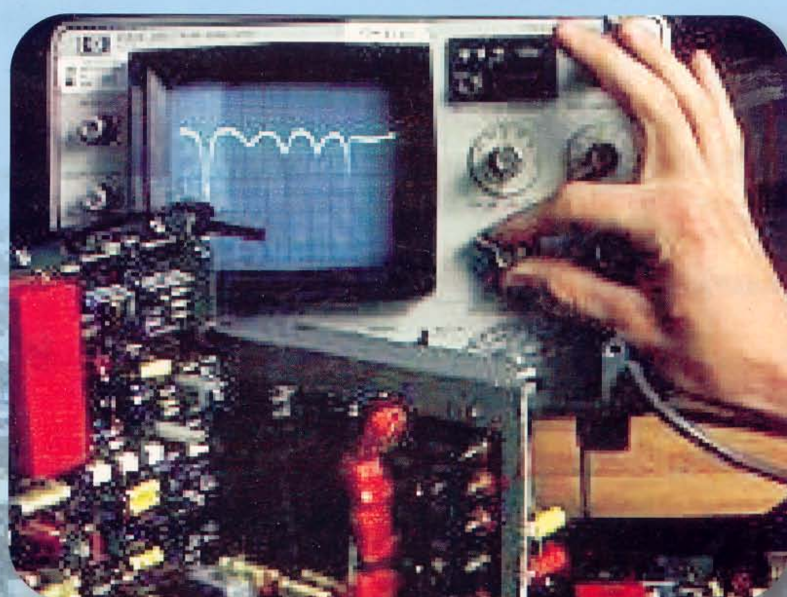
PHYSICS

PRACTICALS

F.Sc. (Part II)

Ross Nazir Ullah



Preface

This notebook has been compiled for F.Sc. Physics students. For helping them in their practicals in the Physics laboratory. Theory and lengthy procedures are intentionally excluded.

Observations and calculations must be completed in the laboratory and get signed by the teacher before the student leaves the laboratory.

I have entered the readings in the blank tables, ***just for guidelines***. It's a new idea! These readings are not perfect. Some of these are taken from a normal student's practical notebook. If you want to take good marks in the exams, you should take the readings by ***yourself.***

I have made major diagrams of the apparatus in two dimensions, so that the students can ***reproduce the figures easily***.

There is no shortage of Physics practical note books in the market. But this notebook presents a different approach. No claim of originality is laid, but some pioneer work should be appreciated. Brevity is the soul of everything. It is hoped that the teacher and taught will give the proper response for this work.

I have added new practicals in this manual, which are being introduced by the Education Department.

This manual has more than required practicals. It contains more than 23 **standard experiments**, 23 **exercises** and 23 **home projects**.

Useful suggestions will be appreciated to make this notebook more comprehensive and helpful.

F. C. College,
LAHORE.
August 2006.

Ross Nazir Ullah

I never did anything worth doing by accident, nor did any of my inventions come by accident; they came by work. —*Edison*

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Graphs

Standard Experiments

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Readings

In 1642 Galileo died. In the same year Newton was born in a farmer's home. *–history*

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Method for plotting a graph

Step 1: Selecting independent and dependent variables

a) Find the values, which are changing independently. It will be your independent variable.

b) Find the values that depend upon the independent variable. It will be your dependent variable.

Step 2: Making the Scale

a) Take difference of highest and lowest values.

b) Divide that difference by 6 [= No. of big divisions] for X-axis. Make that calculated difference a round figure. Write it down as the Scale on top right corner of the graph paper.

c) Divide the difference by 8 [= No. of big divisions] for Y-axis. Make that calculated difference a round figure. Write it down as Scale on top right corner.

Step 3: Writing numbers along the Axes

a) Take lowest reading and write its round figure on the origin O.

b) Write down the values along the X-axis and Y-axis below the bold lines (big squares) progressively. That is, after adding the big division's value in each next value.

Step 4: Plotting the points [*Please look last reading (R_6) on page 11*]

a) First divide big division's scale by 10, to get small division's (or squares) value. Make small division's scale for X- and Y-axis.

b) Take a point from X-values. Find its position along big divisions [step 3(b)] for its whole figure part of the point [B.d. value].

c) Multiply this point's fractional part [s.d. multiplier] with small division's scale, and add to B.d. value [step 4(b)]. Then locate the position of the point along X-axis.

d) Take corresponding Y-value point. Repeat the above steps (b) & (c).

e) Locate intersection of both values in the graph paper. Mark this point with a dot and encircle it.

f) Similarly plot all the points.

Step 5: Drawing the Curve

i) For straight line graph

a) Take a transparent ruler.

b) Put the ruler in such a way that maximum points are symmetrical or pass through it.

c) Finally draw the line which is called Curve.

ii) If it is not straight line graph, then draw a smooth free hand curve passing symmetrically through large number of points.

Step 6: Writing Graph Title

Finally write down in bold letters, 'Graph between (say) A and B' on top location, starting from left side of the sheet.

Genius is one percent inspiration and ninety-nine percent perspiration.

–Edison

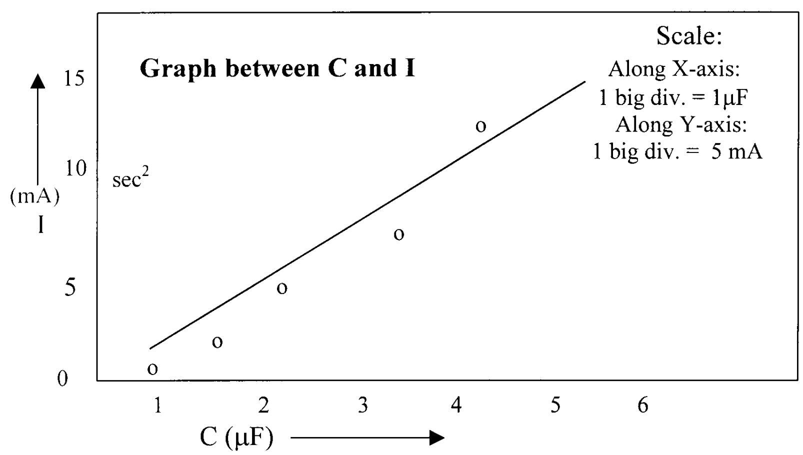
Date..............

Plotting graphs.

Graph between C & I :

Capacity (μF)	C	3.3	2.2	1	1.5	5.5	2.5	4.3	3.7	4.8
Current (mA)	I	12	9	6	7	14	10	13	12	13

Typical graph:



Imagination is more important than knowledge.

–Albert Einstein

Experiment A:

To plot a graph between current and capacity.

Materials:

Graph papers, lead pencil, rubber, sharpener, and transparent ruler.

Procedure:

1) *Draw the two axes with a sharp pencil, at right angles to each other taking a point O as origin at the left bottom corner of the graph paper.*
2) *Take independent variable (capacity) along X-axis and dependent (current) along Y-axis.*
3) *Select suitable scales for both axes, so that all the graph paper would be covered.*
4) *Mark the scale on each axis, so that the value after every ten divisions is specified.*
5) *Start with a certain value represented along the X-axis and then locates the corresponding point along the Y-axis. Mark this point by a dot and encircle it. Similarly plot all points for different values of the two quantities.*
6) *Draw a smooth free hand curve passing symmetrically through large number of points. For straight line graph then draw with a transparent ruler so that maximum points pass through the line or symmetrical with it.*

Precautions:

1. A sharp pencil should be used.
2. Take along X-axis independent variable and along Y-axis dependent.
3. Small circles should be drawn around the plotted points.

Viva Voce:

Q.1 *What is a graph?*

Ans. A graph is a curve, which shows relation between an independent variable and its dependent variable.

Q.2 *What is variables?*

Ans. These are the quantities, which do not have fixed values.

Q.3 *What are independent and dependent variables?*

Ans. Independent variable is that which we vary independently and dependent variable is that which vary according to the variation depending upon independent variable.

Graph Illustration

V and I graph

V (volts)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.07
I (mA)	0	0.12	0.22	0.28	0.32	0.36	0.40	0.42	0.44	0.45

(Read method for plotting a graph on page 7)

Step 1: taking V along X-axis & I along Y-axis

Step 2:

$V \rightarrow \frac{1 - 0.1}{6} = \frac{0.9}{6} = 0.15 \cong 0.2 \Rightarrow$ B.d = 0.2 (big division) & s.d = 0.02 (small division)

$I \rightarrow \frac{0.46 - 0.12}{8} = \frac{0.34}{8} \cong 0.043 \cong .05 \cong .07 \Rightarrow$ B.d = 0.07 & s.d = 0.007

Scale:
Along X-axis:
1 big div = 0.2 volts
Along Y-axis:
1 big div = 0.07 mA

Step 4:

$V_1 \rightarrow 0$ & $I_1 \rightarrow 0$

$V_2 \rightarrow 0 + 5x\ .02 = 0.1$ & $I_2 \rightarrow .07 + 7.14x.007 = 0.12$

$V_3 \rightarrow 0.2$ & $I_3 \rightarrow .21 + 1.4x.007 = 0.22$

$V_4 \rightarrow 0.2 + 5x\ .02 = .3$ & $I_4 \rightarrow 0.28$

$V_5 \rightarrow 0.4$ & $I_5 \rightarrow 0.28 + 5.7x.007 = 0.32$

$V_6 \rightarrow 0.4 + 5x\ .02 = .5$ & $I_6 \rightarrow 0.35 + 1.4x.007 = 0.36$

$V_7 \rightarrow 0.6$ & $I_7 \rightarrow 0.35 + 7.14x.007 = 0.40$

$V_8 \rightarrow 0.6 + 5x\ .02 = .7$ & $I_8 \rightarrow 0.42$

$V_9 \rightarrow 0.8$ & $I_9 \rightarrow 0.42 + 2.86x.007 = 0.44$ 5.92

$V_{10} \rightarrow 1 + 2.5x\ .02 = 1.05 < 1.07$ (a little higher point)
(2 & ½ s.d)

& $I_{10} \rightarrow 0.42 + 5.5x\ .007 = 0.46 > 0.45$ (a little lower point)
5 & ½ s.d

Evaluation

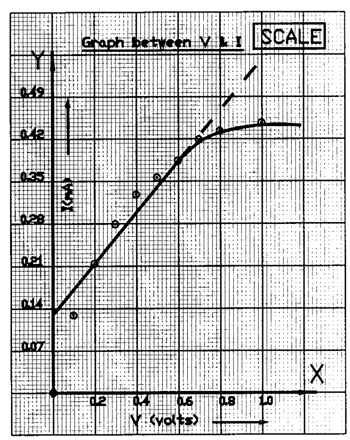
Finding:

Time rate of energy dissipation across tungsten filament (resistor)

$$\frac{W}{t} = P = V\,I$$

$= 0.7 \times 0.42$

$= 0.3$ watts



Graphs arrange numerical information into a picture.

R and 1/V graph

R (ohms)	0	500	1000	1500	2000	2500
1/V (volts^{-1})	0.66	0.76	0.90	1.00	1.11	1.25

(Read method for plotting a graph on page 7)

Step 1: taking R along X-axis & 1/V along Y-axis

Scale:
Along X-axis:
1 big div = 1000 ohms
Along Y-axis:
1 big div = 0.2 volt^{-1}

Step 2:

R → $\frac{2500 - 0}{3}$ = 833 ≅ 1000 ⇒ B.d = 1000 & s.d = 100

1/V → $\frac{1.25 - 0.66}{4}$ =0.15 ≅ 0.2 ⇒ B.d. = 0.2 & s.d. = 0.02

Step 4:

R_1 → 0 & 1/V → 0.6 + 3 x 0.02 = 0.66

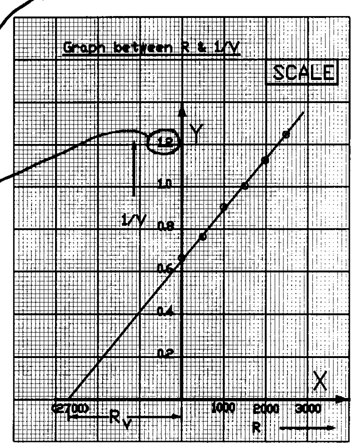
R_2 → 100x5= 500 & 1/V → 0.6 + 8 x 0.02 = 0.76

R_3 → 1000 & 1/V → 0.8 + 5 x 0.02 = 0.90

R_4 → 1000 +100x5=1500 & 1/V → 1.00

R_5 → 2000 & 1/V → 1 + 5.5x 0.02= 1.11

R_6 → 2000+100x5 =2500 & 1/V → 1.2 + 2.5 x 0.02 = 1.25



How to find s.d. multiplier

$\frac{\text{Plot value} - \text{B.d. value}}{\text{s.d.}}$

$= \frac{1.25 - 1.2}{0.02} = \frac{0.05}{0.02} = 2.5$

Evaluation

Finding:

Value of R_V from graph:

R_{27} → 100 x 27 = 2700 ohms

Increasing straight line shows that both values are directly proportional to each other.

Absolute Temperature & Thermister Resistor

T (K)	289	293	303	313	323	333	343
R (KΩ)	6	5	3	2.5	1	0.5	0.2

(Read method for plotting a graph on page 7)

Scale:
Along X-axis:
1 big div = 10 K
Along Y-axis:
1 big div = 1 K Ω

Step 1: taking T along X-axis & R along Y-axis

Step 2:

$T \rightarrow \frac{343 - 289}{6} = 9 \cong 10 \Rightarrow$ B.d = 10 & s.d = 1

$R \rightarrow \frac{6 - 0.2}{8} = 0.73 \cong 1 \Rightarrow$ B.d. = 1 & s.d. = 0.01

Step 4:

$T_1 \rightarrow 289$ & $R_1 \rightarrow 6$

$T_2 \rightarrow 293$ & $R_2 \rightarrow 5$

$T_3 \rightarrow 303$ & $R_3 \rightarrow 3$

$T_4 \rightarrow 313$ & $R_4 \rightarrow 2.5$

$T_5 \rightarrow 323$ & $R_5 \rightarrow 1$

$T_6 \rightarrow 333$ & $R_6 \rightarrow 0.5$

$T_7 \rightarrow 343$ & $R_7 \rightarrow 0.2$

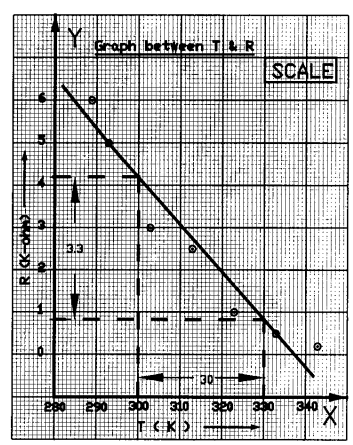
Evaluation

Finding:

The slope from graph:

$\Delta R / \Delta T = 3.3 / 30$

$= 0.11 \Omega K^{-1}$



We define slope of a line as tan θ, where θ is the inclination of a line.

Distance verses tan θ graph

x(cm)	14	12	10	8	6	4	2	0	-2	-4	-6	-8	-10	-12	-14
tanθ	.27	.58	.84	1.15	1.57	1.92	2.41	5.14	3.17	2.41	2.05	1.19	.58	.38	.27

(Read method for plotting a graph on page 7)

Scale:
Along X-axis:
1 big div = 5 cm
Along Y-axis:
1 big div = 0.8

Step 1: taking x along X-axis & tan θ along Y-axis

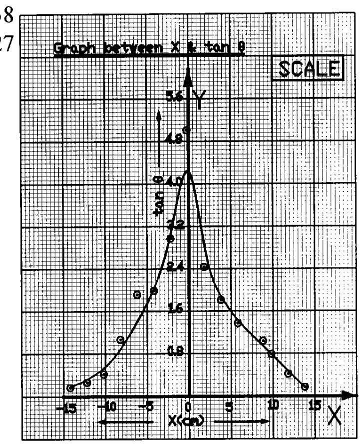
Step 2:

$x \rightarrow \dfrac{14-0}{3} = 4.67 \cong 5 \Rightarrow$ B.d = 5 & s.d = 0.5

$\tan\theta \rightarrow \dfrac{5.14 - 0.27}{8} = 0.61 \cong 0.8 \Rightarrow$ B.d. = 0.8 & s.d. = 0.08

Step 4:

$x_1 \rightarrow 10+8x.5=14$ & $\tan\theta_1 \rightarrow 3.37x.08 = 0.27$
$x_2 \rightarrow 10+4x.5=12$ & $\tan\theta_2 \rightarrow 7.25x.08=0.58$
$x_3 \rightarrow 10$ & $\tan\theta_3 \rightarrow .8+.5x.08=.84$
$x_4 \rightarrow 5+6x.5=8$ & $\tan\theta_4 \rightarrow .8+4.37x.08=1.15$
$x_5 \rightarrow 5+2x.5=6$ & $\tan\theta_5 \rightarrow .8+9.62x.08=1.57$
$x_6 \rightarrow 8x.5=4$ & $\tan\theta_6 \rightarrow 1.6+4x.08=1.92$
$x_7 \rightarrow 4x.5=2$ & $\tan\theta_7 \rightarrow 2.4+.12x.08=2.41$
$x_8 \rightarrow 0$ & $\tan\theta_8 \rightarrow 4.8+4.25x.08=5.14$
$x_9 \rightarrow -4x.5=-2$ & $\tan\theta_9 \rightarrow 2.4+9.62x.08=3.17$
$x_{10} \rightarrow -8x.5=-4$ & $\tan\theta_{10} \rightarrow 2.4+.12x.08=2.41$
$x_{11} \rightarrow -(5+2x.5)=-6$ & $\tan\theta_{11} \rightarrow 1.6+5.62x.08=2.05$
$x_{12} \rightarrow -(5+6x.5)=-8$ & $\tan\theta_{12} \rightarrow .8+4.67x.08=1.19$
$x_{13} \rightarrow -10$ & $\tan\theta_{13} \rightarrow 7.25x.08=.58$
$x_{14} \rightarrow -(10+4x.5)=-12$ & $\tan\theta_{14} \rightarrow 4.75x.08=.38$
$x_{15} \rightarrow -(10+8x.5)=-14$ & $\tan\theta_{15} \rightarrow 3.37x.08=.27$



Evaluation

Finding:

The distance *x* at slope 2.

Checking the value along X-axis corresponding to,

$\tan\theta = 2$,

it is equal to 3.5 cm

It is not must that you follow my method of manipulation, you may adopt your own.

Charging of a capacitor

t (sec)	0	4	8	18	25	33
V (volts)	0	5	10	12	12.5	13

(Read method for plotting a graph on page 7)

Step 1: taking t along X-axis & V along Y-axis

Scale:
Along X-axis:
1 big div = 5 sec
Along Y-axis:
1 big div = 2.5 volts

Step 2:

$t \rightarrow \frac{33-0}{6} = 4.12 \cong 5 \Rightarrow$ B.d = 5 & s.d = 0.5

$V \rightarrow \frac{13-0}{8} = 2.16 = 2.5 \Rightarrow$ B.d. = 2.5 & s.d. = 0.25

Step 4:

$t_1 \rightarrow 0$ & $V_1 \rightarrow 0$

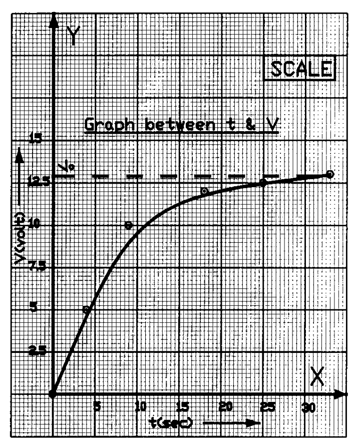
$t_2 \rightarrow 8x\ .5=4$ & $V_2 \rightarrow 5$

$t_3 \rightarrow 5+6x\ .5= 8$ & $V_3 \rightarrow 10$

$t_4 \rightarrow 15+ 6x\ .5 = 18$ & $V_4 \rightarrow 10 + 8x\ .25 = 12$

$t_5 \rightarrow 25$ & $V_5 \rightarrow 12.5$

$t_6 \rightarrow 30 + 6x\ .5 = 33$ & $V_6 \rightarrow 12.5 +2x\ .25 = 13$



Evaluation

Finding:

The maximum voltage V_o

Corresponding to maximum value,

V_o = 13 volts

Not a good result. Sources of error might be in readings, or plotting the graph.

Discharging of a capacitor

t (sec)	0	2	6	9	20	28	30	37
V(volt)	13	10	5	2.5	2	0.5	0.25	0

(Read method for plotting a graph on page 7)

Scale:
Along X-axis:
1 big div = 7 sec
Along Y-axis:
1 big div = 2.5 volts

Step 1: taking t along X-axis & V along Y-axis

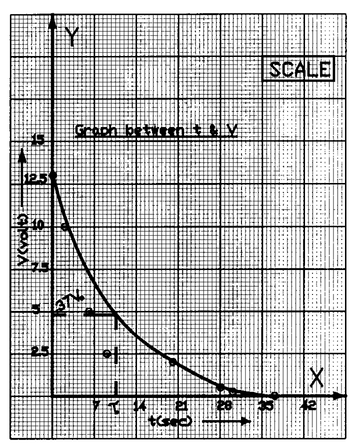
Step 2:

$t \rightarrow \frac{37-0}{6} = 6.167 \cong 7 \Rightarrow$ B.d = 7 & s.d = 0.7

$V \rightarrow \frac{13-0}{8} = 2.16 = 2.5 \Rightarrow$ B.d. = 2.5 & s.d. = 0.25

Step 4:

$t_1 \rightarrow 0$ & $V_1 \rightarrow 12.5 + 2x\ .25 = 13$
$t_2 \rightarrow 2.86x\ .7 = 2$ & $V_2 \rightarrow 10$
$t_3 \rightarrow 8.57x\ .7 = 6$ & $V_3 \rightarrow 5$
$t_4 \rightarrow 7 + 2.86x\ .7 = 9$ & $V_4 \rightarrow 2.5$
$t_5 \rightarrow 14 + 8.57x\ .7 = 20$ & $V_5 \rightarrow 8x\ .25 = 2$
$t_6 \rightarrow 28$ & $V_6 \rightarrow 2x\ .25 = 0.5$
$t_7 \rightarrow 28 + 2.86x\ .7 = 30$ & $V_7 \rightarrow 1x\ .25 = 0.25$
$t_8 \rightarrow 35 + 2.86x\ .7 = 37$ & $V_8 \rightarrow 0$



Evaluation

Finding:

Time constant τ:

Corresponding to $0.37V_o$,

The value along X-axis is,

$\tau = 10.64$ sec

Decreasing straight line shows inversely proportional & decreasing curved line shows exponentially decreasing.

Characteristics of semi-conductor diode

Forward characteristics

V (volt)	1	2	3	4	5	6	7	8	9	10
I (mA)	0	0	0	0	0.25	0.75	1.25	1.75	2.25	2.75

Reverse characteristics

V (volt)	1	2	3	4	5	6	7	8	9	10
I (μA)	10	15	28	30	50	91	140	190	239	290

(Read method for plotting a graph on page 7)

Forward Bias
Scale:
Along X-axis:
1 big div = 4 volts
Along Y-axis:
1 big div = 0.9 mA

Reverse Bias
Scale:
Along X-axis:
1 big div = 4 volts
Along Y-axis:
1 big div = 100μA

Step 1: taking V along X-axis & I along Y-axis

Step 2:

V $\rightarrow \frac{10-1}{3} = 3 \cong 4 \Rightarrow$ B.d = 4 & s.d = 0.4

For Forward Bias

I $\rightarrow \frac{2.75-0}{4} = 0.69 \cong 0.9 \Rightarrow$ B.d. = 0.9 & s.d. = 0.09

For Reverse Bias

I $\rightarrow \frac{290-10}{4} = 70 \cong 100 \Rightarrow$ B.d. = 100 & s.d. = 10

Step 4: Forward Bias | Reverse Bias

$V_1 \rightarrow 2.5x.4 = 1$ & $I_1 \rightarrow 0$ & $I_1 \rightarrow 1x10 = 10$
$V_2 \rightarrow 5x.4 = 2$ & $I_2 \rightarrow 0$ & $I_2 \rightarrow 1.5x10 = 15$
$V_3 \rightarrow 7.5x.4 = 3$ & $I_3 \rightarrow 0$ & $I_3 \rightarrow 2.8x10 = 28$
$V_4 \rightarrow 10x.4 = 4$ & $I_4 \rightarrow 0$ & $I_4 \rightarrow 3.0x10 = 30$
$V_5 \rightarrow 12.5x.4 = 5$ & $I_5 \rightarrow 2.78x.09 = 0.25$ & $I_5 \rightarrow 5x10 = 50$
$V_6 \rightarrow 15x.4 = 6$ & $I_6 \rightarrow 8.33x.09 = 0.75$ & $I_6 \rightarrow 9.1x10 = 91$
$V_7 \rightarrow 17.5x.4 = 7$ & $I_7 \rightarrow 0.9 + 3.89x.09 = 1.25$ & $I_7 \rightarrow 100+4x10 = 140$
$V_8 \rightarrow 20x.4 = 8$ & $I_8 \rightarrow 0.9+9.44x.09 = 1.75$ & $I_8 \rightarrow 100+9x10 = 190$
$V_9 \rightarrow 22.5x.4 = 9$ & $I_9 \rightarrow 1.8+5x.09 = 2.25$ & $I_9 \rightarrow 200+3.9x10 = 239$
$V_{10} \rightarrow 25x.4 = 10$ & $I_{10} \rightarrow 2.7+.56x.09 = 2.75$ & $I_{10} \rightarrow 200+9x10 = 290$

Evaluation

Finding:

Forward resistance r_f,

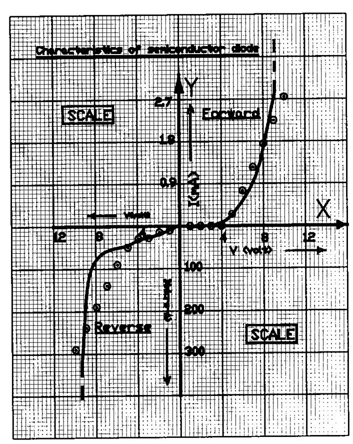
$$r_f = \frac{\Delta V}{\Delta I} = \frac{9volts}{2.25mA} = \frac{9}{.0023}$$

$$= 4\,K\,\Omega$$

Reverse resistance, r_v,

$$r_v = \frac{\Delta V}{\Delta I} = \frac{9volts}{239\mu A} = \frac{9}{.000239}$$

$$= 0.04 \text{ mega ohms}$$



In the graph, what conclusion you make from the decreasing curve?

Output Characteristics of Transistor

For $I_B = 10\ \mu A$

V_{CE} (volts)	0	2	4	5	10	15
I_C (mA)	0	1	1	1	1	1

For $I_B = 20\ \mu A$

V_{CE} (volts)	0	2	4	5	10	15
I_C (mA)	0	2	2	2.1	2.2	2.5

For $I_B = 50\ \mu A$

V_{CE} (volts)	0	0.5	1	5	10	15
I_C (mA)	0	5	5	5	5.5	6.5

(Read method for plotting a graph on page 7)

Scale:
Along X-axis:
1 big div = 3 volts
Along Y-axis:
1 big div = 1 mA

Step 1: taking V_{CE} along X-axis & I_C along Y-axis

Step 2:

$V_{CE} \rightarrow \frac{15-0}{6} = 2.5 \cong 3 \Rightarrow$ B.d = 3 & s.d = 0.3

$I_C \rightarrow \frac{6.5-0}{8} = 0.813 \cong 1 \Rightarrow$ B.d. = 1 & s.d. = 0.1

Step 4:

For $I_B = 10\ \mu A$

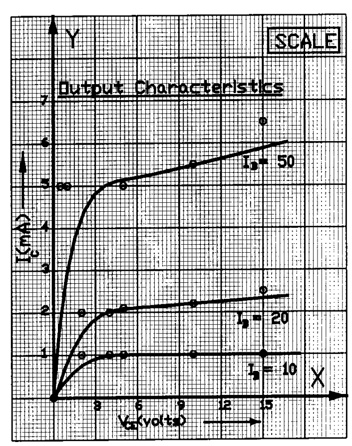
$V_{CE\ 1} \rightarrow 0$ & $I_{C\ 1} \rightarrow 0$
$V_{CE\ 2} \rightarrow 6.6x.3=2$ & $I_{C\ 2} \rightarrow 1$
$V_{CE\ 3} \rightarrow 3+3.3x.3= 4$ & $I_{C\ 3} \rightarrow 1$
$V_{CE\ 4} \rightarrow 3+6.6x.3= 5$ & $I_{C\ 4} \rightarrow 1$
$V_{CE\ 5} \rightarrow 9+3.3x.3= 10$ & $I_{C\ 5} \rightarrow 1$
$V_{CE\ 6} \rightarrow 15$ & $I_{C\ 6} \rightarrow 1$

For $I_B = 20\ \mu A$

$V_{CE\ 1} \rightarrow 0$ & $I_{C\ 1} \rightarrow 0$
$V_{CE\ 2} \rightarrow 6.6x.3=2$ & $I_{C\ 2} \rightarrow 2$
$V_{CE\ 3} \rightarrow 3+3.3x.3= 4$ & $I_{C\ 3} \rightarrow 2$
$V_{CE\ 4} \rightarrow 3+6.6x.3= 5$ & $I_{C\ 4} \rightarrow 2.1$
$V_{CE\ 5} \rightarrow 9+3.3x.3= 10$ & $I_{C\ 5} \rightarrow 2.2$
$V_{CE\ 6} \rightarrow 15$ & $I_{C\ 6} \rightarrow 2.5$

For $I_B = 50\ \mu A$

$V_{CE\ 1} \rightarrow 0$ & $I_{C\ 1} \rightarrow 0$
$V_{CE\ 2} \rightarrow 1.6x.3=0.5$ & $I_{C\ 2} \rightarrow 5$
$V_{CE\ 3} \rightarrow 3.3x.3= 4$ & $I_{C\ 3} \rightarrow 5$
$V_{CE\ 4} \rightarrow 3+6.6x.3=5$ & $I_{C\ 4} \rightarrow 5$
$V_{CE\ 5} \rightarrow 9+3.3x.3=10$ & $I_{C\ 5} \rightarrow 5.5$
$V_{CE\ 6} \rightarrow 15$ & $I_{C\ 6} \rightarrow 6.5$



Evaluation

Finding:
Output resistance r_c
of the collector circuit,
for I = 50 μ A

$$r_c = \frac{\Delta V_{CE}}{\Delta I_C} = \frac{15\text{volts}}{6.5\text{mA}} = \frac{15}{.0065}$$

$$= 2.3\ K\Omega$$

Your calculations and result should be better than this.

Input Characteristics of Transistor

For V_{CE} = 0 volts

V_{BE} (volts)	0	0.3	0.4	0.5	0.6	0.7
I_B (μA)	0	0	25	150	225	280

For V_{CE} = 3 volts

V_{BE} (volts)	0	0.3	0.4	0.6	0.8	1
I_B (μA)	0	0	5	42	100	250

For V_{CE} = 6 volts

V_{BE} (volts)	0	0.3	0.4	0.6	0.8	1
I_B (μA)	0	0	2	50	95	200

(Read method for plotting a graph on page 7)

Scale:
Along X-axis:
1 big div = 0.2 volts
Along Y-axis:
1 big div = 50 μA

Step 1: taking V_{BE} along X-axis & I_B along Y-axis

Step 2:

$V_{CE} \rightarrow \frac{1-0}{6} = 0.167 \cong 0.2 \Rightarrow$ B.d =0.2 & s.d = 0.02

$I_C \rightarrow \frac{280-0}{8} = 35 \cong 50 \Rightarrow$ B.d. = 50 & s.d. = 5

Step 4:

For V_{CE} = 0 volts

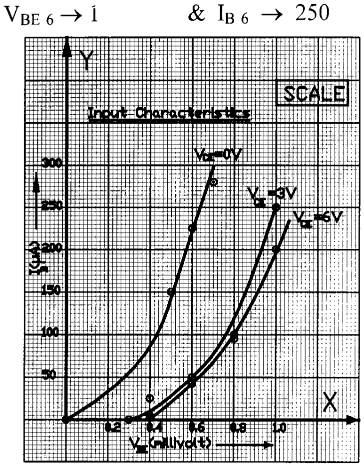
$V_{BE\,1} \rightarrow 0$ & $I_{B\,1} \rightarrow 0$
$V_{BE\,2} \rightarrow .2+.5x.2=.3$ & $I_{B\,2} \rightarrow 0$
$V_{BE\,3} \rightarrow 0.4$ & $I_{B\,3} \rightarrow 5x5=25$
$V_{BE\,4} \rightarrow .4+.5x.2=.5$ & $I_{B\,4} \rightarrow 150$
$V_{BE\,5} \rightarrow 0.6$ & $I_{B\,5} \rightarrow 200+5x5=225$
$V_{BE\,6} \rightarrow .6+.5x.2=.7$ & $I_{B\,6} \rightarrow 250+6x5=280$

For V_{CE} = 3 volts

$V_{BE\,1} \rightarrow 0$ & $I_{B\,1} \rightarrow 0$
$V_{BE\,2} \rightarrow 2+.5x.2=.3$ & $I_{B\,2} \rightarrow 0$
$V_{BE\,3} \rightarrow 0.4$ & $I_{B\,3} \rightarrow 1x5=5$
$V_{BE\,4} \rightarrow 0.6$ & $I_{B\,4} \rightarrow 8.4x5=42$
$V_{BE\,5} \rightarrow 0.8$ & $I_{B\,5} \rightarrow 100$
$V_{BE\,6} \rightarrow 1$ & $I_{B\,6} \rightarrow 250$

For V_{CE} = 6 volts

$V_{BE\,1} \rightarrow 0$ & $I_{B\,1} \rightarrow 0$
$V_{BE\,2} \rightarrow .2+.5x.2=.3$ & $I_{B\,2} \rightarrow 0$
$V_{BE\,3} \rightarrow 0.4$ & $I_{B\,3} \rightarrow .4x5=2$
$V_{BE\,4} \rightarrow 0.6$ & $I_{B\,4} \rightarrow 50$
$V_{BE\,5} \rightarrow 0.8$ & $I_{B\,5} \rightarrow 50+9x5=95$
$V_{BE\,6} \rightarrow 1$ & $I_{B\,6} \rightarrow 200$



Evaluation

Finding:
Input resistance r_i
for V_{CE} = 3 volts

$$r_i = \frac{\Delta V_{BE}}{\Delta I_B} = \frac{1\text{volt}}{250\mu A} = \frac{1}{250x10^{-6}}$$

$$= 4\ K\Omega$$

Phonautograph is a device for recording visual traces of speech sound.

G.M. Counter Characteristics

V (volts)	375	385	395	410	430	450	470	490	510	520
N(counts)	6	7	8	9	10	10	10	12	13	14

(Read method for plotting a graph on page 7)

Step 1: taking V along X-axis & N along Y-axis

Scale:
Along X-axis:
1 big div = 40 volts
Along Y-axis:
1 big div = 3 counts
~~cm~~

Step 2:

V $\rightarrow \frac{520 - 375}{6} = 24.17 \cong 40 \Rightarrow$ B.d =40 & s.d = 4

N $\rightarrow \frac{14 - 6}{8} = 1 \cong 3 \Rightarrow$ B.d. = 3 & s.d. = 0.3

Step 4:

$V_1 \rightarrow 350 + 6.3x4 = 375$ & $N_1 \rightarrow 5+3.3x.3=6$
$V_2 \rightarrow 350 + 8.7x4 = 385$ & $N_2 \rightarrow 5+6.6x.3= 7$
$V_3 \rightarrow 390 + 1.2x4 = 395$ & $N_3 \rightarrow 8$
$V_4 \rightarrow 390 + 5x4 = 410$ & $N_4 \rightarrow 8+3.3x.3= 9$
$V_5 \rightarrow 430$ & $N_5 \rightarrow 8+6.6x.3= 10$
$V_6 \rightarrow 430 + 5x4 = 450$ & $N_6 \rightarrow 8+6.6x.3= 10$
$V_7 \rightarrow 470$ & $N_7 \rightarrow 8+6.6x.3= 10$
$V_8 \rightarrow 470 + 5x4 = 490$ & $N_8 \rightarrow 11+3.3x.3= 12$
$V_9 \rightarrow 510$ & $N_9 \rightarrow 11+6.6x.3= 13$
$V_{10} \rightarrow 510 + 2.5x4 = 520$ & $N_{10} \rightarrow 14$

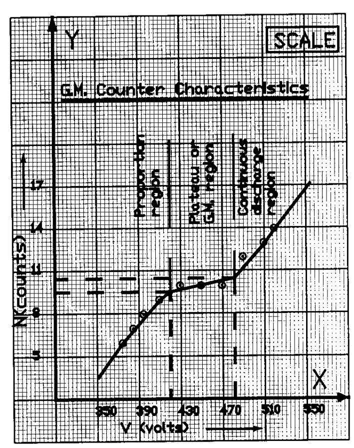
Evaluation

Finding:

Slope percentage per volt:

$$= \frac{482 - 421}{10.4 - 9.5} \times \frac{100}{(9.5+10.4)/2}$$

$$= 0.15\ \%$$



We define x-intercept of a curve is the x-coordinate of the point of intersection of the curve with the x-axis. Similarly y-intercept is defined.

