

3.5 POWER MECHANICS (447)

The 2012 KCSE examinations for Power Mechanics consisted of two papers namely Paper 1 (theory) and Paper 2 (Practical). The theory was worth 60% while practical was worth 40% of the final mark. The revised syllabus was tested for the first time but the format and weighting of the two papers was the same as in the previous years.

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 12: Candidates overall performance in the years 2008 to 2012

Year	Paper	Candidature	Maximum score	Mean score	Standard deviation
2008	1	57	60	24.38	9.32
	2		40	25.49	6.88
	overall		100	49.77	14.67
2009	1	136	60	28.88	9.27
	2		40	27.05	4.15
	overall		100	56.74	12.37
2010	1	159	60	26.49	8.67
	2		40	26.34	5.24
	overall		100	52.66	12.81
2011	1	136	60	28.79	9.25
	2		40	27.74	4.10
	overall		100	56.53	11.69
2012	1	149	60	34.51	7.35
	2		40	30.74	3.08
	overall		100	65.26	9.07

From the table it can be observed that:

- (i) The mean score improved from 56.53 for the year 2011 to 65.26 for the year 2012.
- (ii) The candidature increased from 136 in the year 2011 to 149 in the year 2012.
- (iii) The general performance has been increasing since the year 2010.

3.5.1 Power Mechanics Paper 1 (447/1)

The questions which were reported to have been poorly performed have been analyzed with a view to pointing out candidates' weaknesses and proposed suggestions on some remedial measures that would be taken in order to improve performance in future. The questions for discussions include 1 (b), 3(b), 5, 6 and 7.

Question 1 (b)

List four types of common body cuts.

Candidates were expected to list four types of body cuts.

Weaknesses

Most candidates could not identify body cuts.

Advice to Teachers

They should cover the whole syllabus including safety.

Expected Responses

- i. Types of body cuts:
- ii. Incised
- iii. Lacerated or torn
- iv. Bruised
- v. Stab

Question 3 (b)

Explain the functions of a multimeter and state how it is connected in each case.

Candidates were expected to explain functions of a multimeter and state how they are connected in each case.

Weaknesses

Candidates could not exhaustively identify all the uses of a multimeter and state the connection in each case.

Advice to Teachers

They should explain to the students the applications of a multimeter.

Expected Responses

A multimeter is an electrical instrument consisting of an ammeter, ohmmeter and voltmeter all combined to form one instrument.

- (i) When used as an ammeter it is connected in series to measure current flowing in a circuit.
- (ii) When used as a voltmeter it is connected in parallel to measure voltage in circuit.
- (iii) When used as an ohmmeter it is connected in series to measure the resistance of a circuit.

Question 5 (a)

State two operational differences between an alternator and a generator.

Candidates were expected to state the differences between an alternator and a generator.

Weaknesses

Most candidates could not differentiate between an alternator and a generator.

Advice to Teachers

They should expose students to alternators and generators in terms of operational differences.

Expected response

- i. An alternator delivers alternating current while a generator delivers direct current
- ii. In the DC generator the armature spins inside a field while in an alternator the field spins inside the starter.

Question 6

- (a) Name four parts of an automatic transmission system.
- (b) Draw a labeled circuit diagram of the courtesy light circuit.

Candidates were expected to name parts of an automatic transmission system and draw a labeled circuit diagram of the courtesy light circuit.

Weaknesses

Most candidates could not name parts of an automatic transmission system and draw a labeled circuit diagram of the courtesy light circuit.

Advice to Teachers

They should expose students to automatic gearbox construction and drawing various lighting circuits.

Expected response

- a) Parts of an automatic transmission system
 - i. Torque converter
 - ii. Planetary gearsets
 - iii. Brake bands
 - iv. Multiple disc clutches
 - v. Hydraulic servers and pistons
 - vi. Numerous valves
 - vii. Cooling means
 - viii. Manual control systems

b) Draw a labelled circuit diagram of the courtesy light circuit.

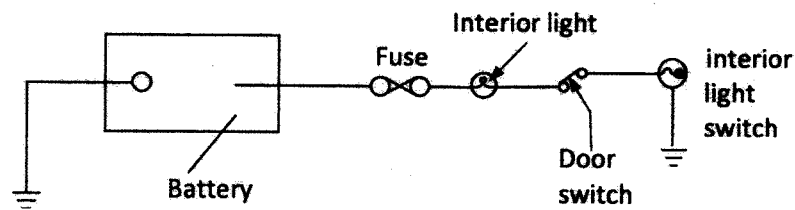


Figure 1

Question 7

State two types of each of the following

- (i) Welding rods
- (ii) Brazing rods
- (iii) Fluxes

Candidates were expected to state two of the above mentioned

Weakness

Candidates were unable to state any type of the above.

