21.0 POWER MECHANICS (447)

In the year 2010, power mechanics was tested in two papers 1(447/1) and paper 2 (447/2) Paper 1 and paper 2 were both theory papers which followed the usual setting format as of the previous years.

21.1 GENERAL CANDIDATES PERFORMANCE

The candidate's performance statistics in the KCSE power mechanics examination since the year 2008 when the syllabus was revised are as shown in the table below.

Table 27: candidates overall performance in the years 2008 to 2010.

Year	Paper	Candidature	Maximum score	Mean score	Standard deviation
2008	1 2 **overall**	**57**	60 40 **100**	24.38 25.49 **49.77**	9.32 6.88 **14.67**
2009	1 2 **overall**	**136**	60 40 **100**	28.88 27.05 **56.74**	9.27 4.15 **12.37**
2010	1 2 **overall**	**159**	60 40 **100**	26.49 26.34 **52.66**	8.67 5.24 **12.81**

From the table it can be observed that:

21.1.1 The candidature increased from 136 in the year 2009 to 159 in the year 2010.
21.1.2 There was a drop in the performance paper 1 from 28.88 in 2009 to 26.49 in 2010.
21.1.3 There was also a drop in the performance paper 2 from 27.05 in 2009 to 26.34 in 2010.
21.1.4 There overall performance of power mechanics dropped significantly from 56.74 to 52.66 in 2010.
The enrollment has continued to increase after the two year break in 2006 and 2007.
The following is a discussion of some of the questions that were poorly done in the two papers.

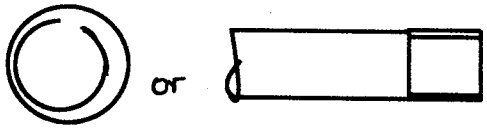
21.2 paper 1 (447/1)

Although Q 10 was poorly done most of the poorly done questions in paper 1were from section B and include 11, 12, 14 and 15.

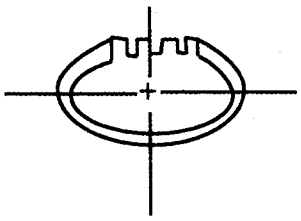
Question 10
Draw the symbols used to represent each of the following machine parts in assembly drawing:
(a) external screw thread;
(b) splined shaft;
(c) cylindrical tension spring.

Candidates were required to draw the symbols used to represent machine parts.
Weakness
Students were unable to draw the symbols properly probably because they did not have background information on the basics of assembly drawing.

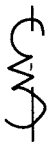
Expected response
(a)



(b)



(c)



Question 11

Figure 1 shows two orthographic views of an object drawn in third angle projection.

On the drawing paper provided, draw an oblique view of the object taking XX as the front face. Indicate **three** leading dimensions. (15 marks)

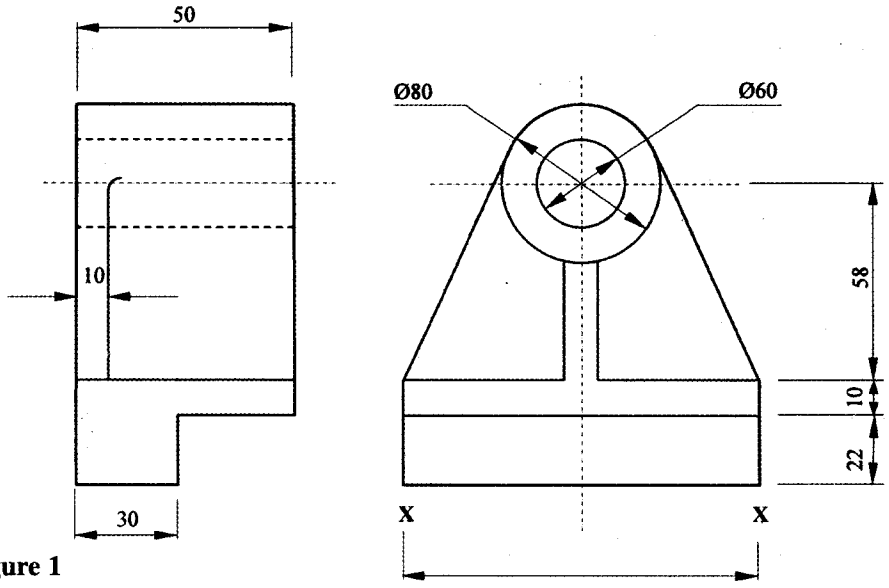


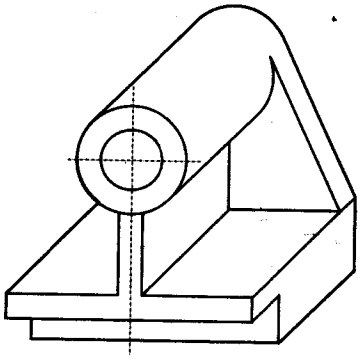
Figure 1

Candidates were required to draw the oblique view give the orthographic views.

