3.6 ELECTRICITY (448)

In the year 2012, Electricity was tested in two papers; paper 1(448/1) and paper 2 (448/2). Paper 1 was a theory paper which constituted 60% of the final mark while Paper 2 was a practical paper which constituted 40% of the final mark. The revised syllabus was tested for the first time with the format and weighting changed for paper 1. The format and weighting for paper 2 was the same as for the previous years.

General Candidates Performance

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

Table 13: Candidates overall performance in the years 2008 to 2012

Year	Paper	Candidature	Maximum score	Mean score	Standard deviation
2008	1		60	26.67	10.78
	2		40	21.83	6.64
	overall	**48**	**100**	**48.58**	**15.29**
2009	1	**2**	60	35.47	9.65
	2		40	24.08	5.66
	overall	**19**	**100**	**59.55**	**13.75**
2010	1		60	32.96	9.53
	2		40	28.56	4.33
	overall	**161**	**100**	**61.52**	**12.56**
2011	1		60	35.21	10.57
	2		40	30.17	3.99
	overall	**183**	**100**	**65.37**	**12.63**
2012	1		60	35.13	9.09
	2		40	25.47	4.29
	overall	**214**	**100**	**60.60**	**11.83**

From the table it can be observed that:

(i) The candidature increased from 183 in the year 2011 to 214 in the year 2012.

(ii) There was a slight drop in the mean for paper 1 from 35.21 in 2011 to 35.13 in 2012.

(iii) Paper 2 also experienced a slight drop in the mean from 30.17 in 2011 to 25.47 in 2012.

(iv) There overall performance dropped from a mean of 65.38 in 2011 to 60.60 in 2012.

3.6.1 Electricity Paper 1 (448/1)

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(a), 2, 3, 5(a), 10 (b),14.

Question 1 (a)

State four categories of institutions that train electrical technicians in Kenya

Candidates were expected to state the institutions that train electricians in Kenya.

Weaknesses

Most candidates could not state the institutions that train electricians in Kenya.

Advice to Teachers

They should teach the whole syllabus including places one can proceed to for upward mobility.

Expected Responses

Institutions that train electricians in Kenya:

i. Universities
ii. Institutes of technology
iii. Technical training institutes
iv. Vocational training centers
v. National polytechnics

Question 2 (a)

State how each of the following electrical waste materials should be disposed

i. Lead acid battery
ii. Fluorescent tube

Candidates were expected to state how electrical waste materials should be deposited.

Weaknesses

Most candidates mixed up the disposal methods.

Advice to Teachers

They should teach the syllabus holistically.

Expected Responses

a) Disposal of electrical waste materials
    i. Lead acid battery-return to the manufacturer

ii. Fluorescent tube- break and burry

Question 2 (b)

State where each of the following type of fire extinguisher is suitably applied:

i. Foam
ii. Water
iii. Dry powder

Candidates were tested on fire extinguishers

Weakness

Most candidates could not answer the question as expected.

Advice to Teachers

They should teach the syllabus holistically.

Expected response

b) Use of fire extinguishers
   i. Water- to put out fires on burning solid materials
   ii. Foam- to put out fires on burning oils and chemicals
   iii. Dry powder- used to deal with fires on burning flammable liquids and some solids

Question 3

A one-watt resistor has the colour code ; blue, grey and brown. Determine:

a) The value of the resistor
b) The maximum value of current that can flow through it without exceeding its power.

Candidates were expected to determine the value of resistor and maximum value of current that can flow through it without exceeding its power.

Weaknesses

Most candidates were not able to put the tolerance values for the stated resistors.

Advice to Teachers

They should teach colour code interpretations exhaustively and let learners understand the tolerance values.

Expected Responses

(a) Value of resistor = 680 Ω (1 mark) ± 20% (1 mark)

(b) Maximum current $I = \sqrt{\frac{P}{R}}$

$P = 1\ W$

$$I = \sqrt{\frac{1}{680.68}}$$

$$= \sqrt{\frac{1}{544}}$$

$$= 42.87 \text{ Amps}$$

Question 5 (a)

Explain the meaning of "sensitivity" as used in meter movement.