Advice to Teachers

They should expose students to types of welding rods, brazing rods and fluxes.

Expected response

- (i) Welding rods:
 - Steel/ metal filler rods
 - Cast iron filler rods
 - Aluminium filler rods
- (ii) Brazing rods
 - Brass filler rods
 - Bronze filler rods
- (iii) Fluxes
 - Borax
 - Killed spirits
 - Zinc chloride
 - Salamonic tallow resin
 - Dilute hydrochloric acid
 - Olive oil
 - Phosphoric acid

3.5.2 Power Mechanics Paper 2 (447/2)

The paper had 10 equally weighted compulsory exercises. It tested competencies in the following areas:

- Drawing the exploded views of a connecting rod assembly and labeling the parts
- Metal fabrication skills on an opener using given materials
- Identification and visual checks for performance of motor vehicle parts
- Naming given parts of a motor vehicle system
- Determining the big end clearance at a torque of 25 KN/m² on a single cylinder engine
- Dismantling an oil pump and measuring rotor body clearance and tip clearance and reassembling the pump and testing it.
- Removing the return spring, measuring the tension spring and replacing the return spring on a drum brake
- Connecting a three-lamp lighting circuit such that two lamps are in series while the third lamp is in parallel.
- Identifying parts on a vehicle provided
- Servicing the spark plugs on a multi-cylinder engine

All the exercises were fairly performed by most of the candidates thus the improved mean score.

4.5 POWER MECHANICS (447)

4.5.1 Power Mechanics Paper 1 (447/1)



MANYAM FRANCHISE
Discover! Learn! Apply

SECTION A (40 marks)

Answer all the questions in this section in the spaces provided.

- 1 (a) Define power mechanics. (1 mark)
- (b) List **four** types of common body cuts. (2 marks)
- 2 (a) State **one** advantage of tubeless tyres over tubed tyres. (1 mark)
- (b) State **three** reasons for writing a business plan. (3 marks)
- 3 (a) The nominal size of a Gudgeon pin is 50 mm. If the tolerance is 0.0825 mm, determine its limits. (2 marks)
- (b) Explain the functions of a multimeter and state how it is connected in each case. (3 marks)
- 4 (a) State the function of each of the following devices in a motor vehicle:
 - (i) split pin; (1 mark)
 - (ii) internal snap ring. (1 mark)
- (b) Explain **two** reasons for alloying metals. (2 marks)
- 5 (a) State **two** operational differences between an alternator and a generator. (2 marks)
- (b) State **two** disadvantages of external combustion engine over internal combustion engine. (2 marks)
- 6 (a) Name **four** parts of an automatic transmission system. (2 marks)
- (b) Draw a labelled circuit diagram of the courtesy light circuit. (3 marks)
- 7 (a) State **two** types of each of the following:
 - (i) welding rods; (1 mark)
 - (ii) brazing rods; (1 mark)
 - (iii) fluxes. (1 mark)
- 8 (a) With the aid of a sketch, explain the term negative caster angle. (2 marks)
- (b) Explain how a stabilizer bar works. (2 marks)

- 9 (a) List **four** main components driven by the crankshaft in a multi-cylinder engine. (2 marks)
- (b) State **two** precautions to observe when fitting a new cylinder head gasket. (2 marks)
- 10 **Figure 1** shows a single cylinder engine carburettor.