Weakness

Most candidates draw the figure in isometric instead of oblique. This is probably due to overemphasis on isometric at the expense of other views such as oblique, pictorial and assembly. This id caused by lack of knowledge on different inclination angles between oblique and isometric.

Expected response



Question 12

(a) State **four** service checks performed on engine valves.

(b) Explain how a radiator is tested for leakage using water.

(c) Outline the procedure of detecting and correcting misfiring spark plug on a running multicylinder engine.

Candidates were required to draw state service checks, explain how a radiator is tested for leakage using water and outline the procedure for correcting misfiring of a sparkplug.

Weakness

Most students did not know the procedures for testing a radiator for leakage and correcting misfiring. This may be caused by limited practical exercises on operational multi-cylinder engines.

Expected response

(a) **SERVICE CHECKS**

Burnt faces
Face wastage
Face pitting
Stem bending
Scoring

Any 4 x ½

(b) **TESTING RADIATOR FOR LEAKS**

Mount radiator in upright position.
Close the lower end
Fill it with water and pressure
Identify and mark leakage points. 4 x1

(c) **DETECTING AND CORRECTING MISFIRING S. PLUG**

- Start the engine and leave it running at idle speed.
- Remove spark plug lead for cylinder number one spark plug and listen to the idling.
- The idling should slow down and get noticeably rougher if that cylinder is firing.
- Repeat the above procedure for each of the three spark plugs.
  The plug that does not five any noticeable change is misfiring.
- Stop the engine and remove this plug.
- Replace the plug with a good one.

- With the engine at idle speed again, remove the plug cable for this new plug and see if there will be a difference in idling. If it is there, then it was the plug that was the cause.

- If the misfiring persists, replace the plug cable with a good one and try to notice the difference.

Question 14

(a) State **three** qualities of effective steering system of a motor vehicle. (3 marks)

(b) Outline **four** preliminary checks carried out before vehicle wheel alignment. (4 marks)

(c) With the aid of a labelled sketch, explain the construction and operation of the rack and pinion steering box. (8 marks)

Candidates were required to express their understanding on the steering system of a motor vehicle and the knowledge of the wheel alignment.

Weakness

Most candidates did not know the preliminary checks on wheel alignment.

Expected response

(a) **EFFECTIVE STEERING SYSTEM**

Being self- centering

Should enable accurate control along the path taken by the vehicle at all times.

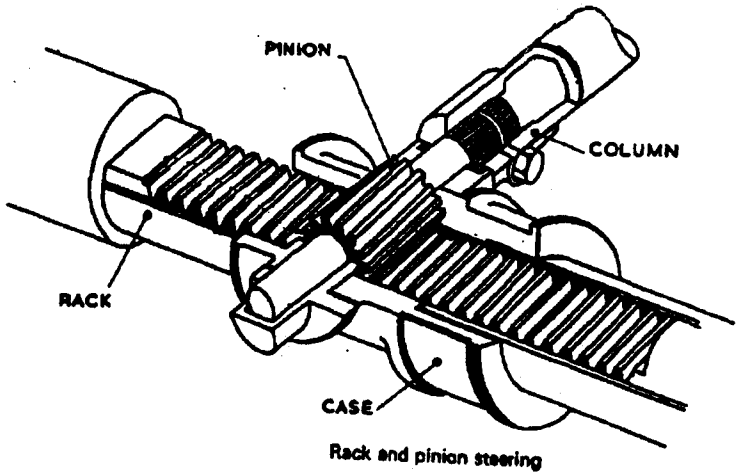
Shouldn't be affected by the action of suspension and braking systems.

(b) **PRELIMINARY CHECKS**

- Kingpins and bushes for excessive wear and lift.
- Ball joints for locking, excessive war and rod lifting.
- Hub bearing for free play and correct adjustment.
- Swivel points of suspension for free movement.
- Steering gear box for excessive wear and being secured.
- Shackles pins and bushes for excessive war and side movement.