Candidates were tested on sensitivity in meters

Weaknesses

Most candidates did not seem to know what they were doing.

Advice to Teachers

They should teach the syllabus in totality without ignoring certain topics.

Expected Responses

Sensitivity is the amount of current required to provide full scale deflection of the pointer.

Question 10 (b)

Figure 2 shows the orthographic views of a bracket drawn in first angle projection.

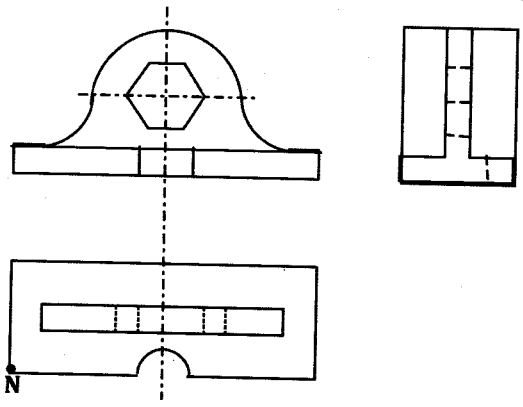


Figure 2

Taking N as the lowest point, make a free hand isometric sketch of the bracket.

Candidates were tested in sketching skills.

Weaknesses

Most candidates drew the bracket in oblique instead of isometric.

Advice to Teachers

They should teach the topic of related drawing to enhance the mental ability of the learners.

Expected Responses

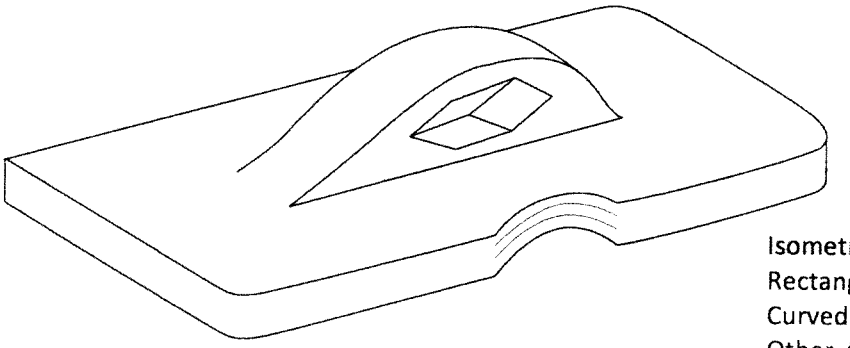


Figure 3

Isometric view with N lowest = 1mark
Rectangular base = 1mark
Curved upper part = 1mark
Other features = 1mark
4marks

Question14 (a)

State :

i. Two IEEE requirements regarding bell transformers
ii. Two advantages of MCB over cartridge fuses.

Candidates were tested on the IEEE regulations

Weaknesses

Most candidates could not answer this question correctly.

Advice to Teachers

They should teach the syllabus holistically and inclusively.

Expected Responses

(i) IEE requirements regarding bell transformers

They :

- Must be double-wound
- Should be earthed at one point of secondary winding iron-core of transformer and metal casing
- Should have a separate control switch and connected on its own final circuit
- Should have a high grade insulation of supply cable to transformer.

(ii) Advantages of MCB over cartridge fuses.

- Easy to reset therefore replacement not necessary
- Give better overall protection against fire shock
- Cannot be replaced by an inexperienced person
- Highly discriminative
- Sustain overload and rejects harmless transient over current.

3.6.2 Electricity Paper 2 (448/2)

The 2011 Electricity Paper 2 tested candidates in the following skills:

- Connecting an electric circuit from the diagram in the question and setting meter ranges to measure and record the values.
- Drawing a graph from values found in the practical
- Drawing orthographic views of a bracket given in isometric
- Trouble shooting and repair.
- Drawing schematic diagram of a given circuit and connecting the circuit
- Circuit study by taking measurements of current and voltage then using them to plot a graph then interpreting the graph.
- Domestic installation of a fluorescent lamp lighting circuit to be controlled from two positions.