High resistance by Neon flash lamp

T (sec)	0.3675	0.6975	1.115	2.36
R (MΩ)	1	3	5	10

(Read method for plotting a graph on page 7)

Step 1: taking T along X-axis & R along Y-axis

Step 2:

$T \rightarrow \frac{2.36 - 0.37}{6} = 0.33 \cong 0.5 \Rightarrow$ B.d = 0.5 & s.d = 0.05

$R \rightarrow \frac{10 - 1}{8} = 1.125 \cong 1.5 \Rightarrow$ B.d. = 1.5 & s.d. = 0.15

Scale:
Along X-axis:
1 big div = 0.5 sec
Along Y-axis:
1 big div =1.5 MΩ

Step 4:

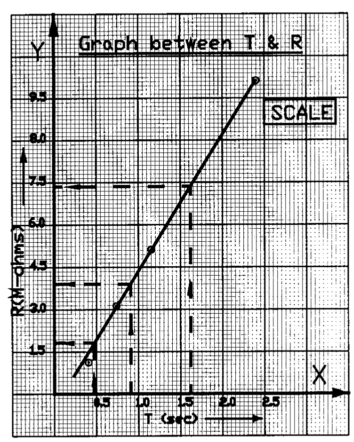
$T_1 \rightarrow 7.3 \times .05 = 0.3675$ & $R_1 \rightarrow 6.6 \times .15 = 1$

$T_2 \rightarrow .5 + 3.9 \times .05 = 0.6975$ & $R_2 \rightarrow 3$

$T_3 \rightarrow 1 + 2.3 \times .05 = 1.115$ & $R_3 \rightarrow 4.5 + 3.3 \times .15 = 5$

$T_4 \rightarrow 2 + 7.2 \times .05 = 2.36$ & $R_4 \rightarrow 9.5 + 3.3 \times .15 = 10$

Evaluation



Finding:

Values of unknown resistances:

R_1 = 1.8 M Ω

R_2 = 3.9 MΩ

R_3 = 7.4 M Ω

Feldman is admired for his innovation in graphic scoring, using visual symbols for musical sound verses time duration.

$1/d^2$ verses θ for photocell

$1/d^2$ (cm^{-2})	156×10^{-6}	177×10^{-6}	204×10^{-6}	236×10^{-6}	277×10^{-6}	330×10^{-6}	400×10^{-6}	493×10^{-6}
θ (μA)	25	27.5	30	32.5	40	47.5	55	62.5

(Read method for plotting a graph on page 7)

Scale:
Along X-axis:
1 big div = 70 cm^{-2}
Along Y-axis:
1 big div = 7 μA

Step 1: taking $1/d^2$ along X-axis & θ along Y-axis

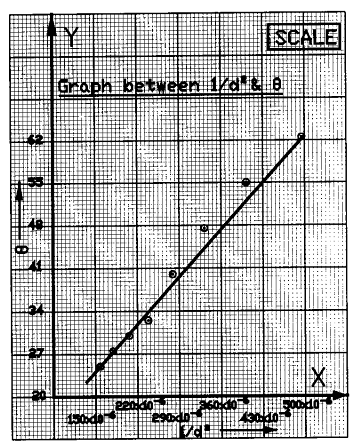
Step 2:

$1/d^2 \rightarrow \frac{493-156}{6} = 56.17 \cong 70 \Rightarrow$ B.d = 70 & s.d = 7

$\theta \rightarrow \frac{62.5-25}{8} = 4.69 \cong 7 \Rightarrow$ B.d. = 7 & s.d. = 0.7

Step 4:

$1/d^2_1 \rightarrow 150 + .86x7 = 156\ [x10^{-6}]$ & $\theta_1 \rightarrow 20 + 7.1x.7 = 25$
$1/d^2_2 \rightarrow 150 + 3.9x7 = 177[x10^{-6}]$ & $\theta_2 \rightarrow 27 + .7x.7 = 27.5$
$1/d^2_3 \rightarrow 150 + 7.7x7 = 204\ [x10^{-6}]$ & $\theta_3 \rightarrow 27 + 4.3x.7 = 30$
$1/d^2_4 \rightarrow 220 + 2.3x7 = 236\ [x10^{-6}]$ & $\theta_4 \rightarrow 27 + 7.9x.7 = 32.5$
$1/d^2_5 \rightarrow 220 + 8.1x7 = 277\ [x10^{-6}]$ & $\theta_5 \rightarrow 34 + 8.6x.7 = 40$
$1/d^2_6 \rightarrow 290 + 5.7x7 = 330\ [x10^{-6}]$ & $\theta_6 \rightarrow 41 + 9.3x.7 = 47.5$
$1/d^2_7 \rightarrow 360 + 5.7x7 = 400\ [x10^{-6}]$ & $\theta_7 \rightarrow 55$
$1/d^2_8 \rightarrow 430 + 9\ x\ 7 = 493\ [x10^{-6}]$ & $\theta_8 \rightarrow 62 + .7x.7 = 62.5$



Evaluation

Finding:

The slope from graph,

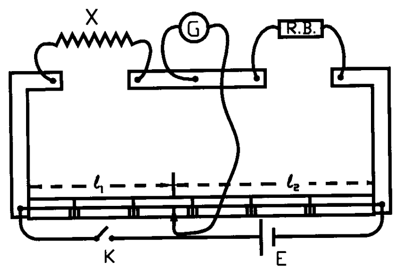
$$\tan\theta = \frac{\Delta\theta}{\Delta\frac{1}{d^2}} = \frac{62.5-25}{(493-156)x10^{-6}}$$

$$= 0.11 \times 10^6 \text{ A cm}^2$$

In the graph, what conclusion you make from the increasing curve?

Date..........

Expt: Slide wire bridge



Observations and Calculations:

Least count of the screw gauge = 1/100 mm = 0.01 mm = 0.001 cm

Diameter of the given wire:

i) ____ cm ii) _____ cm iii) _____ cm

Mean diameter = d = 0.036 cm

Radius of the wire = d/2 = r = _____ cm

Length of the wire = l = _____cm

No. of obs	Resistance taken out R	AB = l_1	BC = l_2	X = R x $\frac{l_1}{l_2}$
	ohms	cm	cm	ohms
1	9	45.7	54.3	10.6
2				
3				

Mean resistance X = _____ohms

Specific resistance = $\frac{X}{l} \times \pi r^2$ = ______ohm-cm = ______ ohm-m

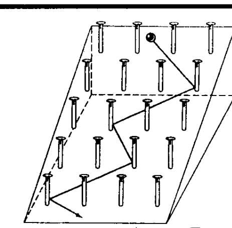
Actual value (for Nichrome) = 1.1 x 10^{-6} ohm-m

Percentage error = _____ %

Man is a tool-using animal. –*Thomas Carlyle*

Home Project:

Make a model analogous to the conduction of electrons in a metal. In the figure, a steel ball rolling down a pegboard incline. Over a long time interval, the motion is characterized by a constant drift velocity down the board.



Experiment No. 1:

To find the resistance of a wire by slide wire bridge.

Apparatus:

Slide wire bridge, resistance wire, battery, galvanometer, resistance box, jockey, connecting wires, sand paper, rheostat, screw gauge, meter rod.

Theoretical Base:

From the principle of Wheatstone Bridge, ordinary electrical resistances are most accurately measured by a method of comparison. According to this principle, P / Q = X / R or X = (P/Q) R ohms. Since resistance is directly proportional to length, so the resistances P & Q are replaced by lengths l_1 and l_2 of the wire BC. So X = (l_1 / l_2) R ohms.

Procedure:

1) *Draw the circuit diagram. Arrange all the components.*
2) *Make all the connections except the battery.*
3) *Call your instructor or the teacher to check the connections, then attach battery.*
4) *Check the connections by taking out resistance (say 5 ohms) from resistance box. Insert the key. Touch the jockey turn by turn on both sides of the wire. If the deflection in Galvanometer is opposite to that in first case then the connections are correct.*
5) *Just touch the jockey in the middle of the wire. Adjust the resistance R from resistance box, so the galvanometer shows no deflection when jockey is placed nearly in the middle.*
6) *Repeat twice with small change in the value of R.*
7) *Complete the table. Calculate the resistance from the formula.*

Precautions:

1. Connections must be tight and clean.
2. Connections must be made with the keys open. Insert key for readings.
3. The jockey should not be rubbed along the wire.

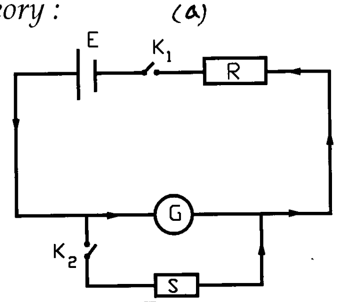
Viva Voce:

Q.1 *Why the null point is sought at the middle of the wire?*
Ans. Because at this part the arrangement becomes very sensitive.
Q.2 *What is the effect of temperature on resistance?*
Ans. It increases as the temperature increases.
Q.3 *On which principle slide wire bridge circuit works?*
Ans. On the principle of Wheatstone bridge.

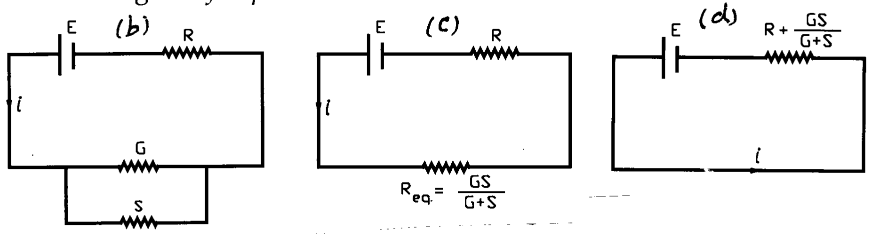
Date...........

Expt: Half deflection method.

Circuit diagram for theory :



Circuit diagram for practical:



Observations and Calculations:

No. of obs.	Resistance R	Deflection θ	Shunt resistance S	Half deflection θ / 2	$G = \frac{R \times S}{R - S}$
	ohms	div.	ohms	div.	ohms
1	4800	30	99	15	101.08
2					
3					

Mean value of galvanometer resistance = G = ______ ohms

The aim of science is always to reduce complexity to simplicity.

–*William James*

Home Project:
Solder two wires to each of four flashlight bulbs. Connect them in the various combinations (in parallel & in series) across a 1.5 V battery. Explain the ways the bulbs glow in each case.

Experiment No. 2:

To find the resistance of a Galvanometer by half deflection method.

Apparatus:

Galvanometer, cell, high resistance box, two plug keys, low resistance box, connecting wires, sand paper.

Theoretical Base:

In the figure, when K_1 is closed and K_2 is open. The current through galvanometer shows deflection θ,

$$I_g = \frac{E}{R+G} = k\theta \quad ..... (1)$$

$[G = R_g$ = galvanometer resistance$]$

When both keys are closed and S adjusted to reduce deflection to one half, and applying Kirchhoff's 2nd rule on loop including G & S,

$$I_g G - (i - I_g) S = 0 \quad \Rightarrow \quad I_g = i \times S / (G + S)$$

Looking up in fig. (d), the above equation gives,

$$I_g = \frac{E}{R + (GS/G+S)} \times \frac{S}{G+S} = \frac{k\theta}{2} \quad .... (2)$$

From eqs (1) & (2), we have

$$\frac{ES}{R(G+S)+GS} = \frac{E}{2(R+G)} \Rightarrow G = \frac{RS}{R-S}$$

If the value of R is large compared to S, i.e., R >> S,

$$\text{then} \quad \frac{R}{R-S} = 1 \Rightarrow G = S$$

Procedure:

1) *Make connections according to the circuit diagram with keys K_1 and K_2 open.*
2) *Check your connections with your teacher.*
3) *Take out high resistance (say 4000 ohms). Close Key K_1, and K_2 being open. Adjust the large deflection (20 to 30) with some more resistances. Note readings.*
4) *Keeping R unchanged close K_2 to see null point of the galvanometer. From shunt resistance take out so much resistances so as the deflection become half of previous one. Note the readings.*
5) *Repeat twice by changing resistance R. Find mean value G.*

Precautions:

1. Key K_1 should be closed only after taking some high resistance.
2. The deflection should be in even number of scale.
3. Zero error of the galvanometer should either be removed or accounted for.

Viva Voce:

Q.1 *What is meant by shunt?*

Ans. A wire or any conductor connected across a galvanometer.

Q.2 *The resistance of which part of galvanometer is measured?*

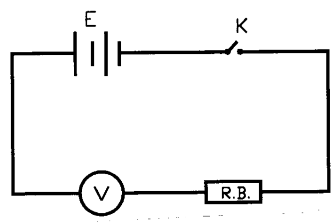
Ans. Of the coil of the galvanometer.

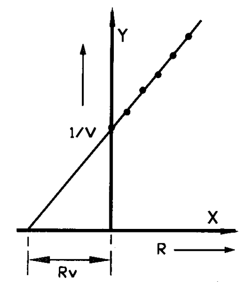
Q.3 *Why galvanometer shows half deflection when both keys are closed?*

Ans. Because half of current goes through shunt and half through galvanometer.

Date...........

Expt: Voltmeter resistance.





Observations and Calculations:

No. of obs.	Resistance R	Voltmeter V	1 / V
	ohms	volts	volts $^{-1}$
1			
2			
3	1000	1.1	0.90
4			
5			
6			

From the graph : The intercept on X-axis = resistance of the voltmeter

R_V = ... ohms

By different methods different men excel
But where is he who can do all things well? –*Charles Churchill*

Home Project:
Determining voltmeter sensitivity, or the resistance per volt of a voltmeter.
First find full scale deflection current, I_{FSD} , and then
sensitivity = 1volt / I_{FSD} = ... Ω /volts
Also total voltmeter resistance is determined by multiplying the sensitivity (ohms per volt) by the voltmeter range:
R_V = (sensitivity x range)

Experiment No. 3:

To find resistance of a voltmeter by drawing graph between R and 1/V.

Apparatus:

Voltmeter, battery, resistance box, rheostat, key, connecting wires.

Theoretical Base:

In the fig. on the left page, the current passing in the circuit is,

$$I = \frac{E}{R + R_v}$$

And the potential applied E, from Kirchhoff's voltage rule is,

$$E = V + IR = V + \left(\frac{E}{R + R_v}\right) R$$

$$\text{or} \quad V = E - \frac{ER}{R + R_v} = E\left(1 - \frac{R}{R + R_v}\right) \quad \text{or} \quad V = \frac{ER_v}{R + R_v}.$$

$$\text{or} \quad \frac{1}{V} = \frac{R + R_v}{ER_v} \quad \text{or} \quad R + R_v = ER_v\left(\frac{1}{V}\right)$$

Since E & R_v are constant, $R \propto 1/V$

Also when $1/V = 0$, then $R + R_v = 0$ or $R_v = -R$

The intercept on the X-axis gives the resistance of the voltmeter.

Procedure:

1) *Make a circuit diagram and connect the circuit with key open.*
2) *The emf of the battery should be checked. It should be at least to the maximum voltmeter reading.*
3) *Insert key K and take out some resistance R from resistance box. Note reading.*
4) *Take out the resistance in regular steps and note down the voltmeter reading.*
5) *Complete the table. Plot a graph between R and 1 / V.*
6) *Produce the straight line of the graph backwards to cut at B. The intercept on X-axis gives the resistance of the voltmeter.*

Precautions:

1. Battery should provide a voltage equal to the maximum voltmeter reading.
2. High resistance voltmeter should be used.
3. Resistance should be increased in regular steps.

Viva Voce:

Q. 1: *What is a voltmeter ?*

Ans. It is an instrument for measuring potential difference.

Q. 2: *Why a high resistance voltmeter is preferred here ?*

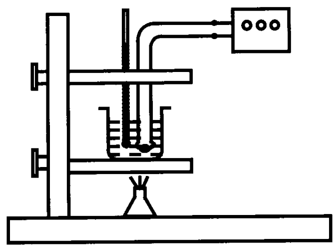
Ans. Because it draws maximum current from the circuit.

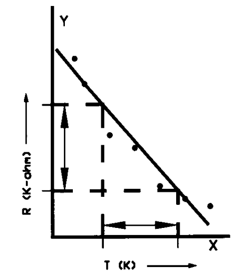
Q. 3: *What is shunt?*

Ans. It is a low resistance placed in parallel to the circuit.

Date…………

Expt: Thermistor resistance.





Observations and Calculations:

No. of obs.	Temperature	Absolute temperature	Resistance R
	°C	K	K Ω
1			
2			
3			
4	40	313	2.05
5			
6			
7			

From the graph:

The slope $\Delta R / \Delta T$ = _____ ohm K^{-1}

In science, read by preference, the newest works, in literature, the oldest.

–Edward Bulwer-Lytton

Home Project:

Take off the insulation of a discarded lamp cord several inches. Cut off a piece of one strand 2 inches long. Using a pair of pliers, connect this across the dry cell. Be careful not to burn yourself. The heat produce will make it melt. A fine piece of iron wire will glow like the filament of an electric lamp, but due to oxygen in the air, it will soon burn up.

Experiment No. 4:

Variation of resistance of thermister with temperature.

Apparatus:

Thermister unit, iron stand, multimeter (ohms range), beaker, spirit lamp, thermometer.

Theoretical Base:

A thermister is a temperature sensitive semi-conductor device. The word thermister is derived from 'thermal resistor'. Usually its resistance decreases considerably with rise in temperature. This high sensitivity to temperature variations makes the thermister good for precise temperature measurements. Depending upon their composition the thermister can have either a positive temperature coefficient (i.e., 'the fractional change in the resistance of a thermister per degree centigrade rise in temperature') or a negative temperature coefficient.

Procedure:

1) *Set up the apparatus as shown in the diagram.*
2) *Set the multimeter to appropriate ohms range. Fill the water in the beaker. Fix thermister a little above base of beaker and thermometer at a readable position.*
3) *Note the temperature on thermometer and the resistance in the multimeter. Record the readings in the table.*
4) *Start heating the beaker very slowly. Stir the water in the beaker with a stirrer. [Or pour boiling water into the beaker containing cold water—quick method!]*
5) *Note temperature and the corresponding resistance at regular intervals of* 5^{o} .
6) *Complete all the columns of the table.*
7) *Plot graph between resistance of thermister and the absolute temperature. The curve is not a straight line. Find the slope of this curve.*

Precautions:

1. Thermister leads must be fixed away from the flame.
2. Thermometer bulb should not touch the walls and the bottom of the beaker.
3. Do not make adjustments to apparatus when it is hot.

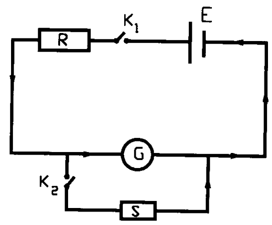
Viva Voce:

Q.1 *What is a thermister?*
Ans. A thermister is heat sensitive semi-conductor device. Its resistance decreases when its temperature increases.
Q.2 *What do you mean by temperature coefficient of resistance?*
Ans. The fractional change in resistance per Kelvin.
Q.3 *Can a thermister have positive temperature coefficient?*
Ans. Yes, thermisters with positive temperature coefficient are also available.

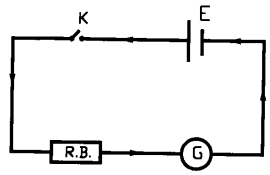
Date...........

Expt: Conversion into ammeter.

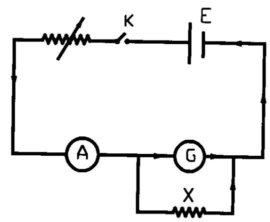
(a)



(b)



(c)



Observations and Calculations:

No. of obs.	Resistance R	Deflection θ	Shunt resistance S	Half deflection θ / 2	$G = \frac{R \times S}{R - S}$
	ohms	div.	ohms	div.	ohms
1	4800	30	99	15	101.08
2					
3					

Mean = G = ______ ohms

Table 2: Figure of merit

No. of obs.	Emf of cell E	Resistance R	Deflec-tion θ	$k = \frac{E}{R+G}\ \frac{1}{\theta}$
	volts	ohms	div.	amp. / div.
1	3.0	3200	22	4.13×10^{-5}
2				
3				

Mean k = ______ amp. / div.

Figure of merit of galvanometer = k = ______

Resistance of the galvanometer = G = ______ ohms

No. of div. on the galvanometer of one extreme end = n = _____

Current for full scale deflection = $I_g = n\,k$ = ______ amp

Range of conversion = I = 0.1 amp.

Value of shunt resistance = $X = \frac{G\ I_g}{I - I_g}$ = ____ ohms

Corrected mean diameter of the wire = ____ mm

Radius of the wire = r = ____ mm = ____ cms

Specific resistance of the wire = $\rho = 115 \times 10^{-6}\ \Omega$-cm

Length of wire used as shunt = $l = \frac{X \pi r^2}{\rho}$ = ____ cm

One scale division after conversion = $\frac{0.1}{n}$ = ____ amp.

Table 3: Verification:

No. of obs.	Galvanometer reading: Deflection θ′	Galvanometer reading: Current in Amp. (0.1 / n) θ′	Ammeter reading	Difference
	S. division	Amp	Amp	Amp
1	10	0.03	0.04	0.01
2				
3				
4				
5				

Give us the tools, and we will finish the job. –*Sir Winston Churchill*

Home Project:

Make an electromagnet by winding many loops of insulated copper wire on a large nail. Wrap a few layers of paper around the nail before you begin winding. Power it with a flashlight battery. If you do not want the battery to run down too quickly, place a flashlight bulb in series with the battery and coil. Observe its magnetic properties.

Experiment No. 5:

Conversion of galvanometer into ammeter reading up to 0.1 amperes.

Apparatus:

Galvanometer, ammeter, voltmeter, high resistance box, fractional resistance box, two keys, screw gauge, connecting wires.

Theoretical Base:

In the figure, according to Ohm's law,

$$V = I_g R_g \quad \ldots\ldots (1)$$

$$\text{and } V = (I - I_g) R_s \quad \ldots\ldots (2)$$

From eqs. (1) & (2) we get

$$I_g R_g = (I - I_g) R_s$$

$$\text{or } R_s = \frac{I_g}{I - I_g} R_g$$

Where = R_s = X = shunt resistance & R_g = G = galvanometer resistance

Taking length of wire equivalent to X,

$$R_s = X = \rho \frac{l}{A} \quad \text{or} \quad l = X \frac{A}{\rho} = X \frac{\pi r^2}{\rho}$$

Procedure:

1) *Make connections as shown in fig. (a) and determine galvanometer resistance by half deflection method. [see expt. No. 2]*
2) *To find figure of merit, determine emf of a cell.*
3) *Make connections as shown in fig. (b), and adjust resistance from resistance box for large scale deflection, and complete the table 2.*
4) *Fill the lines below the table 2, and calculate wire length for shunt.*
5) *For verification, take calculated length of wire, and make connection as in fig. (c).*
6) *Complete the table 3, by adjusting the resistance from rheostat for maximum deflection in the galvanometer to read the desired reading (0.1 A) in the ammeter.*

Precautions:

1. The cell used should have a constant emf.
2. The wire used for shunt should be of convenient length.
3. Large scale deflection should be used for checking conversion of galvanometer.

Viva Voce:

Q.1 *What is a shunt?*

Ans. Small resistance placed parallel to a circuit, called shunt or shunt resistance.

Q.2 *What is an ammeter?*

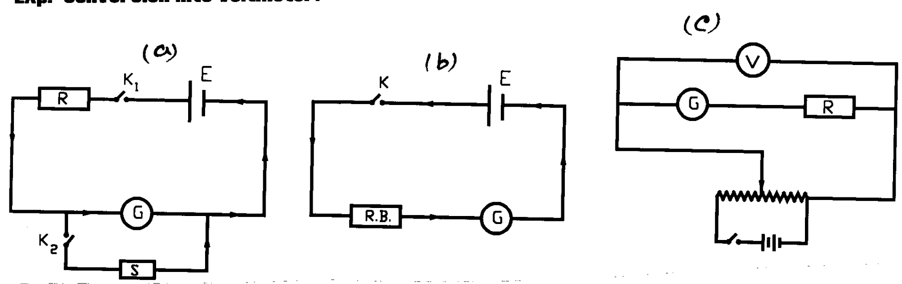
Ans. Device to measure current; it's a low resistance moving coil galvanometer.

Q.3 *How can a galvanometer be converted into an ammeter?*

Ans. By connecting a suitable low resistance in parallel with galvanometer coil.

Date...........

Exp: Conversion into voltmeter.



Observations and Calculations:

Resistance of the galvanometer
(by half deflection method) = G = _____ ohms

No. of div. on the galvanometer of one extreme end = n = 30

Figure of merit of the galvanometer = $k = \frac{E}{R+G}\,\frac{1}{\theta}$ = _______ amp / div

Current for full scale deflection = I_g = n k = _______ amps

Conversion range of galvanometer = V = 2 volts

External resistance to be placed in series with galvanometer = $R_x = \frac{V}{I_g} - G$ = ______ ohms

Verification:

Each scale division on the converted galvanometer = 2 / n = ______ volts

No. of obs.	Galvanometer reading		Voltmeter reading	Difference
	Deflection θ′	P.D. in volts (2/n) θ′		
	small div.	volts	volts	volts
1				
2				
3	15	1.0	1.0	0
4				
5				

No man's knowledge here can go beyond his experience. –John Locke

Home Project:

Make the coil by winding several hundred turns of fine insulated copper wire around a bundle of nails. Connect the coil and a dry cell in series. Hold the ends of the circuit, one in each hand. Touch the two ends together. A current will flow in the coil. With the two ends still in your hands break the circuit. You will feel a slight electric shock. It is due to the induced emf of self-inductance when the circuit was opened.

Experiment No. 6:

Conversion of galvanometer into voltmeter reading up to 2 volts.

Apparatus:

Galvanometer, voltmeter, high resistance box, fractional resistance box, two keys, connecting wires.

Theoretical Base:

To convert a galvanometer into voltmeter reading up to V volts, we have to introduce a resistance R in series with it coil, so that when a potential difference of V volts is applied to its terminals full scale deflection current (I_g) passes through it. In the figure, according to Ohm's law,

$$I_g = \frac{V}{R_x + G} \quad \text{or} \quad R_x = \frac{V}{I_g} \; G$$

An equivalent resistance is placed in series with the galvanometer coil and the readings checked with a standard voltmeter.

Procedure:

1) *Determine the galvanometer resistance G by half deflection method and figure of merit as done in the last experiment.*
2) *Find the current for full-scale deflection* $I_g = nk$.
3) *Fill up the lines above the table and find the value of external resistance.*
4) *Make connections as shown in the fig. (c).*
5) *Fill up the table for verification.*

Precautions:

1. Suitable resistances should be removed from the resistance box to produce large deflections in both the instruments.
2. Red marked terminal of voltmeter is always positive, it should be connected to the positive of the battery.
3. The emf of the battery should be greater than the conversion range of the galvanometer.

Viva Voce:

Q.1 *How will you connect a voltmeter in a circuit?*

Ans. It is always connected in parallel with the circuit.

Q.2 *How does a voltmeter differ from an ammeter?*

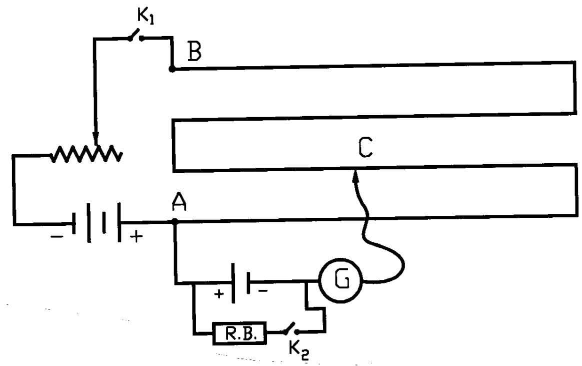
Ans. A voltmeter is high resistance galvanometer, used for measuring potential difference,; ammeter is a low resistance galvanometer used to measure current.

Q.3 *Why should a voltmeter have very high resistance?*

Ans. It is connected in parallel to the circuit for measuring potential difference. Using high resistance in voltmeter would help not to change P.D. in the circuit.

Date...........

Expt: Internal resistance of a cell.



Observations and Calculations:

Length l_1 = _____ cm

No. of obs.	Resistance R	Length l_2	Internal resistance $r = \frac{(l_1 - l_2)}{l_2} R$
	ohms	cm	ohms
1	5	318	0.63
2			
3			

Mean r = _____ ohms

Those who believe that they are exclusively in the right are generally those who achieve something. –*Aldous Huxley*

Home Project:

Take an old dry cell and tear it apart. Examine the zinc container, probably largely eaten away. After it there is a blotting paper. Then there is a paste of ammonium chloride and manganese dioxide and finally there will be a carbon rod. You will find some zinc chloride (dry white substance) left on the zinc.

Make a wet cell by punching holes in the zinc of an old dry cell and placing the cell in a jar containing salt solution.

Experiment No. 7:

To find the internal resistance of a cell using a Potentiometer.

Apparatus:

Potentiometer, cell, battery, two keys, rheostat, galvanometer, resistance box, connecting wires.

Theoretical Base:

When a cell is supplying a current I to an external circuit having resistance R, it is always accompanied by the flow of the same current I inside the cell. This current inside the cell comes across a resistance due to electrolyte present in the cell. This resistance is called internal resistance r of the cell.
Under the condition the potential difference e (= IR) between the terminals of the cell is less than emf E and the difference (E - e) represents the potential difference required to drive the current I through the internal resistance r.

$$\text{So } E - e = I r \quad \text{or } r = \frac{E - e}{I}$$

$$\text{or } r = \left(\frac{E - e}{e}\right) R \quad \text{or } r = \left(\frac{E}{e} - 1\right) R \quad \left[\text{as } I = \frac{e}{R}\right]$$

The lengths l_1 and l_2 correspond to E and e respectively, so

$$R = \left(\frac{l_1}{l_2} - 1\right) R \quad \text{or } r = \left(\frac{l_1 - l_2}{l_2}\right) R$$

Procedure:

1) *Arrange and connect the circuit as shown in the diagram.*
2) *Check the connections from your teacher before adding battery.*
3) *Close the key K_1. keeping key K_2 open, adjust the rheostat. Find the balance point C_1 on the potentiometer wire.. Measure this length l_1 from the point A. Leave the rheostat at this position for rest of the experiment. .*
4) *Take out a resistance R from the resistance box and close key K_2. Obtain new balance point C_2 on the potentiometer wire. Measure l_2 from point A.*
5) *Take different values of R and calculate internal resistance of the cell.*

Precautions:

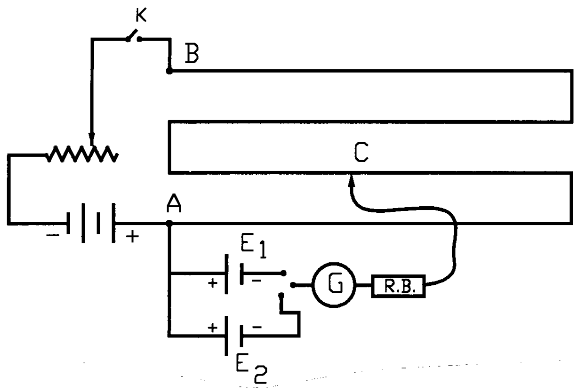
1. When determining l_1, key K_2 must be open.
2. Allow the current to flow only at the time of observations.
3. The rheostat should be so adjusted as to get the null points at large lengths.

Viva Voce:

Q.1 *What do you mean by internal resistance of a cell?*
Ans. The resistance offered by electrolyte to passage of current.
Q.2 *What is potentiometer?*
Ans. It is an apparatus for comparing and measuring potentials.
Q.3 *Whether internal resistance remains constant or not?*
Ans. It does not remain constant but changes when current drawn.

Date...........

Expt: emf of a cell by potentiometer.



Observations and Calculations:

E.M.F. of 1st cell = E_1 = ______ volts

No. of obs.	Length of balance point with cell		$E_2 = E_1 \times l_2 / l_1$
	E_1	E_2	
	l_1 (cm)	l_2 (cm)	volts
1	284	298	1.33
2			
3			

Mean emf of cell E_2 = ______ volts

Energy is Eternal Delight. *–William Blake*

Home Project:
Take 6V or 12V battery. Connect wires to its two terminals. How close together can the tips of the two wires be brought before a spark jumps? Why the sparking distance is so small? What can you conclude about long sparks?

Experiment No. 8:

To determine the emf of a cell using a Potentiometer.

Apparatus:

Potentiometer, battery, two cells, galvanometer, voltmeter, rheostat, jockey, sand paper, connecting wires, three way key, plug key.

Theoretical Base:

Let emf of the cell be E_1 with l_1 the corresponding length, and emf of unknown cell be E_2 with the corresponding length l_2. Since the potentiometer wire is uniform, the length is directly proportional to the potential difference.

$$\text{So} \quad \frac{E_2}{E_1} = \frac{l_2}{l_1} \quad \text{or} \quad E_2 = E_1 \times \frac{l_2}{l_1}$$

Procedure:

1) *Check the emf of the battery and cells using a voltmeter.*
2) *Make connections according to the circuit diagram. Positive terminals of the battery and cells should be connected to a common terminal A. Negative terminals of the cells should be connected with two way key.*
3) *First key K is closed and plug 1 is put in two way key. Now cell E_1 is in circuit. Touch the jockey at both ends A & B, the opposite deflection in the galvanometer will certify correct connections. Now locate balance point between the end A and B. When jockey is at balance point, the deflection of galvanometer is zero.*
4) *Measure l_1 from the end A. Now take out plug 1 and put in plug 2 in two-way key. Find balance point. Measure l_2 from A.*
5) *Repeat the experiment twice by changing rheostat resistance.*
6) *Complete all the columns of the table and the lines above and below the table. Find mean emf of the given cell E_2.*

Precautions:

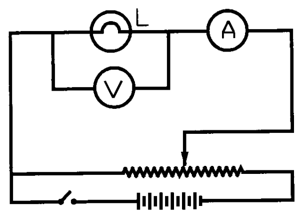
1. The emf of the battery should be higher than each of the cells.
2. Do not drag jockey on the potentiometer wire while locating balance point.
3. Current should be passed for a very short interval of time.

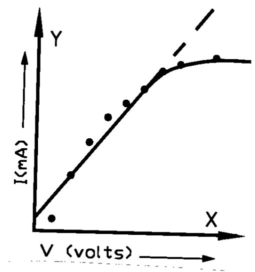
Viva Voce:

Q.1 *What is emf of a cell?*
Ans. The potential difference between its terminals for open circuit.
Q.2 *Why the deflection of galvanometer is zero at balance point?*
Ans. Because emf of the cell is equal to potential drop here.
Q.3 *Which type of galvanometer is suitable in potentiometer circuit?*
Ans. A sensitive center-point galvanometer is most suitable.

Date...........

Expt: Tungsten filament.





Observation and Calculations:

No. of obs.	Voltmeter reading V	Ammeter reading I	R = V/I
	volts	mA	ohms
1			
2			
3			
4			
5	0.4	0.32	1.2
6			
7			
8			
9			
10			

Result : As the graph is not a straight line. So it is non-ohmic resistance.

All things flow; nothing abide. –*Plato*

Home Project:

Take dry cell and a flashlight bulb. Connect them with a finest iron wire. The lamp will light, but not as bright as when you connect a copper wire. By varying the length of the iron wire, you can observe that the resistance depends on its length. By using heavier wire, you can see that resistance depends inversely on the size of the wire.

Experiment No. 9:

Relation between current passing through a tungsten filament lamp and the potential applied across it.

Apparatus:

6 volt battery, bulb (6V, 0.5A), voltmeter, high resistance rheostat, ammeter, connecting wires.

Theoretical Base:

According to Ohm's law, 'the magnitude of the current in metals is proportional to the applied voltage as long as the temperature of the conductor is kept the same'. So the resistance of conductor can be calculated by **R = V / I.** In case of tungsten filament lamp, the Ohm's law is not valid because as the amount of current passing through filament increases, the temperature of filament is also increases. And the resistance of the filament changes. The graph between V and I is straight line in the start but becomes a curve in the end. It shows that the resistance of filament remains constant in the beginning but increases at the end. So that Ohm's law is not valid in this case.

Procedure:

1) *Make the connections according to the circuit diagram. Rheostat and ammeter is connected in series but voltmeter in parallel with the bulb. .*
2) *Apply a small voltage by adjusting the sliding contact, so the ammeter and voltmeter give small initial readings. Note these readings.*
3) *Take the readings of ammeter and voltmeter in regular steps by changing the resistance of rheostat.*
4) *Complete the table . Plot a graph between V and I, which is not a straight line.*

Precautions:

1. High resistance rheostat should be used.
2. Voltmeter and ammeter must be connected with right polarity as in figure.
3. Voltage should be varied in small steps.

Viva Voce:

Q.1 *Why Tungsten filament becomes white hot with passage of current through it?*

Ans. Due to its high resistance, heat is generated by the passage of current in it.

Q.2 *Why bulbs are connected in parallel with power points?*

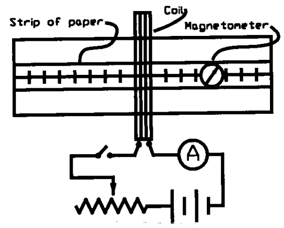
Ans. To keep the voltage same across each of the bulb.