Any 4 x 1

(c)



Rack and pinion steering

The rack consists of a cylindrical steel bar which has gear teeth machined on one side.
The steel pinion, which is attached to the lower end of the steering column, is meshed with the teeth of the rack. When the steering wheel is rotated, it causes the rack to move to and fro along its axis.
The ends of the rack are connected to the steering track arms by the short balt jointed tie rod ends. Therefore, its movement causes the wheels to turn through this mechanism.

Question 15

(a) List **three** operational requirements of a propeller shaft. (3 marks)

(b) Outline the procedure of removing, servicing and assembling a propeller shaft of a vehicle. (12 marks)

Candidates were required to list operational requirements of a propeller, outline the procedure of removing, servicing and assembling the propeller shaft of a vehicle.

Weakness
Most candidates could not bring out the operational requirements of the propeller shaft. Many of them missed some steps in the procedure for servicing the propeller shaft.

Expected response

(a) **OPERATIONAL REQUIREMENT FOR PROPELLER SHAFT**
High resistance to misalignment
Torsional stress of hollow shaft
Shouldn't exceed prescribed maximum length
Low resistance to any change in rotational speed.

(b) **REMOVING SERVICING AND INSTALLING PROPELLER SHAFT (PS)**
(i) Carryout visual inspection to identify the problem;
(ii) Place vehicle on stands to access underneath;
(i) Remove PS with universal joints from vehicle;
(ii) Mark matching flange for accurate reinstallation;
(iii) Remove universal joint from the propeller;
(iv) Check the propeller shaft for defects e.g dents and cracks;
(v) Disassemble the universal joints;
(vi) Inspect the bearing cups and rollers for wear;
(vii) Replace worn out parts;
(viii) Assemble the universal joint;
(ix) Reassemble the unity to the vehicle aligning the flange and pinion shaft;
(x) Test for free movement in all directions;
(xi) Remove vehicle from stands.

21.3 paper 2(447/2)

The paper had 10 equally weighted compulsory exercises. It tested competencies in the following areas:
- Related drawing
- Metal fabrication skills.
- Disassembly and assembly of components.
- Servicing procedures
- Parts identification and visual checks.
- Connecting electrical circuits.
- Basic measurements and calculations.
- Static ignition timing.

- Wheel changing.

All the exercises were fairly done despite a slight drop in the mean score. A general weakness was noted in the reading and interpreting of measuring instruments, specifically the vernier caliper and micrometer screw gauge. A number of candidates were quite tense when drilling and require more practice prior to taking examination.

29.19 POWER MECHANICS (447)

29.19.1 Power Mechanics Paper 1 (447/1)

SECTION A (40 marks)

1 (a) State **two** types of fire extinguishers used to put out fire caused by oil. (1 mark)

(b) State **two** characteristics of liquid pressure. (1 marks)

2 (a) Name **three** areas in an engine where a torque wrench should be used. ($1\frac{1}{2}$ marks)

(b) Give **two** reasons for using cast iron in the construction of engine blocks. (2 marks)

3 (a) State **two** advantages of the integral type of vehicle body over the separate chassis type. (2 marks)

(b) Use labelled sketches to show the difference between camber and kingpin inclination. (2 marks)

4 (a) List **four** types of springs used in motor vehicle suspension systems. (2 marks)

(b) With the aid of sketches, differentiate between countersinking and counterboring. (2 marks)

5 (a) (i) Explain the term viscosity as applied to lubricating oil.

(ii) State **two** areas of application of low viscosity oil in a motor vehicle. (2 marks)

(b) For each of the following sparking plug problems, state **one** possible cause:

(i) wet oily deposit;
(ii) sooty black deposit. (2 marks)

6 (a) Explain the effects of each of the following maladjustments in an engine:

(i) inlet value clearance too small;

(ii) exhaust valve clearance too big. (3 marks)

(b) Calculate the compression ratio of a single cylinder engine with the following measurements:

(i) stroke 100mm;
(ii) bore 100mm;
(iii) clearance volume 100cc. (3 marks)

7 (a) Sate the function of each of the following parts of a vehicle gear box:

(i) synchroniser;
(ii) idler gear;
(iii) fork.

(3 marks)

(b) Sketch the symbols for each of the following electrical devices:

(i) lamp;
(ii) starter motor;
(iii) zener diode;
(iv) capacitor.

