a Toyota pick-up is 75mm; its stroke (h) is 80mm. Calculate
- (i) The total cylinder capacity (V_E) in cm^3 (2 marks)
- (ii) The compression ratio (ρ) of this engine if the volume above the piston at the end of compression (clearance volume) is $V_c = 20.76 \text{ cm}^3$. (1 mark)
- (iii) Name any THREE things that can cause compression loss in an engine. (3 marks)
- (c) At an engine speed (N) of 5000rev/min, what is the power that is available at the crankshaft if it's subjected to a torque (T) of 25Nm from the connecting rod? (1 mark)

7) KNEMATICS

- a) Define kinetic energy and potential energy. (2 marks)
- b) The mass (M) of automobile that is travelling at 60km/h is 750Kg. Determine the following.
- (i) The kinetic energy (K.E) that it possesses in joules (J). (2 marks)
- (ii) The average braking force that is needed to bring the vehicle to a standstill over a distance of 25 meters. (2 marks)
- (iii) The braking efficiency (η). (2 marks)
- (iv) Calculate the minimum stopping distance (S) of this vehicle in meters. (2 marks)
- (Take: $g = 9.81 \text{ m/s}^2$)

8) FRICTION

- a) Define friction. (1 mark)
- b) State TWO laws of coulomb friction. (0.75 mark x 2)
- c) Give TWO areas of the motor vehicle where friction is important and two areas where friction is a disadvantage in the motor vehicle. (1x2= 2 marks)
- d) What is the difference between static friction (f_s) and kinetic friction (f_k)? (1 mark)
- e) A single plate dry friction clutch disc with a mean radius (r_m) of 0.22m has a friction material with a coefficient of friction $f = \mu$ of value 0.25. Knowing that the pressure being exerted by the pressure plate on the clutch disc is 155KN/m^2 , calculate:
- The frictional driving force (F_r) acting at the mean radius. (1.5 mark)
 - The Torque (T) being transmitted. (1.5 mark)
 - The Power (W) that is being transmitted by the clutch at a shafts speed of 3000rev/min. (1.5 mark)

9) ENGINE CHARACTERISTICS

One of your customer Mrs. BIH SONITA brings her vehicle to you having the following parameters, engine torque 190000Nmm, a combustion chamber volume of 50949.3mm^3 , a of stroke 78.7mm and compression ratio of 9.8. The engine develops its power at rotational speed of 5500rpm. The engine has four cylinders each equipped with four valves.

Calculate:

- The swept volume of a cylinder. (2 marks)
- The bore of the cylinder. (1 mark)
- Total cylinder volume. (1 mark)
- Total engine capacity. (1 mark)
- The force acting on the piston if the pressure (P) is 600 N/m^2 . (1 mark)
- Effective engine power. (1 mark)
- Briefly explain why cylinders are fitted with four valves instead of two? (2 marks)