Weaknesses

- The candidates had challenges completing the tasks in time.
- Readings posed challenges to some candidates while some confused the reverse voltage plotting.
- The use of unfamiliar tools and equipment during examinations should be avoided.
- Some candidates could not interpret the maximum power transfer correctly
- Teachers should teach holistically by ensuring that they cover all the details as they are in the syllabus.

4.6 ELECTRICITY (448)

4.6.1 Electricity Paper 1 (448/1)

SECTION A (48 marks)

*Answer **all** the questions in this section.*

1 (a) State **four** categories of institutions that train electrical technicians in Kenya. (2 marks)

(b) List **four** key components of a business plan. (2 marks)

2 (a) State how each of the following electrical waste materials should be disposed:
(i) lead acid battery;
(ii) fluorescent tube. (1 mark)

(b) State where each of the following type of fire extinguisher is suitably applied:
(i) foam;
(ii) water;
(iii) dry powder. (3 marks)

3 A one-watt resistor has the colour code; blue, grey and brown. Determine:

(a) the value of the resistor.
(b) the maximum value of the current that can flow through it without exceeding its power rating. (5 marks)

4 (a) State Lenz's law of electromagnetic induction. (1 mark)

(b) State **two** characteristics of magnetic lines of force. (2 marks)

5 (a) Explain the meaning of "sensitivity" as used in meter movement. (1 mark)

(b) With the aid of a circuit diagram, show how the linearity of a meter is determined. (4 marks)

6 (a) With the aid of a diagram, describe "armature reaction" in a dc generator. (4 marks)

(b) Outline **two** methods of reducing armature reaction. (2 marks)

7 (a) Distinguish between intrinsic and extrinsic semi-conductors and give **one** example of each. (3 marks)

(b) List **four** uses of an ohmmeter in trouble shooting electric circuits. (2 marks)

8 (a) Name **four** conductor materials used in electric circuits. (2 marks)

(b) State **two** advantages of MIMS over PVC cables. (2 marks)

9 **Figure 1** shows a series-parallel circuit connected across a 240V supply.

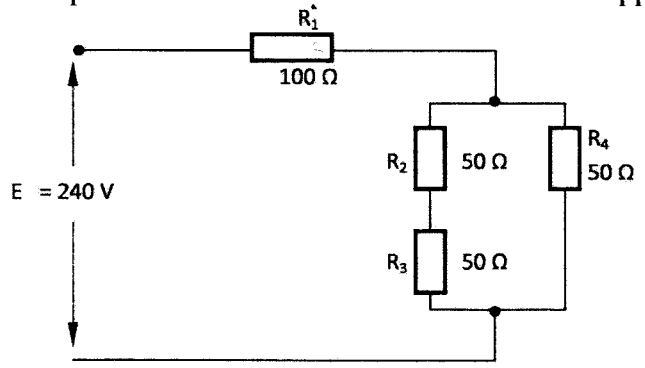


Figure 1

Calculate the:

(a) total circuit current. (2 marks)

(b) voltage drop across;
(i) R_3,
(ii) R_4. (4 marks)

10 (a) Name **four** marking out tools used in metal fabrication. (2 marks)

(b) **Figure 2** shows the orthographic views of a bracket drawn in first angle projection.