(2 marks)

8 (a) List **two** measurements which are normally taken during the inspection of each of the following parts:

(i) valve spring;
(ii) camshaft. (2 marks)

(b) (i) State **one** disadvantage of using acid flux when soldering.

(ii) State the composition of soft solder. (2 marks)

9 Explain each of the following terms as applied to engine operation:

(a) valve lead;

(b) valve lag;

(c) valve overlap. ($4\frac{1}{2}$ marks)

10 Draw the symbols used to represent each of the following machine parts in assembly drawing:

(a) external screw thread;
(b) splined shaft;
(c) cylindrical tension spring.

(3 marks)

SECTION B (60 marks)

*Answer question **11** and any other **three** questions from this section.*
*Candidates are advised to spend **not more than 25 minutes** on question 11.*

11 Figure 1 shows two orthographic views of an object drawn in third angle projection.

On the drawing paper provided, draw an oblique view of the object taking XX as the front face. Indicate **three** leading dimensions. (15 marks)

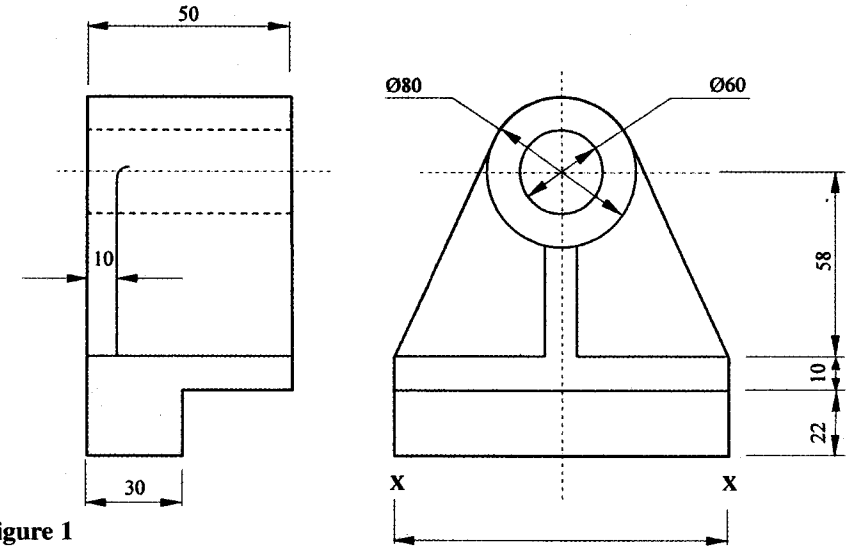


Figure 1

12 (a) State **four** service checks performed on engine valves. (2 marks)

(b) Explain how a radiator is tested for leakage using water. (4 marks)

(c) Outline the procedure of detecting and correcting misfiring spark plug on a running multicylinder engine. (9 marks)

13 (a) State **three** advantages of pneumatic brakes over hydraulic brakes. (3 marks)

(b) Figure 2 shows a cross-sectional view of a brake master cylinder.

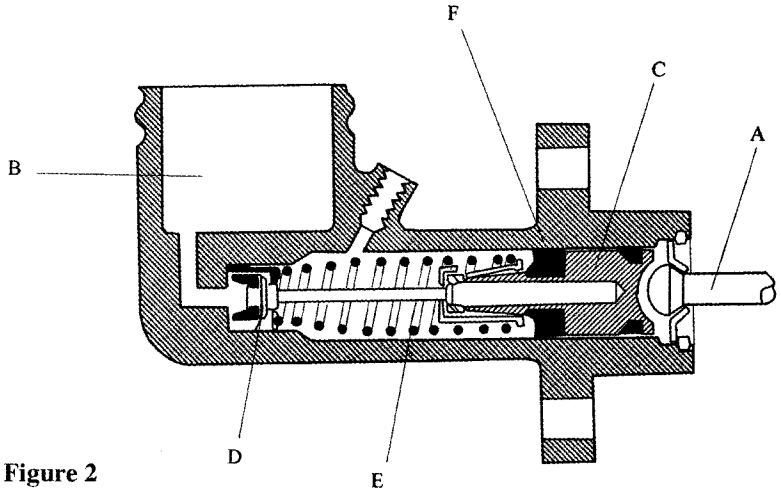


Figure 2

Name the parts labelled A, B, C, D, E and F. (3 marks)