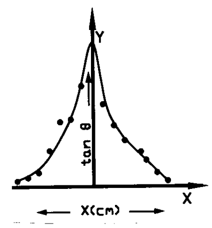
Q.3 *Why a Tungsten filament of a bulb does not obey Ohm's law?*

Ans. As the temperature of filament changes and for Ohm's law, temperature must remain constant.

Date...........

Expt: Variation of magnetic field.





Observation and Calculations:

Number of turns in the coil = n = _____

Diameter of the coil, D = ____ cm. & radius, r = ____ cm = _____ m

Current through the coil = I = 0.8 amp

Deflection = θ = 80°; μ_o = 1.257 x 10^{-6} Weber/amp

Magnetic field at the center = B = $\frac{\mu_o n I}{D}$ = 4.57 x 10^{-4} Tesla

No. of obs.	Distance from the center, x		Deflection of the magnetometer			Mean	Tan θ	$\tan\theta(r^2+x^2)^{3/2}$
			Direct	Reverse current				
	cm	m	θ	θ′	180 - θ′ = θ	θ		
1	14	0.14	20	170	180 – 170 = 10	15	0.2679	9.12 x 10^{-6}
2	12							
3	10							
4	8							
5	6							
6	4							
7	2							
8	0	0	80	102	180 – 102 = 78	79	5.1446	8.56 x 10^{-6}
9	-2							
10	-4							
11	-6							
12	-8							
13	-10	-0.10	20	140	180 – 140 = 40	30	0.5774	8.58 x 10^{-6}
14	-12							
15	-14							

Mean value of $\tan\theta(r^2+x^2)^{3/2}$ = _____ x 10^{-6}

Truth lies within a little and certain compass, but error is immense –*H. Bolingbroke*

Home Project1:

Make simple compass needle by stroking long needle lengthwise with the pole of a strong magnet. To assemble a compass, glue the needle to a small block of wood and float it in a dish of water.

Home Project2:

Iron objects distort the earth's magnetic field. Use a compass to discover how the direction of the earth's field is changed by different metal objects in your home.

Experiment No. 10:

Variation of magnetic field along the axis of a circular coil.

Apparatus:

Circular coil fitted on wooden board, ammeter, rheostat, magnetometer.

Theoretical Base:

From the application of Ampere's Law, field due to a current in a circular coil is : $B = \frac{\mu_0 n I}{2r} = \frac{\mu_0 n I}{D}$ or $B = H \tan\theta = \frac{\mu_0 n I}{D}$ or $H = \frac{\mu_0 n I}{\tan\theta \, D}$

where H = horizontal component of the earth's magnetic field

μ_o = permeability of free space = $4\pi \times 10^{-7}$ Wb $A^{-1} m^{-1}$

n = No. of turns; I = current passing (in amperes) ; D = 2 r

and if this field is made to act at right angles on a freely suspended magnetic needle, the needle will undergo a deflection θ.

The field at any point x on its central axis is given by :

$$B = \frac{\mu_0 n I r^2}{2(r^2 + x^2)^{3/2}} \text{ or } B = H \tan\theta = \frac{\mu_0 n I r^2}{2(r^2 + x^2)^{3/2}}$$

$$\text{or} \quad 2(r^2 + x^2)^{3/2} \tan\theta = \frac{\mu_0 n I r^2}{H}$$

For a given coil and current, $n r^2$ and I are constant, so

$$2(r^2 + x^2)^{3/2} \tan\theta = \text{constant}$$

Procedure:

1) *Place a magnetometer at the center of the coil. Adjust the board so that the plane of the coil is in North-South direction.*
2) *Put 30 cm long strip of paper along the axis of the coil (East –West direction).*
3) *Turn the circuit on. Adjust the current for magnetometer deflection of 70° or 80°.*
4) *Fill up the table and the lines above it.*
5) *Plot graph between distance x verses $\tan\theta$.*

Precautions:

1. Keep current through the coil constant.
2. Do not place magnets or iron pieces near the apparatus.
3. Plane of the coil should be exactly coincident with the magnetic meridian.

Viva Voce:

Q.1 *What is the nature of the field due to current alone?*

Ans. Field due to current alone will be represented by circular lines of force.

Q.2 *Is any practical application of using uniform field at the center of a coil?*

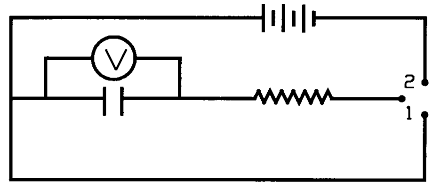
Ans. It is used in the construction of a tangent galvanometer.

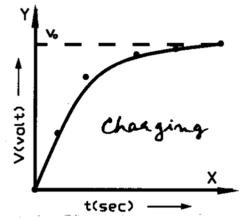
Q.3 *Give an approximate value of the strength of Earth's magnetic field.*

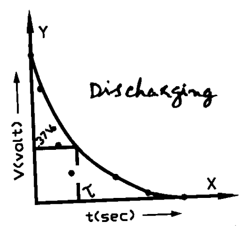
Ans. Earth's magnetic field is about 50 micro-tesla.

Date:................

Expt: Charging & discharging of a capacitor.







Observations & Calculations:

Value of resistor used = R = ____ KΩ

Value of the capacitor used = C = ____ μF

For charging current			For discharging current		
No. of obs.	time sec	voltage volts	No. of obs.	time sec	voltage volts
1					
2					
3					
4	18	12	4	9	2.5
5					
6					

From the graph, time constant = ______ sec

Theoretical value of time constant = R x C = ____ sec

Difference = ________ sec.

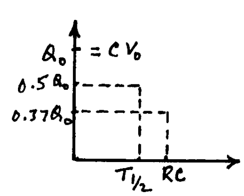
Activity is the only road to knowledge. –*George Bernard Shaw*

Home Project:

Determining half life $T_{1/2}$, which is the time needed to drop to 50% of the initial value.

Thus $I = \frac{1}{2} I_o = I_o e^{-T_{1/2}/RC}$.

Taking natural logarithm and rearranging, we find: $T_{1/2} = RC \ln 2 = 0.693\,\tau$



Experiment No. 11:

Charging and discharging of a capacitor and to measure time constant.

Apparatus:

Capacitor (1000 μF), resistor (10KΩ), voltmeter, power supply (12 VDC), stop watch, two-way key, connecting wires.

Theoretical Base:

A capacitor stores charge. When C is in series with an external resistance R, it forms an RC circuit. The time constant of an RC circuit is, '*the time during which the charging current falls to 37% of initial maximum current*'.

Mathematically, $I = I_o e^{-\tau / RC}$ or $V = V_o e^{-\tau / RC}$.

After one time constant, $t = \tau = RC$, so

$$V = V_o e^{-RC/RC} = V_o e^{-1} = V_o / e = V_o / 2.718 = 0.37V_o$$

Procedure:

1) *Set up the apparatus as shown in the figure. Keep the power supply off till you start taking the readings.*
2) *Close key K of position 1 so that the capacitor is completely discharged and the ammeter shows zero reading.*
3) *Turn power supply on. Shift key K to position 2 and simultaneously start stop watch. Note first reading at zero time corresponding to max. charging current. Take further readings after every 15 seconds. Stop taking observations when the current falls to 20 % of the initial current. Allow the capacitor to be charged further till the deflection of the ammeter becomes almost zero..*
4) *Reset the stop watch to zero reading. Shift key K to position 2 and simultaneously start the stopwatch. Again take observations of discharging current in the same way as before. Keep on taking these readings till the discharging current falls below 20% of the initial current.*
5) *Plot two graphs for charging and discharging of the capacitor as shown in figure.*
6) *Find time constants, against the voltage $V = 0.37V_o$, and fill up all the lines.*

Precautions:

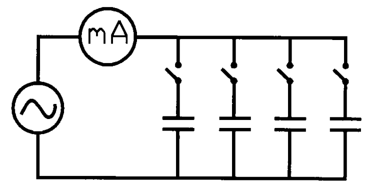
1. As the key is opened, at the same time start the stopwatch should be started.
2. High value capacitor and high value resistance should be used.
3. Discharge capacitor before taking a new set of observation.

Viva Voce:

Q.1 *What is time constant?*
Ans. The time in which a capacitor discharges to 37% of the maximum charge.
Q.2 *Why is the discharging current maximum initially?*
Ans. Because full capacitor voltage is applied across the resistor R.
Q.3 *What type of decrease is that of discharge current?*
Ans. It is the exponential decrease.

Date..............

Expt: Current and capacity relation.



Observations and Calculations:

No. of obs.	Capacity of the capacitor C	Current I	I / C
	μ F	mA	
1	3.3	12	3.63×10^3
2			
3			
4			
5			
6			
7			
8			
9			

Inference: As the ratio I / C is constant, showing the current is directly proportional to the capacity in an A.C. circuit.

The whole of science is nothing more than a refinement of everyday thinking.
–Albert Einstein

Home Project:
Perform analogous experiment for <u>decay</u> or decreases with time the capacitance of a capacitor.
Start with 50 one-rupee coins, shake and throw them and then select those that come up heads on the first throw. Repeat the process using those that come up heads. Select those that come up heads on the second throw and repeat. Continue till no coin is left. Plot a graph of number of coins verses the trial number, which will be a fair approximation to the decay curve.

Experiment No. 12:

Relation between current and capacitance when different capacitors are used in A.C. circuit.

Apparatus:

A.C. supply, step down transformer, five capacitors, key, A.C. milli-ammeter, flexible wires.

Theoretical Base:

The reactance (X_c)of a capacitance in the A.C. circuit is;

$$X_c = 1/\omega C \ , \ \omega = 2\pi f$$

$$\text{or } X_c = \frac{1}{2\pi f C}$$

now the current I in a capacitance will be,

$$I = \frac{V}{X_c} = \frac{V}{1/2\pi f C} = 2\pi f C V$$

Since $2\pi f V$ = constant, so I = const. x C or $\frac{I}{C}$ = constant

Procedure:

1) *Connect the components as shown in the diagram. The components are in series with the secondary of the transformer.*
2) *Note down the zero correction and least count of milli-ammeter scale.*
3) *Put on the circuit by inserting the plug in the key. Note the reading of milli-ammeter and the capacity of the capacitor. .*
4) *Repeat the experiment with the given different capacitors.*
5) *Plot a graph between current and capacity by taking capacity along X-axis and current along Y-axis.*

Precautions:

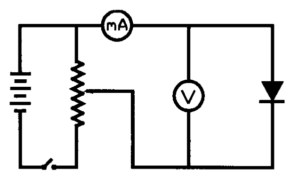
1. One should be cautious of touching various parts of the circuit.
2. Use a step-down transformer with an output of 8-12 volts.
3. Do not use electrolytic capacitor. Paper capacitor may be used.

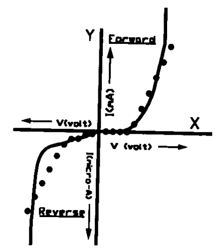
Viva Voce:

Q.1 *What is a capacitor?*
Ans. It is a combination of conducting plates separated by an insulator used to store electric charge.
Q.2 *What is the effect of dielectric in capacitor?*
Ans. It increases the capacitance.
Q.3 *What is the reactance of a capacitor?*
Ans. Reactance of a capacitor is its opposition to alternating current.

Date..............

Expt: Semi-conductor diode.





Observations and Calculations:

Forward characteristics

No. of obs.	Voltmeter reading V volts	Milliammeter reading I mA
1	1	0
2		
3		
4		
5		
6	6	0.75
7		
8		
9		
10		

Reverse characteristics

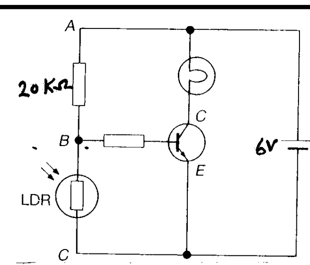
No. of obs.	Voltmeter reading V volts	Micro-ammeter reading I μA
1	1	10
2		
3		
4		
5		
6		
7	7	140
8		
9		
10		

Inference: The shape of the graph between V and I shows that the resulting current increases with the applied voltage upto one volt. At reverse biasing there is less current with the increase of voltage.

The new electronic independence recreates the world in the image of a global village. –*Marshall McLuhan*

Home Project:

Assemble the discrete components as in figure, to turning on a light in the dark. In daylight an LDR resistance is 500 Ω , and in the dark it is 1,000,000 Ω. The voltage across 20kΩ resistor is small compared with voltage across LDR. The transistor is switched on and the lamp lights.



Experiment No. 13:

Characteristics of a semi-conductor diode and calculation of forward and reverse current resistance.

Apparatus:

A semi-conductor diode, milliammeter, voltmeter, rheostat, key, battery, connecting wires.

Theoretical Base:

Semiconductors are not pure materials because small amounts of impurity atoms have been added to them. Their resistivity is intermediate between those of conductors and insulators. A junction between p and n type of materials forms a semiconductor diode. It is unidirectional device in the sense that it allows charge carriers to flow only in one direction. If the positive terminal of a battery is connected with p-type and negative terminal with n-type of diode then the semiconductor diode is called ***forward biased***. If the negative terminal of the battery is connected with p-type and positive terminal with n-type, then the semiconductor diode is called ***reverse biased***. Semiconductors are widely used in circuit elements such as in transistors and other semiconductor devices.

Procedure:

1) *Connect all the components as shown in the circuit diagram. For forward characteristics connect the positive of the diode to the negative of ammeter.*
2) *Plug in the key K_1 and adjust the rheostat so that the voltmeter reads 0.1 volts. Close the key K_2 and take the milliammeter reading.*
3) *Increase the applied voltage in steps of 0.1 volts interval and note both voltmeter and milliammeter readings.*
4) *Reverse the connections of the diode for reverse characteristics. Take the readings as before at least 2 volt interval upto 20 volts.*
5) *Plot a graph by taking voltage along X-axis and current along Y-axis. Use the same graph for forward and reverse characteristics.*

Precautions:

1. The voltage applied should be increased by regular steps.
2. High voltage should be avoided.
3. The end mark with red spot should be treated as cathode.

Viva Voce:

Q.1 *What is a semi-conductor?*

Ans. The substance whose resistance lie in between conductor and insulator.

Q.2 *What is the use of a semi-conductor diode?*

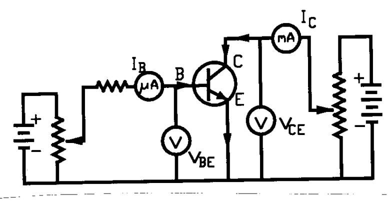
Ans. It is used to convert A.C. into D.C.

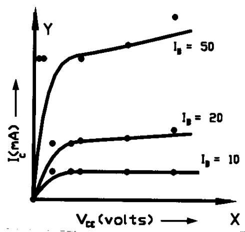
Q.3 *What is a p-n junction?*

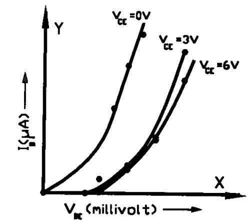
Ans. It is a combination of p and n type substances.

Date..............

Expt: Transistor characteristics.







Observations and Calculations:

For Output Characteristics

No. of obs.	I_B	V_{CE}	I_C
	μA	volts	mA
1			
2			
3	10	4	1
4			
5			
6			
1			
2			
3	20		
4		5	2.1
5			
6			
1			
2			
3	50		
4		5	5
5			
6			

For Input Characteristics

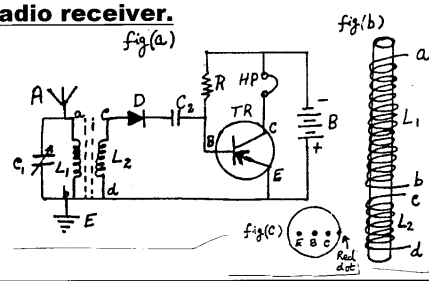
No. of obs.	V_{CE}	V_{BE}	I_B
	volts	milli-volts	μA
1			
2			
3	0	0.4	25
4			
5			
6			
1			
2			
3	3		
4		0.6	42
5			
6			
1			
2			
3	6		
4		0.6	50
5			
6			

Science is nothing but trained and organized common sense.

–*Thomas Henry Huxley*

Home Project:

Assemble the discrete components as in figure, to make a simple radio receiver.



Details of the figure:

A = Aerial, 50 feet
E = Earth
D = Crystle diode, OA 79
L_1= 60 turns coil of ferrite rod
L_2= 10 " " " " "
C_1= Variable condenser, 365 pF
C_2= Condenser, 5 uF
R = Resistor, 220 K
TR= Transistor, AF 117
HP= Headphone, high impedance
B = Batter, 6 volt.

Experiment No. 14:

Characteristics of a N.P.N. transistor.

Apparatus:

A N.P.N. transistor, voltmeter, millivoltmeter, micro-ammeter, milliammeter, two batteries of 9 volts, a resistor (1 K)

Theoretical Base:

A transistor consists of a single crystal of germanium or silicon, which is grown in such a way that it has three regions. The central region is known as base and the other two regions are called emitter and collector. Usually the base is very thin ~ 10^{-6} m. For normal operation, batteries for emitter-base junction is forward biased and its collector-base junction is reverse biased. In npn transistor *conventional current* I_E flows from base to emitter. Small part of it, current I_B flows in base, the rest of it I_C flows in the collector. The fundamental equation is $I_E = I_C + I_B$. Current gain $\beta = I_C / I_B$, is constant for given transistor. Transistors are basically used as amplifiers in major electronic circuits.

Procedure:

1) *Make connections as shown in the figure.*
2) *Adjust all the components with the help of your teacher according to the desired readings and with proper range and polarity.*
3) *Take the readings first for output characteristics and then for input characteristics by filling the above tables with appropriate ranges.*
4) *Take three sets with I_B at 0, 10 and 20 μA by measuring I_C and V_{CE} for output characteristics.*
5) *Take three sets with V_{CE} at 0, 3 and 6 volts by measuring I_B and V_{BE} for input characteristics.*
6) *Draw the curves between V_{CE} and I_C for each value of I_B and the curves between V_{BE} and I_B for each value of V_{CE} .*

Precautions:

1. Avoid the rough handling of the transistor.
2. Care must be taken in connecting the batteries.
3. Proper biasing of base and collector must be applied.

Viva Voce:

Q.1 *What are the types of transistors?*

Ans. There are two types, i) P.N.P. and ii) N.P.N.

Q.2 *How many PN junctions are there in a transistor?*

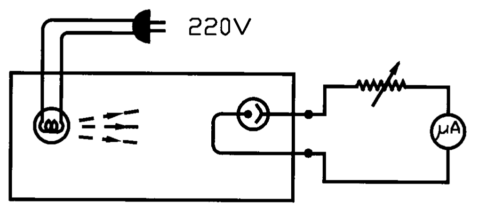
Ans. There are two PN junctions; Emitter-base and Collector-base junction.

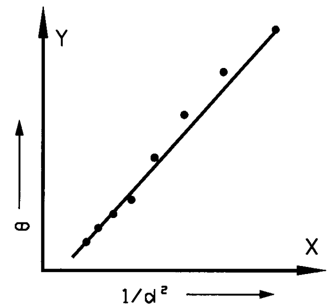
Q.3 *What do you mean by doping?*

Ans. The addition of donor or acceptor atoms (impurity) to a semiconductor.

Date...........

Expt: Photo-cell.





Observations and Calculations:

No. of obs.	Distance of lamp from photo-cell d (cm)	Deflection of galvanometer θ (μA)	($I \propto 1/d^2$) $1/d^2$	θ / d^2
1	80	25	156.25×10^{-6}	39.06×10^{-4}
2				
3				
4				
5				
6				
7				
8				

Inference: As the graph between deflection θ and $1/d^2$ is a straight line, therefore, light intensity from a point source decreases as the inverse square of the distance from the source. This proves the inverse square law.

All human science is but the increment of the power of the eye.

–John Fiske

Home Project:
Finding the wavelength at which the maximum radiation occurs, if temperature of a person's skin is 34 °C.
Apply Wien's displacement Law: $\lambda_{max} T = 2.898 \times 10^{-3}$ **m.K**

Experiment No. 15:

Study of the variation of electric current with intensity of light using a photocell.

Apparatus:

Photo-electric cell, sensitive galvanometer, battery, rheostat, key, electric bulb.

Theoretical Base:

Photocell is a device for converting light energy into electrical energy. It consists of an anode and a photosensitive cathode, from which photoelectrons are emitted when light falls on it. According to inverse square law, 'the intensity of light from a point source varies inverseiy as the square of the distance from the source, i.e., $I \propto 1 / d^2$. So a graph between photoelectric current or deflection (θ) and $1 / d^2$ will be a straight line.

Procedure:

1) *Arrange the apparatus as shown in the figure. Here all the components are in series. The bulb should be selected and fixed in such a way that its point light falls on the photo-electric cell.*
2) *Put on the lamp. Adjust the suitable deflection in the galvanometer.*
3) *Note the deflection, θ in the galvanometer (or micro-ammeter) and the corresponding distance, d of the photo-cell from the lamp. Change the distance d in regular steps and note the deflection θ in the galvanometer.*
4) *Draw a graph between $1 / d^2$ verses θ. It will be a straight line. .*

Precautions:

1. The voltage of the bulb must remain constant.
2. A point source of light should be used.
3. Start the experiment from maximum distance and decrease to minimum.

Viva Voce:

Q.1 *What is meant by photo-electrons?*

Ans. Electrons emitted from a light-sensitive material when illuminated.

Q.2 *Define photoelectric effect.*

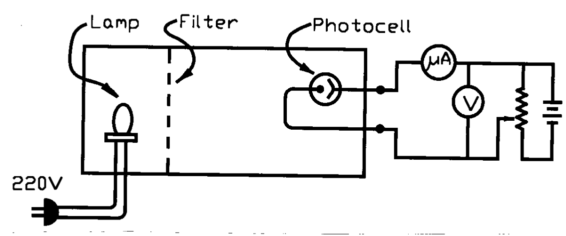
Ans. The emission of electrons by a substance when illuminated by electromagnetic radiation.

Q.3 *What is a photo cell?*

Ans. Photo cell is a device, which convert light energy into electrical energy under certain conditions.

Date...........

Expt: Planck's constant.



Observations and Calculations:

Velocity of light = c = 3×10^{8} m s^{-1}
Charge on an electron = e = 1.6×10^{-19} coulombs

No. of obs.	Filter	Wavelength λ	Current I	Stopping potential V	$h = \frac{e(V_1 - V_2)\lambda_1\lambda_2}{c(\lambda_2 - \lambda_1)}$
	colour	$\times 10^{-10}$ m	μA	volts	J-s
1	Red	6843	1.3	0.3	-----
2	Yellow	5835	0.7	0.6	6.338×10^{-34}
3	Green				
4	Violet				

Mean calculated value of h = _____ $\times 10^{-34}$ J-s

Standard value of h = 6.626×10^{-34} J-s

A man likes marvelous things, so he invents them, and is astonished.

–Edgar Watson

<u>Home Project:</u>
Find the materials that have responses to different colours of ligfht.
The human eye receives a different colour sensation from green light than it receives from red light. However, lights of different colours reaching a phototube make its cathode produce different amounts of electrons.
Check responses of colours with an LDR.

Experiment No. 16:

To estimate the value of Planck's constant by using photo cell tube and coloured light filters.

Apparatus:

Photocell tube with mercury lamp fitted in a box, micro-ammeter (0-10μA), voltmeter (0-1V), coloured filters, power supply, connecting wires.

Theoretical Base:

From photoelectric effect, the maximum energy of photoelectrons is:

$$\tfrac{1}{2} m v^2_{max} = V_o e \qquad \ldots(1)$$

& Einstein's photoelectric equation is; $h f - \phi = \tfrac{1}{2} m v^2_{max}$ ..... (2)

Equations (1) & (2) gives; $V_o e = h f - \phi$ or $V e = h \nu - \phi$

where $V = V_o$ = stopping potential & $\nu = f$

If two incident light radiations having photon energies $h\nu_1$ & $h\nu_2$ falls on photosensitive surface with stopping potentials V_1 & V_2, then we have

$$V_1 e = h\nu_1 - \phi \quad \& \quad V_2 e = h\nu_2 - \phi \quad \Rightarrow V_1 e - V_2 e = h\nu_1 - h\nu_2$$

$$\text{or} \quad (V_1 - V_2)e = h(\nu_1 - \nu_2) \quad \text{or} \quad h(\nu_1 - \nu_2) = (V_1 - V_2)e$$

$$\text{or} \quad h = \frac{(V_1 - V_2)e}{c/\lambda_1 - c/\lambda_2} = \frac{\lambda_1 \lambda_2 (V_1 - V_2)e}{c(\lambda_2 - \lambda_1)} \qquad [\nu = c/\lambda]$$

Procedure:

1) *Make connections as shown in the figure. Note that the anode of the photocell is connected to negative terminal and cathode to positive terminal of the battery.*
2) *Place one of the colour filter (say red) in the slot provided in the box.*
3) *Before making power supply on, check the all connections thoroughly. Turn on the power supply and the lamp in the phtocell. The voltmeter and micro-ammeter will show the readings.*
4) *Slowly increase power supply voltage. The current in the micro-ammeter decreases. At certain voltage this current becomes zero. Note this value of voltage from the voltmeter, which is stopping potential V_s.*
5) *Complete the table by using all the filters. And the lines below the table.*

Precautions:

1. A mercury light should be preferred to white light for better result.
2. Turn off the light before changing the filter.
3. Measure the stopping potential very carefully.

Viva Voce:

Q.1 *How does stopping potential depend upon the intensity of light?*

Ans. Stopping potential does not depend upon the intensity of light.

Q.2 *What is stopping potential?*

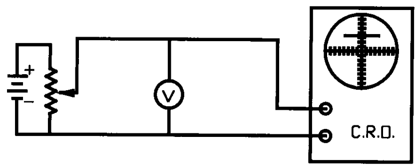
Ans. The reverse potential at which the current becomes zero.

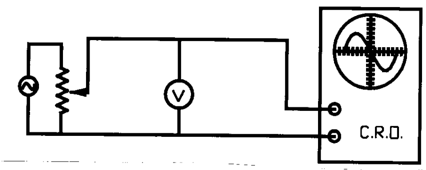
Q.3 *What is Planck's law?*

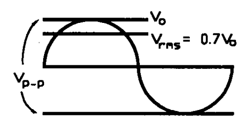
Ans. E = hf, which shows that energy & frequency are directly proportional.

Date………..

Expt: Measuring DC/AC by CRO.







Observations and Calculations:

For measurement of D.C. voltage

No. of obs.	Voltage shown by CRO V_R	Multi-meter reading V_m	Difference $(V_R - V_m)$
	div = volts	volts	volts
1	8 div = 6 volts	6.15	0.15
2			
3			

For measurement of A.C. voltage

Calibrating V_{P-P}: Standard A.C. voltage source = V_S = (say) 6.3 volts a.c.
$V_{P-P} = V_S \times 2 / 0.7$ = y div = (say) 12 div = $6.3 \times 2 / 0.7$ = (say)18 volts
so 1 div. = V_{P-P} / y = 18 / 12 = (say)1.5 volts

No. of obs.	Voltage shown by CRO V_{P-P}	$V_{PP}/2 = V_o$	$0.7 V_o = V_{rms}$	Multi-meter reading V_m	Difference $(V_{rms} - V_m)$
	div = volts	volts	volts	volts	volts
1	6 div = 9 volts	4.5	3.15	3.2	0.05
2					
3					

Science is nothing but perception. –*Plato*

Student Project:
Connect the cathode-ray oscilloscope with a microphone. If you want to see visible demonstration of vibrations, sing into the microphone. Look the screen and adjust the waveform. Differentiate between noise and singing notes.

Experiment No. 17:

Measurement of D.C. and A.C. voltage by Cathode Ray Oscilloscope.

Apparatus:

Cathode ray oscilloscope, DC power supply(0-30V), AC power supply, high resistance potentiometer, digital multimeter, connecting wires.

Theoretical Base:

Cathode ray oscilloscope is an electronic device used to measure voltages, frequency, short time intervals and to display input signals into waveforms. Its principal component is **cathode ray tube**. The filament is heated by an electric supply. The cathode gets heated and emits electrons. The electrons are accelerated towards anode. The **Y-plates** are used to bend to beam up or down. The **grid** controls the brightness. The **X-plates** are used to move the beam across the screen. The **screen** is coated in a fluorescent material. The beam of electrons finally strikes the screen and shows the **output display**.

Procedure:

1) *Check the cathode ray oscilloscope (CRO). Get used to with functioning of all its knobs. See its display by applying with hands the input signal.*
2) *Adjust the knobs of sweep time per division, vertical gain control and others, so that, to observe a horizontal trace on the oscilloscope screen.*
3) *Calibrate CRO with known voltage source. Set the vertical gain control to (say) 1.5 volts per division. So that trace on the oscilloscope screen rises up by one division from the zero line, i.e., 1.5 volt/div x 1 div = 1.5 volts.*
4) *The voltage to be measured from DC & AC power supplies is applied to the Y plates / input terminal of the CRO.*
5) *After the adjustments, AC and DC signals appear as shown in the figures.*
6) *Measure the voltage given by the power supply with a digital multimeter.*
7) *Fill up all the columns of both the tables.*

Precautions:

1. Handle the oscilloscope carefully and with delicate hands.
2. Do not apply more than 30 volts to input of the CRO.
3. Do not handle the current leads to the supply when it is on.

Viva Voce:

Q.1 *What is cathode ray oscilloscope?*

Ans. A device that enables different electrical signals to be examined visually.

Q.2 *Why is a CRO used to measure voltages?*

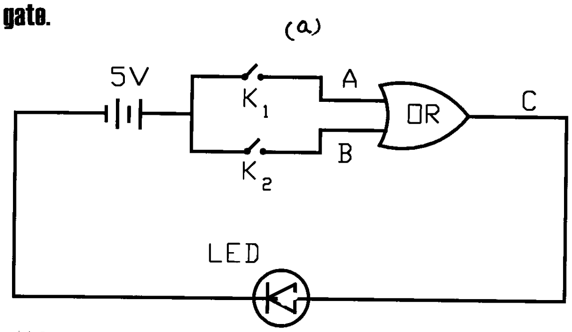
Ans. Because it has an very high resistance and draws no current from a source.

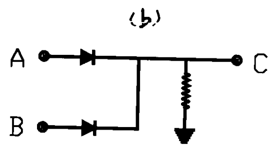
Q.3 *Why is CRO called a visual voltmeter?*

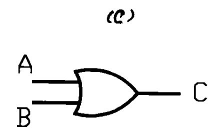
Ans. It is able to show voltage variation with time.

Date...........

Expt: OR gate.







Observations and Calculations:

Truth table for 2 input OR gate:

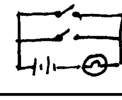
Inputs		Output
A	B	C
0	0	0
0	1	1
1	1	1
1	0	1

Inference:

In case of OR gate, the output becomes high when any one of inputs is high.

Our art is dazzled blindness before the truth. –*Franz Kafka*

Home Project:
Make the OR gate by taking a 1.5V battery, two switches and a flashlight bulb.



Experiment No. 18(a):

To verify truth table for OR gate.

Apparatus:

OR gate unit, LED indicator module, DC power supply (5-8 volts), keys, connecting wires.

Theoretical Base:

Logic gates are electronic circuits designed to perform logical functions based on Boolean algebra. Normally these circuits operate between two discrete voltage levels, i. e., high and low levels, and described as binary logic.
OR gate is a circuit with two or more inputs and one output whose output is high if any one or more of the inputs are high. The **Truth table** is given on the last page. Its **mathematical notation** is : $X = A + B$

Procedure:

1) *From the given apparatus, set up the connections as shown in the fig. (a) or for discrete components as shown in fig. (b). .*
2) *The output terminal of OR gate is to be connected with LED indicator and then with the negative terminal of the power supply.*
3) *Here in OR gate; if either input is ON or if both are ON, the output is also ON.*
4) *To verify, keeping both keys K_1 and K_2 OFF, there is not any current at input terminals A and B, i.e., they are both at 0, 0,. So the output terminal C is also OFF, i.e., at 0, so LED indicator is also OFF.*
5) *Close the key K_1 and keeping K_2 OFF. The input terminal A is ON, i.e., at 1 and B is OFF, i.e., at 0, so LED indicator is ON.*
6) *Close K_2 and keeping K_1 OFF. The input terminal A is OFF, i.e., at 0 and B is ON, i.e., at 1. So at output terminal C LED is ON, i.e., at 1.*
7) *Now close both keys K_1 and K_2, then both input terminal A and B are ON, i.e., at 1, 1. At output terminal C, the LED is ON, i.e., at 1, which verifies the truth table for OR gate.*

Precautions:

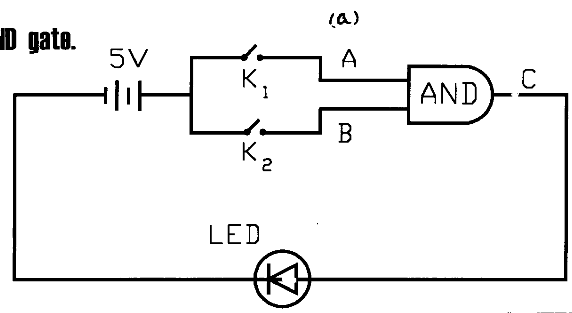
1. The ends of the connecting wires should be rubbed with sand paper.
2. The circuit diagram should be correctly drawn.
3. The connections should be neat and clean.

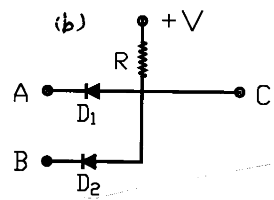
Viva Voce:

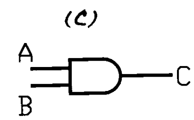
Q.1 *What is a logic gate?*
Ans. The electronic circuits which implement various logic operations.
Q.2 *What is the Boolean expression for OR gate?*
Ans. The Boolean expression for OR gate is $A + B$.
Q.3 *Can an OR gate perform an AND operation?*
Ans. Yes, if we consider the complementary logic.

Date…………

Expt: AND gate.







Observations and Calculations:

Truth table for 2 input AND gate:

Inputs		Output
A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

Inference:

In case of AND gate, the output is high only when all the inputs are high.

Truth never hurts the teller. *–Robert Browning*

Home Project:
Look at the electric meter by which the power company monitors your power. Read it each day to obtain a series of values for your daily use of electric energy.

Experiment No. 18(b):

To verify truth table for AND gate.

Apparatus:

AND gate unit, LED indicator module, DC power supply (5-8 volts), keys., connecting wires.

Theoretical Base:

AND gate is a circuit with two or more inputs and one output in which the output signal is high if and only if all the inputs are high simultaneously. That is, AND gate has output 1 when both inputs are 1. It is all-or-nothing gate because an output occurs only when all its inputs are present. Its **Truth table** is given on the last page. The **mathematical notation** is: $X = A \bullet B$.

Procedure:

1) *From the given apparatus, set up the connections as shown in the fig. (a) or for discrete components as shown in fig. (b). .*
2) *The output terminal of AND gate is to be connected with LED indicator and then with the negative terminal of the power supply.*
3) *To verify, keeping both keys K_1 and K_2 OFF, there is not any current at input terminals A and B, i.e., they are both at 0, 0,. So the output terminal C is also OFF, i.e., at 0, so LED indicator is also OFF.*
4) *Close the key K_1 and keeping K_2 OFF. The input terminal A is ON, i.e., at 1 and B is OFF, i.e., at 0. Then the output terminal C is also OFF, i.e., at 0, so LED indicator is OFF.*
5) *Close K_2 and keeping K_1 OFF. The input terminal A is OFF, i.e., at 0 and B is ON, i.e., at 1. So at output terminal C LED is OFF.*
6) *Now close both keys K_1 and K_2, then both input terminal A and B are ON, i.e., at 1, 1. At output terminal C, the LED is ON, i.e., at 1, which verifies the truth table for AND gate.*

Precautions:

1. The connections should be made according to the circuit diagram.
2. The components should be checked separately, in case of non-verification.
3. Crocodile clips should be preferred with connecting wires.

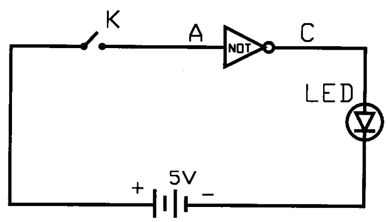
Viva Voce:

Q.1 *Why is the AND gate termed as an all-or-nothing gate?*
Ans. Because output occurs only when all inputs are high.
Q.2 *Is an AND gate equivalent to a series switching circuit?*
Ans. Yes, a series switching circuit is equivalent to an AND gate.
Q.3 *Can an AND gate be used as an OR gate?*
Ans. An AND gate can be used as OR gate with inputs and output in complement form.

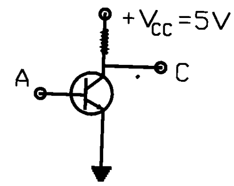
Date...........

Expt: NOT gate.

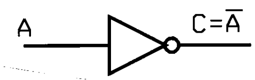
(a)



(b)



(c)



Observations and Calculations:

Truth table for NOT gate:

Input	Output
A	C
1	0
0	1

Inference:

A NOT gate gives a high output when its inputs is low and vice versa.
Output of NOT is complement of input.

The real danger is not that computers will begin to think like men, but that men will begin to think like computers. –*Sydney J. Harris*

Home Project:
Note down the similarities and differences between electrical conduction and heat conduction. Practically take some iron/copper stick and connect the two ends at different temperatures. And then under certain potential difference.