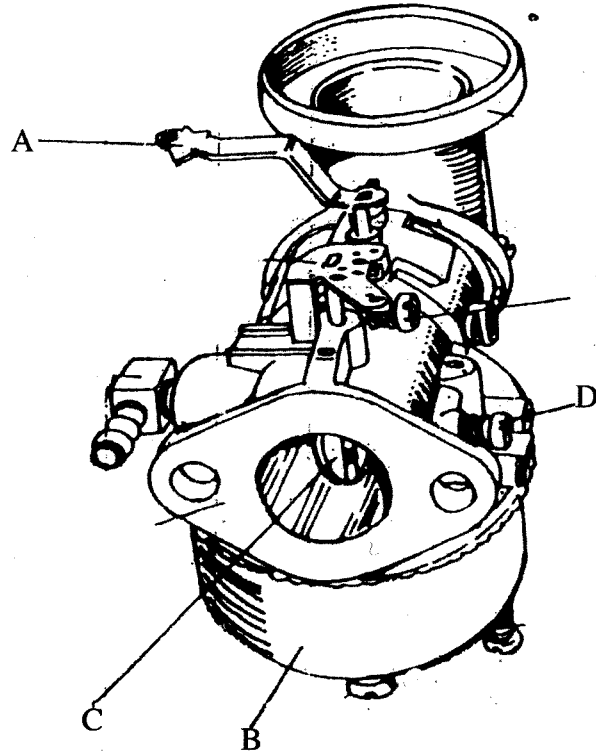


Figure 1

Name the parts labelled **A, B, C** and **D** and state the function of each part.

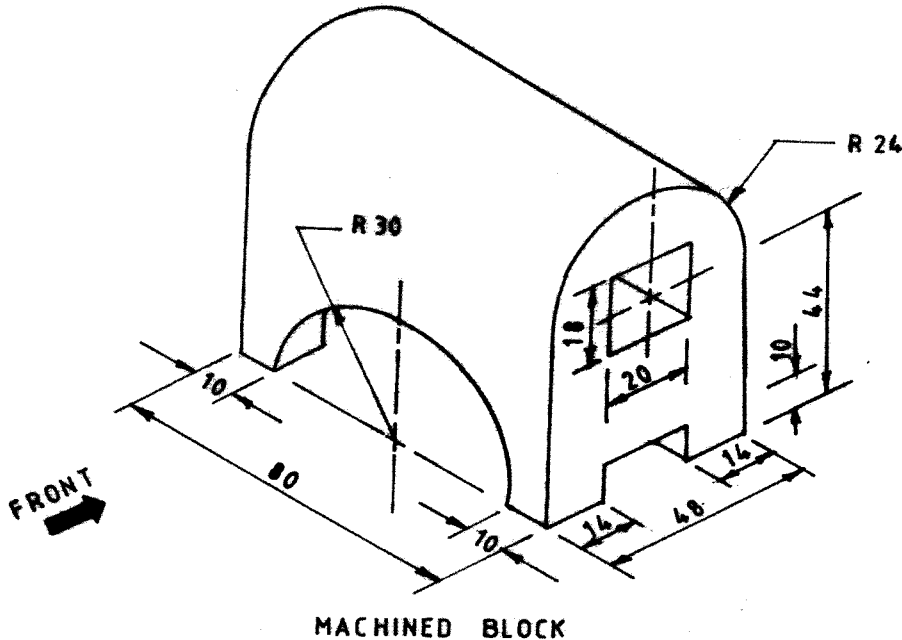
(4 marks)

- A**
- B**
- C**
- D**

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 2 shows a machined block.



NOTE:

Holes and grooves run from one end to the other

Draw, full size in first angle projection the following views:

(12 marks)

- (a) front elevation;
- (b) end elevation;
- (c) plan.

Indicate six leading dimensions.

(3 marks)

(Use A₃ provided)

12 (a) List **ten** components which should be disconnected before removing an engine from a vehicle. (5 marks)

(b) A spark ignition multicylinder engine runs but misfires.

(i) State **five** possible causes of misfiring; (5 marks)

(ii) Outline the procedure of identifying the misfiring cylinder. (5 marks)

13 (a) State **three** provisions required when designing a power mechanics workshop. (3 marks)

(b) Sketch a layout of a power mechanics workshop showing its main areas of operation. (Use A₃ provided) (12 marks)

- 14 (a) State **five** types of care practices that enhance the life span of tyres. (5 marks)
- (b) Outline the procedure of changing a flat wheel of a vehicle. (10 marks)
- 15 **Figure 3** shows a dual master cylinder.