(c) Explain the operation of the master cylinder. (9 marks)

14 (a) State **three** qualities of effective steering system of a motor vehicle. (3 marks)

(b) Outline **four** preliminary checks carried out before vehicle wheel alignment. (4 marks)

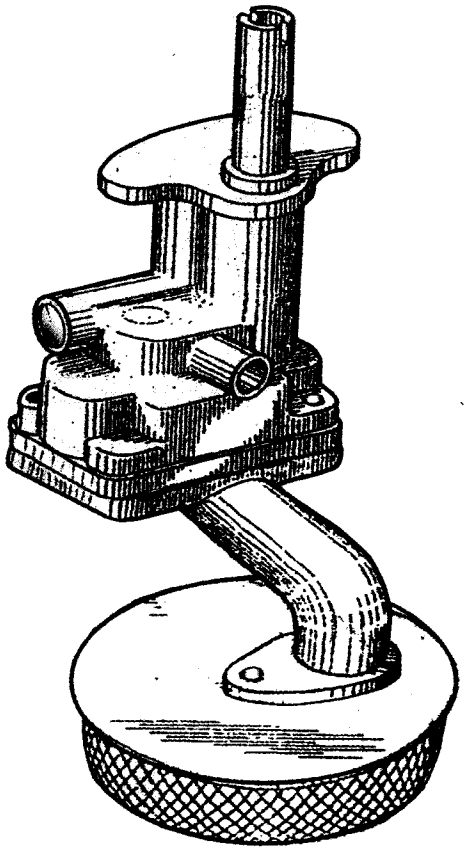
(c) With the aid of a labelled sketch, explain the construction and operation of the rack and pinion steering box. (8 marks)

15 (a) List **three** operational requirements of a propeller shaft. (3 marks)

(b) Outline the procedure of removing, servicing and assembling a propeller shaft of a vehicle. (12 marks)

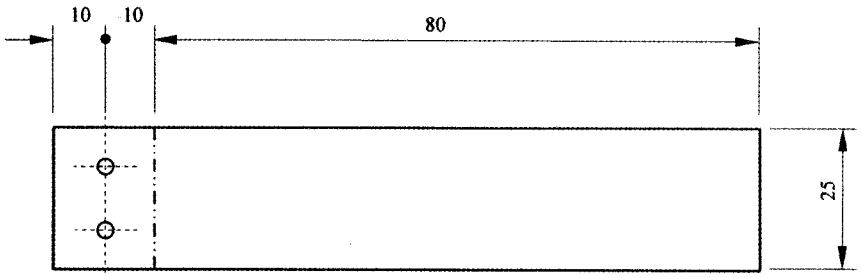
STATION 1

The figure below shows a pictorial view of the gear type oil pump. In the drawing paper provided, sketch in good proportion the exploded view of the pump and label all the parts. (10 marks)

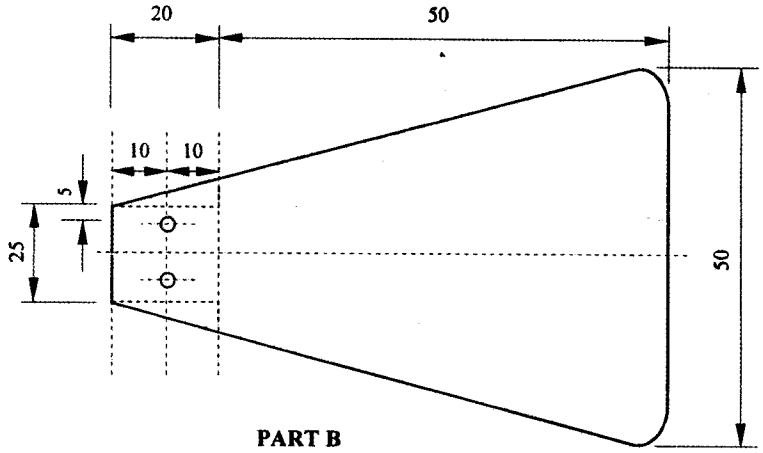


STATION 2

Using the tools, materials and equipment provided, make the scraper as shown in the figure below.
(10 marks)



PART A



PART B

STATION 3

On the single cylinder engine provided, carry out the following tasks:

(a) remove the inlet valve;

(b) lap the valve;

(c) reassemble the valve. (10 marks)

Let the examiner check your work.