Experiment No. 18(c):

To verify truth table for NOT gate.

Apparatus:

AND gate unit, LED indicator module, DC power supply (5-8 volts), keys., connecting wires.

Theoretical Base:

NOT gate is a circuit with one input whose output is high if the input is low and vice versa. It is also called an inverter because it inverts the output. In this gate the output is always complement of the input, i.e., if input is 1 or high then output is 0 or low and vice versa. Its **Truth table** is given on the last page. The **mathematical notation** is: X = A.

Procedure:

1) *Take a NOT gate and make connections as shown in the fig. (a) or for discrete components as shown in fig. (b). .*
2) *The output terminal C of NOT gate is connected with LED indicator and then to the negative terminal of the battery.*
3) *The working of NOT gate is that, the output is ON if the input is OFF.*
4) *To verify it, put the key K, the input terminal A is ON, i.e., at 1. So the output terminal C is OFF, i.e., at 0 state. So LED remains OFF.*
5) *Now open the key, so input terminal A is OFF, i.e., at 0 state. The output terminal C is ON, i.e., at 1 state, so LED indicator is ON.*
6) *The truth table noted describes all the possible states of the NOT gate.*

Precautions:

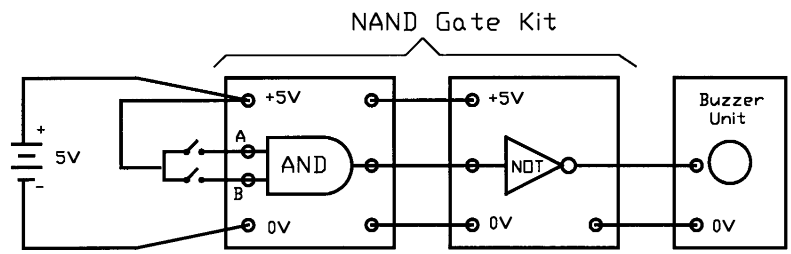
1. Do not use long connecting wires.
2. Do not use A.C. power supply.
3. For good results use logic bread board.

Viva Voce:

Q.1 *What happens when a NOT gate is connected to the output of OR gate?*
Ans. It becomes a NOR gate.
Q.2 *Why is the NOT gate known as an inverter?*
Ans. Because it inverts the input signal, i.e., it reverses the logic state.
Q.3 *What is the only function of a NOT gate?*
Ans. The only function of the NOT gate is to invert the input.

Date...........

Expt: Burglar alarm.



Observations and Calculations:

State — 1 = buzzer On
State — 0 = buzzer Off

Input A	Input B	Output	Buzzer
1	1	0	Off
0	1	1	On
1	0	1	On
0	0	1	On .

Inference:

In a NAND gate the burglar alarm is On when any one of its inputs goes low due some interruption which make the circuit break.

O whistle, and I'll come to you, my dear! –*Robert Burns*

Home Project:
Shuffle across a rug so that your body becomes negatively charged. You then reach toward an uncharged doorknob, but a spark jumps between your index finger and the doorknob when they are separated by 0.50 cm. To find the potential difference between your finger and the doorknob:
$\Delta V = Ed$, [$E = 3.0 \times 10^6$ V/m, $d = 5.0 \times 10^{-3}$ m] = ... = 15000 V !!!

Experiment No. 19:

To make burglar alarm using NAND gate.

Apparatus:

NAND gate unit, buzzer, power supply, keys, connecting wires.

Theoretical Base:

The three most fundamental logic gates are; OR, AND, and NOT gates. **NAND gate** is the combination of AND and NOT gate. It is a circuit with two or more inputs and one output, whose output is high if any one or more of the inputs is low, and low if all the inputs are high.

Burglar alarm is **an application** of logic gates. It used to protect buildings, offices and houses from burglars or thieves. It is fitted inside the building or at main gates.

The **Truth table** (NAND gate) is given on the last page. The **mathematical notation** is $X = A \cdot B$

Procedure:

1) *Set up the circuit as shown in the figure. NAND gate is equivalent to an AND gate followed by a NOT gate.*
2) *Close the keys K_1 and K_2 so that both the inputs A and B of AND gate are at high voltage and thus the output is also at high voltage. so input of NOT gate is high and its output is low. The buzzer will not be switched on.*
3) *The keys K and K to be fitted in the doors are the keys to trap the burglar. When any one of these keys is opened due to interruption, output of AND gate becomes low. This causes the output of NOT gate to be high and ultimately the buzzer is switched on.*

Precautions:

1. Connections should be tight and clean.
2. Two way key should be used for current supply in two paths.
3. The power supply should not exceed beyond 8 volts.

Viva Voce:

Q.1 *Why is it called burglar alarm?*

Ans. As it is fitted inside the office buildings & houses to protect from burglars.

Q.2 *What is a trap switch?*

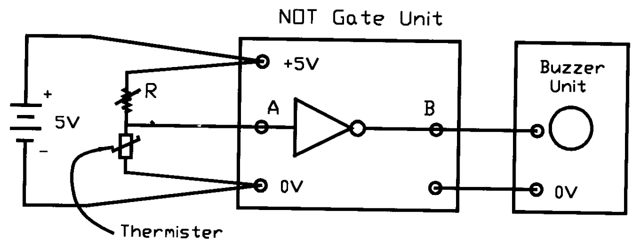
Ans. It is a switch fixed in a door so that when it is opened, the switch opens and changes the state of the input of the system.

Q.3 *What is NAND gate?*

Ans. The NAND gate is, a NOT-AND gate. It operates as an AND followed by a NOT gate.

Date...........

Expt: Fire alarm.



Observations and Calculations:

State — 1 = buzzer On
State — 0 = buzzer Off

Thermister State	Input A	Output B	Buzzer
Hot	1	1	On
Cold	1	0	Off

Inference:

Fire alarm is activated in NOT gate when its input goes low due to circuit break with some interruption. With variable resistor the sensitivity is adjusted.

Your own property is concerned when your neighbor's house is on fire.

–Horace

Home Project1:

Using the smoke from a cigarette, trace air movements in the vicinity of a fireplace, a cold air place, a hot air place, a leaky door or window. Do this preferably on a cold winter.

Home Project2:

Locate the central breaker box in your home. Trip (or switch off) one of the breakers and determine what portion of your home it serves. So check all the breakers and note the portions each of them serve.

Experiment No. 20:

To make a fire alarm using NOT gate.

Apparatus:

NOT gate unit, buzzer unit, thermister unit, power supply, connecting wires, a lamp or burner.

Theoretical Base:

Some detectors are designed to respond to smoke, and others to heat. Detector systems are required in public buildings, apartment houses, and sometimes private homes.

Two major types of smoke detectors are available. One is an ionization device that contains a small radioactive source for ionizing the air molecules between a pair of electrodes, permitting a very small current to flow between the pair. If smoke particles from a fire enter this space, they reduce the flow of current by adhering to the ionized molecules. The drop in current sets off a buzzer or other alarm. The second type of smoke detector uses a photoelectric cell. In some of these detectors smoke that enters obscures a steady beam of light; in others, the smoke scatters a light ray from a diode so that the cell can detect it. In either case the change sets off an alarm.

Procedure:

1) *Set up the circuit as shown in the figure. Adjust the variable resistor in the middle.*
2) *Heat the thermister by moving it quickly over a flame. The buzzer will sound.*
3) *Remove the thermister from heat.*
4) *Adjust the variable resistor to different positions and then repeat step 2 to check the sensitivity of the alarm.*

Precautions:

1. Adjust the variable resistance for maximum sensitivity so that alarm sounds with minimum increase of temperature.
2. Thermister should not be heated excessively.
3. High resistance box should be used for variable resistance.

Viva Voce:

Q.1 *Why is NOT gate called a fire alarm?*

Ans. Because this system operates by heating the thermister with fire or burner.

Q.2 *Why is the NOT gate called an inverter?*

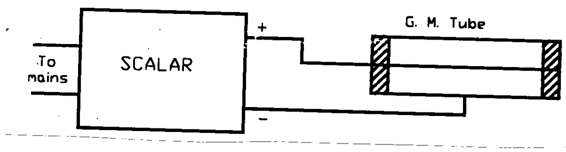
Ans. As its input is 1 when the output is zero and vice versa, the NOT gate is known as inverter.

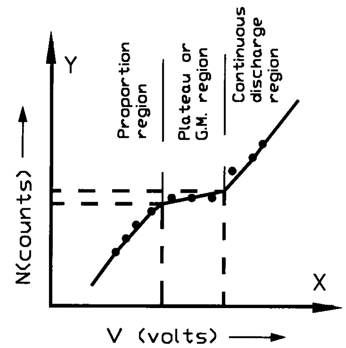
Q.3 *What is the used of fire alarm?*

Ans. It protects the office buildings and houses from danger.

Date...........

Expt: G.M. tube.





Observations and Calculations:

No. of obs.	Voltage applied between electrodes V (volts)	No. of counts N
1	375	6
2		
3		
4		
5		
6		
7		
8		
9		
10		

Value of voltage at the start of plateau = V_1 = _____
Value of voltage at the end of plateau = V_2 = _____
No. of counts at the start of plateau = N_1 = _____
No. of counts at the end of plateau = N_2 = ______

Slope percentage per volt = $\frac{N_2 - N_1}{V_2 - V_1} \times \frac{100}{\frac{(N_1 + N_2)}{2}}$ = ______ %

Science has nothing to be ashamed of, even in the ruins of Nagasaki.

–Jacob Bronowski

Home Project:
Using G.M. Counter, determine the background radiation from luminous dial watches, clocks and some uranium containing chemical salts(you can borrow from your Chemistry Department).

Experiment No. 21:

Characteristics of a G.M. tube.

Apparatus:

Geiger-Muller tube, scalar or electronic counting device, AC mains.

Theoretical Base:

Geiger-Muller tube is an instrument used for the detection and measurement of radioactivity. It is gas-filled radiation detector operated at high voltage in which the gas amplification effect produces a large discharge pulse after each primary ionizing event.

Here the **principle** of ionization chamber is used. The discharge in the tube results from the ionization produced by the incident radiation.

Its **construction** is simple and is most widely used detector of single particles. It is usually worked with about 400 volts applied between the electrodes.

Its essential parts are; a long glass tube containing two electrodes. Stiff central wire is very thin and is the anode in a hollow metal cylinder acting as a cathode.

Procedure:

1) *Fix up the electronic counting device or scalar with G.M. tube. Connect the scalar with the AC mains.*
2) *Switch on the voltage knob and check the recorder whether it records some reading or not. You will see, it will record no reading for a voltage smaller than the threshold voltage.*
3) *Check the response of G.M. counter with natural background source without using artificial source.*
4) *Go on increasing the voltage by regular intervals and note down the readings of the recorder when it starts recording counts.*
5) *Plot graph between the voltage and the number of counts.*
6) *From the graph, fill up the lines below the table. And work out the slope percentage per volt.*

Precautions:

1. Discharge caused by passage of the particles should not become permanent.
2. A natural background source should be used to study the characteristics.
3. The voltage applied should be changed by regular steps.

Viva Voce:

Q.1 *What is a Geiger-Muller counter?*

Ans. A device used for detection and counting of charged particles.

Q.2 *What is a self quenching counter?*

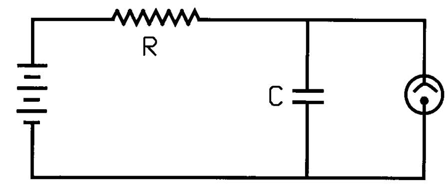
Ans. Having a counter filled with argon and alcohol mixture.

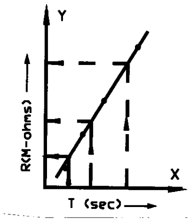
Q.3 *What do you mean by a scalar?*

Ans. It is a device which records directly the counts of the G-M tube pulses.

Date...........

Expt: Neon flash lamp.





Observations and Calculations:

Time period with known resistance:

No. of obs.	Known resistance	Time for 20 flashes			Flashing period
	R	t_1	t_2	$t = \frac{t_1 + t_2}{2}$	$T = t / 20$
	MΩ	sec	sec	sec	sec
1	1	7.4	7.3	7.35	0.37
2					
3					
4					

Time period with unknown resistance:

No. of obs.	Unknown resistance	Time for 20 flashes			Flashing period
	X (from the graph)	t'_1	t'_2	$t'_1 = \frac{t'_1 + t'_2}{2}$	$T' = t' / 20$
	MΩ	sec	sec	sec	sec
1	(1.8)	9.3	9.43	9.4	0.47
2					
3					

From the graph, values of unknown resistances:

R_1 = ____ MΩ, R_2 = ____ MΩ, R_3 = _____ M Ω

The great end of life is not Knowledge but Action.

–Thomas Henry Huxley

Home Project:

Find the resistance of the car stereo system which draws 400 mA current, playing with a 12.0V battery: [R = ΔV / I] . Try to find the current I if possible.

Experiment No. 22:

Determination of high resistance by Neon flash lamp.

Apparatus:

Neon lamp, DC power supply (250V), capacitor (0.2μF), known resistances (1,2,3,4,5 MΩ), unknown high resistances, and stop watch.

Theoretical Base:

When a capacitor is charged through a resistor by a DC voltage, the charge increases with time according to the equation,

$$V = V_o (1 - e^{t/RC}) \quad \text{or} \quad V_o - V = V_o e^{t/RC}$$

$$\text{or} \quad \frac{V_o}{V_o - V} = e^{t/RC} \qquad \text{or} \quad t = RC \log_e \frac{V_o}{V_o - V}$$

If t_1 be the time for the capacitor to charge up to V_1 volts, and t_2 time for V_2 volts, then the above equation gives,

$$t_1 = RC \log_e \frac{V_o}{V_o - V_1} \qquad \text{and} \quad t_2 = RC \log_e \frac{V_o}{V_o - V_2}$$

The **flashing period T** is given by,

$$T = t_1 - t_2 = RC \left(\log_e \frac{V_o}{V_o - V_1} - \log_e \frac{V_o}{V_o - V_2} \right)$$

$$\text{or} \quad T = RC \left(\log_e \frac{V_o \; V_2}{V_o - V_1} \right) \qquad [\log a - \log b = \log a / b]$$

Procedure:

1) *Make connections according to the circuit diagram.*
2) *Switch on the power supply and record the average time of 20 flashes.*
3) *Complete the first table with known resistances by finding flashing period.*
4) *Insert given unknown resistance X and find time period for the flashes as before.*
5) *Plot a graph between T & R as shown in the fig.*
6) *From the graph read the value of resistance against the flashing period T. This value of resistance is equal to the unknown resistance X.*
7) *Complete the second table by filling unknown resistances from the graph.*

Precautions:

1. Voltage supplied from the D.C. source should exceed the striking voltage.
2. The power supply should supply constant voltage.
3. Resistances should be of order of mega ohms to get measurable time period.

Viva Voce:

Q.1 *What is meant by striking voltage?*

Ans. The potential difference across a neon lamp at which it begins to glow.

Q.2 *What is meant by extinction voltage?*

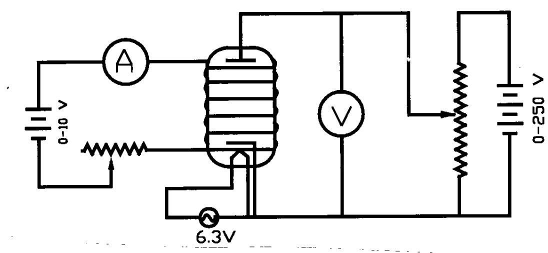
Ans. That certain voltage at which neon lamp extinguishes.

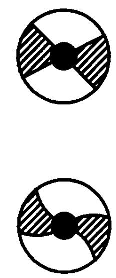
Q.3 *What do you mean by flashing period?*

Ans. Time between two consecutive glows of the neon lamp.

Date...........

Expt: e/m of electrons.





Observations and Calculations:

Radius of the disc used = R = ____ cm = _____ m
Number of turns per unit length of solenoid = n = _______
Permeability of air = μ = 1.257×10^{-6} Weber/m^2

No. of obs.	Anode voltage V (volt)	Solenoid current i (amp)	$B = 4\pi\mu n i$	$e/m = \frac{2V}{B^2 R^2}$
1	130	1.7	2.7×10^{-3}	3.57×10^{11}
2				
3				
4				

Mean value of e / m = _____ $\times 10^{11}$ C / kg

Standard value of e/m = 3.57×10^{11} C/kg

Difference = ______ C / kg

Old boys have their playthings as well as young ones; the difference is only in price. –*Benjamin Franklin*

Home Project:
Finding the speed of an electron that moves undeflected, perpendicular to crossed magnetic and electric fields. [v = V / B]. Check whether this speed is same or different when moving in curved path.

Experiment No. 23:

To determine the e/m of electrons by deflection method (teltron tube).

Apparatus:

Magic eye (6AF6 tube), power supplies (0-250V DC & 6.3V AC) and 0-250V DC, Solenoid coil, ammeter, rheostat, circular disc or coin.

Theoretical Base:

An electron moving along a circular path in a uniform magnetic field will experience two forces, *centripetal force* & the *magnetic force*, both balancing each other,

$$Bev = m v^2 / r \quad \text{or} \quad e/m = v / B r \quad \ldots\ldots (1)$$

If V is the potential difference, then the energy gained by electrons during their acceleration is Ve. This appears as the kinetic energy of electrons,

$$\tfrac{1}{2} m v^2 = Ve \Rightarrow v = \sqrt{2 Ve / m}$$

Substituting the value of v in eq. (1), we have

$$e/m = 2V / B^2 r^2 \quad \ldots\ldots (2)$$

Teltron tube is a thermionic tube designed to show deflection of moving electrons in an electric field.

Also when current i pass through a solenoide, the magnetic field inside is,

$$B = 4\pi\mu n i$$

Procedure:

1) *Make connections as shown in fig. (a).*
2) *Open the key K and apply anode potential of about 150 volts.*
3) *Look down from top of the tube. You will get a view similar to that of fig. (b).*
4) *Close the key K and allow a suitable current to flow through the solenoid.*
5) *Look again into the tube. You will get view similar to that of fig. (c).*
6) *Note that by changing the solenoid current or plate voltage, the curvature of the shadow changes.*
7) *Place a coin on the top of the solenoid and adjust the current or voltage so that the shadow is nearly equal to the curvature of the disc.*
8) *Note the solenoid current and the plate voltage.*
9) *Complete all the columns of the table and find the mean value of e/m.*

Precautions:

1. Solenoid should be placed in vertical position to eliminate the earth's field.
2. The tube should be placed at the center of the solenoid.
3. Curvature of the edge of the shadow should match with curvature of the disc.

Viva Voce:

Q.1 *At what portion of solenoid the magnetic field is uniform?*

Ans. At the center of the solenoid, the magnetic field will be uniform.

Q.2 *Is it possible to use earth's magnetic field to deflect the electron's beam?*

Ans. No, because the earth's magnetic field is too weak to produce deflection.

Q.3 *How many forces acting on the electron while moving in circular path?*

Ans. Two forces are acting on it; centripetal force & magnetic force.

Exercises

> 23 for the standard experiments

Nature and Nature's laws lay hid in night;
God said: 'Let Newton be' and all was light.
–Epitaph at Newton's birthplace

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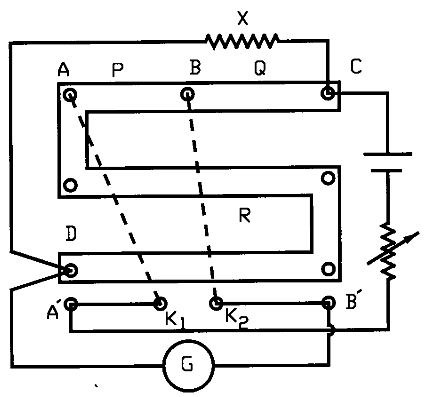
PAGE

Exercise 1:

To find the resistance of a wire by post office box.



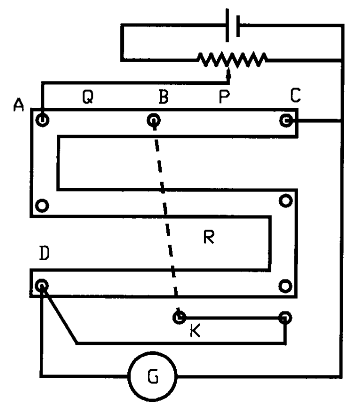
No. of obs.	Ratio arms		Resistance R	Direction of deflection	$X = R\frac{Q}{P}$
	P	Q			
	ohms	ohms	ohms		ohms
1	10	10			
2	10	10			
3	10	10			
4	10	10			
5	100	10			
6	100	10			
7	1000	10			
8	1000	10			

Hints:

Make connections according to circuit diagram.
Take out 10 ohms each from both P and Q arms. First press key K_1 and then key K_2. Complete the table. Please note that opposite deflection in each case should be of the difference of one ohm. Take mean of last two readings, which give the resistance X of the given wire.

Exercise 2:

To find the resistance of a Galvanometer by Kelvin method.



No. of obs.	P	Q	Resistance R	$G = R\frac{P}{Q}$
	ohms	ohms	ohms	ohms
1	10	10		
2	10	10		
3	10	100		
4	10	100		

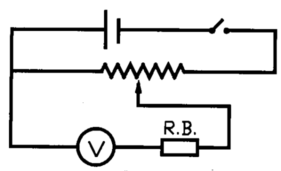
Hints:

Make connections according to circuit diagram. Use a potential divider arrangement for getting a *suitable deflection* in galvanometer. Take out 10 ohms each from P and Q. Adjust R so that on closing and opening the key K there is no change in the deflection. Repeat by taking out 10 and 100 from P and Q for no change, i.e., by taking out two resistances (say 1013 & 1014 ohms) the deflection will be left and right of the *original deflection*. This mean G is between 101.3 & 101.4 ohms. (The 10, 1000 ratio is not sensitive and so is not used.).

Please note that in this method there is always deflection in the galvanometer and it will never zero.

Exercise 3:

To find resistance of a voltmeter without graph.



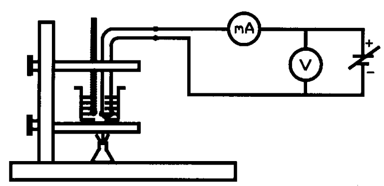
No. of obs.	Voltmeter reading with R = 0 θ	Voltmeter reading for $\theta/2$	Resistance taken from R.B. for half deflection R_V
	div.	div.	ohms

Hints:

Make connections according to circuit diagram.
Get galvanometer deflection θ with R = 0. Then take half deflection θ /2 by taking resistances from the resistance box R. This resistance taken will be the resistance of voltmeter R_V .

Exercise 4:

Variation of resistance of thermister with temperature using voltmeter-ammeter method.



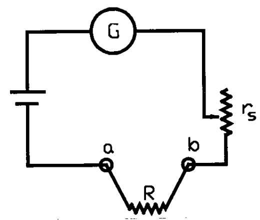
No. of obs.	Temperature	Absolute temperature	Voltage	Current	Resistance R = V / I
	°C	K	volts	μA	ohms
1					
2					
3					
4					
5					
6					
7					

Hints:

Make connections according to the circuit diagram.
Start heating the beaker till about 90 °C and fill up all the columns of the table.
Plot a graph between resistance of thermister and absolute temperature. Find the slope of the curve.

Exercise 5:

Convert a galvanometer into ohmmeter.

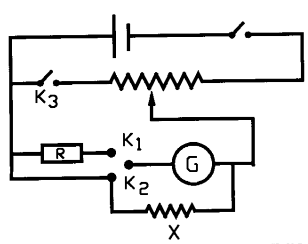


Hints:

Make connections according to the circuit diagram.
Adjust series resistance r_s so that for c and d are short circuited, i.e., R = 0, galvanometer gives full scale deflection. And when c and d are not joined, i.e., $R = \infty$, the deflection is zero. Now a known resistance R is connected across the terminals c and d. The galvanometer deflects to some intermediate point. This point is calibrated, as r. in the same way the whole scale is calibrated into resistance.

Exercise 6:

Combining voltmeter with ammeter in galvanometer conversion.

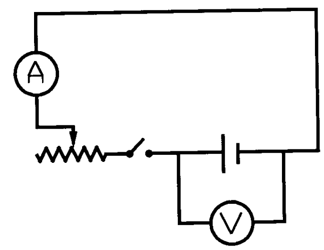


Hints:

Make connections according to the circuit diagram. Here $X = l$ and $R = R_x$ of experiments 5 & 6. Now you will combine the two circuits of converted voltmeter and ammeter from galvanometer through a 2-way key, as shown in the figure. For voltmeter readings, close K_1 & K_3. For ammeter readings, close K_2 & open K_3. Adjust the resistances so that you will get proper range of voltmeter readings and ammeter readings on the galvanometer scale.

Exercise 7:

To find the internal resistance of a cell using voltmeter and ammeter.



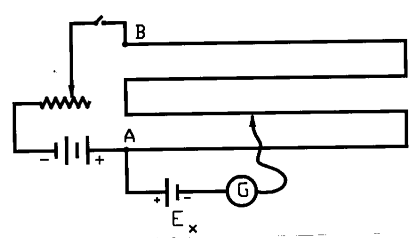
No. of obs.	Voltmeter reading with key open E	Voltmeter reading with key closed V	Ammeter reading I	Internal resistance $r = \frac{E - V}{I}$
	volts	volts	amp.	ohms
1				
2				
3				

Hints:

Make connections according to the circuit diagram.
With the key open, gives emf E of the battery. With the key closed, voltmeter gives voltage V and current I through the circuit. The formula in the last column of the table will give the internal resistance of the cell.

Exercise 8:

To determine the emf of a cell with Potentiometer using single cell.



Hints:

Make connections according to circuit diagram.
Measure emf E of the battery, length L of the potentiometer, and the distance l of the balance point C from end A with the cell E_x . The emf will be

$$E_x = E \times l / L .$$

Exercise 9:

Find temperature coefficient of the resistance of tungsten filament lamp.

Hints:

Put the tungsten bulb in crushed ice for 10 minutes. Measure resistance, R_o between the ends of the filament at 0 °C. Now heat up the bulb by making it on with a battery for 10 minutes. Measure its temperature t, and resistance R_t. apply the formula $\alpha = \frac{R_t - R_o}{R_o\, t}$

Exercise 10:

Find the dip angle (i.e., angle between the field angle and horizontal plane) of earth's magnetic field.

Hints:

Reference from Experiment 10:
Calculating magnetic field at the center of the coil ;

$$B = (\mu_o n I / D) = \ldots\ldots$$

and $H = \frac{\mu_o n I r^2}{\tan\theta\, 2 (r^2 + x^2)^{3/2}} = \ldots\ldots$ [please note factor 2 in denominator]

Now $B = H \tan\theta$ or $\theta = \tan^{-1} B / H$

<u>Check</u> by suspending a small magnet like a compass that is free to swing in a vertical plane.

Exercise 11(a):

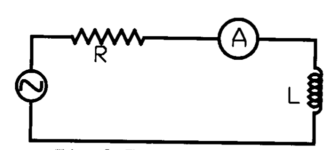
Find energy stored in a charged capacitor.

Hints:

Reference to experiment 11; Take the values of C, R and changing values of current I. Substitute in the equation $E = [\frac{1}{2} CV^2 =]\ \frac{1}{2} C I^2 R^2$. Calculate E_{max}, E_{min} and few in between values. Please note that corresponding to I_{max}, energy is E_{max}.

Exercise 11(b):

Find reactance of an inductor, when A.C. current is passing through it.



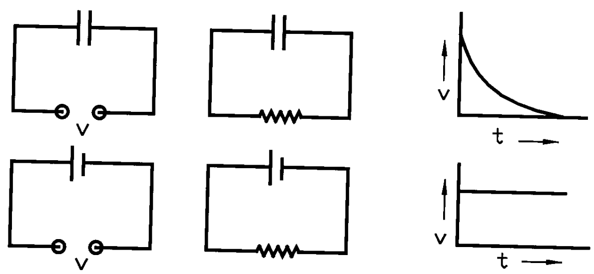
Hints:

Calculate value of: $X_L = V_{rms} / I_{rms} = \ldots\ldots$

Theoretical value: $X_L = 2\pi f L = \ldots\ldots$

Exercise 12:

Compare discharging of a capacitor with a battery.



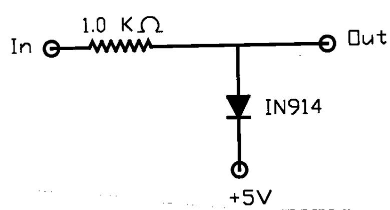
Hints:

Make connections for a capacitor and then for the battery as shown in the circuit diagram. Note different readings for time t verses voltage V in both cases. Plot the both graphs.

Please note that shortening of a battery, by connecting low-resistance wire, even for short periods of time, may damage the battery by draining excessive current.

Exercise 13:

Design a **diode clamp**, i.e., one that prevents it from exceeding + 5.6 volts.

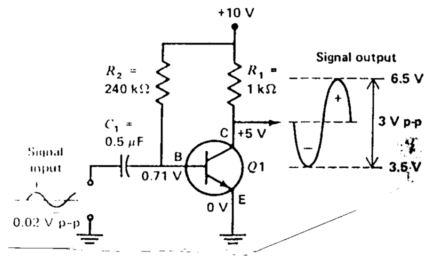


Hints:

Set up the discrete components as shown in the figure. The diode prevents the output from exceeding about +5.6 volts, with no effect on voltages less than that. [Diode clamps are standard equipment on all inputs in the CMOS family of digital logic. Without them, the delicate input circuits are easily destroyed by static electricity discharges during handling.]

Exercise 14:

Set up transistor as an amplifier.



Hints:

Set up the discrete components as shown in the circuit diagram. This is common-emitter amplifier circuit. The NPN transistor is biased so that the collector-to-emitter voltage V_C is half of the supply voltage. The 0.7 V at the base is partially turning on the transistor. The transistor acts as an amplifier when in this partially turned on condition.

Exercise 15:

Tracing the electric current due to intensity of Sunlight using a photocell. And estimate number of photons reaching the surface of Earth per m^2 /sec.

Hints:

Take out in the Sunlight, the box containing photocell and open its lid. Throw sunlight through a mirror upon the photocell. Note the current with a sensitive micro-ammeter.

Calculate energy of a photon. Take average wavelength of sunlight = 500 nm.

$E = hf = h(c/\lambda) = \ldots\ldots.$ $[h = 6.63 \times 10^{-34}$ J.s; $c = 3.0 \times 10^{8}$ m/s$]$

Then calculate n, the number photons per m^2 /sec.

$$n = \frac{\text{Energy per m}^2\text{/sec.}}{\text{Energy per photon}} = \ldots\ldots\ldots \quad [\text{Energy per m}^2\text{/sec.} = 1.0 \times 10^3 \text{ W/m}^2]$$

Exercise 16:

Find the work function of the surface of the photocell from the data in experiment 16.

Hints:

Plot graph between stopping potential verses frequency $[f = c/\lambda]$, by taking data from the table in experiment 16. The intercept of the straight line on frequency axis is the cutoff frequency f_o . Putting $V_o = 0$ and $f = f_o$ in the equation $V_o e = hf - \phi$, we get

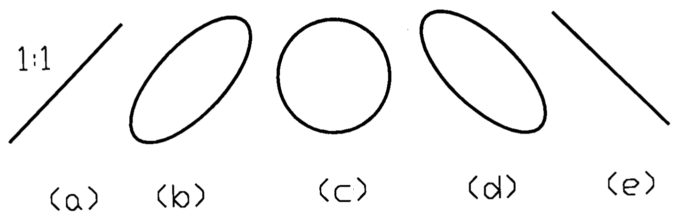
$\phi = hf_o = \ldots.$ J $= \ldots.$ eV

From the slope of the graph, find the value of Planck's constant.

$h = e(\Delta V / \Delta f) = \ldots.$ Js

Exercise 17:

Compare the frequency for a variable frequency oscillator by Cathode Ray Oscilloscope.

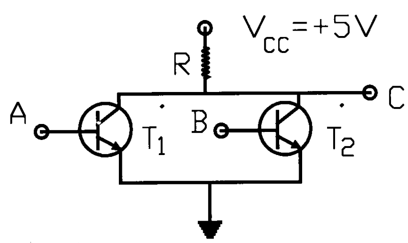


Hints:

In cathode ray oscilloscope, if A.C. voltages are applied simultaneously to the horizontal and vertical deflecting plates, the spot on the screen will produce Lissajous figure shown above. Owing to the phase difference of $\pi / 2$ introduced by a capacitor, the resulting figure on the screen is an ellipse.
If the frequencies are reducible to a common measure, the particle retraces a closed path over and over. If frequencies are very nearly equal, the path changes slowly from straight line at 45° , as in fig. (a), to an ellipse as in fig. (b), and changes so on.

Exercise 18(a):

To verify truth table for NOR gate.

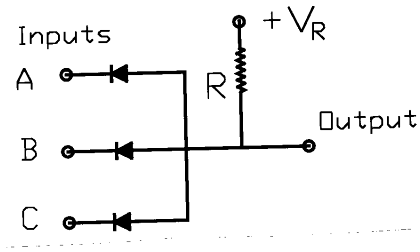


Hints:

Transistor NOR gate is shown in the figure. It is a combination of OR gate followed by NOT gate. When both the inputs A and B are low (0), the two transistors are cut-off and output C is high (1). For any other input combination, both transistors saturate and output C goes to the ground state, i.e., a low (0) output. Write the Truth table for it.

Exercise 18(b):

Make from the diodes a 3-input AND gate.

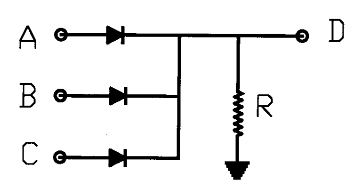


Hints:

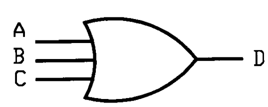
Three input AND gate using diode logic is shown in the figure. The logical level of signal source is $V_{(0)}$ and $V_{(1)}$ for 0 and 1 respectively. V_R is greater than the input level $V_{(1)}$. Write the Truth table for it.

Exercise 18(c):

Verify truth table for 3-input diode OR gate.



Inputs			Output
A	B	C	D
0	0	0	0
1	0	0	0
0	1	0	1
1	1	0	1
0	0	1	1
1	0	1	1
0	1	1	1
1	1	1	1



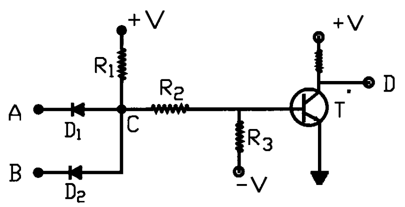
True = +V = 1
False = 0V = 0

Hints:

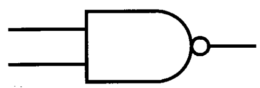
Three input OR gate using diode logic is shown in the figure. The circuit output at D is at +V volts if any input A or B or C is at +V volts. The Truth table lists all the possible input conditions. There is only one condition, the top line, for which the output is false.

Exercise 19:

Verify truth table for NAND gate.



A	B	C	D
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0



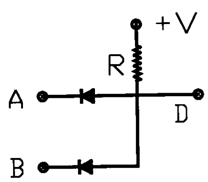
Hints:

The NAND gate circuit is shown in the figure. It is made by connecting the output of AND gate with the input of NOT gate.
The truth table for NAND gate and its symbol is also shown.

Exercise 20:

Verify with the same diode gate circuit AND and OR functions.

(a)



(b)

A	B	D
0	0	0
1	0	0
0	1	0
1	1	1

Voltage

(c)

A	B	D
F	F	F
T	F	F
F	T	F
T	T	T

1 = True
0 = False
AND Gate

(d)

A	B	D
T	T	T
F	T	T
T	F	T
F	F	F

1 = False
0 = True
OR Gate

Hints:

The diode AND circuit is shown in the figure. The truth table usually presents its information by giving values of voltage, expressed as 0 or 1. If 1 voltage is defined as true, then truth table uses T or F. These statements used in fig. (c), are called *positive logic*.
This AND circuit can be used as an OR circuit, by inverting the logic. We must invert the previous statements so that 0 volts is defined as true, while 1 voltage is false. These statements used in fig. (d), are called *negative logic*.

Exercise 21:

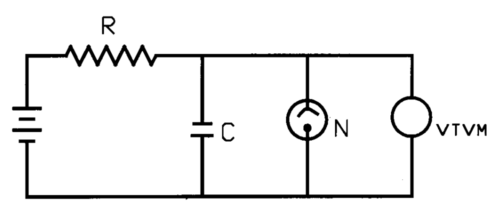
Reducing Background effect in the G.M. tube.

Hints:

Cosmic rays and radioactive contamination are always present as natural background. Screening the counter with a few centimeter of lead can reduce it. Try to find some resources to get lead. Shield the G.M. tube with the lead and note the counting with the scalar.
Try other ways of shielding the tube. Find the difference by bringing sensitive region direct to sunlight. If possible enclosing with some water tank shielding.

Exercise 22:

Determination of high resistance by Neon flash lamp by using different capacitors.