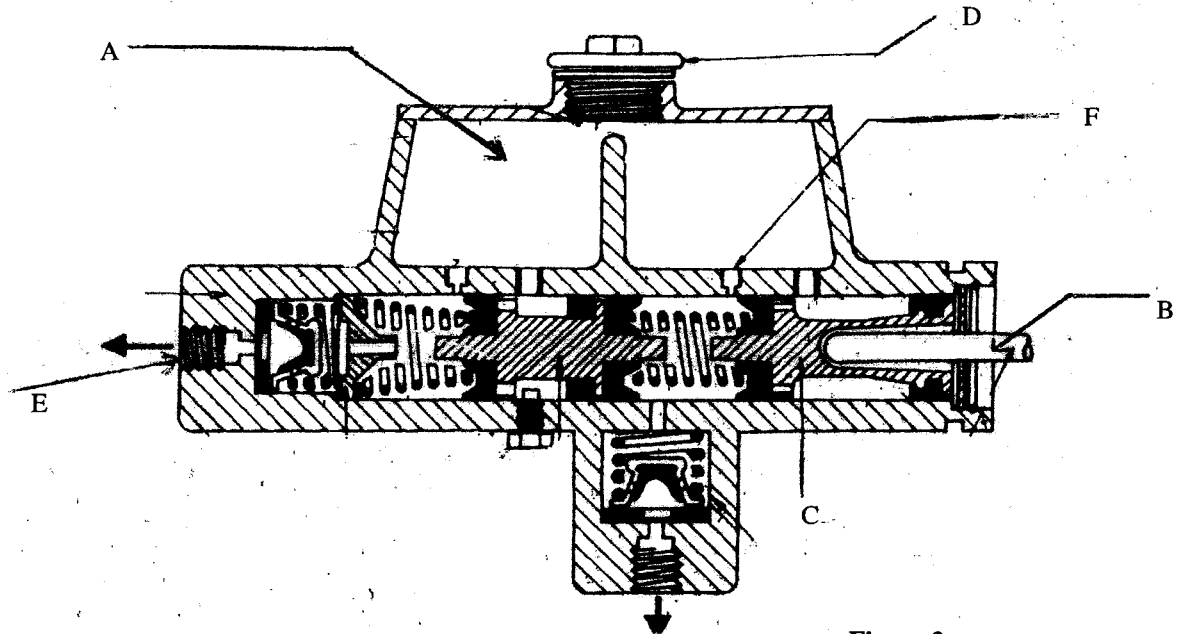


Figure 3

- (a) Name the parts labelled **A, B, C, D, E,** and **F** (3 marks)
- (b) Explain the operation of the dual master cylinder under the following conditions:
- (i) normal operation;
 - (ii) front brakes failure;
 - (iii) rear brakes failure.
- (12 marks)

4.5.2 Power Mechanics Paper 2 (447/2)

STATION 1

In the space below, sketch in good proportion an exploded drawing of a connecting rod assembly.

Label **four** parts.

(10 marks)

STATION 2

Using the tools, materials and equipment provided, make the template shown in **figure 1** below.

(10 marks)

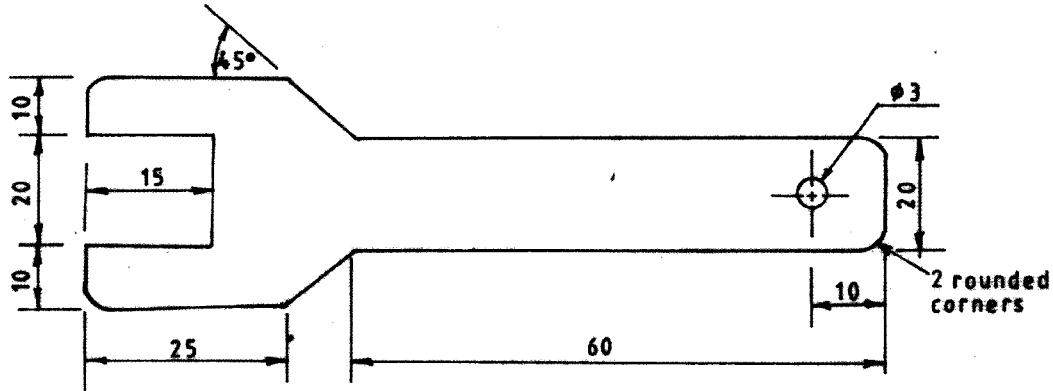


Figure 1

STATION 3

Identify the parts labelled **M, N, O, P** and **Q** and name the motor vehicle system in which each is used.

For each part, identify one defect and state its effect on vehicle performance. Complete the table below.

(10 marks)

PART	NAME	VEHICLE SYSTEM	DEFECT	EFFECT
M				
N				
O				
P				
Q				

STATION 4

On the single cylinder engine provided, determine the big-end bearing clearance at a torque of 25kN/m².

Let the examiner check your work.

(10 marks)

STATION 5

Dismantle the oil pump provided. Measure and record the following:

- (i) rotor - body clearance
- (ii) tip clearance

Reassemble the pump and test it for functionality.

Let the examiner check your work.