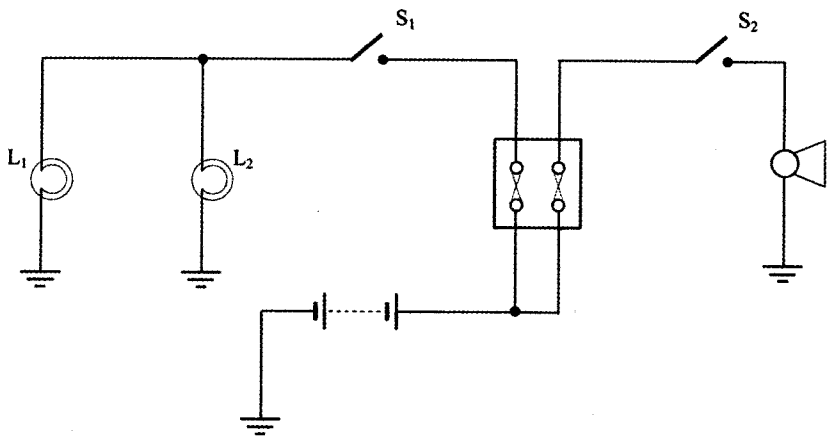
STATION 4

Identify the tools and fasteners labelled A to J and state one use of each. (10 marks)

ITEM	NAME	USE
A		
B		
C		
D		
E		
F		
G		
H		
I		
J		

STATION 5

Using the components and connecting leads provided, connect the vehicle electrical circuit as shown in the figure below.



Let the examiner check your work. (10 marks)

STATION 6

(a) Demonstrate to the examiner how to test the cylinder head provided for warpage. (4 marks)

(b) For the piston provided determine:

(i) taper;

(ii) ovality. (6 marks)

STATION 7

Change the wheel marked on the vehicle provided.
Let the examiner check your work. (10 marks)

STATION 8

Using the measuring tools provided, take and record each of the measurements listed below:

	PART AND MEASUREMENT REQUIRED			READING
(a)	Valve:	(i)	length	_____
		(ii)	margin width	_____
		(iii)	stem diameter	_____
		(iv)	head diameter	_____
(b)	Valve spring free length			_____
(c)	Piston ring:	(i)	free gap	_____
		(ii)	width	_____
		(iii)	working gap	_____

(10 marks)

STATION 9

Name the parts labelled K to P. For each part, identify one defect and one possible cause and complete the table below. (10 marks)

PART	NAME	DEFECT	CAUSE
K			
L			
M			
N			
P			

STATION 10

On the multicylinder engine provided carry out the static ignition timing given the firing order as 1342. (10 marks)

Let the examiner check your work.

30.19 POWER MECHANICS (447)

30.19.1 Power Mechanics Paper 1 (447/1)

1. (a) **FIRE EXTINGUISHERS**
Carbon dioxide
Dry powder
Sand or soil — Any 2 x ½

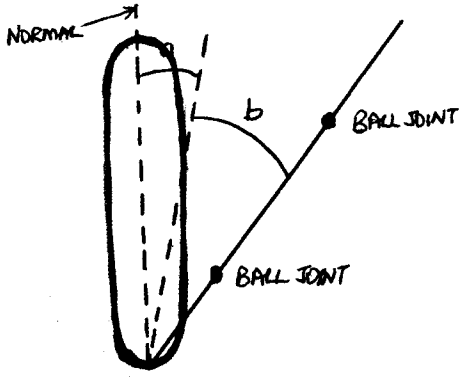
(b) **LIQUID PRESSURE**
It increases with depth
Act equally in all direction
Finds its own level — Any 2 x ½

2. (a) **USE OF TORQUE WRENCH**
Cylinder head bolts
Crankcase studs or bolts
Main and big end nuts
Flywheel bolts — Any 3 x ½

(b) **CAST IRON FOR ENGINE BLOCKS**
Has low melting point
Easy to machine
Cheaper compared to other types of iron — Any 2 x 1

3. (a) **ADVANTAGE OF INTEGRAL BODY**
Light in weight
Strong and compact
Cheap for mass production
Less noisy I vibrations — Any 2 x 1

(b) Camber a kingpin inclination



a CAMBER ANGLE
b KPI

4 x ½

4. (a) TYPES OF SPRINGS
Coil
Torsinal bar
Rubber
Laminated elliptical — 4 x ½

(b) **COUNTERSINKING & COUNTER BORING**

5. (a) **VISCOSITY**

(i) Measure of the rate of flow of an oil.