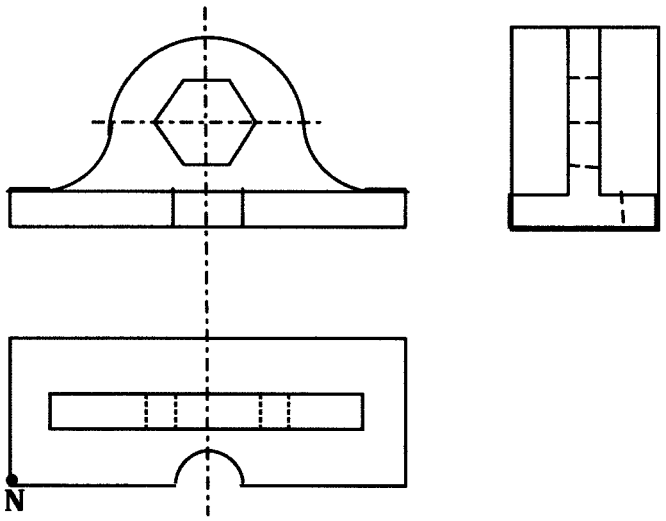


Figure 2

Taking N as the lowest point, make a free hand isometric sketch of the bracket.
(4 marks)

SECTION B (52 marks)

*Answer any **four** questions from this section, in the spaces provided after question **15**.*

11 (a) Convert:

(i) 41_{10} to binary;

(ii) 1101101_2 to decimal.

(4 marks)

(b) Sketch the symbol for each of the following logic gates:

(i) AND;
(ii) OR;
(iii) NAND.

(3 marks)

(c) Draw a truth table for each of the following logic gates:

(i) NAND;
(ii) NOR.

(6 marks)

12 (a) State **three** advantages of torroidal type transformer over shell type transformer.

(3 marks)

(b) (i) Outline **three** assumptions made in order to consider a transformer as an ideal machine. (3 marks)

(ii) A 5000/500V, 10KVA ideal single-phase transformer has 40 turns on the secondary. Calculate:

I primary turns;
II primary full load current;
III secondary full load current.

(7 marks)

13 (a) State the phase relationship between current and voltage in circuits that are purely:

(i) resistive;
(ii) inductive.

(2 marks)

(b) **Figure 3** shows an RLC circuit.

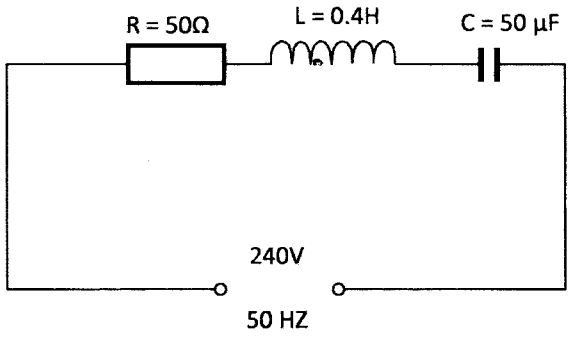


Figure 3

Calculate the:

(i) inductive reactance;
(ii) capacitive reactance;
(iii) circuit impedance;
(iv) circuit current;
(v) power dissipated in the circuit.

(11 marks)

14 (a) State:

(i) **two** IEE requirements regarding bell transformers;
(ii) **two** advantages of MCB over cartridge fuses.

(4 marks)

(b) Outline the procedure of carrying out an insulation resistance test on a new domestic insulation.

(9 marks)

15 (a) With the aid of a diagram, explain how the right hand grip rule is used to determine the direction of the magnetic field around a current carrying conductor.

(3 marks)

(b) With the aid of a labelled diagram, explain the principle of operation of a trembler bell.

(10 marks)

5.6 ELECTRICITY (448)

5.6.1 Electricity Paper 1 (448/1)

1. (a) **Institutions that train electrical technicians in Kenya**:
- University colleges
- Institutes of technology
- Technical training institutes
- Vocational Training centres
- National polytechnics

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

(b) **Components of a business plan**:
(i) Business description
(ii) Organisation/ management plan
(iii) Marketing plan
(iv) Production/ operation plan
(v) Financial plan

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

2. (a) **Disposal of electrical waste materials**
- Lead acid battery - return to the manufacturer.
- Fluorescent tube - break and bury.

$2 \times \frac{1}{2}$ = 1 mark

(b) **Use of extinguishers**
Water - to put out fires on burning solid materials
Foam - to put out fires on burning oils and chemicals
Dry powder - used to deal with fires on burning flammable liquids and some solids as wood and paper.