Hints:

Make connections according to circuit diagram.
Note value of striking voltage V for the flash lamp.(Its range is between 150-170 volts). Measure DC main voltage V_o . ($V_o > V$ will be applied).
Simultaneously switch on DC supply and stop watch, read off V and t when the lamp glows. Take a number of readings by using different capacitors and find unknown resistance from the following formula:

$$R = \frac{t}{2.303\, C \log(1 - V / V_o)}$$

Exercise 23:

Find velocity of the moving electrons in the teltron tube.

Hints:

Reference experiment 23; Take average anode voltage V from the table. Apply the formula,

$$v = \sqrt{\frac{2\,Ve}{m}} \qquad [e = 1.61 \times 10^{-19}\ C,\ m = 9.11 \times 10^{-31}\ kg]$$

> 1200 Objective Questions

Types:

Type 1: Fill in the blanks
Type 2: Tick the correct Answer
Type 3: True and False Statements
Type 4: Short Ans. to Questions

Selection includes papers
from different Boards.

Almost everything that is great has been done by youth. –Diogenes

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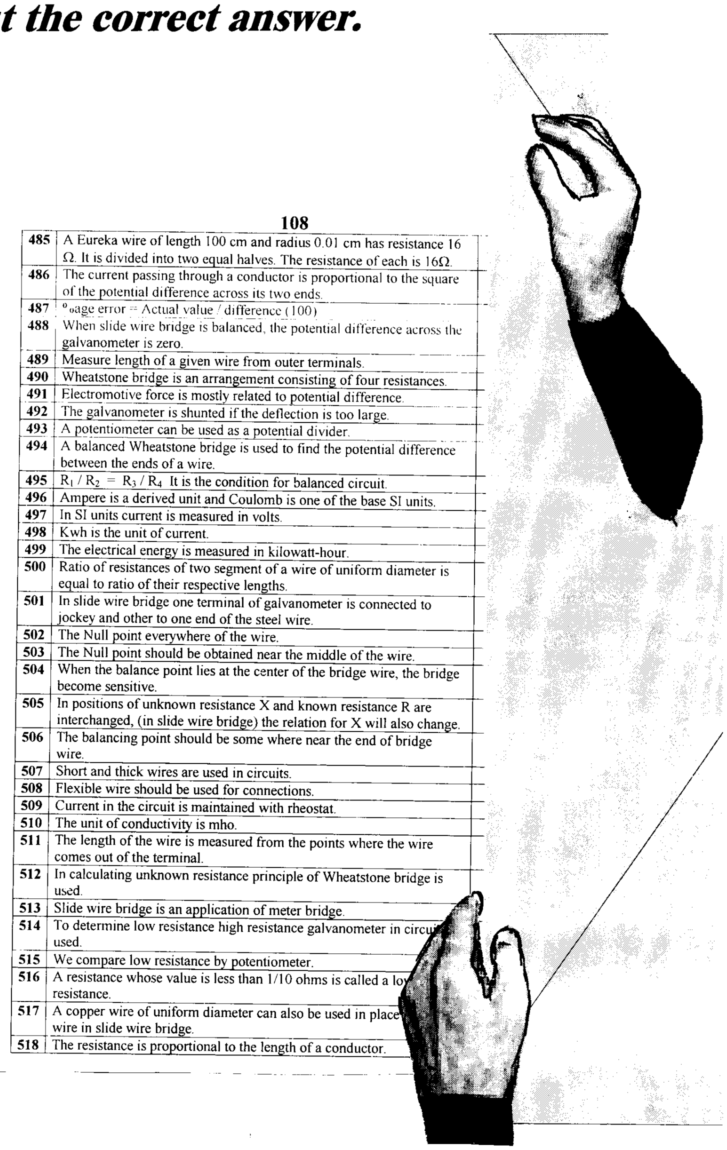
PAGE

For best results:

Cover the answers ***and first think out answer.***
It doesn't matter, that may be wrong!
Afterwards uncover the paper
and look out the correct answer.



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485	A Eureka wire of length 100 cm and radius 0.01 cm has resistance 16 Ω. It is divided into two equal halves. The resistance of each is 16Ω.
486	The current passing through a conductor is proportional to the square of the potential difference across its two ends.
487	%age error = Actual value / difference (100)
488	When slide wire bridge is balanced, the potential difference across the galvanometer is zero.
489	Measure length of a given wire from outer terminals.
490	Wheatstone bridge is an arrangement consisting of four resistances.
491	Electromotive force is mostly related to potential difference.
492	The galvanometer is shunted if the deflection is too large.
493	A potentiometer can be used as a potential divider.
494	A balanced Wheatstone bridge is used to find the potential difference between the ends of a wire.
495	$R_1 / R_2 = R_3 / R_4$ It is the condition for balanced circuit.
496	Ampere is a derived unit and Coulomb is one of the base SI units.
497	In SI units current is measured in volts.
498	Kwh is the unit of current.
499	The electrical energy is measured in kilowatt-hour.
500	Ratio of resistances of two segment of a wire of uniform diameter is equal to ratio of their respective lengths.
501	In slide wire bridge one terminal of galvanometer is connected to jockey and other to one end of the steel wire.
502	The Null point everywhere of the wire.
503	The Null point should be obtained near the middle of the wire.
504	When the balance point lies at the center of the bridge wire, the bridge become sensitive.
505	In positions of unknown resistance X and known resistance R are interchanged, (in slide wire bridge) the relation for X will also change.
506	The balancing point should be some where near the end of bridge wire.
507	Short and thick wires are used in circuits.
508	Flexible wire should be used for connections.
509	Current in the circuit is maintained with rheostat.
510	The unit of conductivity is mho.
511	The length of the wire is measured from the points where the wire comes out of the terminal.
512	In calculating unknown resistance principle of Wheatstone bridge is used.
513	Slide wire bridge is an application of meter bridge.
514	To determine low resistance high resistance galvanometer in circu[illegible] used.
515	We compare low resistance by potentiometer.
516	A resistance whose value is less than 1/10 ohms is called a lo[illegible] resistance.
517	A copper wire of uniform diameter can also be used in place [illegible] wire in slide wire bridge.
518	The resistance is proportional to the length of a conductor.

FILL IN THE BLANKS

1	Slide wire bridge is used to find _______	Unknown resistance
2	The unit of resistance is _______	ohm
3	The opposition to the flow of current through a conductor is called _______	resistance
4	Slide wire bridge consists of a meter long uniform wire of _______	Eureka wire
5	Connections should be clean and _______	Tight
6	The wire should be free from _______	Kinks
7	Eureka wire is an ______ of nickel and copper.	Alloy
8	Eureka wire is an alloy of 40% nickel and 60%_______	Copper
9	Constantan wire is used for making standard resistances because it has _______ resistivity.	High
10	Specific resistance of Nichrome wire is _______	110×10^{-6} ohm-cm
11	The wire used in the construction of electric heater_______	Nichrome
12	The rate of flow of electric charge through the cross-section of any surface is called _______	Current
13	Resistance of a piece of metal _______on raising its temperature.	Increases
14	The principle applied in the slide wire bridge is _______	Wheatstone bridge principle
15	The _______ allows a continuous change in the value of resistance.	Slide wire bridge
16	When the resistances are adjusted for no deflection in the galvanometer then principle used P/Q = _______	R / X
17	The _______ allows the change of resistance only in integral values.	Post office box
18	A _______ is used for regulating or varying the flow of current in an electric circuit.	Rheostat
19	The null point in the galvanometer indicates the absence of _______	Current
20	Using meter bridge, it is advised to obtain the null point_______	In the middle of the wire
21	Thick copper strips are used in a meter bridge to _______ the resistance of the connecting strips.	Minimize
22	When deflection in the galvanometer is zero, then _______ across it is also zero.	Potential difference
23	The device to measure the unknown resistance of a wire is called_______	Slide wire bridge
24	The device to measure the current is called ______	Ammeter
25	Conductivity is reciprocal of _______	Resistivity
26	The current flows from a body at a _______ potential to a body at a ______potential.	Higher, lower
27	1 coulomb = _______ pico coulomb	10^{-12}

28	The potential difference verses current curve for a given wire at a fixed temperature is a _______	Straight line
29	The resistance of a wire of length 1 cm and area of cross section 1 cm^2 is called _______	resistivity
30	If a material is a good conductor its resistivity is____	Small/poor
31	In a galvanometer the deflection is directly proportional to the _______	current
32	The resistance of a conductor increases with the increase of _______	temperature
33	If two resistances R_1 and R_2 are connected in parallel, equivalent resistance is given by the relation______	$1/R_{eq} = 1/R_1 + 1/R_2$
34	The resistance of conductor is inversely proportional to its _______	Are of cross-section
35	Formula for the specific resistance is given by______	$X \pi r^2 / L$
36	A galvanometer is used to _______ current in an electrical circuit.	Detect
37	SI unit of specific resistance is _______	Ohm-meter
38	Area of cross-section of wire is A = _______	πr^2
39	Diameter of a wire is measured by the instrument called ________	Screw gauge
40	The resistance of one cm^3 of a substance _______	Specific resistance
41	The _______ of the material of a conductor is defined as the resistance of a conductor of unit length and unit area of cross-section.	Specific resistance / resitivity
42	The obstruction which a conductor offers to the flow of charge through it is called_______	resistance
43	The resistivity of a substance depends on its _______	Nature
44	The unit of resistivity in M.K.S. system is _______	Ohm-meter
45	The reciprocal of resistivity is _______	Conductivity
46	The specific resistance of a wire depends upon its nature and _______	Diameter and length
47	Resistance is the measure of the ______ to the flow of free electrons.	Opposition
48	The unit of conductivity is _______	Mho
49	Graph between R and 1/V is _______	Straight line
50	Volt is the unit of _______	Potential difference
51	Current in the circuit is maintained with _______	Rheostat
52	Current through a metallic conductor is due to the motion of _______	Electrons
53	A rheostat supplies a _______ resistance.	Variable
54	Rheostat in a circuit is used to vary _______	Potential
55	Longer is the length of potentiometer wire, _______ is the accuracy.	Higher / greater
56	A ______ can be used as a variable resistance.	Rheostat
57	When the resistance in the four arms of a wheatstone bridge are of the same order, the bridge is _______	Most sensitive
58	No current flows through galvanometer in wheatstone bridge, when it is balanced, because the galvanometer is connected to two points which are ________	At the same potential

59	The unknown resistance 'X' connected in left gap of the slide wire bridge is _______	l_1 / l_2 x R
60	Amount of charge flowing through a given cross-section of a conductor per unit time is called _______	Electric current
61	Current is measured in ampere or _______	Milli-amperes
62	1 micro-micro ampere = _______	10^{-12} ampere
63	The ratio of P.D. between the ends of a conductor and the current flowing through it is _______	Constant
64	Resistances are said to be connected _______ if they are connected end to end.	In series
65	The equivalent resistance _______combination decreases.	In parallel
66	In parallel combination of resistances _______ remains the same but ______ is different.	Current; potential difference
67	A potentiometer can also be used to find ______ of a cell.	e.m.f.
68	_______ can be used to compare the E.M.F. of two cells.	Potentiometer
69	SI unit of electric power is _______	Watt
70	Unit of e.m.f. is ______	Volt
71	Post office box works on the principle of _______	Wheatstone bridge
72	In the Post office box experiment, the battery key is pressed first and the galvanometer key _______	Afterwards
73	Ends of axle attached to frame of coil in Weston type galvanometer are _______	Pivoted
74	The shunt resistance across a galvanometer is so adjusted that only half the current passes through the shunt. It leads to determine the resistance of galvanometer by _______ method.	Half deflection
75	Half-deflection method for the measurement of galvanometer resistance is _______ accurate.	Not
76	_______ is more accurate than half deflection method because its accuracy depends on the ratio P: Q.	Kelvin's method
77	The higher the ratio P : Q in Kelvin's method, _______ the accuracy of Kelvin's method.	The greater
78	The resistance of galvanometer can be determined by using the relation G = _______	P/Q x R
79	The galvanometer is shunted if the deflection is_____	Large
80	The resistance of galvanometer by relation _______	RxS / (R-S)
81	A low resistance box should be used as the _______	Shunt resistance
82	Low resistance connected in parallel with galvanometer is _______	Shunt resistance
83	By connecting a shunt resistance in parallel with the galvanometer its effective resistance is _______	Reduced
84	An instrument to detect and measure current is_____	Galvanometer
85	The resistance of galvanometer _______ by shunting it.	Decreases
86	Lamp and scale arrangement is used to measure deflection in _____ galvanometer.	Ballistic

87	When a current carrying coil is placed in magnetic field _____ acts on it.	A torque
88	The current that produces a deflection of one small divisions in galvanometer is known as its _____	Sensitivity
89	The deflection produced in the galvanometer is proportional to the _______ flowing through it.	Electric current
90	If one coulomb charge passes through a _______ of conductor in one second then current in it is said to be _______	Cross-section; 1 ampere
91	A post office box is used in the laboratory to find the value of _______ of a wire.	Resistance
92	A resistance box contains a number of coils of fixed resistances in _______	Series
93	The apparatus used for comparing and measuring potential is called _______	Potentiometer
94	Potentiometer is based on the principle that the fall of potential across a given length of a current carrying wire is directly _______	Proportional to length of wire
95	The device which can measure and compare potential without drawing any current is known as ______	Potentiometer
96	An instrument which measure the potential accurately _______	Potentiometer
97	A potentiometer gives a continuously _______	Varying potential
98	_____ across any segment of wire of potentiometer is directly proportional to its length.	Potential difference
99	The diameter of potentiometer wire should be _____	Uniform
100	Potentiometer is an accurate device for measuring___	Potentials
101	A potentiometer can also be used as _____	Potential divider
102	Due to low resistivity, copper wire _______ used in a potentiometer.	Is not
103	A wire with smaller potential gradient will give _______ accurate results than the one with greater potential gradient in a potentiometer.	More
104	Fall of potential per unit length of wire is called____	Potential gradient
105	Potential difference per unit length of potentiometer wire is known as ______	Potential gradient
106	Potentiometer is also used to _____ ammeter and voltmeter.	Calibrate
107	The relation for Wheatstone bridge principle is_____	$R_1 / R_2 = R_3 / R_4$
108	Avometer is used for the measurement of current, potential difference and _______	Resistance
109	When resistances in the four arms are adjusted so that the galvanometer shows no deflection, the Wheatstone bridge is said to be _______	Balanced
110	When no current flows through the galvanometer in a Wheatstone bridge, then we write for the ratio arms_______	$R_1 / R_2 = R_3 / R_4$
111	Wheatstone bridge principle is used to determine unknown resistance by _______ and _______	Slide wire bridge; post office box

112	A small resistance connected in parallel across the galvanometer is called _______	Shunt
113	An ammeter is connected in _______ with the circuit.	Series
114	A voltmeter is connected in _______ with the circuit.	Parallel
115	A voltmeter is a high resistance _______	Galvanometer
116	For a voltmeter to be accurate, it should be of______	High resistance
117	A voltmeter is a modified form of a ______ used to measure_______	Galvanometer; potential difference
118	The graph between R and 1/V is a ______	Straight line
119	The law that deals with heating of filament of bulb (or any other resistor) due to flow of current in it is called _______ law of heating.	Joule's
120	An ammeter is a low resistance _______	Galvanometer
121	An ammeter connected in _______ to a circuit is permanently damaged.	Parallel
122	Potential difference depends on the _______ between two points and also on _______	Resistance; current strength
123	The P.D. between two points is one volt if work done in moving a positive charge of _______ from one point to another point is one _______	One coulomb; joule
124	The P.D. between the terminals of a cell falls when it _______ a current.	Delivers
125	Electrical potential is a ______ quantity.	Scalar
126	______ across the ends of the conductor is directly proportional to the current passing through it.	Voltage
127	A device which converts chemical energy into electrical energy is called _______	Battery
128	A device which converts light energy into electrical energy is called _______	Photo cell
129	The practical unit of power is _______	Watt
130	A voltmeter is _______ galvanometer.	High resistance
131	High resistancesa are usually made of _____	Carbon
132	To convert the galvanometer into an ammeter, a low resistance is connected in _______ with the galvanometer.	Parallel
133	A D.C. ammeter is ineffective in an _______ circuit.	A.C.
134	The low resistance connected in parallel with galvanometer is called _______	Ammeter
135	Ammeter is the modified form of _______ used to measure current.	Galvanometer
136	One micro-ampere is ______ than micro-micro ampere.	Greater
137	An ammeter is used to measure ______	Current
138	An ammeter is always connected in_____ in a circuit.	Series
139	To convert the galvanometer into voltmeter, high resistance is connected in _______ with the galvanometer.	Series
140	Voltmeter and ammeter are the two modified forms of _______	Moving coil galvanometer

141	A resistance whose value is less than 1/10 ohm is called _______	Low resistance
142	To convert the galvanometer into voltmeter, high resistance R is connected in series with the galvanometer. Value of R determines the _______ of the voltmeter.	Range
143	To convert a galvanometer into an ammeter a______ resistance is connected in _______	Parallel; galvanometer
144	The battery key is pressed first before the galvanometer key to avoid _______ current.	Induced
145	To convert a galvanometer into _______ a high resistance is connected in series with the galvanometer.	Voltmeter
146	The effective resistance of ammeter is made low by connecting a _______ in parallel with the galvanometer.	Shunt / a low resistance
147	The current flowing at the rate of one coulomb per second through any section of conductor is called___	Ampere
148	The amount of work done in moving a unit positive charge from one point to the other against the electric field is called _______	Potential difference
149	When current is drawn from a cell, then potential difference across its terminals is called______	Terminal potential difference
150	If one ampere current flows through a conductor for one second then charge flown is _______	One coulomb
151	In liquids and gases, the current is due to motion of _______	Negative and positive charges
152	A balance point on the potentiometer is obtained when the galvanometer shows _______ reading.	Zero
153	When the circuit of a battery is open, the P.D. between the poles of battery is called _______	E.M.F.
154	Work done in transporting unit positive charge from negative to positive terminal inside a cell is known as _____ of cell.	e.m.f.
155	The resistance offered by the electrolyte in the cell to the passage of current is called _______	Internal resistance of cell
156	In determining the internal resistance of cell using a potentiometer, the resistance box is connected in _______ to the cell.	Series
157	The internal resistance of a cell determine by_______	Potentiometer
158	The internal resistance 'r' of the cell by the relation is $r = l_2 / l_1$ x _______	R
159	Internal resistance of coil determine by _______	Increase of current
160	The resistance offered by material inside a cell to flow of current is known as _____ of cell.	Internal resistance
161	In a closed circuit, when a current is drawn from a cell. The terminal potential difference of the cell is always less than the _______ of the cell.	e.m.f.
162	An open circuit has _______ resistance.	Infinite

163	A good conductor material has _______ resistivity.	Low
164	Graph between (R - S) and RxS is ______	Straight line
165	Rate of flow of charge is called _______	Current
166	Potentiometer can be used as _______ divider.	Potential
167	The rate at which work is done to maintain a steady current in an electric circuit is called _______	Electric power
168	A unit of electrical energy used commercially is called _______	Kilowatt-hour
169	_______ consumed in a conductor is one watt if one ampere current flows through it when _______ potential difference is applied to it.	Power; one volt
170	A watt-hour meter measures _______	Electric energy
171	______ can be used to find the internal resistance of a cell.	Potentiometer
172	Resistance of thermister ______ with temperature.	Decreases
173	Resistance of thermister is ______ proportional to temperature.	Inversely
174	The resistance of a conductor in most cases rise with a rise of _______	Temperature
175	______ coefficient of a thermister is negative.	Temperature
176	Thermister is used to ______ and _____ temperature.	Measure; control
177	Temperature coefficient is defined as, the change in ______ per degree change in temperature per ohm at a particular temperature.	Resistance
178	Ohm-meter is the unit of ___________	Resistivity
179	Unit of temperature coefficient is _____	$^{o}C^{-1}$ or K^{-1}
180	In any circuit a loose connection itself offers a _____	Resistance
181	Tungsten filament of a bulb does not obey ______ law.	Ohm's
182	A conductor obeys Ohm's law only when V-I curve is _______	Linear
183	Resistance of a 100 watt bulb is _______ than the resistance of a 25 watt bulb when connected to the same supply.	Smaller
184	Magnetic flux through the area A is mathematically defined by _______	**B.A**
185	Watt/m^2 is the unit of ______	Flux density
186	Magnetic intensity is a ______ quantity.	Vector
187	The field due to current alone will be represented by ______ lines of force.	Circular
188	______ at a point on surface of earth is the plane containing that point and magnetic axis.	Magnetic meridian
189	Magnetic axis is the straight line through magnetic _____ and ______ poles of earth.	North; south
190	The direction of magnetic induction around a current carrying conductor is given by ______ rule.	Right hand
191	Unit of magnetic flux ______	Weber
192	Magnetic induction B depends upon ______ of magnetic field as well as ______ around it.	Strength ; medium

193	If Φ_m is magnetic flux through a small plane surface of area ΔA in magnetic field of uniform magnetic induction B then Φ_m = ______	**B • ΔA**
194	The relation which gives magnitude of magnetic induction at a point near a current carrying wire is known as ______ law.	Biot-Savart
195	The unit of magnetic field is ______	Tesla or Weber / m^2
196	Magnetic field in moving coil galvanometer is______	Radial
197	Unit of magnetic induction in S.I. is ______	Tesla or Weber / m^2
198	Magnetic field lines are ______ lines.	Closed
199	In a current-carrying coil, the face along which the direction of current is clockwise will behave like a ______	South pole
200	Capacitance of a capacitor is measured in ______	Farad
201	One micro-farad = ______	10^{-6} F
202	1 coulomb = ______ micro coulomb.	10^6
203	The unit of capacitance is ______	Farad
204	SI unit of inductance is ______	Henry
205	A device for storing charge is called ______	Capacitor
206	Capacitances of two or more capacitors are simply added when they are connected in ______	Parallel
207	The capacitor in which one plate is fixed and the other set moveable is called ______	Variable capacitor
208	Henry is the unit of ______	Inductance
209	In order to obtain equivalent capacitance greater than either of them, capacitors of different capacitances are connected in ______	Parallel
210	The ratio of the charge on one of the plates of the capacitor to the potential difference across the capacitor is called ______	Capacitance
211	A capacitor is a device used to store ______ and ______	Charge; energy
212	When a battery is removed from an RC circuit charge on capacitor decays ______	Exponentially
213	Time constant of RC circuit is the time in which capacitor is charged to about ______ % of its full capacity.	63
214	Time constant is measured by the product of ______ and ______ of a capacitor.	Resistance; capacitance
215	If capacitors are arranged ______ , then equivalent capacitance is greater than either of them.	In parallel
216	A transformer functions only with ______	A.C.
217	Frequency of A.C. used in Pakistan is ______	50 cps
218	r.m.s. value of A.C. voltage is always ______ than the Peak value.	Smaller
219	Alternating voltage and current vary ______ between a maximum and minimum value.	Periodically
220	The effective value of AC according to which power is dissipated when it flows in a resistor is equal to its ______ value.	r.m.s.

221	When an alternating voltage source is connected across a capacitor voltage across it ______ the current in phase by ______	Lags behind; $\pi/2$
222	One electron volt is equal to ______	1.6×10^{-19} J
223	Reactance offered by a capacitor to flow of AC is similar to _______ offered by a resistor to flow of current.	Resistance
224	In an ideal transformer input power is always equal to _______	Output power
225	Alternating current is one which changes its _______ continuously and reverses its ______ periodically.	Magnitude; direction
226	The resistivity of semiconductors increases with____	Temperature
227	For rectification we use _______	Semiconductor diode
228	The name of the semiconductor is ______	Silicon or Germanium
229	Semiconductor elements belong to ______ of periodic table.	Fourth group
230	The resistance of semiconductor decreases with increasing _______	Temperature
231	N-type germanium is obtained by doping intrinsic germanium with _______	Pentavalent
232	A pure semiconductor behaves like an _______ near absolute zero.	Insulator
233	In a small quantity of _____ group elements is doped in an intrinsic crystal of _____ group element than material so formed is called p-type material.	3rd; 4th
234	A junction between p and n materials together forms a semiconductor _______	Diode
235	The diode that operates at breakdown potential is called _____ diode.	Zener
236	If p-side of the diode is at a positive potential, the diode is ______	Forward biased
237	If p-side of the diode is at a negative potential, the diode is ______	Reverse biased
238	In reverse bias current through PN junction is in _____ amperes.	Micro
239	Substances which have values of resistivity intermediate between conductors and insulators are called _______	Semiconductors
240	Semiconductor diode _____ A.C. to D.C.	Rectifies
241	The basic structural unit of a crystal is called a_____	Unit cell
242	In p-type semiconductor, majority carriers are______	Holes
243	In n-type semiconductor, majority carriers are______	Free electrons
244	A single crystal of germanium or silicon doped with trivalent impurity_______	p-type
245	A single crystal of germanium or silicon doped with pentavalent impurity_______	n-type
246	In n-type substances ______are the minority carriers.	Holes
247	In ______ type material holes are majority charge carriers.	P

248	Holes are the charge carrier in ______	P-type substances
249	In _______ semiconductor crystal number of free electrons is equal to number of holes at a temperature.	Intrinsic
250	When diode behave forward biased it offers ______	Low resistance
251	When diode behave reversed biased it offers ______	High resistance
252	The addition of small quantity of impurity to a semiconductor is called _______	Doping
253	Combination of P and N-type substance is_______	PN junction
254	The region on both sides of PN junction in which there are no charge carriers (free electrons or holes) is called ______ region.	Depletion
255	In forward bias a PN junction offers_____ resistance.	Low
256	The movement of holes corresponds to _______ in semiconductor materials.	Conventional current
257	A diode may serve as a _______	Rectifier
258	The conversion of A.C. into D.C. is _______	Rectification
259	Bipolar junction is called _______	Transistor
260	The sandwiched of N-type material between two P-type material is_______	PNP transistor
261	The sandwiched of P-type material between two N-type material is_______	NPN transistor
262	In a ______ transistor, n-type material is sandwiched between the p-type materials.	p-n-p
263	In the transistor, symbol of arrow is located on_____	Emitter
264	The process to convert low voltage or current to high voltage or current is known as _______	Amplification
265	______ are preferred than vacuum tubes.	Semiconductor diodes
266	Compared to vacuum tubes, _______ have longer life and low power consumption.	Transistors
267	PNP or NPN combinations are called ______	Transistors
268	The transistor is basically a current _______	Amplifier
269	The term transistor stands for transfer of_______	Electrons
270	The middle portion of transistor is called a ______	Base
271	In any configuration base current is in_____ amperes.	Micro
272	In transistors of any type the end materials are called _______ and the central material is called _______	Emitter, collector; base
273	Ratio of collector current to base current of a transistor in CEC is known ________ gain.	β
274	In a transistor function of _____ is to provide charge carriers.	Emitter
275	According to law of conservation of charge _______ current must be equal to sum of base current and _____ current.	Emitter; collector
276	The voltage of base with respect to grounded emitter is denoted by _____	V_{BE}
277	Emitter base of a transistor is always ______	Forward biased
278	At temperature of 0 K, germanium behaves as______	Insulator
279	______ does not give p-type properties to a semiconductor when used as a doping agent.	Antimony

280	The electrons produced by photoelectric effect are called ______	Photoelectrons
281	A device which converts light energy into electrical energy is called _______	Photocell
282	The ionization produced by incoming particle is called ____ ionization.	Primary
283	In photo cell, the cathode is connected with _____ terminal of the battery.	Negative
284	The value of Planck's constant is _______	6.625×10^{-34} J-sec
285	Joule-second is the unit of ______	Planck's constant, h
286	The charge on photoelectron is ______	1.6×10^{-19} C
287	Electron volt is a unit of ______	Nuclear energy
288	The phenomenon in which electrons are emitted by falling an ultraviolet light on a metal surface is called _______	Photoelectric effect
289	Photocell should not be exposed to light ______ time.	For long
290	Process reverse to pair production is known as______	Annihilation
291	Radiations whose frequency is less than threshold frequency can not produce_______	Photoelectric effect
292	The graph between $1/d^2$ (intensity of light) and deflection θ (current) will be a ______	Straight line
293	Minimum frequency of incident light which causes the emission of photoelectrons is called _______	Threshold frequency
294	Intensity of light is ______ to the square of the distance.	Inversely proportional
295	The number of photo electrons ejected is directly proportional to ______	Intensity of light
296	Invisible region maximum wavelength is of___ light.	Red
297	In visible region maximum frequency is of ___ light.	Violet
298	The strength of ______ current depends upon the intensity and wavelength of incident light.	Photoelectric
299	A photo cell converts light energy into ______	Electrical energy
300	Photoelectric current varies _______ as the intensity of incident light.	Directly
301	Intensity of light varies ______ as the square of distance from a point source.	Inversely
302	Mathematically inverse square law is expressed as_______	$I \propto 1/d^2$
303	______ may be used to switch on and off the automatic switches of street light.	Photo cell
304	_______ are packets of electromagnetic energy.	Photons
305	The phenomenon of electron ejection by light is called_______	Photoelectric effect
306	There exists a minimum frequency of incident light known as _______ which just starts the emission of photoelectrons.	Threshold frequency
307	Threshold frequency depends only upon _____ of metal.	Nature
308	Einstein's photoelectric equation is given by _______	$V_o e = hf - hf_o$

309	Minimum amount of energy required by an electron to come out of a metal surface is known as ______	Work function
310	The unit of work function is ______	Joule or electron volt
311	The value of Planck's constant can be found by using photocell tube and coloured _____	Light filters
312	D.C. and A.C. voltage can be measured by _______	Cathode ray oscilloscope (CRO)
313	The electrical signal whose voltage is to be measured is given at _____ input of oscilloscope.	Vertical / Y
314	The ______ of electrical signals can be observed by oscilloscope.	Waveform
315	The waveform of electrical signal is seen on screen when its frequency is _____ to frequency of sweep generator.	Comparable
316	OR, AND and NOT are the _____ gates.	Fundamental
317	In case of OR gate, the output becomes high when anyone of the inputs is______	High
318	If one input of OR gate is 0 and other input is 1 then its output will be _____	1
319	In case of AND gate, the output is high only when all the inputs are______	High
320	OR gate is also called _____ gate.	Any of all
321	NOT gate is also called _____	Inverter
322	AND gate is also called _____ gate.	All or nothing
323	In case of NOT gate, the output is the complement of ______	Input
324	A gate is a circuit, which can make _____ divisions.	Logic
325	_____ gate is used to make a fire alarm.	NOT
326	_____ gate is used to make burglar alarm.	NAND
327	If a NOT gate is connected in output of OR gate then combination is called _____ gate.	NOR
328	G.M. tube is used to detect _____	Nuclear radiations
329	Mass deficit per nucleon is called _____	Mass difference (Δm)
330	In GM tube between electrodes _______volts applied	400
331	When a γ-ray photon enters G.M. tube it emits electrons from inner wall of the tube by _____	Photoelectric effect
332	If vapours of Bromine are filled in the tube along with Argon, then it is called _____ counter.	Halogen
333	_____ prevents discharge of electrons from cathode if voltage across electrodes is not very high.	Argon
334	If number of particles entering the G.M. Tube exceeds _____ per second, and then some of them may not be detected and counted.	10^4
335	In ______ region of characteristic curve G.M. tube becomes inoperative.	Continuous discharge
336	The process of bringing counter back to unionized state is known as ______	Quenching
337	Secondary ionization in G.M. tube depends on primary ionization and _____	Voltage across electrodes

338	Atoms in an element whose atomic number are the same but have different mass numbers are called ______	Isotopes
339	In G.M. tube a thin _____ sheet is used as window.	Mica
340	α-particles are _____ charged particles.	Positively
341	β-particles are _____ charges particles.	Negatively
342	Charge on an electron is ______	1.6×10^{-19} Coulombs
343	1 mega volt = _____ volt	10^6
344	γ-rays are ______ particles.	Chargeless
345	Amount of energy equivalent to 1 a.m.u. is____ Mev.	931
346	_______resistance can be determined by Neon flash lamp.	High
347	The voltage across neon flash lamp at which it ceases to glow is called _____ voltage.	Extinction
348	The voltage across neon flash lamp at which it begins to glow is called ______ voltage.	Striking
349	The fuse wire is connected in _____ to A.C. main supply in electrical connection of a house.	Series
350	In a house all electrical appliances are connected in ______ to one another across A.C. mains supply.	Parallel

TICK THE CORRECT ANSWER

351	In Wheatstone Bridge, electrical resistances are accurately measured by: a) relating, b) method of comparison, c) equating, d) taking powers	**(b)**
352	In Ohm's Law, graph between V and I is: a) exponentially decreasing, b) exponentially increasing, c) straight line, d) vertical line	**(c)**
353	In Slide wire bridge, if balance point is at 60 cm with resistance of 10 ohms in right gap, then unknown resistance in left gap will be: a) 15 ohms, b) 7.87 ohms, c) 20 ohms, d) 35 ohms	**(a)**
354	Adjustment of shunt resistance for half deflection, galvanometer current a) increases, b) decreases, c) remain same, d) halved	**(d)**
355	The diameter of a wire is measured by a) meter rod b) vernier calipers c) screw gauge d) foot ruler	**(c)**
356	Resistivity is measured in units: a) ohms, b) ohm/m, c) ohm-m, d) mho	**(b)**
357	The unit of conductance is a) ohm b) mho c) ampere d) none of them	**(b)**
358	In Weston type galvanometer, the terminals are: a) magnet pole pieces, b) fixed ends of spiral hair sprigs, c) pivoted ends, d) steel bearing	**(b)**
359	The resistance of a voltmeter in comparison with galvanometer resistance will be: a) less, b) greater, c) equal, d) minor difference	**(b)**
360	In Lamp-and-scale arrangement, the distance from the mirror is: a) 2 m, b) 2.5 m, c) 1 m, d) 1.5 m	**(c)**
361	A thermister is sensitive to: a) current, b) voltage, c) temperature, d) water	**(c)**
362	Thermisters are made of: a) pure semiconductor elements, b) insulators, c) metals, d) metal oxides	**(d)**
363	With rise in temperature, resistance of a thermister: a) Slightly decrease, b) slightly increase, c) considerably decrease, d) remains constant	**(c)**
364	Temperature coefficient of thermister at higher temperature: a) increases, b) decreases, c) becomes zero, d) remains same	**(b)**
365	The range of the thermister resistance is a) 0.5Ω to 10 Ω b) 0.5Ω to 100 M Ω c) 1Ω to 100 Ω d) any range	**(b)**
366	In converting galvanometer into ammeter a resistance is connected: a) parallel to it, b) in series, c) with voltmeter, d) with ammeter	**(a)**
367	In converting galvanometer into ammeter, the resistance connected called: a) resistor, b) shunt, c) conductor, d) none of three	**(b)**
368	A galvanometer can be converted into ammeter by connecting: a) a high resistance in series, b) high resistance in parallel, c) a low resistance in parallel, d) low resistance in series	**(c)**
369	Connecting a voltmeter in parallel between two point makes its actual potential difference: a) greater, b) less, c) no effect, d) none of these	**(b)**
370	If a resistance of a higher value is connected in series with galvanometer, then the range of voltmeter made will:: a) decrease, b) increase, c) remain same, d) no effect	**(b)**
371	After converting galvanometer into voltmeter, we should calibrate its reading in: a) amperes, b) divisions, c) volts, d) none of these	**(c)**
372	Internal resistance of a cell is: a) large, very large, c) very small, d) normal	**(c)**

373	The current inside the cell comes across a resistance due to: a) chemical solution, b) electrolyte, c) emf, d) inner structure of the cell	**(b)**
374	When battery is connected to outer circuit, its potential difference is: a) same as emf, b) less than emf, c) equal to battery voltage, d) none of them	**(b)**
375	If potentiometer wire is uniform, its length is proportional to: a) current, b) resistance, c) potential difference, d) diameter	**(c)**
376	To adjust current in a circuit, rheostat can be replaced by: a) a resistance wire, b) choke, c) resistance box, d) filament bulb	**(c)**
377	For varying voltage in a circuit, battery is connected with rheostat in: a) parallel, b) series, c) without key, d) shunt resistance	**(a)**
378	For varying current in a circuit, battery is connected with rheostat in: a) parallel, b) series, c) without key, d) shunt resistance	**(b)**
379	Usually potentiometer circuit consists of a wire of length: a) 2 m, b) 1 m, c) 3 m, d) 4 m	**(d)**
380	In potential divider circuit the battery is connected with a resistance: a) in series, b) by an galvanometer, c) in parallel, d) any combination	**(c)**
381	In an electrolyte the current flow is: a) not possible, b) easy, c) not clear, d) face great obstacles	**(b)**
382	Nichrome wire is used in potentiometer circuit due to its: a) low resistance b) high strength, c) high resistivity, d) good flexibility	**(c)**
383	The filament of an ordinary bulb is of: a) silver, b) copper, c) aluminium, d) tungsten	**(d)**
384	When current pass through a metallic conductor, its temperature: a) decreases, b) increases, c) remains constant, d) may increase or decrease	**(b)**
385	When current passes through tungsten filament, Ohm's law is not valid because: a) variation of voltage, b) increasing of current, c) increase of temperature, d) non-uniform filament	**(c)**
386	Heat generated in a resistor is: a) $IR^2 t$, b) Irt^2, c) $I^2 Rt$, d) IRt	**(c)**
387	Two 40 watt bulbs are connected in series, two in parallel with same 240 volts power line, the brightness of parallel bulbs will be: a) more, b) less, c) same, d) half	**(a)**
388	1 Tesla is equal to: a) 1 $Wb\text{-}m^2$, b) 1 Wb-N, c) 1 Wb m^{-2}, d) N-m	**(c)**
389	1 Weber is equal to: a) NA/m, b) J / Am, c) Nm/A, d) N/Am^2	**(c)**
390	Weber is the unit of: a) magnetic flux, b) magnetic flux density, c) electric flux, d) intensity	**(a)**
391	In Wb/m^2, earth's magnetic field is: a) 10^{-5}, b) 10^{-2}, c) 10^2, d) 10^{-4}	**(d)**
392	In Wb/Am, permeability of free space is: a) $2\pi \times 10^{-7}$, b) $4\pi \times 10^6$, c) $4\pi \times 10^{-7}$, d) $2\pi \times 10^7$	**(c)**
393	The units of relative permeability are: a) NA/m, b) J / Am, c) Nm/A, d) no units	**(d)**
394	Geographical N-S direction and magnetic N-S directions have: a) same, b) minor difference, c) opposite, d) parallel	**(b)**
395	Farad is the unit of: a) electric current, b) inductance, c) capacitance, d) magnetic intensity	**(c)**