(10 marks)

STATION 6

On the drum brake of the vehicle provided:

- (a) remove the return spring.
- (b) measure the tension of the spring.
- (c) replace the return spring

Let the examiner check your work.

(10 marks)

STATION 7

Using the tools, materials and components provided, connect a three-lamp lighting circuit such that two lamps are in series while the third lamp is in parallel.

Let the examiner check your work.

(10 marks)

STATION 8

On the vehicle provided:

- (a) identify the parts labelled X, Y and Z. (3 marks)
- (b) determine the toe-in of the vehicle. (7 marks)

Let the examiner check your work.

STATION 9

Using the tools and materials provided, mend the hole marked on the tube.

Let the examiner check your work.

(10 marks)

STATION 10

On the multicylinder engine provided, carry out the following tasks:

- (a) check and comment on the condition of the spark plug for cylinder number 3. (3 ½ marks)
- (b) service the spark plug.

Let the examiner check your work.

(6 ½ marks)

5.5 POWER MECHANICS (447)

5.5.1 Power Mechanics Paper 1 (447/1)



1. (a) Define power mechanics
It is the study about machines that exert mechanical force. (1 mark)
- (b) List **four** types of body cuts
- incised;
- lacerated or torn;
- bruised;
- stab. (4 x □)= 2 marks
2. (a) State **one** advantage of tubeless tyres over tubed tyres.
- they are lighter in weight;
- they run at lower temperatures;
- they hold pressure for a longer time. any(1 x 1) = (1 mark)
- (b) State **three** reasons for writing a business plan.
- to enable a business obtain finances from banks and other financial institutions.
- to provide guidelines for opening a new business or expanding an existing one.
- to communicate to outsiders about the goals, objectives and activities of the business.
- to serve as a tool for managing every aspect of the operation of business. Any 3 x 1 = 3 marks
3. (a) The nominal size of a Gudgeon pin is 50mm. If the tolerance is 0.0825mm, determine its limits.
- Upper limit = $50 + 0.0825 = 50.0825$ (1 mark)
- Lower limit = $50 - 0.0825 = 49.9175$ (1 mark)
- (b) Explain the functions of a multimeter and state how it is connected in each case.
- A multimeter is an electrical instrument consisting of an ammeter, ohmmeter and voltmeter all combined to form one instrument. (1 mark)
- When used as an ammeter the instrument is connected in series with a circuit to measure current.
- When used as voltmeter it is connected in parallel with a circuit to measure voltage with a circuit to measure voltage.
- When used as an ohmmeter it is connected in series to measure the resistance of a circuit. (2 marks)
4. (a) State the function of each of the following devices in a motor vehicle:
- (i) Split pin - it is used together with either a slotted or castellated nut to prevent it working loose during an operation. (1 mark)
- (ii) Internal snap ring - used in housings to keep shafts on other parts in position. (1 mark)

- (b) Explain two reasons for alloying materials:
- to lower the melting point of the metal.
 - to achieve additional strength and hardness.
 - To increase resistance to corrosion.
 - To alter the colour appearance.
 - To secure cleaner and sharper castings.

Any 2 x 1 = 2 marks

5. (a) State **two** operational differences between an alternator and a generation.
- An alternator delivers alternating current while DC generation delivers direct current
 - In the DC generator the amature spins inside a field while in the alternator the field spins inside the startor.

2 x 1 = 2 marks

- (b) State **two** disadvantages of external combustion engine over internal combustion engine.
- External combustion engines are too large for general application.
 - They are not as efficient as the internal combustion engines.

2 x 1 = 2 marks

6. (a) Name **four** parts of an automatic transmission system.

- Torque converter.
- Planetary gearcets.
- Brake bands.
- Multiple disc clutches.
- Hydraulic servers and pistons
- Numerous valves.
- Cooling means.
- Manual control systems.

any 4 x $\frac{1}{2}$ = 2 marks

- (b) Draw a labelled circuit diagram of the courtesy light circuit.

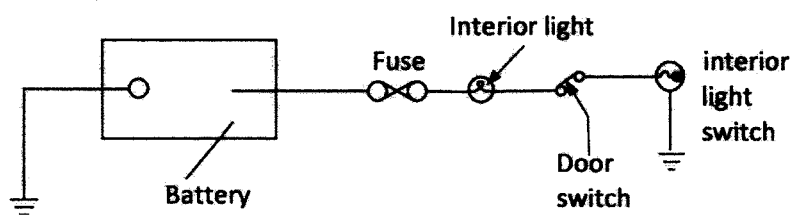


Figure 1

Components correctly drawn and labelled = $5 \times \frac{1}{2} = 2 \frac{1}{2}$ marks
 Circuit neatly drawn = $\frac{1}{2}$ marks

Total = 3 marks

7. (a) State **two** types of each of the following:

- (i) Welding rods:
- Steel /metal filler rods .
 - Cast iron filler rods.