3. (a) Value of resistor = 680 Ω (1 mark) ± 20% (1 mark)

(b) Maximum current $I = \sqrt{\frac{P}{R}}$ 1 mark

$P = 1\ W$

$I = \sqrt{\frac{1}{680.68}}$ $\frac{1}{2}$ mark

$= \sqrt{\frac{1}{544}}$ $\frac{1}{2}$ mark

= 42.87 Amps 1 mark

5 marks

4. (a) Lenz's law of electromagnetic induction states that the direction of an induced emf is always such that it tends to set up a current opposing the motion or change of flux responsible for inducing that emf.

(b) **Characteristics of magnetic lines of force.**

- They have a direction from north to south poles.
- They form complete loops.
- They do not cross each other.

Any 2 x 1 = 2 marks

5. (a) Sensitivity is the amount of current ½ required to provide full scale ½ deflection of the pointer. (1 mark)

(b)

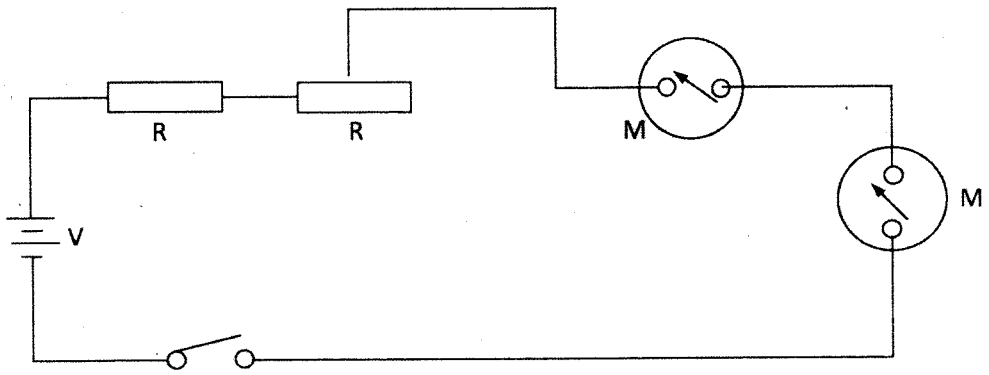
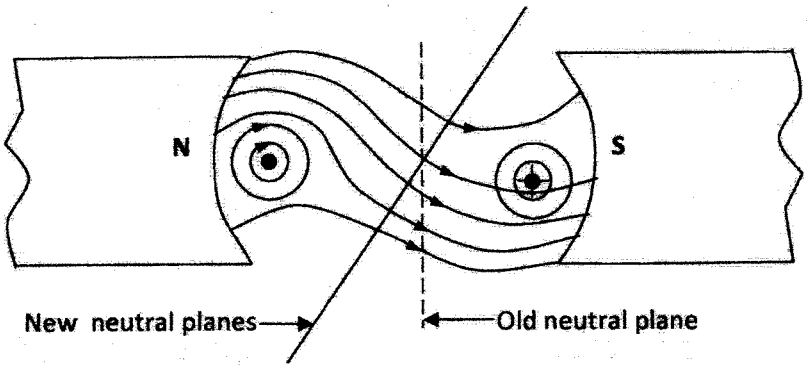


Figure 1

Components 6×½=3marks
Series connection =1mark
4 marks

6. (a) Armature reaction: This refers to the distortion of ½ the main magnetic field of a d.c generator by the magnetic field created by a generated ½ current 1 around the conductor.



Polarity
Conductors
field axis
4×½=2

Figure 2

OR

Armature reaction changes the neutral plane of the main field such that it becomes 1 irregular. This causes arcing between the brushes and the commutator and also 1 lowers generator output. (4 marks)

(b) **Methods of reducing Reaction**:

- Adjusting the brushes to the new neutral plane.
- Use of interpoles between main field poles to cancel its effect.
- Use of compensating windings in series with the armature to counter its effects.

