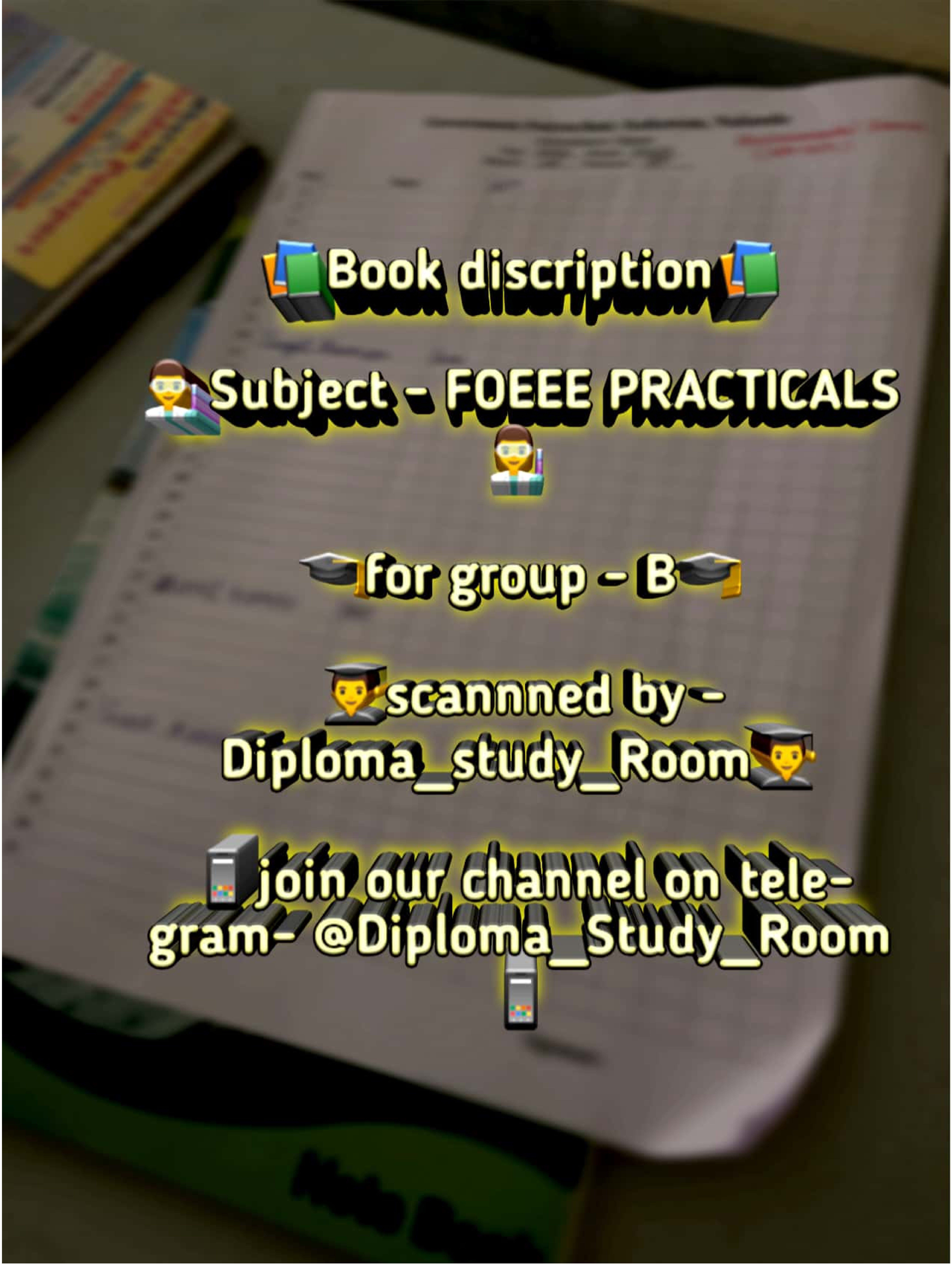

Book discription
Subject - FOEEE PRACTICALS
for group - B
scannned by -
Diploma_study_Room
join our channel on tele-
gram- @Diploma_Study_Room

Experiment-01

Identify various passive electronic components in the given circuit

Breadboards:

In order to temporarily construct a circuit without damaging the components used to build it, we must have some sort of a platform that will both hold the components in place and provide the needed electrical connections. In the early days of electronics, most experimenters were amateur radio operators. They constructed their radio circuits on wooden breadboards. Although more sophisticated techniques and devices have been developed to make the assembly and testing of electronic circuits easier, the concept of the breadboard still remains in assembling components on a temporary platform.