- Aluminium filler rods.

Any 2 x $\frac{1}{2}$ = 1 mark

(ii) Brazing rods

- Brass filler rods.
- Bronze filler rods

Any 2 x $\frac{1}{2}$ = 1 mark

(iii) Fluxes

- Borax
- Killed spirits.
- Zinc chloride.
- Salamonic tellow resin
- Dilute hydrochloric acid.
- Olive oil.
- Phosphoric acid.

Any 2 x $\frac{1}{2}$ = 1 mark

8. (a) With the aid of a sketch explain the terms negative caster angle.

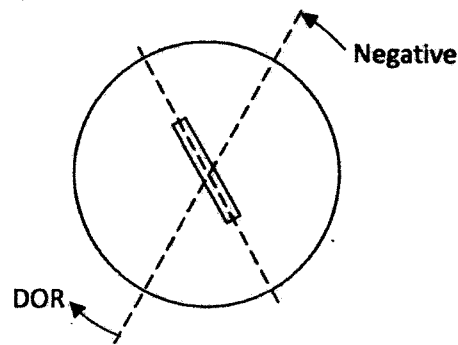


Figure 2

This is the angle formed by the forward or tilting of the steering axis when viewed from the side of the wheel.

Sketch 1 mark

Explanation 1 mark
2 marks

(b) Explain how a stabilizer bar works when the body of the vehicle attempts to lean onto one side, as in rounding a curve, one end of the bar bends downwards, producing a torsional effect in the bar that resists the roll-tipping effect/action and helps keep the body level. 2 marks

9. (a) List **four** main components driven by the crankshaft in a multi-cylinder engine:

- Crankshaft;
- Fan;
- Oil pump.
- Water pump
- Alternator
- Flywheel.

Any 4 x $\frac{1}{2}$ = 2 marks

- (b) State **two** precautions to be observed when fitting a new cylinder head gasket:
- Ensure the head and block surfaces are clean and flat.
 - Handle the gasket carefully to avoid creasing the metal and breaking the asbestos filing.
 - use either gasket varnish or smear a thin layer of grease over the whole surface.
 - Fit the gasket properly without blocking any of the holes.
 - Tighten the cylinder-head nuts to the right torque and sequence.

any 2 x 1 = 2 marks

10. Name the parts labelled A, B, C and D and state the function of each part.
- A - Choke lever reduces the amount of air supplied during engine cold starting.
- B - Float bowl Acts as a storage for petrol and operating needle valve to regulate the petrol flow into the float bowl.
- C - Throttle valve regulates the amount of air-fuel mixture entering the cylinder.
- D- Idle mixture adjustment screw- it regulates the mixture for idling cct screw.

4 x 1 = 4 marks

11.

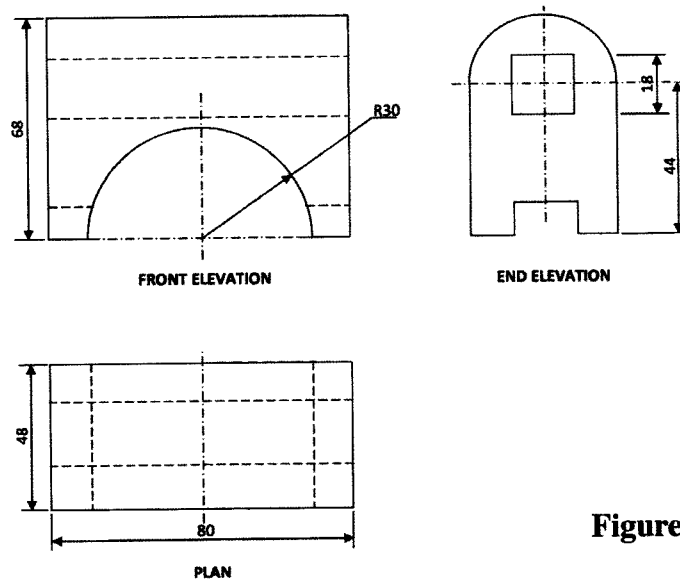


Figure 4

$$\begin{array}{l}
 \text{FE} = \text{HD} = 3 \times \frac{1}{2} = 1\frac{1}{2} \\
 \text{Semicircle} = 1 \\
 \text{Face} = 1 \\
 \hline
 3\frac{1}{2} \text{ marks}
 \end{array}$$