396	The time constant of an RC circuit having resistor of 10kΩ and capacitor of 10μ F will be: a) 100 sec, b) 10 sec, c) 0.001 sec, d) 0.1 sec	**(d)**
397	A dielectric material is inserted between the plates of a capacitor, then its capacitance: a) decreases, b) increases, c) remains same, d) is full	**(b)**
398	A dielectric material is inserted between the plates of a charged capacitor, and it is disconnected from the battery then its potential difference across its plates: a) decreases, b) increases, c) remains same, d) halved	**(a)**
399	The reactance of a capacitor in the A.C. circuit is: a) $X_c = 1 / 2\pi C$, b) $X_c = 2\pi / f C$, c) $X_c = 1 / 2\pi f C$, d) $2\pi f C$	**(c)**
400	If two capacitors each of capacitance C are connected in series then the equivalent capacitance will be: a) 2C, b) 2/C, c) C /2, d) C	**(c)**
401	Three capacitors are connected in parallel, their equivalent capacitance will be: a) C/3, b) 3C, c) C^2 , d) 3/C,	**(b)**
402	Two resistors each of resistance R, are connected in parallel, their equivalent resistance will: a) 2 R b) 2/R c) $2R^2$ d) $1/R^2$	**(b)**
403	Two resistors each of resistance R, are connected in series, their equivalent resistance will: a) 2 R b) 2/R c) $2R^2$ d) $1/R^2$	**(a)**
404	Ohm-meter is the unit of a) current b) voltage c) resistivity d) conductivity	**(c)**
405	In A.C. circuit, the ratio between current and capacitance is: a) increasing, b) varies, c) decreasing, d) constant	**(d)**
406	In A.C. circuit, the graph between current and capacitance is: a) straight line, b) exponentially increasing, c) exponentially increasing, d) curved	**(a)**
407	If resistance is in ohms and capacitance is in farads, then unit of time constant is: a) farad b) second c) volts d) ohms	**(b)**
408	The smallest unit of capacitance is a) milli farad , b) micro farad c) pico farad d) farad	**(c)**
409	The semiconductor element is: a) Silver, b) Potassium, c) Silicon, d) Sodium	**(c)**
410	In forward bias current flowing through a semi-conductor diode is few, a) Amperes, b) milli-Amperes, c) micro-Amperes, d) nano-Amperes	**(b)**
411	When the semiconductor diode is reverse biased, it offers a) no resistance b) minor resistance c) high resistance d) low resistance	**(c)**
412	In n-type material every impurity atom of 5^{th} group element contributes net number of free electrons, a) 2 b) 3 c) 1 d) 4	**(c)**
413	In intrinsic semiconductor crystal valence electrons share with electrons the number of covalent bonds, a)2 b) 1 c) 4 d) 3	**(c)**
414	With increase in voltage across PN junction in reverse bias, current a) decreases, b) remains almost constant, c) increases, d) fluctuates	**(b)**
415	In a transistor total number of PN junctions are, a) 3, b) 1, c) 2, d) 4	**(c)**
416	The depletion region of PN junction acts as a small, a) resistor, b) battery, c) capacitor, d) none of them	**(b)**
417	In CE configuration of a transistor, the terminal grounded is a) collector, b) base, c) emitter, d) none of them	**(c)**

418	At stopping potential photoelectric current becomes a) minimum, b) zero, c) maximum, d) opposite direction	**(b)**
419	The maximum KE of photoelectron is given by a) $V_o e^2$ b) ½ $V_o e^2$ c) $V_o e$ d) $V e^2$	**(c)**
420	The base of a transistor is thin and has concentration of impurity, a) high, b) low, c) equal, d) very high	**(b)**
421	Threshold frequency of a photocell, operating in visible light, will be in the region a) visible, b) ultra-violet, c) infra-red, d) X-ray	**(c)**
422	The value of Planck's constant, k is equal to a) 6.626 x 10^{-19} b) 1.6 x 10^{-19} c) 6.626 x 10^{-34} d) 9.11 x 10^{-27}	**(c)**
423	A photon's energy is given by a) hf/c b) hc/f c) $h\lambda/c$ d) hc/λ	**(d)**
424	The relation for intensity is a) E/A x t b) EA x t c) E/A x It d) I/A x t	**(a)**
425	A gamma ray photon possesses a) energy, b) charge, c) rest mass, d) high charge	**(a)**
426	The number of digits in Boolean algebra are a) 1 b) 2 c) 10 d) 5	**(b)**
427	Boolean equation for AND gate for A & B as inputs and C its output is a) A + B = C, b) A.B = C, c) $\overline{A}.B = C$, d) none of them	**(b)**
428	Boolean equation for OR gate for A & B as inputs and C its output is a) A + B = C, b) A.B = C, c) $\overline{A}.B = C$, d) none of them	**(a)**
429	The output for NOR gate is 1 when a) both inputs are '0' b) both inputs are '1' c) one is '1' & other is '0' d) none of them	**(a)**
430	The output for NAND gate is '1' when a) both inputs are '0' b) both inputs are '1' c) one is '1' & other is '0' d) none of them	**(b)**
431	The CE configuration of an NPN transistor can act as a) OR gate, b) NOT gate, c) AND gate, d) NOR gate	**(b)**
432	A photocell converts light energy into a) heat energy b) mechanical energy c) electrical energy d) radiation	**(c)**
433	The scientist who used the term photons for quanta of radiation. a) Bohr b) Einstein c) J.J.Thomson d) Newton	**(b)**
434	An alpha particle is heavier than proton by a) 3 times, b) 2 times, c) 4 times, d) 5 times	**(c)**
435	An beta particle is heavier than proton by a) 3 times, b) 1/1833 times, c) 4 times, d) 5 times	**(b)**
436	When β-particle is emitted from a nucleus its charge number increases by a) 1, b) 2, c) 3, d) 4	**(a)**
437	Neutrons and protons in a nucleus are together called a) Nucleus particle b) Nucleons c) photons d) mesons	**(b)**
438	X-rays cannot be deflected by a) lead b) iron c) electric field d) radiation	**(c)**
439	The rest mass of photon is a) negligible b) countable c) zero d) not known	**(c)**
440	In G.M. tube, in the mixture, the percentage of ethyl-alcohol is a) 2 b) 5 c) 10 d) 20	**(c)**

441	The G.M. region of the characteristic curve of G.M. tube is also called a) proportion region, b) plateau region c) continuous discharge region, d) none of them	(b)
442	In G.M. tube anode is a thin wire of a) Iron b) Steel c) Tungsten d) Silver	(c)
443	In plateau region all particles are detected and counted irrespective of their a) mass b) momentum c) energy d) none of them	(c)
444	The principal gas used in G.M. tube is a) Neon b) Argon c) Helium d) Oxygen	(b)
445	External quenching is done due to presence of high resistance in the circuit of a) slide wire bridge b) G.M. tube c) NAND gate d) CRO	(b)
446	High resistance in the circuit of G.M. tube is of the order of a) 10^{20} ohms. b) 10^{9} ohms c) 10^{3} ohms d) 10^{2} ohms	(b)
447	The electronic device which detects and counts pulses of current is called a) oscillator, b) scalar, c) amplifier, d) rectifier	(b)
448	The ratio charge to mass (e/m) is equal to a)9.11×10^{-37}C/kg b)1.6×10^{-19} C/kg a)6.26×10^{-34}C/kg a)1.76×10^{11} C/kg	(d)
449	Charge on electron was determined by a) Milikan b) Bohr c) J.J. Thomson d) Rutherford	(a)
450	To determine e/m of electrons the method used is a) moving coil b) electric method c) deflection method d) any one	(c)

TRUE/FALSE STATEMENTS

451	Slide wire bridge is practical application of Wheatstone bridge.	✓ True/False
452	The flow of electrons in a current-carrying conductor is in the same direction as that of the conventional current.	True/False ✓
453	Current is the flow of positive charge per unit time.	True/False ✓
454	Slide wire bridge is also called Meter Bridge.	✓ True/False
455	Slide wire bridge is based upon Ohm's law.	True/False ✓
456	Using meter bridge, it is advised to obtain the null point near the ends of the meter bridge wire.	True/False ✓
457	Post office box is the practical application of Wheatstone bridge.	✓ True/False
458	The wire under test should be free of kinks.	✓ True/False
459	Continuous flow of current heats up the wire and consequently not changing its resistance.	True/False ✓
460	When unknown wire is in left gap, relation for unknown resistance is R x l_1 / l_2	✓ True/False
461	The relation for the specific resistance is = XL / πr^2	✓ True/False
462	The area of cross section of wire is πr^2	
463	The slide wire may not be of uniform diameter.	True/False ✓
464	While locating the balance point, the jockey slides along the wire.	True/False ✓
465	The current that flows in one direction is direct current.	✓ True/False
466	While locating the balance point the jockey is pressed at different points.	✓ True/False
467	In a slide wire bridge, the balance point should be somewhere in the middle of the slide wire.	✓ True/False
468	Ampere is a unit of resistance.	True/False ✓
469	Coulomb is a unit of current.	True/False ✓
470	One coulomb per second is called volt.	True/False ✓
471	A current carrying wire is a charged conductor.	True/False ✓
472	1 Ampere = 1 Coulomb per second.	✓ True/False
473	The graph between potential difference and current for a given wire at fixed temperature is a straight line.	✓ True/False
474	The resistance of one-centimeter cube of a substance is called specific resistance.	✓ True/False
475	The area of cross-section of a given circular wire is determined by $2\pi r$	True/False ✓
476	The resistivity does not depend upon geometrical shape.	✓ True/False
477	The unit of resistivity is Ohm-cm.	✓ True/False
478	A wire of resistivity ρ is stretched to double its length. The new resistivity will be 2ρ.	True/False ✓
479	The quantity of charge cannot be measured with the help of galvanometer.	True/False ✓
480	The resistivity of eureka wire is 55 x 10^{-6} Ohm-cm.	True/False ✓
481	The unit of specific resistance is Ohm-m^2 .	True/False ✓
482	The resistivity of eureka wire is 49 x 10^{-6} Ohm-cm.	✓ True/False
483	The resistivity of nichrome ire is 110 x 10^{-6} Ohm-cm.	✓ True/False
484	The specific resistance is given by πr_1^2 / X.	True/False ✓

485	A Eureka wire of length 100 cm and radius 0.01 cm has resistance 16 Ω. It is divided into two equal halves. The resistance of each is 16Ω.	True/False ✓
486	The current passing through a conductor is proportional to the square of the potential difference across its two ends.	True/False ✓
487	%age error = Actual value / difference (100)	True/False ✓
488	When slide wire bridge is balanced, the potential difference across the galvanometer is zero.	✓ True/False
489	Measure length of a given wire from outer terminals.	True/False ✓
490	Wheatstone bridge is an arrangement consisting of four resistances.	✓ True/False
491	Electromotive force is mostly related to potential difference.	✓ True/False
492	The galvanometer is shunted if the deflection is too large.	✓ True/False
493	A potentiometer can be used as a potential divider.	✓ True/False
494	A balanced Wheatstone bridge is used to find the potential difference between the ends of a wire.	True/False ✓
495	$R_1 / R_2 = R_3 / R_4$ It is the condition for balanced circuit.	✓ True/False
496	Ampere is a derived unit and Coulomb is one of the base SI units.	True/False ✓
497	In SI units current is measured in volts.	True/False ✓
498	Kwh is the unit of current.	True/False ✓
499	The electrical energy is measured in kilowatt-hour.	✓ True/False
500	Ratio of resistances of two segment of a wire of uniform diameter is equal to ratio of their respective lengths.	✓ True/False
501	In slide wire bridge one terminal of galvanometer is connected to jockey and other to one end of the steel wire.	True/False ✓
502	The Null point everywhere of the wire.	True/False ✓
503	The Null point should be obtained near the middle of the wire.	✓ True/False
504	When the balance point lies at the center of the bridge wire, the bridge become sensitive.	✓ True/False
505	In positions of unknown resistance X and known resistance R are interchanged, (in slide wire bridge) the relation for X will also change.	✓ True/False
506	The balancing point should be some where near the end of bridge wire.	True/False ✓
507	Short and thick wires are used in circuits.	✓ True/False
508	Flexible wire should be used for connections.	✓ True/False
509	Current in the circuit is maintained with rheostat.	✓ True/False
510	The unit of conductivity is mho.	True/False ✓
511	The length of the wire is measured from the points where the wire comes out of the terminal.	✓ True/False
512	In calculating unknown resistance principle of Wheatstone bridge is used.	✓ True/False
513	Slide wire bridge is an application of meter bridge.	True/False ✓
514	To determine low resistance high resistance galvanometer in circuit is used.	✓ True/False
515	We compare low resistance by potentiometer.	✓ True/False
516	A resistance whose value is less than 1/10 ohms is called a low resistance.	✓ True/False
517	A copper wire of uniform diameter can also be used in place of steel wire in slide wire bridge.	True/False ✓
518	The resistance is proportional to the length of a conductor.	✓ True/False

519	One meter long steel wire has more resistance than two meter long steel wire.	True/False ✔
520	The resistance of wire is doubled if area of cross section of wire is doubled.	True/False ✔
521	The coils are connected in series inside the resistance box.	✔ True/False
522	The unit of conductivity is mho-m^{-1}.	✔ True/False
523	The unit of potential difference is ampere.	True/False ✔
524	The resistance box is a device, which is used for introducing any known resistance in a circuit.	✔ True/False
525	Post office box does not work on the principle of Wheatstone bridge.	True/False ✔
526	Post office box is used to determine an unknown resistance.	✔ True/False
527	Post office box is compact form of Wheatstone bridge.	✔ True/False
528	Post office box was originally designed for measuring the resistance of telephone wires.	✔ True/False
529	When the battery key is pressed, induced current in produced.	✔ True/False
530	To test the circuit first press galvanometer key and then battery key.	True/False ✔
531	The plugs of the resistance box must be loose.	True/False ✔
532	The battery key should be pressed before the galvanometer key to avoid self induction.	✔ True/False
533	Inductance is measured in Weber.	True/False ✔
534	The insulation from the ends of the connecting wire should not be removed.	True/False ✔
535	Resistivity and resistance is one and the same thing.	True/False ✔
536	Resistivity of wire is calculated by formula $\rho = XA / L$.	✔ True/False
537	Resistance of a substance one meter in length and $1m^2$ in cross-sectional area is called resistivity.	✔ True/False
538	Resistance and resistivity are one and the same thing.	True/False ✔
539	The copper wires used in the laboratory have a resistance of 2 Ω only.	True/False ✔
540	The resistance decreases with the decrease in temperature.	True/False ✔
541	The reciprocal of resistance is called conductance.	✔ True/False
542	Conductivity is the reciprocal of resistivity.	✔ True/False
543	Non-inductive resistances are used in resistance boxes.	✔ True/False
544	Half deflection method is the only method by which resistance of a galvanometer can be measured.	True/False ✔
545	In half deflection method to find the resistance of galvanometer (G) we know that the shunt resistance $S \approx G$.	✔ True/False
546	The battery should be closed before the galvanometer circuit.	✔ True/False
547	A dry cell supplies A.C. voltage.	True/False ✔
548	Conductivity and resistivity are reciprocal to each other.	✔ True/False
549	Opposition to the flow of free electrons is resistance.	✔ True/False
550	Resistivity and conductivity have the same units.	True/False ✔
551	The zero position of pointer of galvanometer is in the middle of its dial.	✔ True/False
552	The deflection of galvanometer should be large and in even number.	✔ True/False
553	The current for full scale deflection can be had by $I = E / G$.	True/False ✔
554	The current for full scale deflection (30 divisions) = 30 RS / R – S.	True/False ✔
555	Deflection in galvanometer is inversely proportional to the current passing through it.	True/False ✔
556	The current for full scale deflection is $I = E / R + G$.	✔ True/False

557	Galvanometer is connected in series with high resistance box.	✔ True/False
558	The galvanometer constant is = C / BNA.	✔ True/False
559	A galvanometer is used to measure the current.	True/False ✔
560	Working of galvanometer depends upon the torque exerted on the coil.	✔ True/False
561	The resistance of galvanometer is very high.	True/False ✔
562	When no current flows through a galvanometer, P.D. across it is maximum.	✔ True/False
563	For sensitive galvanometer, the factor C / BNA should be large.	True/False ✔
564	Resistance of galvanometer means resistance of the coil of the galvanometer.	✔ True/False
565	The resistance of galvanometer increases by shunting it.	True/False ✔
566	If direction of current through galvanometer is reversed, deflection of its pointer will be opposite direction.	✔ True/False
567	Galvanometer shows half deflection because resistances in galvanometer and shunt path are in ratio 1:2.	True/False ✔
568	Graph between (R - S) and R x S is hyperbola.	True/False ✔
569	Galvanometer is connected in one of the arms of Wheatstone bridge.	✔ True/False
570	The terminals of the galvanometer are marked as positive and negative in the circuit.	True/False ✔
571	The unit of electric power is ampere.	True/False ✔
572	Current passing through resistors heat them up.	✔ True/False
573	Low resistance voltmeter must be used in circuit.	True/False ✔
574	The graph between R x S and R – S is a straight line.	✔ True/False
575	Galvanometer with high series resistance works as voltmeter.	✔ True/False
576	A low resistance connected in series to a galvanometer is called a shunt.	True/False ✔
577	The galvanometer should not be shunted.	True/False ✔
578	A charge flowing through a ballistic galvanometer for a very short time will not be detected by it.	True/False ✔
579	High resistance voltmeter should be used.	✔ True/False
580	In half deflection method, resistance of galvanometer is calculated by the formula, G = R – S /R x S	True/False ✔
581	In half deflection method $G \approx S$ when $R >> S$.	✔ True/False
582	During one observation, voltage of the battery must not change.	✔ True/False
583	Voltmeter is essentially a high resistance device.	✔ True/False
584	To find resistance of a voltmeter fresh cells should be used.	✔ True/False
585	In an electrical circuit, a voltmeter is always connected in series.	True/False ✔
586	In short circuit, no current flows through the circuit.	True/False ✔
587	An open circuit has zero resistance.	True/False ✔
588	A circuit with zero resistance is known as open circuit.	True/False ✔
589	An A.C. voltmeter is different in construction from D.C. voltmeter.	✔ True/False
590	D.C. ammeter can also be used to measure A.C.	True/False ✔
591	D.C. voltmeter can be used in A.C. circuit.	True/False ✔
592	Infinite current flows in a short circuit.	✔ True/False
593	The unit of electric power is ampere.	True/False ✔
594	Wheatstone bridge is an arrangement consisting of four resistances.	✔ True/False
595	An ammeter is always connected in parallel with the circuit.	True/False ✔
596	Resistance of thermister is directly proportional to temperature.	True/False ✔
597	Thermisters are made of pure metals.	True/False ✔
598	Resistance of thermistrer decreases with temperature.	✔ True/False

599	Thermometer should not touch resistance wire.	✓ True/False
600	Thin copper wires have more resistance than thick copper wires.	✓ True/False
601	The voltmeter whose resistance is to be measured is connected across resistance box.	True/False ✓
602	To determine resistance of voltmeter, galvanometer should be used.	True/False ✓
603	The deflection should be kept large with the help of rheostat.	✓ True/False
604	The resistance in the circuit should be increased in regular steps.	✓ True/False
605	The graph between R and 1/V is a straight line.	✓ True/False
606	The negative intercept gives the resistance of the voltmeter.	✓ True/False
607	The voltmeter whose resistance is to be measured connected across resistance box.	✓ True/False
608	A voltmeter is a low resistance device.	True/False ✓
609	During one observation, voltage of battery must not change.	✓ True/False
610	A D.C. voltmeter can measure A.C. voltage.	True/False ✓
611	An avometer can measure the resistance as well as current.	✓ True/False
612	Position of rheostat is adjusted such that for R = 0, the voltmeter reading is in even divisions.	✓ True/False
613	Voltmeter is always connected parallel with the circuit.	✓ True/False
614	A voltmeter is a low resistance galvanometer.	True/False ✓
615	Voltmeter has high resistance and is connected in parallel.	✓ True/False
616	The resistance of an ideal voltmeter is zero and resistance of an ideal ammeter is infinity.	True/False ✓
617	An avometer can only measure the resistance in a circuit.	True/False ✓
618	Ammeter can be damaged when connected in parallel.	✓ True/False
619	An ammeter is simply a galvanometer with a suitable low resistance connected in parallel with it.	✓ True/False
620	An ammeter must be connected in series.	✓ True/False
621	Ammeter has low resistance and is connected in parallel.	True/False ✓
622	Ammeter measures potential difference.	True/False ✓
623	An ammeter connected in series to a circuit or battery would be damaged.	True/False ✓
624	An ammeter is used to store the current.	True/False ✓
625	Galvanometer is used for the detection of current.	✓ True/False
626	A galvanometer can be converted into an ammeter by connecting a low resistance in parallel with galvanometer.	✓ True/False
627	A wire connected across a galvanometer is called shunt.	✓ True/False
628	High resistance is connected in parallel with galvanometer coil.	True/False ✓
629	Galvanometer is used to measure the large value of current.	True/False ✓
630	The current passing through the coil of the galvanometer is directly proportional to the angle of deflection.	✓ True/False
631	A galvanometer can be converted into ammeter of different ranges.	✓ True/False
632	A galvanometer is used to detect small current in a circuit.	✓ True/False
633	In ammeter most of the current passes through galvanometer and only a small fraction of current passes through shunt.	True/False ✓
634	An ammeter is a high resistance galvanometer.	True/False ✓
635	By an ammeter current flowing only in one direction can be measured at a time.	✓ True/False
636	Ammeter is connected in parallel and voltmeter in series in the circuit.	True/False ✓

637	When three equal resistances are connected in parallel in a circuit, the voltage drop across each resistance is the same.	✔ True/False
638	The value of combined resistance decreases when two resistances are combined in series.	True/False ✔
639	When the resistances are combined in parallel, their equivalent resistance has value less than the lowest resistance in the combination.	✔ True/False
640	An ammeter is always connected in parallel with the circuit.	True/False ✔
641	Ammeter has highest internal resistance.	True/False ✔
642	Voltmeter is always connected parallel with the circuit.	✔ True/False
643	Voltmeter is high resistance galvanometer.	✔ True/False
644	Ammeter is connected in series and voltmeter in parallel in circuit.	✔ True/False
645	A device used for detection and measurement of current is called voltmeter.	True/False ✔
646	An instrument, which can measure potential without drawing any current, is voltmeter.	True/False ✔
647	When a small resistance is connected in parallel with the galvanometer, then it is converted into voltmeter.	True/False ✔
648	A galvanometer can be converted into a voltmeter by connecting a high resistance in series with galvanometer.	✔ True/False
649	The value of combined resistance decreases when to resistances are combined in series.	True/False ✔
650	Volt is the unit of current.	True/False ✔
651	The coils are connected in series inside the resistance box.	True/False ✔
652	Wheatstone bridge principle is applied in a slide wire bridge.	✔ True/False
653	The resistance of current decreases with the increase of temperature.	True/False ✔
654	For determination of resistance of galvanometer Kelvin method is superior to half-deflection method.	✔ True/False
655	Half deflection method is accurate method to determine the resistance of galvanometer.	True/False ✔
656	The slope R x S / R – S gives the resistance of galvanometer.	✔ True/False
657	Galvanometer gives half deflection when both keys are closed.	✔ True/False
658	Low current is used to prevent resistances from heating.	✔ True/False
659	To reduce current in the circuit, a potential divider should be used.	✔ True/False
660	All the positive terminals are connected to one end of potentiometer.	✔ True/False
661	The balancing length is measured from the positive end of potentiometer.	✔ True/False
662	In short circuit no current flows through the circuit.	True/False ✔
663	To get three observations low resistance should be used.	True/False ✔
664	Rheostat is a variable resistor.	✔ True/False
665	Shunt resistance in ammeter also acts as safety measure for galvanometer.	✔ True/False
666	Shunt is high resistance connected in parallel to a galvanometer.	True/False ✔
667	The resistance of galvanometer is smaller than the shunt resistance.	True/False ✔
668	A current carrying conductor is surrounded by an electric field.	True/False ✔
669	Copper is better conductor than all other metals except silver.	✔ True/False
670	Gold is better conductor than silver.	True/False ✔
671	Shunt resistance placed parallel to the galvanometer to protect it from high current.	✔ True/False
672	A low resistance box should be used as the shunt resistance in the half deflection method.	✔ True/False

673	Shunt is a low resistance, which is always connected in series.	True/False ✓
674	A low resistance should be used as the shunt.	✓ True/False
675	If terminals of voltmeter connected in a circuit are interchanged, even then it will read voltage.	True/False ✓
676	If current drawn from a cell is increased, then terminal voltage across it will decrease.	✓ True/False
677	Potential gradient everywhere on potentiometer wire will be equal if its diameter is uniform.	✓ True/False
678	Weak current is used to prevent heating of resistance wire of potentiometer.	✓ True/False
679	Greater the length of potentiometer wire, more will be its potential gradient if voltage across wire is same.	True/False ✓
680	Potentiometer is a device, which can measure the accurate value of potential difference.	✓ True/False
681	A battery cannot be recharged.	True/False ✓
682	Internal resistance of a freshly prepared cell is high and it goes on decreasing as the cell is put to more and more use.	True/False ✓
683	The internal resistance of a cell increases with the increase of current.	True/False ✓
684	The internal resistance of a cell remains constant.	True/False ✓
685	Internal resistance of a cell depends on the nature of the electrolyte.	✓ True/False
686	The internal resistance of a car battery decreases on a chilly day.	True/False ✓
687	The internal resistance of a car battery increases on a warm day.	True/False ✓
688	Due to internal resistance of cell the terminal potential difference is greater than emf.	True/False ✓
689	A cell has a high internal resistance.	True/False ✓
690	An ideal cell must have infinite internal resistance.	True/False ✓
691	In the measurement of internal resistance of a cell the formula used is $(l_1 - l_2)R / l_2$	✓ True/False
692	Wheatstone bridge is used to determine internal resistance of a cell.	True/False ✓
693	We can compare low resistance by a potentiometer.	✓ True/False
694	A low resistance connected in series with galvanometer is called shunt.	True/False ✓
695	In normal use of a battery EMF and terminal potential difference have different values.	True/False ✓
696	EMF is the potential difference across the terminals of a battery when current is drawn from it.	True/False ✓
697	EMF of a cell is independent of the resistance of the circuit connected to it.	✓ True/False
698	Potential difference and emf have different units.	True/False ✓
699	Volt is the unit of emf.	✓ True/False
700	SI unit of electrical energy is Watt.	True/False ✓
701	The term potential difference is used for the difference of potential between any two points of an electric circuit.	✓ True/False
702	Current is flowing in two conductors connected in series. The potential difference across the two is the same.	True/False ✓
703	Current flowing in a metal is due to the motion of valence electrons.	✓ True/False
704	Two unequal resistances are connected in parallel. The voltage drop across both resistances is the same.	✓ True/False
705	Potentiometer is a device for comparing and measuring resistance.	True/False ✓
706	The emf of a cell can be found by using a potentiometer.	✓ True/False

707	Potentiometer is used to compare the emf of two cells.	✓ True/False
708	In comparison of emf's of two cells, the balancing length is measured from positive terminal of potentiometer.	✓ True/False
709	The emf of 'E_2' of a cell using potentiometer is found by the formula, $E_2 = E_1 \times l_2 / l_1$	✓ True/False
710	When current is drawn from the cell, then the terminal P.D. is equal to the EMF of the cell.	✓ True/False
711	A potentiometer does not draw any current from the circuit under study.	✓ True/False
712	Potentiometer can be used as a potential divider.	✓ True/False
713	EMF of battery used in auxiliary circuit of potentiometer should be less than emf of all other sources connected with it.	True/False ✓
714	Emf's of cells to be compared should have emf less than that of battery in the circuit.	✓ True/False
715	A potentiometer does not draw any current from the cell whose emf is to determine.	✓ True/False
716	We prefer a voltmeter to measure the emf of a cell rather than a potentiometer.	True/False ✓
717	In a single battery or cell terminal potential difference can exceed its emf.	True/False ✓
718	In potentiometer arrangement for comparing emf of two cells, the voltage across the potentiometer wire should be smaller than the emf of either of the two cells.	True/False ✓
719	In comparing of EMF of two cells using potentiometer, the formula used is $E_1 / E_2 = l_2 / l_1$	True/False ✓
720	It is preferable to use potentiometer wire of longer length for accurate measurements.	✓ True/False
721	The potentiometer is based on Wheatstone bridge principle.	True/False ✓
722	Farad is the unit of emf.	True/False ✓
723	SI unit of emf is volt.	✓ True/False
724	Volt = joule / ampere.	True/False ✓
725	Volt = joule / coulomb.	✓ True/False
726	Battery is a device in which electrical energy is converted into mechanical energy.	✓ True/False
727	Batteries convert electrical energy into chemical energy.	True/False ✓
728	Battery is a device in which electrical energy is stored in the form of chemical energy.	✓ True/False
729	In a current carrying wire the electrical energy is converted into mechanical energy.	True/False ✓
730	We can compare low resistances by a potentiometer.	True/False ✓
731	When a cell is in a closed circuit, the potential difference between its electrodes is equal to its electromotive force.	True/False ✓
732	Electromotive force of a cell is the maximum potential difference between its electrodes when no current is drawn from it.	✓ True/False
733	The term electromotive force is used for the potential difference between any two points of an electric circuit.	True/False ✓
734	The term potential difference is used for the electromotive force of the source of electric current.	True/False ✓
735	Electromotive force is mostly related to potential difference.	✓ True/False

736	Potential difference = current x resistance.	✓ True/False
737	A dry cell is a form of Lechlanche cell.	✓ True/False
738	Lechlanche cell is source of constant emf of about 1.4 volts.	✓ True/False
739	Copper container of Daniel cell acts as cathode.	True/False ✓
740	Mathematical form of Ohm's law is $V \propto I$.	✓ True/False
741	Tungsten filament bulb obeys the Ohm's law.	True/False ✓
742	According to Ohm's law, I = V/R.	✓ True/False
743	The graph between log I and log V will be a straight line.	✓ True/False
744	Temperature is kept constant when $V \propto I$.	✓ True/False
745	Resistance of a conductor is independent of its temperature.	True/False ✓
746	Ohm's law states that, physical conditions remaining constant, the current flowing through a conductor is proportional to the potential difference across its ends.	✓ True/False
747	Relation between voltage and current through tungsten filament shows that Ohm's law is obeyed.	True/False ✓
748	When a bulb is switched on temperature of its filament initially rises but then becomes constant after some time.	✓ True/False
749	A filament of bulb has greater chances to burn where it is comparatively thick.	True/False ✓
750	Initially temperature of filament bulb rises as heat generated per unit time is greater than heat dissipated per unit time.	✓ True/False
751	Voltage should be varied in large steps.	True/False ✓
752	High resistance Rheostat be used.	✓ True/False
753	Ohm's law is valid in all temperatures.	True/False ✓
754	Ohm's is obeyed by an ordinary bulb just after current in it is switched on	True/False ✓
755	60 watt means that heat is generated 60 J per second.	✓ True/False
756	The graph between the current passing through the tungsten filament lamp and the potential applied across it is a straight line.	True/False ✓
757	The current through an appliance can be calculated by the relation, Current = voltage / power.	True/False ✓
758	Power dissipated by an electric instrument is $I^2 R t$.	✓ True/False
759	Power = Potential difference multiplied by current.	✓ True/False
760	There is always dissipation of energy when current flows through a conductor.	✓ True/False
761	If equal amount of charge is given to conductors of different shapes and sizes corresponding rise in potential of all of them will be equal.	True/False ✓
762	For a series combination of resistance, the current across each resistance is different.	True/False ✓
763	The ratio of current to the potential difference is called capacitance.	True/False ✓
764	The current due to motion of electrons in an electric circuit is called conventional current.	True/False ✓
765	When capacitors are in series, $C_e = C_1 + C_2 + C_3$	True/False ✓
766	When resistors are in series, $R_e = R_1 + R_2 + R_3$	✓ True/False
767	Inductor is a device for storing the charge.	True/False ✓
768	Capacitor is used for storing the charge.	✓ True/False
769	Mica is a dielectric.	✓ True/False
770	The unit of inductance is μF.	True/False ✓

771	Two 5 μF capacitors are connected in parallel, then C_{equ} = 2.5 μF.	True/False ✔
772	One coulomb = 1 ampere x one second.	✔ True/False
773	Unit of magnetic field is weber/m^2.	✔ True/False
774	1 Gauss = 10^4 Tesla. .	✔ True/False
775	1 coulomb = 1 Ampere / 1 second.	True/False ✔
776	The SI unit of magnetic field is oersted.	True/False ✔
777	Gauss and oerted are two different units.	True/False ✔
778	Tesla or weber/m^2 are same.	✔ True/False
779	Gauss is unit of magnetic flux.	True/False ✔
780	Unit of magnetic induction is weber / m^2.	✔ True/False
781	1 K = 1 °F	True/False ✔
782	The electrons flow from a body at higher potential to a body at lower potential.	✔ True/False
783	In power transmission, high voltage stepped down by a transformer for domestic use is 220 volt.	✔ True/False
784	Potential at a point is the work done in bringing a unit negative charge from infinity to that point.	True/False ✔
785	Electric potential of earth always remains zero whether any amount of charge is given to it or taken out of it.	✔ True/False
786	Frequency of A.C. used in Pakistan is 110 cycles per second.	True/False ✔
787	Two similar charges do not exert any force on each other.	True/False ✔
788	Total K.E. of molecules of a body is called internal energy.	True/False ✔
789	Ideal gas has only K.E.	✔ True/False
790	The current carrying circular loop behaves like a north pole.	True/False ✔
791	There is nothing like a monopole magnet.	✔ True/False
792	The field due to current alone is represented by circular lines of force.	✔ True/False
793	Strength of magnetic field is independent of medium around its source	✔ True/False
794	The direction of coil should be perpendicular to the magnetic meridian.	True/False ✔
795	A current carrying loop of single turn is shortest magnetic dipole.	✔ True/False
796	Adjust the current through coil such that the field lines within the range of paper.	✔ True/False
797	The magnetic field produced by the current in the coil is uniform at all points.	True/False ✔
798	Earth's magnetic field lines are parallel to its surface everywhere on it.	True/False ✔
799	The north pole of earth's magnet is near its geographical south pole.	✔ True/False
800	Arrow heads on magnetic lines of force are placed according to right hand rule.	✔ True/False
801	Magnetic intensity is a vector quantity.	✔ True/False
802	The line joining two poles of a magnet is called magnetic axis.	✔ True/False
803	The current carrying circular loop behaves as a magnetic dipole.	✔ True/False
804	Parallel currents repel and anti-parallel currents attract each other.	True/False ✔
805	The magnetic field at the center of the coil is , $2\pi nI / 10r$	✔ True/False
806	The SI unit of magnetic field is Tesla.	✔ True/False
807	Two field lines can intersect each other.	True/False ✔
808	Magnetic intensity is a scalar quantity.	True/False ✔
809	A transformer functions only with A.C.	✔ True/False
810	A transformer works on the principle of self-induction.	True/False ✔