Any 2 x 1 = 2 marks

7. (a) Intrinsic semiconductor is made of semiconductor material in its pure form. Extrinsic semiconductor is intrinsic semiconductor to which some suitable impurity or duping agent has been added in small amounts. (3 marks)

Examples are:
Intrinsic -
Extrinsic -

(b) **Uses of ohmeter in trouble shooting**

- To check short circuits
- To test open circuits
- To ascertain polarity of diodes and transistors
- To measure values of resistors.

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

8. (a) **Conductor materials used in electric circuits**

- Copper
- Aluminium
- Silver
- Brass
- Gold
- Steel
- Mercury

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

(b) **Advantages of MIMS over PVC cables**

- They require no further protection/ mechanically stronger
- They are impervious to oil
- They last longer
- They have better heat resistance

Any 2 x 1 = 2 marks

9. (a) (i) $\therefore$ current through $C_1 R_3 = I_t - I_4$

$= 1.8 - 1.2 = 0.6\ A$ (½)

$\therefore$ p.d across $R_3 = I_3 \times R_3$

$= 0.6 \times 50$

$= 30\ V.$ (1)

AWARD FULL MAKES FOR CORRECT ALTERNATIVE METHOD.

(ii) $I_t = \frac{V}{R_t}$

$R_t = R_1 + (R_2 + R_3) // R_4$ (½)

$R_2 + R_3 = 50 + 50 = 100\ \Omega$

$100\Omega // R_4 = \frac{100 \times 50}{100 + 50} = \frac{5000}{150} = 33.3\ \Omega$ (½)

$\therefore R_t = R_1 + 33.3\ \Omega$

$= 100 + 33.3 = 133.3\ \Omega$

$I_t = \frac{V}{R_t} = \frac{240}{133.3}$

$= 1.8\ A$

b) (i) $I_t = I_3 + I_4$

$V_4 = 240 - I_t R_1 = 240 - 180 = 60\ V$

$\therefore$ p.d across R4 = 60 V

(ii) P.d across R_4 = P.d across $R_2 + R_3$

Current through $R_4 = \frac{V_4}{R_4} = \frac{60\ V}{50\ \Omega}$

$I_4 = 1.2\ A$

10. (a) Marking out tools
- Scriber
- Try square
- Centre punch
- Steel rule
- Calliper

Any 4 x ½ = 2 marks

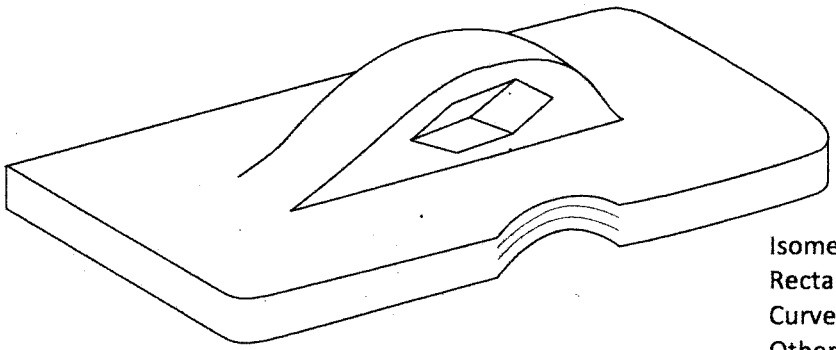


Figure 3

Isometric view with N lowest = 1mark
Rectangular base = 1mark
Curved upper part = 1mark
Other features = 1mark
4marks

11. (a) (i) 41 ten to binary

Divide 2 41
2 20 - 1
2 10 - 0
2 5 - 0
2 2 - 1
1 - 0

Correct method = 1
Correct answer = 1

$= 101001_2$ 2 marks

(ii) $1\,1\,0\,1\,1\,0\,1_2$ to decimal

$2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0$
1 1 0 1 1 0 1

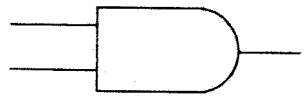
Correct method = 1
Correct answer = 1

$64 + 32 + 0 + 8 + 4 + 0 + 1$

$= 109_{10}$ 2 marks

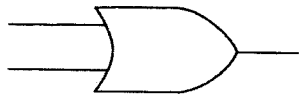
(b) (i) A logic gate is an elementary building block of a digital circuit. Most logic gates have two inputs and one output.