$$\begin{array}{l}
 \text{E.E} = \text{Face} - 2 \\
 \text{Engrare} - \frac{1}{2} \\
 \hline
 \text{HD} - 1 \\
 3\frac{1}{2} \text{ marks}
 \end{array}$$

$$\begin{array}{l}
 \text{PLAN} = \text{HD} = 4 \times \frac{1}{2} = 2 \\
 \text{Face} = 1 \\
 3 \text{ marks}
 \end{array}$$

$$\begin{array}{l}
 \text{Dimensions} \quad 6 \times \frac{1}{2} = 3 \text{ marks}
 \end{array}$$

$$\begin{array}{l}
 \text{Correct position of} \quad -1 \text{ mark}
 \end{array}$$

$$\begin{array}{l}
 \text{Correct angle of projection} - 1 \text{ mark} \\
 \text{Total} = 15 \text{ marks}
 \end{array}$$

Components to be disconnected before removing an engine from a vehicle:-

12. (a)

- Battery cables and the battery.
- Air cleaner.
- Radiator hoses from the engine and water pump. (Drain Radiator)
- Heater hoses.
- Fan and radiator.
- Oil pressure cables.
- Fuel pump hoses.
- Alternator.
- Primary wire from ignition coil.
- Exhaust pipe from exhaust manifolds.
- Starter motor and its cables.
- Intake manifold hoses.
- Engine mounts from frame brackets.
- Clutch or automatic transmission.

any $10 \times \frac{1}{2} = 5$ marks

(b)

- Start the engine and leave it idling.
- Using insulated pliers, disconnect each spark plug at a time and note if there is change in engine speed.
- No change in speed means the cylinder is missing even before the cable was disconnected.
- Check a missing cylinder further by holding the spark plug lead clip close to the engine block while the engine is running.
- No spark implies a high voltage leak, hence the cylinder misfires.

Possible causes of misfiring.

- Defective spark plug or its cable.
- Defective distributor cap.
- Defective valve action.
- Worm pistons and rings.
- Overheated engine.
- Defective head gasket
- Compression leakage.
- Intake manifold leakage.
- Cross-firing plugs wires.
- Defective coil, condenser.
- Large gap c.b. among others.

any $5 \times 1 = 5$ marks

13. (a) State **three** provisions required when designing a power mechanics workshop.

- doors
- spaces
- passage ways
- washing place
- provision of light
- ventilation
- fire points
- emergency points.

any 3 x 1 = 3 marks

(b)