811	A transformer works on the principle of Wheatstone bridge.	True/False ✔
812	If $N_s > N_p$ the transformer is said to be step down.	True/False ✔
813	Transformer steps up energy.	True/False ✔
814	A transformer is used to convert A.C. to D.C.	True/False ✔
815	A current, which changes its direction many times in one second, is called Direct Current.	True/False ✔
816	Capacitor can block A.C.	True/False ✔
817	Electrical energy is measured in kilowatt.	True/False ✔
818	Giga = G = 10^{12}	True/False ✔
819	Pico = p = 10^{-11}	True/False ✔
820	1 k.w.h = 3.6 x 10^6 J.	✔ True/False
821	Pico is smaller than micro.	✔ True/False
822	J-sec is the unit of power.	True/False ✔
823	Normal temperature of man is 37 °C.	✔ True/False
824	0 °C is called absolute zero.	True/False ✔
825	The equivalent capacity in a parallel combination is always greater than the largest capacity of capacitor in the combination.	✔ True/False
826	The capacitance is decreased when capacitors are connected in series combination.	✔ True/False
827	When two capacitors are connected in series, their capacitance are added to get equivalent capacitance.	True/False ✔
828	When two capacitors are connected in parallel, their capacitance are simply added to get equivalent capacitance.	✔ True/False
829	Paper capacitors of low capacitance should be used.	✔ True/False
830	Value of capacitance does not depend on the shape or size of the capacitor.	True/False ✔
831	In RC circuit infinite time is required to charge capacitor to its full capacity.	✔ True/False
832	The energy stored in a capacitor is ½ CV^2.	✔ True/False
833	Time constant is the product of capacitance and resistance, i.e. t =RxC	✔ True/False
834	Graph between capacitance and current is a straight line.	✔ True/False
835	Capacitive reactance is the ratio of r.m.s. voltage to r.m.s. current.	✔ True/False
836	Voltage should be kept constant throughout the experiment.	✔ True/False
837	Different capacitors are connected in parallel in capacitors in A.C. circuit experiment.	✔ True/False
838	The reactance offered by a capacitor to flow of A.C. is inversely proportional to frequency of A.C.	✔ True/False
839	A capacitor of higher capacitance offers greater reactance.	True/False ✔
840	The total capacitance in the circuit will be equal to the sum of their capacitances.	✔ True/False
841	Voltage should not be kept constant throughout the experiment.	True/False ✔
842	Unit of capacitance is Henry.	True/False ✔
843	SI unit of capacitance is farad.	✔ True/False
844	Capacitance of a capacitor is negative sometimes.	True/False ✔
845	In a series arrangement of capacitors, the net capacitance of the combination increases.	True/False ✔
846	The capacitance in parallel combination increases.	✔ True/False
847	A capacitor blocks D.C. and allows A.C.	✔ True/False

848	The frequency of A.C. mains in Pakistan is 50 cps.	✔ True/False
849	A capacitor is used to storing large amount of electric charge.	✔ True/False
850	The amount of charge in coulombs necessary to increase the potential of a conductor by 1 volt is called capacitance.	✔ True/False
851	Capacitance = potential difference between the plates / charge on either plate.	True/False ✔
852	A single conductor can not be used as capacitor.	True/False ✔
853	Capacitance of a capacitor is directly proportional to separation between its plates.	True/False ✔
854	A capacitor does not allow of AC in a circuit in which it is connected.	True/False ✔
855	Free electrons are tightly bound.	True/False ✔
857	Conductivity of a conductor is always smaller than that of semi-conductor.	True/False ✔
858	Resistivity of semiconductor increases with decrease in temperature.	True/False ✔
859	A semi-conductor will become more conducting at high temperature.	✔ True/False
860	The material whose resistivity is less than 10^6 Ohm-cm is semiconductor.	True/False ✔
861	A p-n junction diode obeys Ohm's law.	True/False ✔
862	The resistivity of semiconductors decreases with temperature.	✔ True/False
863	Transistors are made of semi-conductors.	✔ True/False
864	Electrons are the major charge carriers in an N-type of semiconductor.	✔ True/False
865	For forward bias connect P side of diode to negative of battery and N side of diode to positive of battery.	True/False ✔
866	The current is greatly affected by the temperature in forward biased P-N junction.	✔ True/False
867	Forward current in diode is due to majority carriers.	✔ True/False
868	Electrons are not majority carriers in N-type materials.	True/False ✔
869	In forward bias diode offers maximum resistance.	True/False ✔
870	Reverse current in diode is due to minority carriers.	✔ True/False
871	In reverse bias barrier potential decreases.	True/False ✔
872	For forward bias connect P side of diode to positive of battery and N side of diode to negative of battery.	✔ True/False
873	Millimeter should be used in reverse bias and micrometer should be used in forward bias.	True/False ✔
874	Transistor can be used as an amplifier.	✔ True/False
875	Transistor consists of two back to back diodes.	✔ True/False
876	Transistor consumes much energy.	True/False ✔
877	Emitter-base junction of transistor is forward biased and collector-base junction is reverse biased.	✔ True/False
878	Emitter-base junction of transistor is reverse biased	True/False ✔
879	In a P-N-P transistor, N-type material is sandwiched between two type materials.	✔ True/False
880	A transistor is a bipolar junction.	✔ True/False
881	Transistor can be used as a rectifier.	True/False ✔
882	The substances having resistivity intermediate between conductors and insulators are called semiconductors.	✔ True/False
883	The conductivity of a semiconductor decreases by adding impurities to the sample.	True/False ✔
884	Gallium is trivalent.	✔ True/False

885	A crystal of germanium formed after adding impurity from 4th group is known as P-type substance.	True/False ✔
886	The germanium crystal formed after adding impurity from 5th group is known as N-type substance.	✔ True/False
887	A junction between the sample of N-type and P-type germanium is called a semiconductor diode.	✔ True/False
888	Semiconductor diode cannot be used as rectifier.	True/False ✔
889	Semiconductors in pure form are called intrinsic semiconductors.	✔ True/False
890	Semiconductor diode can conduct when it is reverse biased.	True/False ✔
891	In forward bias diode offers maximum resistance.	True/False ✔
892	The main use of semiconductor is to rectify A.C. to D.C.	✔ True/False
893	The P-N-P or N-P-N junctions are called transistors.	✔ True/False
894	In PNP transistors holes are charge carriers.	✔ True/False
895	In common emitter configuration collector of NPN transistor is given a negative potential.	True/False ✔
896	The three ends of a transistor are called emitter, base and collector.	✔ True/False
897	N-type substances are donors.	✔ True/False
898	A N-type substance is positively charged.	True/False ✔
899	Conduction of P-type materials is due to electrons.	True/False ✔
900	The minority carriers in a p-type substance are protons.	True/False ✔
901	Holes are the charge carriers in N-type material.	True/False ✔
902	Electrons in a P-type material due to thermal pair-generation are known as minority carriers.	✔ True/False
903	A P-type substance is formed by doping Ge or Si with trivalent impurity.	✔ True/False
904	The process of adding impurity in a Ge or Si crystal is doping.	✔ True/False
905	A P-type substance is positively charged.	✔ True/False
906	A P-type crystal has a net positive charge.	True/False ✔
907	If Arsenic atoms are doped in intrinsic crystal of Ge then p-type material is formed.	True/False ✔
908	Transistors are of two types.	✔ True/False
909	Transistor stands for transfer of resistance.	True/False ✔
910	Transistor mainly consists of three parts.	✔ True/False
911	Germanium and Silicon do not lie in the same group of periodic table.	True/False ✔
912	The extreme right end of P-N-P transistor represents collector.	✔ True/False
913	Rectifier is a device, which converts A.C. into D.C.	✔ True/False
914	A device, which can be used to amplify current, is called rectifier.	True/False ✔
915	The holes exist only in semiconductors.	✔ True/False
916	Adding small impurity to the semiconductor material is called doping.	✔ True/False
917	The charge on a free electron is $+6.1 \times 10^{-19}$ C.	True/False ✔
918	Electron volt (eV) is the unit of potential difference.	True/False ✔
919	The semiconductor conducts only when it is reverse biased. .	True/False ✔
920	The charge on positron is $+6.1 \times 10^{-19}$ C.	✔ True/False
921	The photo cell should not be exposed to light for long time.	✔ True/False
922	Rest mass of photon is zero.	✔ True/False
923	Photoelectric effect is possible at all frequencies.	True/False ✔
924	Photoelectric emission also occurs with X-rays and γ-rays.	✔ True/False

925	Graph between intensity of light and photoelectric current is a straight line.	✔ True/False
926	Decrease the distance between source of light and photocell in regular steps.	✔ True/False
927	The number of photoelectrons increases as the intensity of light increases.	✔ True/False
928	Thermions are electrons.	✔ True/False
929	A device for converting light energy into electrical energy is called photocell.	✔ True/False
930	The strength of photoelectric current does not depend upon the intensity of light.	True/False ✔
931	Electrons emitted by photoelectric effect are called photoelectrons.	✔ True/False
932	Photoelectric current is proportional to the intensity of incident light.	✔ True/False
933	Intensity of light is directly proportional to the square of the distance.	True/False ✔
934	The maximum energy required by the electron to come out of the metal surface is called work function.	✔ True/False
935	The unit of work function is Joule.	✔ True/False
936	The work function of all metals has the same value.	True/False ✔
937	The graph between photoelectric current and intensity ($1/d^2$) is not a straight line.	True/False ✔
938	Intensity of light I, is inversely proportional to d^2, distance of bulb from the cell.	✔ True/False
939	The relation between photon energy and frequency of radiation is given by $E = h / f$.	True/False ✔
940	The maximum energy of incident light, which causes the emission of photoelectrons, is called threshold frequency.	True/False ✔
941	The photocell and bulb are enclosed in a wooden box.	✔ True/False
942	The value of Planck's constant is 6.625×10^{-24} J-s.	True/False ✔
943	Decrease the distance between source of light and photocell in regular steps.	✔ True/False
944	The photocell should be exposed to light for a long time.	True/False ✔
945	The relation or intensity of light is E A x t.	✔ True/False
946	The charge on photoelectron is zero.	True/False ✔
947	The charge of neutron is 1.6×10^{-19} C.	True/False ✔
948	The rest mass of X-ray photon is 9.1×10^{-31} kg.	True/False ✔
949	Rest mass of photon is zero, but it has momentum.	✔ True/False
950	One a.m.u. is equal to 1.66×10^{-27} kg.	✔ True/False
951	The holes exists only in conductors.	True/False ✔
952	The reverse process of photoelectric effect is called pair production.	True/False ✔
953	X-rays cannot produce photoelectric emission.	True/False ✔
954	The unit of Planck's constant is J-sec.	✔ True/False
955	A light of threshold frequency can produce photoelectric emission.	✔ True/False
956	In visible region red colour has highest frequency.	True/False ✔
957	Solar cell is photovoltaic cell.	✔ True/False
958	In photoelectric experiment, the ratio I/θ remains constant.	✔ True/False
959	Photoelectric current is independent of intensity of light above the threshold frequency.	True/False ✔
960	A photo cell consists of a cathode and anode in a glass tube.	✔ True/False

961	By increasing intensity of incident radiation, KE_{max} of photoelectron increases.	True/False ✔
962	X-rays can cause photoelectric emission.	✔ True/False
963	The mass of photoelectron is equal to 9.1×10^{-31} kg.	✔ True/False
964	A device based on photoelectric effect is called transistor.	True/False ✔
965	Planck's constant cannot be found by using photocell.	True/False ✔
966	Photon of light has no charge.	✔ True/False
967	Oscilloscope can be used as voltmeter.	✔ True/False
968	C.R.O. can be used to find only A.C. voltage.	True/False ✔
969	The horizontal input is usually provided by an in-built arrangement in the oscilloscope.	✔ True/False
970	Peak value of alternating voltage is greater than its rms value.	✔ True/False
971	OR, AND and NOT are fundamental gates.	✔ True/False
972	There cannot be more than one output of OR gate.	✔ True/False
973	There can be more than two inputs of OR gate.	✔ True/False
974	Only one diode is used in OR gate.	True/False ✔
975	The output of OR gate is 1 only when its all inputs are 1.	True/False ✔
976	Output of NOT gate is not same as its input.	✔ True/False
977	There cannot be more than two inputs of AND gate.	True/False ✔
978	There can be two outputs of AND gate.	True/False ✔
979	There can be two inputs of NOT gate.	True/False ✔
	Symbols for NAND gate and NOT gate are same.	True/False ✔
980	If one input of NOR gate is 1 and other is 0, then its output will be 1.	True/False ✔
981	Pressure of gases inside G.M. Tube is nearly 1 atmosphere.	True/False ✔
982	Voltage across electrodes of G.M. tube in plateau region is about 35 volts.	True/False ✔
983	In G.M. tube gas-filled radiation detector operate at low voltage.	True/False ✔
984	In G.M. counter the function of the Scalar is just like foot ruler.	True/False ✔
985	The values of Planck's constant and Rydberg's constants are same.	True/False ✔
986	X-rays are complex waves.	True/False ✔
987	β-rays reside in the nucleus.	True/False ✔
988	Gamma rays consist of charged particles.	True/False ✔
989	Neon flash lamp is used to find the low resistance.	True/False ✔
990	Flashing time is directly proportional to the voltage applied.	True/False ✔
991	A neon flash lamp consists of two electrodes enclosed in a glass bulb.	✔ True/False
992	Graph between resistance and flashing time is a straight line.	✔ True/False
993	Coloured TV emits x-rays.	True/False ✔
994	A charged particle moves in a circular path when it enters perpendicularly in a uniform magnetic field.	✔ True/False
995	Holes cannot be deflected by electric field.	True/False ✔
996	In the magic eye (tube of e/m exp.), beam of electrons is more deflected on increasing anode voltage.	True/False ✔
997	To determine e/m of electrons deflection method is used.	✔ True/False
998	Deflection method is used to find m/e of electron.	True/False ✔
999	At the center of the solenoid the magnetic field is not uniform.	True/False ✔
1000	Teltron tube (for determining e/m) is a solid state device.	True/False ✔

SHORT ANSWERS TO QUESTIONS

Write brief answers of each question in the space provided.

1001	***Why the null/ balance point is sought at the middle of the slide wire?***	Because at this part the arrangement becomes very sensitive.
1002	***What is the effect of temperature on resistance?***	It increases as the temperature increases.
1003	***What does the zero deflection of the galvanometer in case of slide wire bridge indicate?***	It indicates the absence of current through the galvanometer.
1004	***If two wires have same length but different thickness, which of them will be more resistive.***	The wire having smaller thickness will be more resistive.
1005	***Is the slide wire bridge arrangement suitable for measuring low resistance?***	No, it not suitable for low resistance, as the resistances of end pieces and connecting wires are not negligible.
1006	***How can you arrange to make balance point lie nearly at the center of slide wire?***	It is done by adjusting R comparable to that of the resistance of wire connected across the gap.
1007	***Why is the continuous flow of current through the slide wire generally discouraged?***	Continuous flow of current will heat the wire and its resistance will increase, so position of null point will change.
1008	***Why should the connections be clean, neat and tight?***	To minimize unwanted resistance of the circuit. Dirty and loose connections add the resistance.
1009	***What is electric current?***	The rate of flow or charge past a given point in an electric circuit..
1010	***What is unit of current?***	The unit of current is ampere.
1011	***What is unit of charge? Also define it.***	The unit of charge is Coulomb. It is defined, as quantity of charge flowing in a conductor in one second for current passing in it, is one ampere.
1012	***Define Ampere.***	The current due to flow of charge at the rate of one coulomb per second.
1013	***What is resistance? Give its units.***	The opposition to the flow of electricity is called resistance. Its unit is Ohm.
1014	***What is specific resistance?***	The resistance of one cm cube of sample of material.
1015	***What is the unit of specific resistance or resistivity?***	Ohm-meter is the unit of resistivity.
1016	***Upon which factors resistance of a conductor depends?***	It depends upon; i) length, ii) area of cross-section, iii) temperature, iv) material of the wire
1017	***Will a thicker wire have larger or smaller specific resistance?***	The thicker wire will have larger specific resistance according to the formula: $\rho = X\pi r^2 / L$
1018	***Why is the slide wire bridge so called?***	Because it works on the principle of Wheatstone bridge.

1019	***On which principle slide wire bridge circuit works?***	On the principle of Wheatstone bridge.
1020	***What is the principle of Wheatstone bridge?***	Its principle is: when no current flows through the galvanometer then; $R_1 / R_2 = R_3 / R_4$
1021	***What is Eureka wire?***	An alloy of 60% copper and 40% nickel used for electrical filament and resistance wire.
1022	***What is the effect of temperature on the resistance of a conductor?***	The resistance of the conductor increases with the increase of temperature.
1023	***Give unit of conductivity.***	The unit of conductivity is $(\text{Ohm-m})^{-1}$
1024	***Why is the potentiometer an accurate device for measuring potential difference?***	Because the potentiometer does not draw any current as in case of the voltmeter.
1025	***Describe the principle of potentiometer.***	The P.D. across any length of the wire is directly proportional to the length, when the current passes through the potentiometer wire.
1026	***What is potentiometer?***	An instrument for measuring electrical potential differences by balancing two opposing potentials so that no current flows through a galvanometer.
1027	***Why the galvanometer shows half deflection upon closing the two keys.***	The current is divided into two paths, half the current passes through the shunt S and half through the galvanometer.
1028	***What is meant by shunting the galvanometer?***	A wire or any conductor connected across a galvanometer.
1029	***Why galvanometer is shunted?***	To limit the current flowing through the galvanometer and make it sensitive.
1030	***The resistance of which part of galvanometer is measured?***	Of the coil of the galvanometer.
1031	***What do you mean by the resistance of the galvanometer?***	Galvanometer resistance means the resistance f the moving coil inside the galvanometer.
1032	***Should we use resistance box to alter strength of a heavy current in electric circuit?***	No, we should use a rheostat which uniformly vary the strength of current.
1033	***Why should the galvanometer be never shunted, while its resistance is being measured?***	Because the resistance of the galvanometer decreases by shunting it.
1034	***Why galvanometer shows half deflection when both keys are closed?***	Because half of current goes through shunt and half through galvanometer.
1035	***Is the half deflection method an accurate method?***	No, it is not accurate. Kelvin method is more sensitive.
1036	***What is a voltmeter ?***	It is an instrument for measuring potential difference.
1037	***How will you connect a voltmeter in a circuit?***	It is connected in parallel to the circuit or across a resistor.
1038	***What should be the characteristics of a good voltmeter?***	Its resistance should be very high as compared to the resistance of the circuit. Connected across some resistor and parallel to the battery.

1039	***Can you use a D.C. voltmeter in an A.C. circuit?***	No, a D.C. voltmeter in only used in d.c. current circuit.
1040	***Name a device that can measure current in the circuit, P.D. between any two points and resistance of a conductor.***	Avometer or multimeter can measure current, P.D. and the resistance.
1041	***Why high resistance voltmeter is preferred for measuring more exact voltage?***	Because it does not draw any current by itself and potential drop does not occur.
1042	***What is shunt?***	It is a low resistance placed in parallel to the circuit.
1043	***Does the resistance of a circuit increase when it is shunted?***	No, combined resistance of the circuit decreases.
1044	***Is voltmeter high resistance or low resistance galvanometer?***	The voltmeter is a high resistance galvanometer.
1045	***What is short circuit?***	A closed circuit with no resistor and will have a continuous flow of current.
1046	***What is an open circuit?***	A broken circuit or a circuit having infinite resistance.
1047	***What is a thermister?***	A thermister is heat sensitive semi-conductor device. Its resistance decreases when its temperature increases.
1048	***What is temperature coefficient of resistance?***	The fractional change in resistance per Kelvin.
1049	***Can a thermister have positive temperature coefficient?***	Yes, thermisters with positive temperature coefficient are also available.
1050	***What do you mean by response time of thermister?***	It is the time required by the thermister to get heated and change its resistance.
1051	***What is an ammeter?***	Device to measure current; it's a low resistance moving coil galvanometer.
1052	***What will happen if ammeter is connected in parallel to a circuit or across a battery?***	The ammeter will damage and burn out.
1053	***How can a galvanometer be converted into an ammeter?***	By connecting a suitable low resistance in parallel with galvanometer coil.
1054	***How can a galvanometer be converted into a voltmeter?***	By connecting a suitable high resistance in series with galvanometer coil.
1055	***What is difference between galvanometer and ammeter?***	Galvanometer is used to detect small current. Ammeter is simply a galvanometer, shunted with low resistance, used to measure current.
1056	***How will you connect a voltmeter in a circuit?***	It is always connected in parallel with the circuit.
1057	***How does a voltmeter differ from an ammeter?***	A voltmeter is high resistance galvanometer, used for measuring potential difference,; ammeter is a low resistance galvanometer used to measure current.
1058	***What is resistance?***	The opposition to the flow of electricity due to collisions of free electrons with atoms.

1059	***Why should a voltmeter have very high resistance?***	It is connected in parallel to the circuit for measuring potential difference. Using high resistance in voltmeter would help not to change P.D. in the circuit.
1060	***What is conductance of a conductor?***	Ability to conduct electricity. It is reciprocal to the resistance.
1061	***What is mho?***	It is the unit of electrical conductance; the reciprocal of the ohmic resistance.
1062	***Define an ohm.***	One ohm resistance when 1 ampere current passes through a conductor with one volt P.D.
1063	***What do you mean by internal resistance of a cell?***	The resistance offered by electrolyte to passage of current.
1064	***What is potentiometer?***	It is an apparatus for comparing and measuring potentials.
1065	***Whether internal resistance remains constant or not?***	It does not remain constant but changes when current drawn.
1066	***What is emf of a cell?***	The potential difference between its terminals for open circuit.
1067	***Is electron volt (eV) a unit of P.D. or energy?***	Electron volt is the unit of energy. Used for nuclear energy.
1068	***What is a power supply?***	It is an energy source used to operate electrical and electronic devices.
1069	***What is solar cell?***	A device which converts solar energy or artificial light into electrical energy.
1070	***What is a battery?***	A battery is group of electric cells.
1071	***What is primary cell?***	It is a device which converts chemical energy into electrical energy.
1072	***What does one-sided deflection of the galvanometer indicate?***	It shows that the emf of battery used is smaller than the emf of any of the two cells.
1073	***Define electron volt.***	The energy required to move an electron between two points, which have a potential difference of one volt.
1074	***What is the value of electron volt.***	The equivalent is: $1\ eV = 1.6 \times 10^{-19}$ Joules
1075	***What is battery or a storage cell?***	A device in which energy is stored in the form of chemical energy and then changed to electrical energy as to deliver current.
1076	***Name a device that converts chemical energy into electrical energy.***	A battery or cell converts chemical energy into electrical energy.
1077	***Under what condition terminal P.D. is equal to the E.M.F. of the cell?***	When the cell is in open circuit, i.e., when no current is drawn from the cell.
1078	***What is potential difference?***	The work done per unit charge as a charge is moved between two points in an electric field.
1079	***What is the unit of potential difference and define it.***	The unit is volt. It is the P.D. between two points when one Joule of work is done in moving one coulomb of charge from one point to the other.

1080	***If two equal resistances are connected across a battery how will the P. D. vary?***	The same value of current will pass through each resistance. P.D. across each resistance will be same.
1081	***How does the P.D. vary across resistances in series?***	The P.D. varies according to resistances' value, for larger resistance the P.D. will be greater.
1082	***Why the deflection of galvanometer is zero at balance point?***	Because emf of the cell is equal to potential drop here.
1083	***Which type of galvanometer is suitable in potentiometer circuit?***	A sensitive center-point galvanometer is most suitable.
1084	***Why should the weak current be used in the potentiometer wire?***	So that due to heat produced, the resistance may not change.
1085	***Why P.D. between the terminals of a cell falls when it delivers a current?***	Because some potential drop occurs in the internal resistance of the cell.
1086	***Why a rheostat is used?***	To change the P.D. across potentiometer wire.
1087	***Why should the current in the potentiometer circuit be stopped quickly?***	Heat is produced as current passes, which change the resistance of wire of the potentiometer.
1088	***Why the resistance of tungsten filament changes when the circuit is on?***	As the temperature of the tungsten filament changes, so the resistance changes.
1089	***Why Tungsten filament becomes white hot with passage of current through it?***	Due to its high resistance, heat is generated by the passage of current in it.
1090	***Why bulbs are connected in parallel with power points?***	To keep the voltage same across each of the bulb.
1091	***Why a Tungsten filament of a bulb does not obey Ohm's law?***	As the temperature of filament changes and for Ohm's law, temperature must remain constant.
1092	***Why is the nichrome wire used in the construction of electric heater?***	Nichrome wire has high resistance to convert electrical energy into heat.
1093	***What is temperature coefficient of resistance?***	The change in resistance per degree change in temperature per ohm at a particular temperature.
1094	***What is Ohm's law?***	The potential difference is proportional to the current, provided there is no change in the state of the conductor.
1095	***Define Ohm.***	Amount of resistance when P.D. of 1 volt applied across a conductor produces a current of 1 ampere.
1096	***Under what conditions Ohm's law is applicable?***	If the temperature of the conductor remains constant then Ohm's law is applicable.
1097	***What is the nature of the field due to current alone?***	Field due to current alone will be represented by circular lines of force.
1098	***Is any practical application of using uniform field at the center of a coil?***	It is used in the construction of a tangent galvanometer.
1099	***What is a line of force?***	The line along which a free north pole will move if free to move in a magnetic field.

1100	***Can two lines of force intersect each other?***	No, they cannot intersect each other.
1101	***Give an approximate value of the strength of Earth's magnetic field.***	Earth's magnetic field is about 50 micro-tesla.
1102	***What is the S.I. unit of magnetic field?***	It is Tesla or Weber/m or Newton/ampere-meter.
1103	***What kind of magnetic field is produced at the center of the coil?***	The uniform magnetic field. The lines of force are straight and parallel.
1104	***What kind of field does a current carrying wire produce?***	The field produced makes circular lines of force.
1105	***What is time constant?***	The time in which a capacitor discharges to 37% of the maximum charge.
1106	***When does time constant of an RC circuit equals one second?***	If R = 1 ohm & C = 1 farad, then the time constant τ of RC circuit will be 1 second.
1107	***Why is the discharging current maximum initially?***	Because full capacitor voltage is applied across the resistor R.
1108	***What type of decrease is, of discharge current in capacitor?***	It is the exponential decrease.
1109	***What is a capacitor?***	It is combination of conducting plates separated by an insulator used to store electric charge.
1110	***What is the unit of capacitance of a capacitor?***	The unit of capacitance is Farad.
1111	***Define a Farad.***	It is the capacitance of a capacitor between the plates of which there appears a difference of potential of one volt when it is charged by a quantity of electricity equal to one coulomb.
1112	***What is the equivalent capacitance of capacitors connected in parallel?***	For two capacitors C_1 & C_2, connected in parallel, the formula is: $C_{eq} = C_1 + C_2$
1113	***What is the equivalent capacitance of capacitors connected in series?***	For two capacitors C_1 & C_2 , connected in series, the formula is: $1/C_{eq} = 1/C_1 + 1/C_2$
1114	***What is the effect of dielectric in capacitor?***	It increases the capacitance.
1115	***What is the reactance of a capacitor?***	Reactance of a capacitor is its opposition to alternating current.
1116	***What is a semi-conductor?***	The substance whose resistance lie in between conductor and insulator.
1117	***How does the resistivity of semiconductor changes with temperature?***	The resistivity of a semiconductor decreases with increasing temperature.
1118	***What is super conductor?***	A substance having the properties of super conductivity.
1119	***What is super conductivity?***	The effective disappearance of electrical resistance in certain substances when they are cooled close to absolute zero.
1120	***What is the use of a semi-conductor diode?***	It is used to convert A.C. into D.C.

1121	***What is the difference between insulator and semiconductor?***	Semiconductors have resistivity midway between that of conductors and that of insulators. In insulators electric charge is not readily transferred.
1122	***Is current induced in superconductors sustain?***	Yes, currents induced in circuits of such materials have persisted for several years with no measurable change.
1123	***What is a rectifier?***	Rectifier is a device to convert A.C. into D.C.
1124	***What is a p-n junction?***	It is a combination of p and n type substances.
1125	***What do you understand by doping?***	The process of adding impurity to control the conductivity is called doping.
1126	***What are the types of transistors?***	There are two types, i) P.N.P. and ii) N.P.N.
1127	***What are different parts of transistors?***	There are three parts of a transistor: i) emitter, ii) base, iii) collector
1128	***Does base-emitter junction have reverse bias?***	No, it is forward biased.
1129	***How does the resistance of conductors & semiconductors change with temperature?***	In conductors, resistance increases with increase of temperature; in semiconductors, resistance decreases with increase of temperature.
1130	***Define temperature coefficient of resistance.***	The change in resistance per degree change in temperature per ohm at a particular temperature.
1131	***What happens to resistance at absolute zero?***	The value of resistance is not zero at absolute zero. It will have some low value.
1132	***Does the resistance of a circuit increases, or decreases or remains constant?***	The resistance of the circuit increases, as the current decreases, from the knowledge of Ohm's law.
1133	***How many PN junctions are there in a transistor?***	There are two PN junctions; Emitter-base and Collector-base junction.
1134	***What is P-type semi-conductor or P-type germanium?***	"Hole rich" semiconductor (or germanium) consisting of equal number of free positive holes and bound negative charges so that the net charge is zero.
1135	***What is N-type semi-conductor or N-type germanium?***	Electron rich semi-conductor (or germanium) consisting of equal number of free electrons and bound positive charges so that the net charge is zero.
1136	***What is net charge of P-type crystal?***	Net charge of P-type crystal is zero.
1137	***What is net charge of N-type crystal?***	Net charge of N-type crystal is zero.
1138	***Distinguish between silicon and germanium.***	Silicon is non-metallic crystal and germanium is metallic crystal. Both are tetravalent.
1139	***Which is more temperature resistant, germanium or silicon?***	Germanium can work upto 80 ^{o}C, but silicon can work upto 200 ^{o}C.
1140	***What do you mean by doping?***	The addition of donor or acceptor atoms (impurity) to a semiconductor.
1141	***What are the disadvantages of transistors?***	Transistors are not independent from temperature but depend upon it.

1142	***What is meant by photo-electrons?***	Electrons emitted from a light-sensitive material when illuminated.
1143	***Define photoelectric effect.***	The emission of electrons by a substance when illuminated by electromagnetic radiation.
1144	***What is a photo cell?***	Photo cell is a device which convert light energy into electrical energy under certain conditions.
1145	***What is a transducer?***	Any device that converts energy from one form to another form.
1146	***What are the uses of photocell?***	Photocells are used in electronic equipments (e.g.calculators), space vehicles and in satellites.
1147	***What is energy of photon?***	Energy of photon is; $E = h f$
1148	***How does energy of photo-electrons vary with intensity of incident radiation?***	It does not vary, as the energy of photoelectrons does not depend upon the intensity of incident light.
1149	***What happens with number of ejected photoelectrons if we increase the intensity of incident radiation?***	Number of ejected photoelectrons will increase if we increase the intensity.
1150	***Does photoelectric effect take place at all frequencies?***	No, photoelectric emission starts at a certain frequency called threshold frequency.
1151	***What is the unit of intensity of light?***	Intensity of light is measured in the units: $J\ m^{-2}\ s^{-1}$
1152	***What is intensity of light?***	The energy transmitted per second through a unit area by the light waves.
1153	***What is photon?***	A quantum of electromagnetic radiation that has energy equal to the product of the frequency of the radiation and Planck's constant.
1154	***Why ordinary light can easily cause photoelectric emission in alkali metals?***	Because alkali metals posses low work function.
1155	***What is rest mass of photon?***	The rest mass of photon is zero.
1156	***What is charge & momentum of photon, when it is at rest?***	It is chargeless and its momentum is given by $p = mc$.
1157	***Define threshold frequency.***	Minimum frequency required for a photon of radiation to remove an electron from the surface of a material.
1158	***What is work function?***	The minimum energy required to remove an electron from the surface of a material and send it into field-free space.
1159	***What is the difference between work function and threshold frequency?***	Work function relates with minimum energy and threshold frequency relates with minimum frequency to remove an electron from the surface.
1160	***What is inverse square law?***	The intensity of light is inversely proportional to the square of distance from the point source.
1161	***Name the device that converts light energy into electrical energy***	Photocell converts light energy into electrical energy.
1162	***How does stopping potential depend upon the intensity of light?***	Stopping potential does not depend upon the intensity of light.

1163	***What is stopping potential?***	The reverse potential at which the current becomes zero.
1164	***What is Planck's law?***	E = hf, which shows that energy & frequency are directly proportional.
1165	***What is Planck's constant?***	A universal proportionality constant relating photon energy to the frequency of radiation; 6.6256×10^{-34} J-s.
1166	***What is cathode ray oscilloscope?***	A device that enables different electrical signals to be examined visually.
1167	***Why is a CRO used to measure voltages?***	Because it has an very high resistance and draws no current from a source.
1168	***Why is CRO called a visual voltmeter?***	It is able to show voltage variation with time.
1169	***Describe the principle of CRO.***	CRO works by a deflecting beam of electrons as they pass through uniform electric field between the two sets of parallel plates.
1170	***What is a logic gate?***	The electronic circuits which implement various logic operations.
1171	***What is the Boolean expression for OR gate?***	The Boolean expression for OR gate is A + B.
1172	***Can an OR gate perform an AND operation?***	Yes, if we consider the complementary logic.
1173	***Why is the AND gate termed as an all-or-nothing gate?***	Because output occurs only when all inputs are high.
1174	***Is an AND gate equivalent to a series switching circuit?***	Yes, a series switching circuit is equivalent to an AND gate.
1175	***Can an AND gate be used as an OR gate?***	An AND gate can be used as OR gate with inputs and output in complement form.
1176	***What are fundamental gates?***	OR, AND and NOT are fundamental gates.
1177	***What gate is used for fire alarm?***	NOT gate is used for fire alarm.
1178	***What gate is used for burglar alarm?***	NAND gate is used for burglar alarm.
1179	***What happens when a NOT gate is connected to the output of OR gate?***	It becomes a NOR gate.
1180	***Why is the NOT gate known as an inverter?***	Because it inverts the input signal, i.e., it reverses the logic state.
1181	***What is the only function of a NOT gate?***	The only function of the NOT gate is to invert the input.
1182	***Why is it called burglar alarm?***	As it is fitted inside the office buildings & houses to protect from burglars.
1183	***What is a trap switch?***	It is a switch fixed in a door so that when it is opened, the switch opens and changes the state of the input of the system.
1184	***Which one of the three basic logic gates is simplest one.***	The NOT gate is the simplest one. Also called the inverter.
1185	***Can the logic NOT gate have more than one input?***	The NOT gate can have only one input.

1186	***What is NAND gate?***	The NAND gate is, a NOT-AND gate. It operates as an AND followed by a NOT gate.
1187	***Does NAND gate perform reverse function of AND gate.***	Yes, it can perform reverse function of an AND gate.
1188	***Why is NOT gate called a fire alarm?***	Because this system operates by heating the thermister with fire or burner.
1189	***Why is the NOT gate called an inverter?***	As its input is 1 when the output is zero and vice versa, the NOT gate is known as inverter.
1190	***What is the used of fire alarm?***	It protects the office buildings and houses from danger.
1191	***What is a Geiger-Muller tube or counter?***	A device used for detection and counting of charged particles.
1192	***What is a self quenching counter?***	Having a counter filled with argon and alcohol mixture.
1193	***What do you mean by a scalar?***	It is a device which records directly the counts of the G-M tube pulses.
1194	***What is the background effect?***	In the absence of radioactive source, the response of G.M. Counter to cosmic rays and radioactive contaminations.
1195	***What is characteristic curve of a counter?***	The curve obtained by plotting applied voltage verses number of counts.
1196	***What is meant by striking voltage?***	The potential difference across a neon lamp at which it begins to glow.
1197	***What is meant by extinction voltage?***	That certain voltage at which neon lamp extinguishes.
1198	***What do you mean by flashing period?***	Time between two consecutive glows of the neon lamp.
1199	***At what portion of solenoid the magnetic field is uniform?***	At the center of the solenoid, the magnetic field will be uniform.
1200	***What is the path followed by an electron projected in a uniform magnetic field at right angle to it?***	The path followed will be circular.
1201	***Is it possible to use earth's magnetic field to deflect the electron's beam?***	No, because the earth's magnetic field is too weak to produce deflection.
1202	***How many forces acting on the electron while moving in circular path?***	Two forces are acting on it; centripetal force & magnetic force.
1203	***How does a current carrying loop behave?***	It behaves like a magnetic dipole with one face as north pole and the other as south pole.
1204	***Why magnetic needle used in compass needle is very small***	Because the field produced is uniform only over a small region at the center.

Science is simply common sense at its best—that is, rigidly accurate in observation, and merciless to fallacy in logic. —*T. H. Huxley*

LAHORE BOARD

204 (INTER PART-II)

PHYSICS (New Course) GROUP-I Roll No.__________
PRACTICAL (Objective Type)
Time Allowed : 20 Minutes
Maximum Marks : 10 Examiner's Signature________________

SECTION – I

1. Encircle the correct answer of the following:

(a) Galvanometer is used for the detection of current. True/False
(b) For a series combination of resistance the current across each resistance is different. True/False
(c) Gauss and oersted are same units. True/False
(d) The units of Planck's constant are joule sec. True/False
(e) The conductivity of a conductor is always smaller then that of semi conductor. True/False
(f) Magnetic intensity is a vector quantity. True/False
(g) The extreme right end of P-N-P transistor represent collector. True/False
(h) The units of specific resistance ohm x m. True/False
(i) A transformer works on the principle of self induction. True/False
(j) A thermister is a light sensitive resistor. True/False

Roll No.______________ (To be filled in by the candidate)
204 (INTER PART-II) Time Allowed: 1 Hour & 40 Minutes
PHYSICS (New Course) GROUP-I Max. Marks : 15
(Practical Work)

Note: The candidate will mark two experiments from Section-II. The Examiner will allot one experiment out of the marked ones to be performed.

SECTION – II

2. Convert a galvanometer into ammeter of range (0 – 0.5) amp.

3. Find the internal resistance of a cell using potentiometer.

4. Determine the EMF of a cell using potentiometer.

5. Study the variation of electric current with the intensity of light using a photo cell.

Viva Voce.

Note Book.