(ii) Gearbox and differential. 2 x 1

(b) Wet oily deposits: Oil leakage at piston rings, valve guides or fuel pump.
Sooty black deposit: Over choking, clogged air filter, excessive idling.
2 x 1

6. (a) Inlet value clearance too small – opens too early and closes too soon hence reduce volumetric efficiency.
Exhaust valve clearance too big - value open too late hence high fuel consumption low volumetric efficiency 2 x 1½

(b) Compression ratio

$$CR = \frac{DV - CV}{CV}$$

Where $DV = Tir^2 \times stroke$

$$= \frac{22}{7} \times 5010^2 \times \frac{100}{20}$$

$$= 785.7cc$$

$$CR = \frac{785.7}{100100} = 8.9:1$$

6 x ½

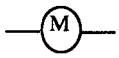
7. (a) **FUNCTION**

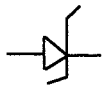
Sychronizer	-	matches the speed of countershaft
Idler gear	-	facilitates change of motion to reverse
Fork	-	selects preferred gear

3 x 1

(b) **SYMBOLS**

(i) 

(ii) 

(iii) 

(iv) 

4 x ½

8. (a) **MEASUREMENTS**

(i)	SPRING	-	Height and squareness
(ii)	CAMSHAFT	-	Lobe height, journal ⌀

4 x ½

(b) DISADVANTAGES – Residue attracts oxidation leading to weakened joint.
SOFT SOLDER - Tin (60%) and Lead (40%) 2 x 1

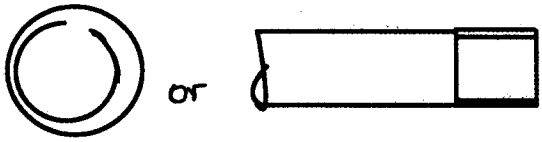
9. **ENGINE TERMS**

(a)	Valve lead	-	Where exhaust valve opens before BDC as exhaust stroke to allow exhaust gases to exit.
(b)	Valve lag	-	Inlet valve closes after BDC on oilet stroke to allow a admission of more flesh mixture.
(c)	Valve overlap	-	When both exhaust and intake valves are open at the end of exhaust stroke and beginning of intake stroke.

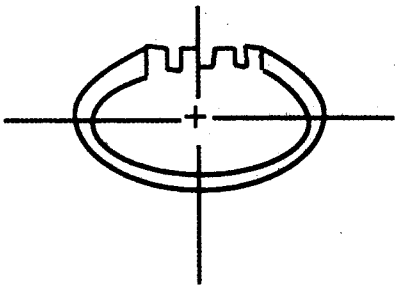
(1½ x 3)

10. **SYMBOLS**

(a)



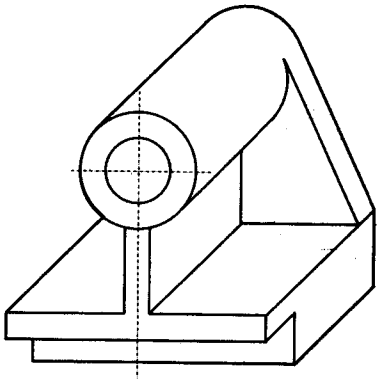
(b)



(c)

3 x 1

11.



10 faces x 1	*= 10*
Oblique	*= 1*
Face X X at front	*= 1*
Dimensioning 3 x ½	*= 1½*
Proportionality	*= 1*
Neat ness	*= ½*
TOTAL	*= 15 marks*

12. (a) **SERVICE CHECKS**

Burnt faces
Face wastage
Face pitting
Stem bending
Scoring

Any 4 x ½

(b) **TESTING RADIATOR FOR LEAKS**

Mount radiator in upright position.
Close the lower end
Fill it with water and pressure
Identify and mark leakage points. 4 x1

(c) **DETECTING AND CORRECTING MISFIRING S. PLUG**

- Start the engine and leave it running at idle speed. 1
- Remove spark plug lead for cylinder number one spark plug and listen to the idling.
- The idling would slow down and get noticeably rougher if that cylinder is firing. 1
- Repeat the above procedure for each of the three spark plugs. 1
  The plug that does not five any noticeable change is misfiring. 1
- Stop the engine and remove this plug. 1
- Replace the plug with a good one. 1
- With the engine at idle speed again, remove the plug cable for this new plug and see if there will be a difference in idling. If it is there, then it was the plug that was the cause.
- If the misfiring persists, replace the plug cable with a good one and try to notice the difference. 1

9 x 1

13. (a) **ADVANTAGES OF PHEUMATIC BRAKES**

- Maintenance is cheaper
- Compressed air can be used for other application
- Air is readily available at no cost
- Equipment is cheap to produce.