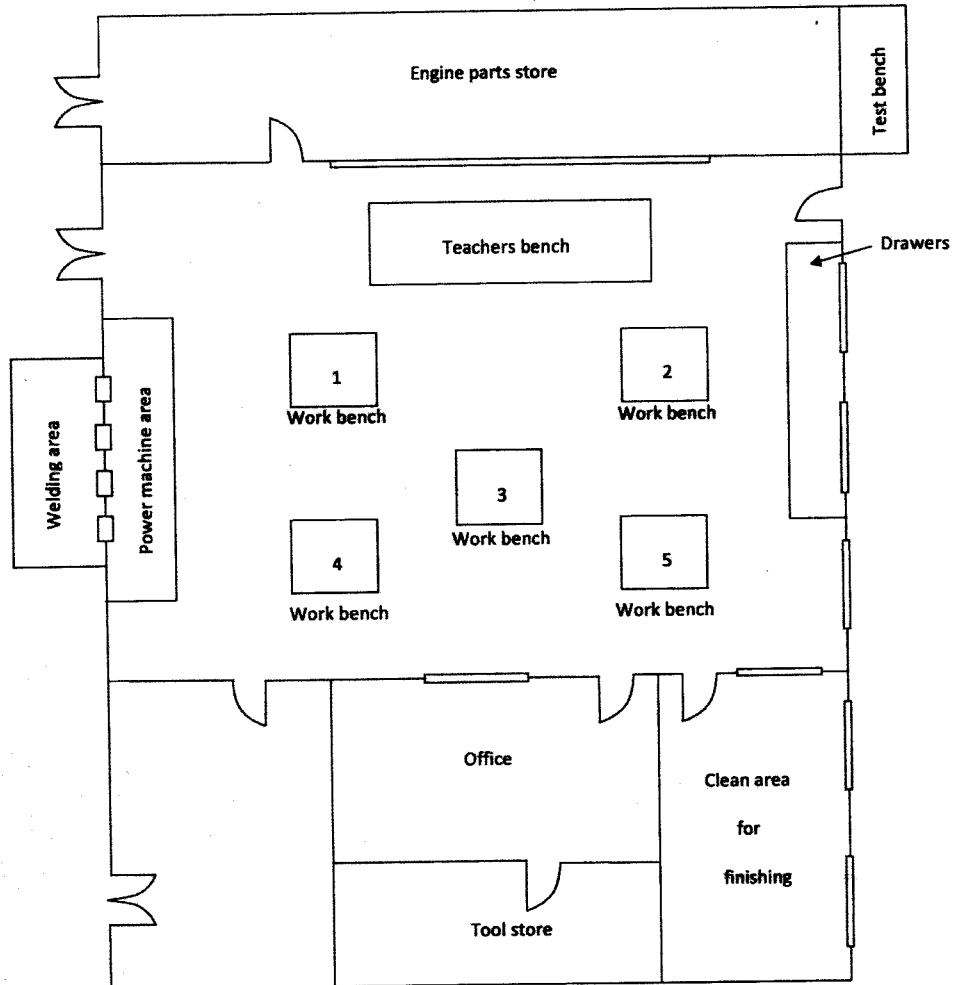


Figure 5

Layout		- 1 mark
Locations		- 2 marks
Labelling		- 3 marks
Relationship between areas for workflow		- 2 marks
Windows	4 x $\frac{1}{2}$	= - 2 marks
Doors	4 x $\frac{1}{2}$	= - 2 marks
		12 marks

14. (a) Solution: Care practices that enhance tyre lifespan.

- Regular inspection of tyres for nails, stones e.t.c. They should be removed and small cuts should be repaired by vulcanising.
- Maintaining inflation pressures at the recommended values.
- Keeping toe-in and toe-out within specified limits.
- Avoiding violent usage of clutch and brakes (e.g. sudden braking and sudden release clutching).
- Frequent checking of suspension and steering system which can cause misalignment.
- Wheel rotation after every 5000 km or so, incorporating the spare wheel.
- Avoiding contact with oil, grease or paint.
- Avoiding continuous exposure to ultra-violet light from strong sunshine.

any 5 x 1 = 5 marks

(b) Procedure for changing a wheel:

- parking vehicle on a flat surface.
- chocking the appropriate wheel.
- loosening nuts diagonally, remove nuts.
- Jacking up the vehicle.
- putting support stands (or equivalent) under the vehicles
- removal of the flat wheel.
- fitting the inflated wheel to replace the flat wheel.
- replacing wheel nuts and tightening them slightly.
- unjacking the wheel and removal of the jack.
- final tightening of the wheel diagonally and to the correct torque. Unchoke.

10 x 1 = 10 marks

15. The parts labelled A to F.

- A - Rear reservoir.
- B - Push rod.
- C - Primary piston.
- D - Vented cap
- E - Outer port.
- F - Front by-pass port.

6 x $\frac{1}{2}$ = 3 marks

(b) Explain the operation of the unit under the following conditions.

(i) Normal operation.

The brake pedal is depressed ($\frac{1}{2}$), it pushes the push ($\frac{1}{2}$) rod to more forward once by front pass ($\frac{1}{2}$) port. It is passed by primary piston which pushes the secondary ($\frac{1}{2}$) piston. In both areas brakes are applied at the front areas brakes are applied at the front and rear ($\frac{1}{2}$) axles. Any excess ($\frac{1}{2}$) movement is controlled by top secondary piston. (3 marks)

On release of ($\frac{1}{2}$) pedal the push rod releases (1) the spring that releases the piston ($\frac{1}{2}$) and brake fluid is ($\frac{1}{2}$) released to the reservoir thus releasing ($\frac{1}{2}$) brake application. (3 marks)

(ii) Front brake failure.

On application of the pedal the primary piston gets no resistance (1) until it comes into contact with secondary, (1) it is then pushed to apply rear brakes.(1) (3 marks)

Rear brakes failure/leakage. (3 marks)

The pedal is depressed, the secondary (1) piston does not get any resistance its pushed to end of cylinder (1), on further application the front wheel brakes (1) are applied.