Tables of Constants & Useful Data

$\pi = 3.14$; $\sqrt{\pi} = 1.773$; $\pi^2 = 9.87$
Sphere's surface area = $4\pi R^2$
Circumference of a circle = $2\pi R$

Area of cross-section = πR^2
Volume of a sphere = $4/3\ \pi R^3$
Volume of a cylinder = $\pi R^2 \times l$

Value of *g* at different places	
Peshawar	970.3 cm/sec^2
Rawalpindi	973.2 cm/sec^2
Lahore	979.0 cm/sec^2
Multan	979.4 cm/sec^2
North pole	983.2 cm/sec^2

Substance	Critical Angle	μ
Crown glass	41°	1.52
Flint glass	37°	1.67
Water	48.5°	1.33
Glycerin	44.5°	1.47
Diamond	24°	2.42
Air	nil	1.00

Elastic constants for wire		
Material	Breaking stress	Young's modulus
	kgm/mm^2	dynes/cm^2
Aluminum	20 to 25	7.2 to 7.5 x 10^{11}
Brass	30 to 90	8 to 10.5 x 10^{11}
Copper	40 to 45	10 to 13 x 10^{11}
Iron	40 to 55	19 to 20 x 10^{11}

Surface Tension	
Substance	Surface tension
Water	72.3 dynes/cm
Kerosene oil	26.3 dynes/cm
Turpentine oil	27.3 dynes/cm
Paraffin oil	26.4 dynes/cm
Alcohol	22 dynes/cm
Mercury	465 dynes/cm

Specific Heat for Solids and Liquids					
Solid	Kcal / kg °C	J / Kg °C	Liquid	Kcal / kg °C	J / Kg °C
Aluminum	0.212	903.0	water	1.000	4200.0
Brass	0.088	369.6	Glycerin	0.58	2226.0
Copper	0.094	387.7	Kerosene oil	0.53	2226.0
Glass	0.19	798.0	Castor oil	0.508	2133.6
Iron	0.119	499.8	Olive oil	0.47	1974.0

Coefficients of Linear Expansion (°C^{-1})			
Aluminum	0.000023	Silver	0.00001
Brass	0.000019	Iron	0.00001
Copper	0.000017	Platinum	0.00000
Glass	0.000008	Ice	0.00005

Coefficients of Viscosity					
Water	.01793 at 0 °C	.01142at 15 °C	.01006at 20 °C	.00902at 50 °C	.00012at100 °C
Air	.00017at 0 °C	.00018at 15 °C	Mercury	.016 at 20 °C	.00532at100 °C
Ether	.00234at 20 °C	.000097at100 °C	Alcohol	.0119at 20 °C	.00011at100 °C

Wavelength of light: Sodium (yellow) = 5896 A.U. = 5.9 x 10^{-7} m
Laser (red) = 6800 A.U. = 6.8 x 10^{-7} m

Velocity of Sound in: Air at 0 °C = 331.3 m/sec; Increase for 1 °C = 61 cm/sec
Water at 15 °C = 1450 m/sec, Copper at 20 °C = 3560 m/sec, Steel = 5000 m/sec

Conversion Factors

1 inch = 2.54 cm = 0.0255 meter, 1 meter = 100 cm = 39.37 inch
1 Newton = 10^5 dynes, 1 calorie = 4.18 joules, 1 Joule = 10^7 erg = 0.239 calorie
1 litre = 1000 c.c., 180 = π radians, 1 radian = 57.3°, 1 mile = 1.61 km

Some Fundamental Constants

Velocity of light	c	2.9979×10^{8} m/s = 186,000 miles/s
Elementary charge	e	1.6021×10^{-19} C
Electron rest mass	m_e	9.1091×10^{-31} kg
Proton rest mass	m_p	1.6725×10^{-27} kg = 1.008 amu= 1836 electron masses
Neutron rest mass	m_n	1.6748×10^{-27} kg = 1837 electron masses
Planck's constant	h	6.6256×10^{-34} J.s.
e/m for electron	e/m_e	1.7588×10^{11} kg^{-1} C
Rydberg constant	R	1.0974×10^{7} m^{-1}
Avogadro constant	N_o	6.0225×10^{23} mol^{1}
Boltzmann constant	$k = R/N_o$	1.3805×10^{-23} J $K^{o\,-1}$
Universal gas constant	R	8.3143 J $K^{o\,-1}$ mol^{-1}
Vacuum permittivity	ε_o	8.8544×10^{-12} N^{-1} m^{-2} C^{2}
Vacuum permeability	μ_o	1.3566×10^{-6} m kg C^{-2}
Acceleration of gravity	g	9.7805 m s^{-2}
Gravitational constant	G	6.673×10^{-11} N-m^{2} /kg^{2}
One atomic mass unit	μ (C^{12})	1.66×10^{-27} kg = 931 Mev = 1.49×10^{-10} J
1 electron volt	E eV	1.501×10^{-12} erg
Stefan-Boltzmann constant	K	5.6697×10^{-8} W m^{-2} $K^{o\,-4}$
Bohr magneton	$\mu_B = eh/2m_e$	9.274×10^{-24} J T^{-1}

Electromotive force & composition of voltaic cells

Electromotive force is that which causes a flow of current. The electromotive force of a cell is measured by the maximum difference of potential between its plates.

Standard Cells

Name of cell	Negative pole	Solution	Positive pole	Depolarizer	EMF in volts
Weston normal	Cadmium amalgam	Saturated solution of $CdSO_4$	Mercury	Paste of Hg_2SO_4 & $CdSO_4$	1.0183 at 20° C
Clark standard	Zinc amalgam	Saturated solution of $ZnSO_4$	Mercury	Paste of Hg_2SO_4 & $ZnSO_4$	1.4328 at 15° C

Double Fluid Cells

Name of cell	Negative pole	Solution	Positive pole	Solution	EMFin volts
Bunsen	Amal. Zinc	1 part H_2SO_4 to 12 parts H_2O	Carbon	HNO_3, density1.38	1.86
Daniell	Amal. Zinc	1 part H_2SO_4 to 4 parts H_2O	Copper	Saturated solution of $CuSO_4 + 5H_2O$	1.06

Single Fluid Cells

Name of cell	Negative pole	Solution	Positive pole	E.M.F. in volts
Dry cell	Zinc	Ammonium Chloride	Carbon with MnO_2	1.53
Leclanche	Amal. Zinc	Solution of sal-ammoniac	Manganese peroxide with powd. carbon	1.46

Resistance

Definition: It is a property of conductors depending on their dimensions, material and temperature when determines the current produced by a given difference of potential. The practical unit is ohm.

Resistance of a conductor at 0 °C, of length l, cross-section s and specific resistance ρ,

$$R_o = \rho \frac{l}{s}$$

Resistance of wires

B. & S. Gauge	Diameter in mm.	Ohms per cm	B. & S. Gauge	Diameter in mm.	Ohms per cm
Constantan (0 °C) $\rho = 44.1 \times 10^{-6}$ ohm-cm			Nichrome $\rho = 100 \times 10^{-6}$ ohm-cm		
10	2.588	.000838	10	2.588	.00190
12	2.053	.00133	12	2.053	.00302
14	1.628	.00212	14	1.628	.00481
16	1.291	.00337	16	1.291	.00764
20	0.8118	.00852	20	0.8118	.0193
24	0.5106	.0215	24	0.5106	.0489
28	0.3211	.0545	28	0.3211	.123
32	0.2019	.138	32	0.2019	.312
36	0.1270	.348	36	0.1270	.789
40	0.07987	.880	40	0.07987	2.00
Copper $\rho = 1.724 \times 10^{-6}$ ohm-cm			Platinum $\rho = 10 \times 10^{-6}$ ohm-cm		
10	2.588	.0000328	10	2.588	.000190
12	2.053	.0000521	12	2.053	.000302
14	1.628	.0000828	14	1.628	.000481
16	1.291	.000132	16	1.291	.000764
20	0.8118	.000333	20	0.8118	.00193
24	0.5106	.000842	24	0.5106	.00489
28	0.3211	.00213	28	0.3211	.0123
32	0.2019	.00538	32	0.2019	.0312
36	0.1270	.0136	36	0.1270	.0789
40	0.07987	.0344	40	0.07987	.200
Eureka (0 °C) $\rho = 47 \times 10^{-6}$ ohm-cm			Steel (0 °C) $\rho = 11.8 \times 10^{-6}$ ohm-cm		
10	2.588	.000893	10	2.588	.000224
12	2.053	.00142	12	2.053	.000357
14	1.628	.00226	14	1.628	.000567
16	1.291	.00359	16	1.291	.000901
20	0.8118	.00908	20	0.8118	.00228
24	0.5106	.0230	24	0.5106	.00576
28	0.3211	.0580	28	0.3211	.0146
32	0.2019	.147	32	0.2019	.0368
36	0.1270	.371	36	0.1270	.0931
40	0.07987	.938	40	0.07987	.236
Iron $\rho = 10 \times 10^{-6}$ ohm-cm			Tungsten $\rho = 5.51 \times 10^{-6}$ ohm-cm		
10	2.588	.000190	10	2.588	.000105
12	2.053	.000302	12	2.053	.000167
14	1.628	.000481	14	1.628	.000265
16	1.291	.000764	16	1.291	.000421
20	0.8118	.00193	20	0.8118	.00106
24	0.5106	.00489	24	0.5106	.00269
28	0.3211	.0123	28	0.3211	.00680
32	0.2019	.0312	32	0.2019	.0172
36	0.1270	.0789	36	0.1270	.0435
40	0.07987	.200	40	0.07987	.110

Specific resistance or resistivity (ρ):

Definition: It is the reciprocal of conductivity, is measured by the resistance of a body of the substance of unit cross-section and of unit length at 0 °C also called **volume resistivity**. The unit may be defined as the ohm-centimeter.

Mass resistivity is the longitudinal resistance per unit length of a uniform bar of the substance of such a sectional areas that it contains one unit of mass per unit length.

Surface resistivity is the resistance of unit length and unit width of a surface.

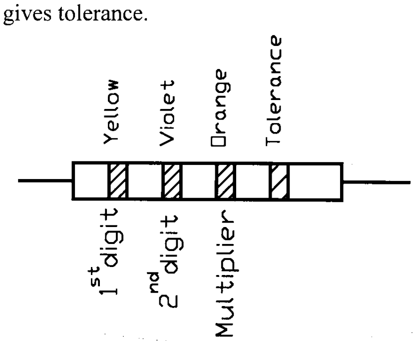
Material	Temp °C	Resistivity ohm-cm	Material	Temp °C	Resistivity ohm-cm
Aluminum	20	2.828×10^{-6}	Mercury	20	95.783×10^{-6}
Brass	0	$6.4—8.4 \times 10^{-6}$	Molybdenum	20	5.7×10^{-6}
Carbon	0	3500×10^{-6}	Nichrome	20	100×10^{-6}
Chromium	0	2.6×10^{-6}	Nickel	20	7.8×10^{-6}
Copper	20	1.72×10^{-6}	Platinum	20	10×10^{-6}
Eureka	0	48×10^{-6}	Platinum-iridium	0	24×10^{-6}
German silver, Ni	20	33×10^{-6}	Rose metal [Bi49,Pb28,Sm23]	0	64×10^{-6}
Gold pure	20	2.44×10^{-6}	Silver	0	2.4×10^{-6}
Iron	20	10×10^{-6}	Sodium	-180	1.0×10^{-6}
Steel	20	64×10^{-6}	Tin	-180	3.40×10^{-6}
Manganin	20	44×10^{-6}	Tungsten	20	5.51×10^{-6}

Colour code for resistors

Black	Brown	Red	Orange	Yellow	Green	Blue	Violet	Gray	White
0	1	2	3	4	5	6	7	8	9

Colour bands interpretation:

1. First band indicates the first significant figure.
2. The send band gives second significant figure.
3. The third band gives actual resistance; it is decimal multiplier.
4. The fourth band gives tolerance.



Example: A resistor whose bands are yellow, violet, and orange has a resistance of 47,000 Ω or green, blue, green signifies 5,600,00 , or 5.6 M Ω.
A fourth band of either gold or silver tells the tolerance.

Internal resistance of various voltaic cells

The following values are approximate. It is a subject of large variations.

Cell	Resistance in ohms	Cell	Resistance in ohms
Daniell	0.85	Leclanche	0.4—0.2
Silver Chloride	4	Storage	0.004—0.02
Dry cell	0.05—0.10	Weston standard	20—50

Magnetic fields in the Solar System

Planet	μ ($A.m^2$)	B at Surface (μT)
Mercury	5×10^{19}	0.35
Venus	$< 10^{19}$	< 0.01
Earth	8.0×10^{22}	30
Mars	$< 2 \times 10^{18}$	< 0.01
Jupiter	1.6×10^{27}	430
Saturn	4.7×10^{25}	20
Uranus	4.0×10^{24}	10-100
Neptune	2.2×10^{24}	10-100

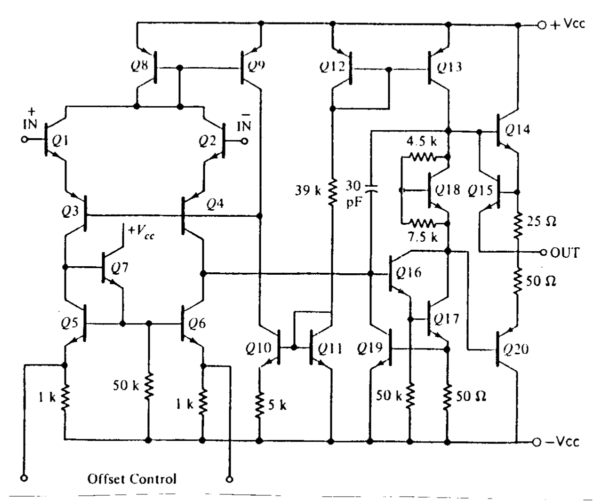
Some magnetic elements

Dip: The angle measured in a vertical plane exerted on unit charge. Unit field intensity is the field, which exerts the force of one dyne on unit positive charge.

Values of magnetic elements at some places. (1 gamma = 0.00001 C.G.S. Units)

Place	Declination	Angle of Dip	Horizontal force	Vertical force
Lahore	1° East	47° 23.9′	32,950 gammas	35,830 gammas
Karachi	1° East	36° 48.3′	35,550 gammas	26,600 gammas
Peshawar	2° East	51° 29.1′	31,000 gammas	38,950 gammas
Quetta	1.25° East	45° 36.1′	33,000 gammas	33,700 gammas

An OP-AMP: Schematic of the 741 type of internally compensated integrated circuit(IC).



Natural Trigonometric Functions

Angle	Sine	Cosine	Tangent	Angle	Sine	Cosine	Tangent
1°	.018	.999	.018	46°	.719	.695	1.036
2°	.035	.999	.035	47°	.731	.682	1.072
3°	.052	.999	.052	48°	.743	.669	1.111
4°	.070	.998	.070	49°	.755	.656	1.150
5°	.087	.996	.087	50°	.766	.643	1.192
6°	.105	.995	.105	51°	.777	.629	1.235
7°	.122	.993	.123	52°	.788	.616	1.280
8°	.139	.990	.141	53°	.799	.602	1.327
9°	.156	.988	.158	54°	.809	.588	1.376
10°	.174	.985	.176	55°	.819	.574	1.428
11°	.191	.982	.194	56°	.829	.559	1.483
12°	.208	.978	.213	57°	.839	.545	1.540
13°	.225	.974	.231	58°	.848	.530	1.600
14°	.242	.970	.249	59°	.857	.515	1.664
15°	.259	.966	.268	60°	.866	.500	1.732
16°	.276	.961	.287	61°	.875	.485	1.804
17°	.292	.956	.306	62°	.883	.469	1.881
18°	.309	.951	.325	63°	.891	.454	1.963
19°	.326	.946	.344	64°	.899	.438	2.030
20°	.342	.940	.364	65°	.906	.423	2.145
21°	.358	.933	.384	66°	.914	.407	2.246
22°	.375	.927	.404	67°	.921	.391	2.356
23°	.391	.921	.425	68°	.927	.375	2.475
24°	.407	.914	.445	69°	.934	.358	2.655
25°	.432	.906	.466	70°	.940	.342	2.748
26°	.438	.899	.488	71°	.946	.326	2.904
27°	.454	.891	.510	72°	.951	.309	3.078
28°	.469	.883	.525	73°	.956	.292	3.271
29°	.485	.875	.554	74°	.961	.276	3.487
30°	.500	.866	.577	75°	.966	.259	3.732
31°	.515	.857	.601	76°	.970	.242	4.011
32°	.530	.848	.625	77°	.974	.225	4.331
33°	.545	.839	.649	78°	.978	.208	4.705
34°	.559	.829	.675	79°	.982	.191	5.145
35°	.574	.819	.700	80°	.986	.174	5.671
36°	.588	.809	.727	81°	.988	.156	6.314
37°	.602	.799	.754	82°	.990	.139	7.115
38°	.616	.788	.781	83°	.993	.122	8.144
39°	.629	.777	.810	84°	.995	.106	9.514
40°	.643	.766	.839	85°	.996	.087	11.43
41°	.656	.755	.869	86°	.998	.070	14.30
42°	.669	.743	.900	87°	.999	.062	19.80
43°	.682	.731	.933	88°	.999	.030	28.64
44°	.695	.719	.966	89°	.999	.018	57.29
45°	.707	.707	1.000	90°	1.000	.000	∞

An example of calculating sines or tangents of intermediate angles: To find sin 57.8 ; sin 57 is .839 and sin 58 is .848. the difference is .009 for 10 and .0009 for 1 of a degree. Therefore sin 57.8 is .839 + .0072 = .846 .

The readings of a normal student in the lab

Experiment No. 1:

To find the resistance of a wire by slide wire bridge.

Observations and Calculations:

Least count of the screw gauge = 1/100 mm = 0.01 mm = 0.001 cm
Diameter of the given wire:
i) 0.037 cm ii) 0.035 cm iii) 0.036 cm
Mean diameter = d = 0.036 cm
Radius of the wire = d/2 = r = 0.018 cm
Length of the wire = l = 99.6 cm

No. of obs.	Resistance taken out R	AB = l_1	BC = l_2	X = R x $\frac{l_1}{l_2}$
	ohms	cm	cm	ohms
1	5	34.1	65.9	9.7
2	7	41.5	58.5	9.8
3	9	45.7	54.3	10.6

Mean resistance X = 10.03 ohms

Specific resistance = $\frac{X}{l} \times \pi r^2 = 102.5 \times 10^{-6}$ ohm-cm = 1.02×10^{-6} ohm-m

Actual value (for Nichrome) = 1.1×10^{-6} ohm-m

Percentage error = 6.82 %

Experiment No. 2:

To find the resistance of a Galvanometer by half deflection method.

Observations and Calculations:

No. of obs.	Resistance R	Deflection θ	Shunt resistance S	Half deflection θ / 2	G = $\frac{R \times S}{R - S}$
	ohms	div.	ohms	div.	ohms
1	4800	30	99	15	101.08
2	5570	26	100	13	101.83
3	5500	24	100	12	101.85

Mean value of galvanometer resistance = G = 101.59 ohms

Experiment No. 3:

To find resistance of a voltmeter by drawing graph between R and 1/V.

Observations and Calculations:

No. of obs.	Resistance R	Voltmeter V	1 / V
	ohms	volts	volts $^{-1}$
1	0	1.5	0.66
2	500	1.3	0.76
3	1000	1.1	0.90
4	1500	1.0	1.00
5	2000	0.9	1.11
6	2500	0.8	1.25

From the graph : The intercept on X-axis = resistance of the voltmeter

R_V = …… ohms

Experiment No. 4:

Variation of resistance of thermister with temperature.

Observations and Calculations:

No. of obs.	Temperature	Absolute temperature	Resistance R
	^{o}C	K	K Ω
1	16	289	6
2	20	293	5
3	30	303	3
4	40	313	205
5	50	323	1
6	60	333	0.5
7	70	343	0.2

From the graph:

The slope $\Delta R / \Delta T$ = 0.08 ohm K^{-1}

Experiment No. 5:

Conversion of galvanometer into ammeter reading up to 0.1 amperes.

Observations and Calculations:

No. of obs.	Resistance R	Deflection θ	Shunt resistance S	Half deflection $\theta/2$	$G = \frac{R \times S}{R - S}$
	ohms	div.	ohms	div.	ohms
1	4800	30	99	15	101.08
2	5570	26	100	13	101.83
3	5500	24	100	12	101.85

Mean = G = 101.59 ohms

Table 2: Figure of merit

No. of obs.	Emf of cell E	Resistance R	Deflection θ	$k = \frac{E}{R+G} \frac{1}{\theta}$
	volts	ohms	div.	amp. / div.
1	3.0	3200	22	4.13×10^{-5}
2	3.0	3500	20	4.16×10^{-5}
3	3.0	3800	18	4.27×10^{-5}

Mean k = 4.17×10^{-5} amp. / div.

Figure of merit of galvanometer = k = 4.17×10^{-5}

Resistance of the galvanometer = G = 101.59 ohms

No. of div. on the galvanometer of one extreme end = n = 30

Current for full scale deflection = $I_g = n\,k$ = 0.0013 amp

Range of conversion = I = 0.1 amp.

Value of shunt resistance = $X = \frac{G\,I_g}{I - I_g}$ = 1.29 ohms

Corrected mean diameter of the wire = 1.15 mm

Radius of the wire = r = 0.575 mm = 0.0575 cms

Specific resistance of the wire = $\rho = 115 \times 10^{-6}\ \Omega$-cm

Length of wire used as shunt = $l = \frac{X \pi r^2}{\rho}$ = 116.51 cm

One scale division after conversion = $\frac{0.1}{n}$ = 0.0033 amp.

Table 3: Verification:

No. of obs.	Galvanometer reading: Deflection θ'	Galvanometer reading: Current in Amp. $(0.1/n)\,\theta'$	Ammeter reading	Difference
	S. division	Amp	Amp	Amp
1	10	0.03	0.04	0.01
2	15	0.04	0.05	0
3	20	0.07	0.06	0.01
4	25	0.08	0.08	0
5	30	0.1	0.1	0

Experiment No. 6:

Conversion of galvanometer into voltmeter reading up to 2 volts.

Observations and Calculations:

Resistance of the galvanometer
(by half deflection method) = G = 101.59 ohms

No. of div. on the galvanometer of one extreme end = n = 30

Figure of merit of the galvanometer = $k = \frac{E}{R+G} \frac{1}{\theta}$ 4.17×10^{-5} amp / div

Current for full scale deflection = I_g = n k = 0.0013 amps

Conversion range of galvanometer = V = 2 volts

External resistance to be placed in series with galvanometer = $R_x = \frac{V}{I_g} - G$ = 1437 ohms

Verification:

Each scale division on the converted galvanometer = 2 / n = 0.0667 volts

No. of obs.	Galvanometer reading: Deflection θ'	Galvanometer reading: P.D. in volts $(2/n)\,\theta'$	Voltmeter reading	Difference
	small div.	volts	volts	volts
1	5	0.3	0.3	0
2	10	0.7	0.6	0.1
3	15	1.0	1.0	0
4	20	1.3	1.2	0.1
5	30	2.0	2.0	0

Experiment No. 7:

To find the internal resistance of a cell using a Potentiometer.

Observations and Calculations:

Length l_1 = 358 cm

No. of obs.	Resistance R	Length l_2	Internal resistance $r = \frac{(l_1 - l_2)}{l_2} R$
	ohms	cm	ohms
1	5	318	0.63
2	7	334	0.50
3	6	327	0.57

Mean r = 0.56 ohms

Experiment No. 8:

To determine the emf of a cell using a Potentiometer.

Observations and Calculations:

E.M.F. of 1st cell = E_1 = 1.4 volts

No. of obs.	Length of balance point with cell E_1	E_2	$E_2 = E_1 \times l_2 / l_1$
	l_1 (cm)	l_2 (cm)	volts
1	284	298	1.33
2	294	301	1.36
3	304	317	1.34

Mean emf of cell E_2 = 1.34 volts

Experiment No. 9:

Relation between current passing through a tungsten filament lamp and the potential applied across it.

Observation and Calculations:

No. of obs.	Voltmeter reading V	Ammeter reading I	R = V/I
	Volts	mA	Ohms
1	0	0	0
2	0.1	0.12	0.8
3	0.2	0.22	0.9
4	0.3	0.28	1.07
5	0.4	0.32	1.2
6	0.5	0.36	1.3
7	0.6	0.4	1.5
8	0.7	0.42	1.6
9	0.8	0.44	1.8
10	1	0.46	2.1

Result : As the graph is not a straight line. So it is non-ohmic resistance.

Experiment No. 10:

Variation of magnetic field along the axis of a circular coil.

Observation and Calculations:

Number of turns in the coil = n = 50

Diameter of the coil, D = 11 cm. & radius, r = 5.5 cm = 0.11 m

Current through the coil = I = 0.8 amp

Deflection = θ = 80^o ; μ_o = 1.257×10^{-6} Weber/amp

Magnetic field at the center = B = $\frac{\mu_o n I}{D}$ = 4.57×10^{-4} Tesla

No. of obs.	Distance from the center, x		Deflection of the magnetometer			Mean θ	Tan θ	$\tan\theta(r^2+x^2)^{3/2}$
			Direct	Reverse current				
	cm	m	θ	θ'	$180 - \theta' = \theta$			
1	14	0.14	20	170	180 – 170 = 10	15	0.2679	9.12×10^{-6}
2	12	0.12	30	150	180 – 150 = 30	30	0.5774	0.13×10^{-6}
3	10	0.10	40	140	180 – 140 = 40	40	0.8391	0.12×10^{-6}
4	8	0.08	48	130	180 – 130 = 50	49	1.1504	0.11×10^{-6}
5	6	0.06	50	115	180 – 115 = 65	57.5	1.5697	8.46×10^{-6}
6	4	0.04	55	110	180 – 110 = 70	62.5	1.9210	6.04×10^{-6}
7	2	0.02	60	105	180 – 105 = 75	67.5	2.4142	4.84×10^{-6}
8	0	0	80	102	180 – 102 = 78	79	5.1446	8.56×10^{-6}
9	-2	-0.02	70	105	180 – 105 = 75	72.5	3.1716	6.36×10^{-6}
10	-4	-0.04	65	110	180 – 110 = 70	67.5	2.4142	7.59×10^{-6}
11	-6	-0.06	60	112	180 – 112 = 68	64	2.0503	0.11×10^{-6}
12	-8	-0.08	40	120	180 – 120 = 60	50	1.1918	0.11×10^{-6}
13	-10	-0.10	20	140	180 – 140 = 40	30	0.5774	8.58×10^{-6}
14	-12	-0.12	12	150	180 – 150 = 30	21	0.3839	8.83×10^{-6}
15	-14	-0.14	10	160	180 – 160 = 20	15	0.2679	9.11×10^{-6}

Mean value of $\tan\theta(r^2+x^2)^{3/2}$ = 5.21×10^{-6}

Experiment No. 11:

Charging and discharging of a capacitor and to measure time constant.

Observations & Calculations:

Value of resistor used = R = 10 KΩ

Value of the capacitor used = C = 1000 μF

For charging current			For discharging current		
No. of obs.	time sec	voltage volts	No. of obs.	time sec	voltage volts
1	0	0	1	0	13
2	4	5	2	2	10
3	8	10	3	6	5
4	18	12	4	9	2.5
5	25	12.5	5	20	2
6	33	13	6	28	0.5
			7	30	0.25
			8	37	0

From the graph, time constant = 10.64 sec

Theoretical value of time constant = R x C = 10 sec

Difference = 10.64 – 10 = 0.64 sec.

Experiment No. 12:

Relation between current and capacitance when different capacitors are used in A.C. circuit.

Observations and Calculations:

No. of obs.	Capacity of the capacitor C	Current I	I / C
	μ F	mA	
1	3.3	12	3.63×10^3
2	2.2	9	4×10^3
3	1	6	4.2×10^3
4	1.5	7	4.6×10^3
5	5.5	14	3×10^3
6	2.5	10	3.75×10^3
7	4.3	13	4×10^3
8	3.7	12	3.6×10^3
9	4.8	13	3.02×10^3

Inference: As the ratio I / C is constant, showing the current is directly proportional to the capacity in an A.C. circuit.

Experiment No. 13:

Characteristics of a semi-conductor diode and calculation of forward and reverse current resistance.

Observations and Calculations:

Forward characteristics

No. of obs.	Voltmeter reading V	Milliammeter reading I
	volts	mA
1	1	0
2	2	0
3	3	0
4	4	0
5	5	0.25
6	6	0.75
7	7	1.25
8	8	1.75
9	9	2.25
10	10	2.75

Reverse characteristics

No. of obs.	Voltmeter reading V	Micro-ammeter reading I
	volts	μA
1	1	10
2	2	15
3	3	28
4	4	30
5	5	50
6	6	91
7	7	140
8	8	190
9	9	239
10	10	290

Inference: The shape of the graph between V and I shows that the resulting current increases with the applied voltage upto one volt. At reverse biasing there is less current with the increase of voltage.

Experiment No. 14:

Characteristics of a N.P.N. transistor.

Observations and Calculations:

For Output Characteristics

No. of obs.	I_B	V_{CE}	I_C
	μA	volts	mA
1		0	0
2		2	1
3	10	4	1
4		5	1
5		10	1
6		15	1
1		0	0
2		2	2
3	20	4	2
4		5	2.1
5		10	2.2
6		15	2.5
1		0	0
2		0.5	5
3	50	1	5
4		5	5
5		10	5.5
6		15	6.5

For Input Characteristics

No. of obs.	V_{CE}	V_{BE}	I_B
	volts	milli-volts	μA
1		0	0
2		0.3	0
3	0	0.4	25
4		0.5	150
5		0.6	225
6		0.7	280
1		0	0
2		0.3	0
3	3	0.4	5
4		0.6	42
5		0.8	100
6		1	250
1		0	0
2		0.3	0
3	6	0.4	2
4		0.6	50
5		0.8	95
6		1	200

Experiment No. 15:

Study of the variation of electric current with intensity of light using a photocell.

Observations and Calculations:

No. of obs.	Distance of lamp from photo-cell d (cm)	Deflection of galvanometer θ (μA)	($I \propto 1/d^2$) $1/d^2$	θ / d^2
1	80	25	156.25×10^{-6}	39.06×10^{-4}
2	75	27.5	177.78×10^{-6}	48.89×10^{-4}
3	70	30	204.08×10^{-6}	61.22×10^{-4}
4	65	32.5	236.69×10^{-6}	76.92×10^{-4}
5	60	40	277.77×10^{-6}	111.11×10^{-4}
6	55	47.5	330.58×10^{-6}	157.02×10^{-4}
7	50	55	400.00×10^{-6}	220.00×10^{-4}
8	45	62.5	493.83×10^{-6}	308.64×10^{-4}

Inference: As the graph between deflection θ and $1/d^2$ is a straight line, therefore, light intensity from a point source decreases as the inverse square of the distance from the source. This proves the inverse square law.

Experiment No. 16:

To estimate the value of Planck's constant by using photo cell tube and coloured light filters.

Observations and Calculations:

Velocity of light = c = 3×10^{8} m s^{-1}
Charge on an electron = e = 1.6×10^{-19} coulombs

No. of obs.	Filter	Wavelength λ	Current I	Stopping potential V	$h = \frac{e(V_1 - V_2)\lambda_1\lambda_2}{c(\lambda_2 - \lambda_1)}$
	colour	$\times 10^{-10}$ m	μA	volts	J-s
1	Red	6843	1.3	0.3	-----
2	Yellow	5835	0.7	0.6	6.338×10^{-34}
3	Green	5452	0.6	0.7	4.431×10^{-34}
4	Violet	4175	0.3	1.4	6.655×10^{-34}

Mean calculated value of $h = 5.807 \times 10^{-34}$ J-s

Standard value of $h = 6.626 \times 10^{-34}$ J-s

Experiment No. 17:

Measurement of D.C. and A.C. voltage by Cathode Ray Oscilloscope.

Observations and Calculations:

For measurement of D.C. voltage

No. of obs.	Voltage shown by CRO V_R	Multi-meter reading V_m	Difference $(V_R - V_m)$
	div = volts	volts	volts
1	4 div = 3 volts	3.1	0.1
2	8 div = 6 volts	6.15	0.15
3	10 div =7.5volts	7.62	0.12

For measurement of A.C. voltage

Calibrating V_{P-P}: Standard A.C. voltage source = V_S = 6.3 volts a.c.
$V_{P-P} = V_S \times 2 / 0.7$ = 12 div = $6.3 \times 2 / 0.7$ = 18 volts
so 1 div. = V_{P-P} / y = 18 / 12 = 1.5 volts

No. of obs.	Voltage shown by CRO V_{P-P}	$V_{PP} / 2 = V_o$	$0.7 V_o = V_{rms}$	Multi-meter reading V_m	Difference $(V_{rms} - V_m)$
	div = volts	volts	volts	volts	volts
1	12 div = 18 volts	9	6.3	6.4	0.1
2	6 div = 9 volts	4.5	3.15	3.2	0.05
3	5.3 div = 8 volts	4	2.8	2.52	0.12

Experiment No. 18(a):

To verify truth table for OR gate.

Observations and Calculations:

Truth table for 2 input OR gate:

Inputs		Output
A	B	C
0	0	0
0	1	1
1	1	1
1	0	1

Inference:

In case of OR gate, the output becomes high when any one of inputs is high.

Experiment No. 18(b):

To verify truth table for AND gate.

Observations and Calculations:

Truth table for 2 input AND gate:

Inputs		Output
A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

Inference:

In case of AND gate, the output is high only when all the inputs are high.

Experiment No. 18(c):

To verify truth table for NOT gate.

Observations and Calculations:

Truth table for NOT gate:

Input	Output
A	C
1	0
0	1

Inference:

A NOT gate gives a high output when its inputs is low and vice versa. Output of NOT is complement of input.

Experiment No. 19:

To make burglar alarm using NAND gate.

Observations and Calculations:

State — 1 = buzzer On
State — 0 = buzzer Off

Input A	Input B	Output	Buzzer
1	1	0	Off
0	1	1	On
1	0	1	On
0	0	1	On

Inference:

In a NAND gate the burglar alarm is On when any one of its inputs goes low due some interruption which make the circuit break.

Experiment No. 20:

To make a fire alarm using NOT gate.

Observations and Calculations:

State — 1 = buzzer On
State — 0 = buzzer Off

Thermister State	Input A	Output B	Buzzer
Hot	1	1	On
Cold	1	0	Off

Inference:

Fire alarm is activated in NOT gate when its input goes low due to circuit break with some interruption. With variable resistor the sensitivity is adjusted.

Experiment No. 21:

Characteristics of a G.M. tube.

Observations and Calculations:

No. of obs.	Voltage applied between electrodes V (volts)	No. of counts N
1	375	6
2	385	7
3	395	8
4	410	9
5	430	10
6	450	10
7	470	10
8	490	12
9	510	13
10	520	14

Value of voltage at the start of plateau = V_1 = 421
Value of voltage at the end of plateau = V_2 = 482
No. of counts at the start of plateau = N_1 = 9.5
No. of counts at the end of plateau = N_2 = 10.4

$$\text{Slope percentage per volt} = \frac{N_2 - N_1}{V_2 - V_1} \times \frac{100}{\frac{(N_1 + N_2)}{2}} = 0.15\ \%$$

Experiment No. 22:

Determination of high resistance by Neon flash lamp.

Observations and Calculations:

Time period with known resistance:

No. of obs.	Known resistance	Time for 20 flashes			Flashing period
	R	t_1	T_2	$t = \frac{t_1 + t_2}{2}$	T = t / 20
	MΩ	sec	Sec	sec	sec
1	1	7.4	7.3	7.35	0.37
2	3	13.9	14.1	13.95	0.69
3	5	22.3	22.4	22.35	1.12
4	10	47.3	47.4	47.35	2.36

Time period with unknown resistance:

No. of obs.	Unknown resistance	Time for 20 flashes			Flashing period
	X (from the graph)	t'_1	t'_2	$t'_1 = \frac{t'_1 + t'_2}{2}$	$T' = t' / 20$
	MΩ	sec	Sec	sec	sec
1	(1.8)	9.3	9.43	9.4	0.47
2	(3.9)	18.09	18.3	18.2	0.91
3	(7.4)	32.5	32.3	32.4	1.62

From the graph, values of unknown resistances:

R_1 = 1.8 MΩ, R_2 = 3.9 MΩ, R_3 = 7.4 M Ω

Experiment No. 23:

To determine the e/m of electrons by deflection method (teltron tube).

Observations and Calculations:

Radius of the disc used = R = 1.0025 cm = 0.01 m

Number of turns per unit length of solenoid = n = 1000/10 = 10^2

Permeability of air = μ = 1.257×10^{-6} Weber/m^2

No. of obs.	Anode voltage V (volt)	Solenoid current i (amp)	B = 4πμ n i	$e / m = \frac{2V}{B^2 R^2}$
1	130	1.7	2.7×10^{-3}	3.57×10^{11}
2	180	1.9	3.0×10^{-3}	4.00×10^{11}
3	210	2.1	3.3×10^{-3}	3.86×10^{11}
4	250	2.3	3.6×10^{-3}	3.85×10^{11}

Mean value of e / m = 3.82×10^{11} C / kg

Standard value of e/m = 3.57×10^{11} C/kg

Difference = 2.06 C / kg

The workers are the saviours of society, the redeemers of the race.

–Eugene V. Debs