MARKING SCHEME

ELECTRICAL ENGINEERING IV 2025.

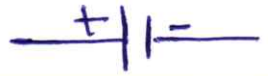
1(i) A
(ii) C
iii) B
iv) C
v) C
vi) A
vii) A
viii) A
ix) B
x) B

2. i) D
ii) C
iii) J
iv) F
v) A
vi) K

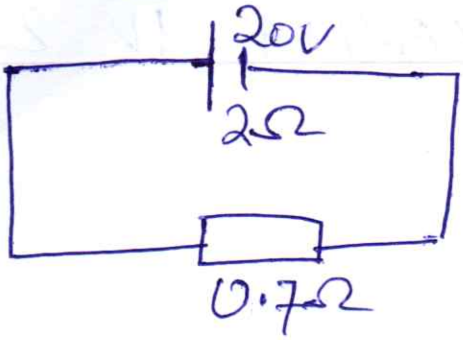
3(a)(i) Local action:
It occurs due to impurities in the electrodes.

(ii) Polarization:
Is caused by the formation of gas bubbles on the electrode surface.

(b)

Cell	battery
i) 	
ii) A cell is a single unit of device that converts chemical energy into electrical energy.	A battery is a collection of cells that convert chemical energy into electrical energy.

3 (c) Emf = 20V, r = 2Ω, R = 0.7Ω, I = ?



$$I = \frac{Emf}{R+r} = \frac{20}{0.7+2}$$

$$I = 7.41A.$$

4 a) i) Branch: Is the part of the circuit between two nodes that can deliver electrical energy.

(ii) or A branch is a single or group of components which are connected between two nodes.

(ii) Node: Is a point in a network where two or more circuit elements are connected,

(iii) Circuit: Is the electrical diagram which shows how the electrons flows through a conductor.

b) i) In fans,

ii) In toys.

iii) In hair dryes,

iv) In cooling fans,

v) In air conditioners.

a)(i) Voltage regulation:
Is the ratio of change in Secondary Voltage from no Load to full load.

(ii) Efficiency of a transformer

$$= \frac{\text{output Power}}{\text{Input power}} \times 100\%$$

(iii) Current ratio $= \frac{\text{Primary current}}{\text{Secondary current}}$

(iv) Ideal transformer:
Is any ~~thra~~ transformer that does not have any losses.

→ Input power = Output power.

$$V_P I_P = V_S I_S$$

(b) $V_1 = 1100V$, $V_2 = 550V$, $N_1 = 100$, $N_2 = ?$

$$\frac{V_P}{V_S} = \frac{N_P}{N_S}$$

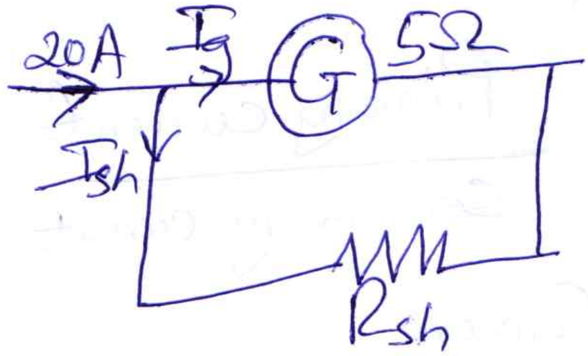
$$\frac{1100}{550} = \frac{100}{N_S}. \quad N_S = \frac{550 \times 100}{1100} = 50.$$

The low voltage turns is 50 turns.

6 a) i) Ammeter — For measuring current in amperes.
ii) Voltmeter — for measuring Voltage in Volts.
iii) Ohmmeter — for Measuring resistance in ohms.
iV) Wattmeter — for Measuring Power in Watts

b) $R_g = 5\Omega$, $V_g = 75mV = \frac{75}{1000} = 0.075V$

$I_T = 20A$.



$$I_g = \frac{V_g}{R_g} = \frac{0.075}{5} = 0.015A$$

$$I_{sh} = I_T - I_g$$
$$= 20 - 0.015 = 19.985A.$$

$V_g = V_{sh}$ (Parallel).