Any 3 x 1

(b)

A Push rod
B Reserviour
C Piston
D Valve
E Spring
F Seal

6 x ½

(c) **OPERATION**

ENGAGEMENT

- When the push rod moves into the cylinder it compresses the fluid. 1
- Further movement closes the port to reserviour thus trapping the fluid into the cylinder.
- Continued movement of the piston increases the fluid pressure. 1
- Increased pressure acts equally in the system and pushes pistons in the wheel cylinder outward to engage the brake shoes. 1
- Further pressure on pedal sustains pressure in the system. 1

DISENGAGEMENT

- When it is released, the spring action and back pressure of fluid releases the pressure on the wheel cylinder to release the brakes. 1
- Pressure is balanced through the reserviour by pass. 1

(9 marks)

14. (a) **EFFECTIVE STEERING SYSTEM**

Being self- centering
Should enable accurate control along the path taken by the vehicle at all times.
Shouldn't be affected by the action of suspension and braking systems.

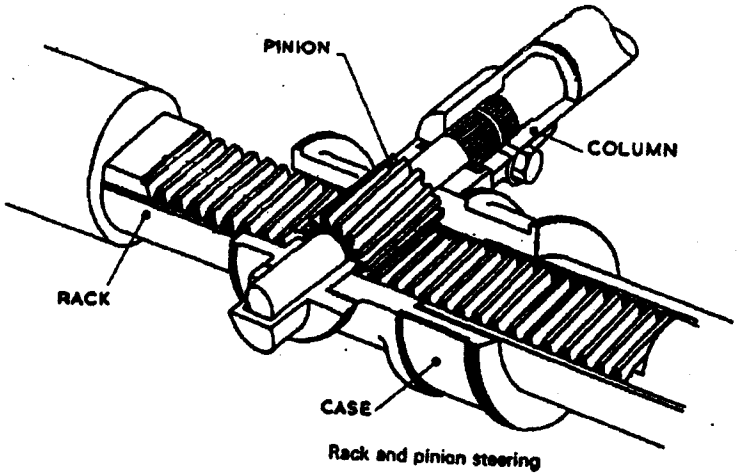
Any 3 x 1

(b) **PRELIMINARY CHECKS**

- Kingpins and bushes for excessive wear and lift.
- Ball joints for locking, excessive war and rod lifting.
- Hub bearing for free play and correct adjustment.
- Swivel points of suspension for free movement.
- Steering gear box for excessive wear and being secured.
- Shackles pins and bushes for excessive war and side movement.

Any 4 x 1

(c)



Rack and pinion steering

SKETCH 2 x 1
LABELLING 4 x ½

The rack consists of a cylindrical steel bar which has gear teeth machined on one side.
The steel pinion, which is attached to the lower end of the steering column, is meshed with the teeth of the rack. When the steering wheel is rotated, it causes the rack to move to and fro along its axis.
The ends of the rack are connected to the steering track arms by the short balt jointed tie rod ends. Therefore, its movement causes the wheels to turn through this mechanism.

15. (a) **OPERATIONAL REQUIREMENT FOR PROPELLER SHAFT**

High resistance to misalignment
Torsional stress of hollow shaft
Shouldn't exceed prescribed maximum length
Low resistance to any change in rotational speed.

(b) **REMOVING SERVICING AND INSTALLING PROPELLER SHAFT (PS)**

(i) Carryout visual inspection to identify the problem;
(ii) Place vehicle on stands to access underneath;
(iii) Remove PS with universal joints from vehicle;
(iv) Mark matching flange for accurate reinstallation;

(v) Remove universal joint from the propeller;
(vi) Check the propeller shaft for defects e.g dents and cracks;
(vii) Disassemble the universal joints;
(viii) Inspect the bearing cups and rollers for wear;
(ix) Replace worn out parts;
(x) Assemble the universal joint;
(xi) Reassemble the unity to the vehicle aligning the flange and pinion shaft;
(xii) Test for free movement in all directions;
(xiii) Remove vehicle from stands.

(10 x 1 and 4 x ½)