(i)



AND gate

(ii)



OR gate

3×1=3 Marks

(iii)

NAND gate

Figure 4

(c) NAND gate

Input 1	Input 2	Output
0	0	1
0	1	1
1	0	1
1	1	0

Input $2 \times \frac{1}{2}$ = 1 mark
Output 4 x $\frac{1}{2}$ = 2 marks

NOR gate

Input 1	Input 2	Output
0	0	1
0	1	0
1	0	0
1	1	0

Input 2 □½ = 1 mark
Output 4 x ½ = 2 marks

12. (a) **Advantages**
- Size is smaller for a given kilo-volt - ampere rating
- The core is more rigid
- They are cheaper
- Lower in iron losses at higher densities

Any 3 x 1 = 3 marks

(b) **Assumptions**
- No core losses
- Windings have negligible resistance
- All the flux produced links the primary and the secondary
- Negligible emf is required to set up the flux as the core permeability is very high

Any 3 x 1 = 3 marks

(ii) (I) Ideal transformer has no losses

$E_1 = V_1 = 5000$ V (½)

$E_2 = V_2 = 500$ V (½)

$$\text{Turns Ratio} = \frac{E_1}{E_2} = \frac{N_1}{N_2} = \frac{5000}{500} = 10 \quad (1)$$

$$\therefore \frac{N_1}{N_2} = 10 \quad \Rightarrow N_1 = 10 \times N_2 \quad (½)$$

N1 = 10 x 40
= 400 turns (1)

(II) $I_1 V_1$ = VA (input) ½

∴ Primary full load current (I_1)

$= \frac{kVA}{V_1} = \frac{10 \times 10^3}{5000}$ ½

= 2A ½

(III) $I_2 V_2$ = VA(output) ½

∴ Secondary full-load current (I_2)

$= \frac{kVA}{V_2} = \frac{10 \times 10^3}{500}$ ½

= 20 A ½

TOTAL = 7 marks

13. (a) (i) Current and voltage are in phase. (1 mark)

(ii) Current lags voltage. (1 mark)

(b) (i) $X_L = 2\pi fL$ 1

$= 2\pi \times 50 \times 0.4$ ½

= 125.6 Ω ½

(ii) $X_C = \frac{1}{2\pi fc}$ 1

$= \frac{1}{2 \times 3.14 \times 50 \times 50 \times 10^{-6}}$ ½

= 63.7 Ω 1

(iii) Z (impedance) $= \sqrt{R^2 + (X_L - X_C)^2}$ 1

$= \sqrt{50^2 + (125.7 - 63.7)^2}$ ½

= 79.6 Ω 1

(iv) Current I $= \frac{V}{Z}$ 1

$= \frac{240}{79.6}$ ½

= 3A ½

(v) Power (P) = $I^2 R$

= 3^2 x 50

= 450 W

TOTAL = 11 marks

SECTION B

14. (a) (i) **IEE requirements**

- Must be double - wound
- Should be earthed at one point of secondary winding iron-core of transformer and metal casing
- Should have a separate control switch and connected on its own final circuit
- Should have a high grade insulation of supply cable to transformer

Any 2 x 1 = 2 marks

(ii) **Advantages of MCB**

- Easy to reset therefore replacement not necessary
- Gives better overall protection against fire and shock
- Cannot be replaced by an inexperienced person
- Highly discriminative
- Sustained overload and reject harmless transient overcurrent.