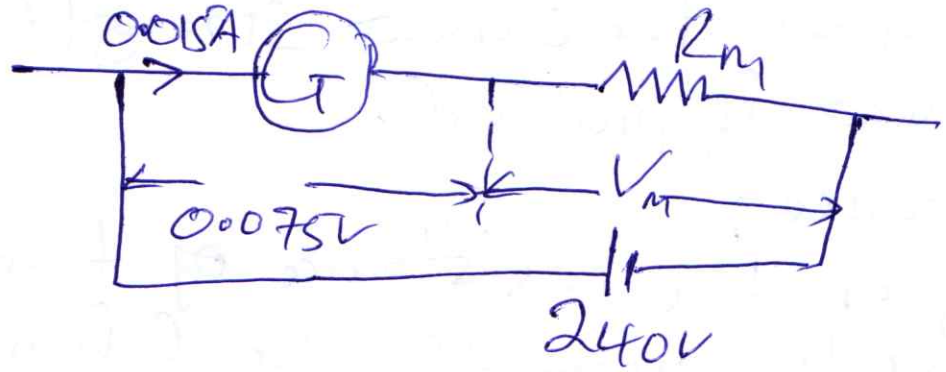
$$I_g R_g = I_{sh} R_s$$

$$0.075 = I_{sh} R_{sh}$$

$$R_{sh} = \frac{V_g}{I_{sh}} = \frac{0.075}{19.985} = 0.00375\Omega$$
$$= 3.75 \times 10^{-3}\Omega$$

(ii) The shunt resistance is $0.00375\,\Omega$.

(2i)



$I_g = I_m$ (series).

$V_m = V_T - V_g$

$= 240 - 0.075$

$= 239.925\,V$.

$$R_m = \frac{V_m}{I_m} = \frac{239.925}{0.015} = 15{,}995\,\Omega.$$

The series resistance is $15{,}995\,\Omega$.

7(a) i) Heating effect.

ii) Chemical effect.

iii) Magnetic effect.

b) i) First law: When the magnetic flux passes through a coil, an emf is induced.

ii) Second law: The magnitude of the induced emf is directly proportional to the rate of change of magnetic flux.

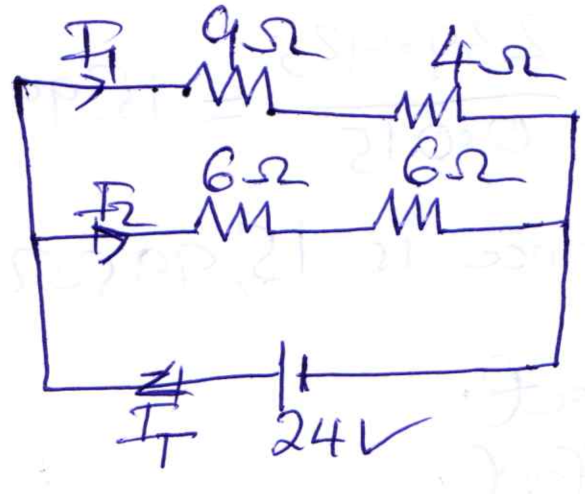
7 b) i) Current strength:
The higher the current strength, the more heat is produced.

(ii) Resistance:
The higher the resistance of the conductor, the more the heat is produced.

(iii) Time:
The ~~higher the resistance of the conductor,~~

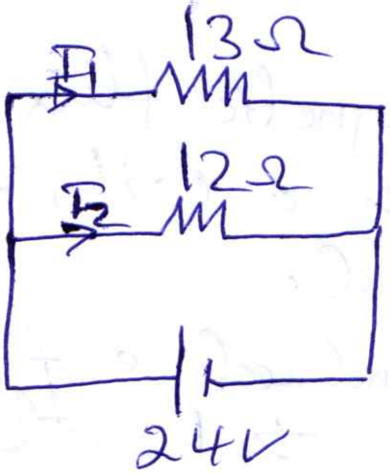
(iii) Time: The longer the current flows, the more the heat is produced.

8 a)



$R_a = 9\Omega + 4\Omega$
$= 13\Omega$

$R_b = 6\Omega + 6\Omega$
$= 12\Omega$



$I_1 = \frac{V}{13} = \frac{24}{13} = 1.85A.$

Power dissipated in 9Ω resistor $= I_1^2 \times 9\Omega$
$= (1.85)^2 \times 9$
$= 30.74W$

any motion of the material as a whole.

→ It occurs when two solid bodies or atoms are in contact.

Convection: Is the process of heat transfer by mass motion of a fluid when the heated fluid is caused to move away from the source of heat carrying energy with it.

Radiation: Is the process of transferring energy between an object and its environment through electromagnetic waves.

→ Energy transfered in this way is often called thermal radiation

10(b) ~~heat developed = M~~

$\cancel{Volume = 0.1m^3}$ $\quad$ $1kg = 0.00m^3$

$\cancel{1m^3 = 0.001kg}$ $\quad$ $? = 0.1m^3$

$\cancel{0.1m^3 = ?}$

$$0.1m^3 = \frac{0.1}{0.001} = 100kg.$$

$M = 100kg$

$V = 240V$

$T = 85°C$

$t = 1.5hrs$

Specific heat capacity of water $= Wc = 42$

$We = 4200J/kg°C$

$eff = 82\%$

9. $R_p = 25\Omega$, $X_p = 40\Omega$, $V = 400V$, $f = 50Hz$.

$$V_p = \frac{V_L}{\sqrt{3}} = \frac{400}{\sqrt{3}} = \frac{400}{1.732} = 230.9 \simeq 231V.$$

$$Z_p = \sqrt{(R_p)^2 + (X_p)^2} = \sqrt{(25)+(40)^2} = \sqrt{625+1600}$$

$$Z_p = \sqrt{2225} = 47.2\Omega.$$

$$I_p = \frac{V_p}{Z_p} = \frac{231}{47.2} = 4.9A.$$

In star connection $I_L = I_p = 4.9A$.

(a) Line current is 4.9 A

(b) Power factor $= \frac{R_p}{Z_p} = \frac{25}{47.2} = 0.52966$

(c) Power consumed

$$= \sqrt{3}\, V_L I_L \cos\theta$$

$$= \sqrt{3} \times 400 \times 4.9 \times 0.52966$$

$$\simeq 1,798W.$$

Power consumed is 1,798W.

10) i) Conduction

ii) Radiation.

iii) Convection.

b) ii) conduction: Is the process of heat transfer by means of molecular agitiation within a material without heated developed $= M_w C_w T$

$= 100kg \times 4200J/kg°C \times 85°C$

$= 35,700,000$ Joules.

$1kwh = 1kw \times 1hr$

$= 1000W \times 1 \times 60 \times 60s$

$= 3,600,000Ws$

$= 3,600,000J.$

$1Kwh = 3,600,000 J.$

$? = 35,700,000J$

$$= \frac{35,700,000}{3,600,000} = 9.92kwh.$$

heat developed (output) in Kwh $= 9.92kwh.$

$$\eta = \frac{output}{Input} \times 100\%$$

$$Input = \frac{output}{eff.} \times 100 = \frac{9.92 \times 100}{82}$$

$= 12.1 Kwh \approx 12kwh.$

$Kwh = Kw \times h$

$$Kw = \frac{Kwh}{h} = \frac{12kwh}{1.5h} = 8kw.$$

(1) The rating of the heat is 8kw

(iv) $P = VI$

from $V = IR$

$I = V/R$.

$P = V \times V/R$

$P = \frac{V^2}{R}$

$$R = \frac{V^2}{P} = \frac{240 \times 240}{8 \times 1000} = 7.2\Omega.$$

The resistance of the element is 7.2Ω.

11 (a) i) Inverse law:

The illumination of a surface is inversely proportional to the square of the distance between the source and the surface.

(ii) Cosine law or Lambert's law.

The illumination of the surface is directly proportional to the cosine of the angle between the direction of incident light and normal surface.

b) (i) Luminous flux: Is the measure of the power of visible light produced by a light source.

11(b) (ii) Luminous intensity:
Is the quantity of vissible light that is emitted in unit time per unit solid angle.

(iii) Candle power:
Is a measure of luminous intensity expressed in candles.

11(c) $A = 20m \times 15m = 300m^2$.

$$\text{Luminous flux} = \frac{A \times E}{C.U \times M.F} = \frac{300m^2 \times 60\,lux}{0.6 \times 0.85}$$

$$= 35{,}291 \text{ lumens.}$$

$$\text{Total Power} = \frac{\text{total lumens}}{\text{efficiency}}$$

$$= \frac{35{,}291 \text{ lumens}}{65\,lm/w}$$

$$= 542.986W$$

$$\text{Number of Lamps} = \frac{\text{total lumen}}{\text{Power per lamp}} = \frac{542.986}{125}$$

$$= 4.34 \approx 5 \text{ lamps.}$$

The required lamps will be 5 Lamps.