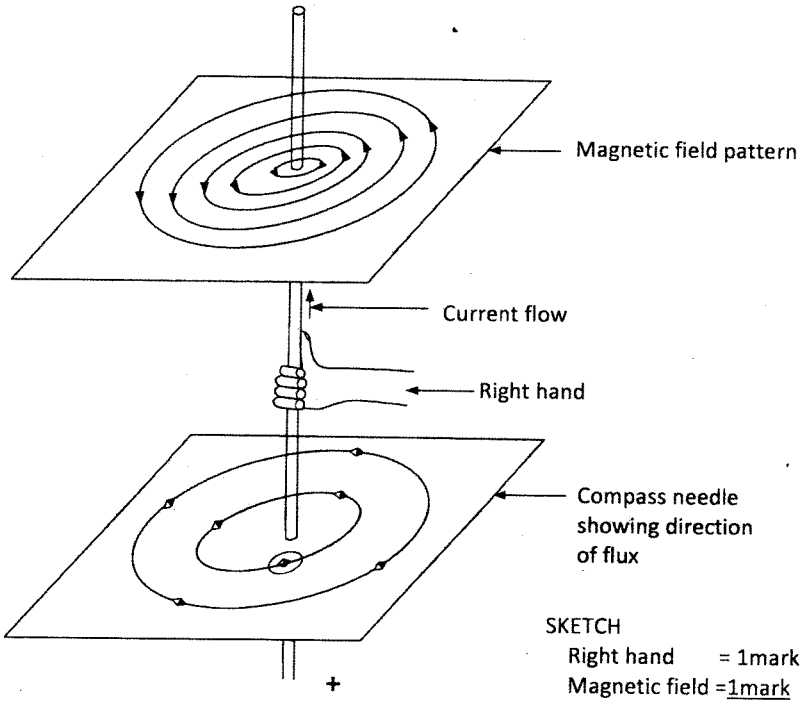
Any 2 x 1 = 2 marks

(b) **Insulation resistance test**

- Set the ohmeter/megger to a suitable range.
  Ensure the following:
  - the main supply is disconnected
  - all switches are on ON position
  - all MCB are on ON position
  - all loads e.g. bulbs are in position or join conductors where there's no load
- Connect the ohmeter/megger between live and neutral terminals with earth terminal.
- Carryout the resistance test.
- Get the required readings.
- Repeat the procedure by taking measurements between the L and N conductors
- The reading should not be below/ mega ohm.

9 x 1 = 9 marks

15. (a)



SKETCH
Right hand = 1mark
Magnetic field =1mark
2Marks

Figure 5

When conductor is gripped with right hand:
Thumb points in direction of current
Fingers point in direction of magnetic field } (1)

(3 marks)

(b)

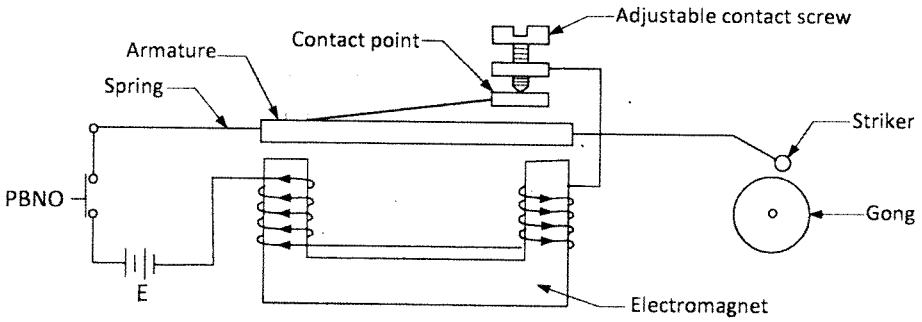


Figure 6

SKETCH
Correct circuit = 2mark
Labelling any 6×½ =3mark
5Marks

- When the push button is pressed, current flow through the circuit. (1)
- The coils become energized and attracts the armature and the striker hits the gong. (1) This movement of the armature away from the contact - screw breaks the circuit. (1)
- The coils are denergized and the armature falls back to its original position and its circuit is completed once again. (1)
- The sequence of movements recurs causing a continuous ringing/trembling sound. (1)