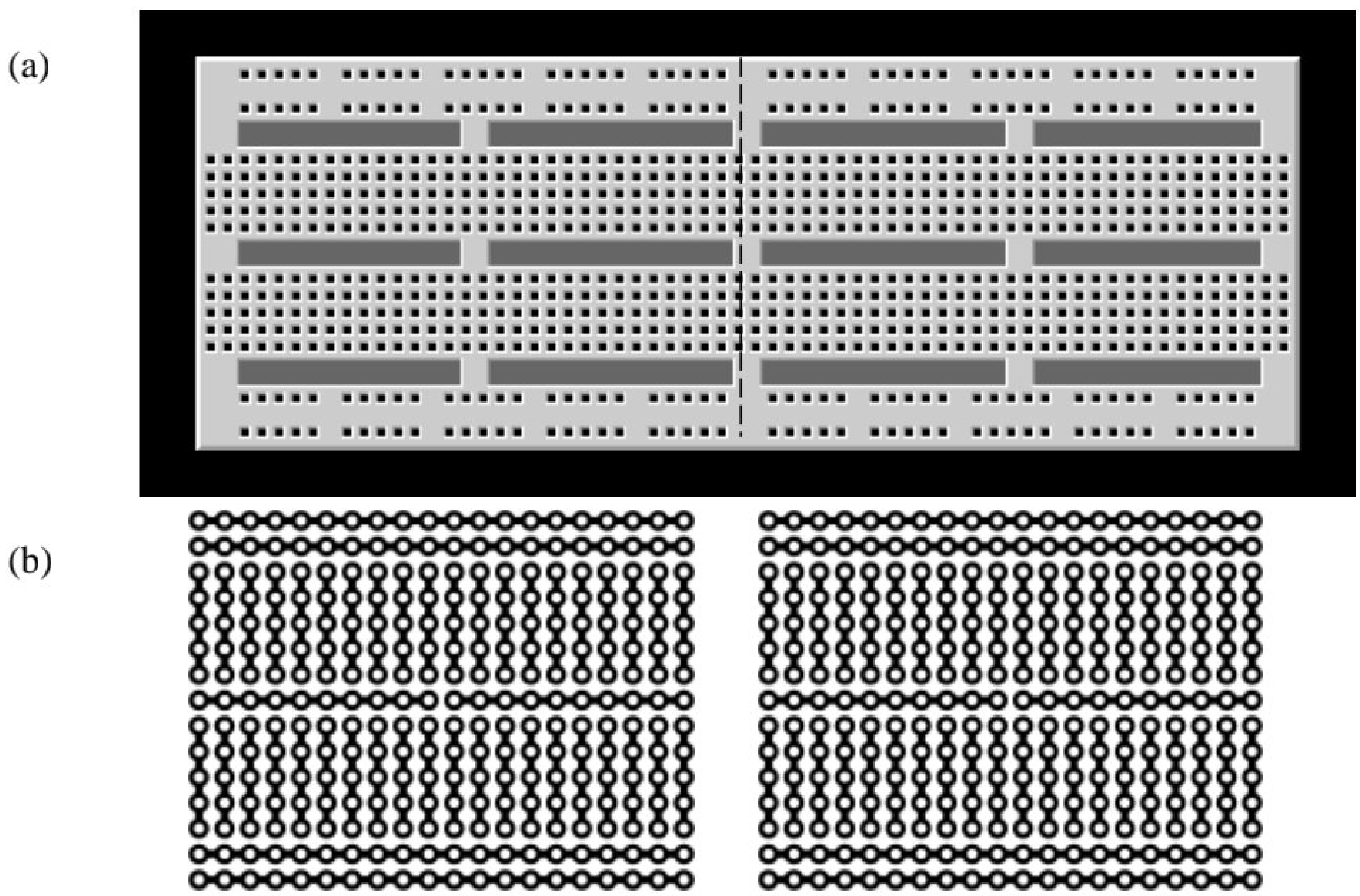


Fig. 1: (a) A typical Breadboard and (b) its connection details

A real breadboard is shown in Fig. 1(a) and the connection details on its rear side are shown in Fig. 1(b). The five holes in each individual column on either side of the central groove are electrically connected to each other, but remain insulated from all other sets of holes. In addition to the main columns of holes, however, you'll note four sets or groups of holes along the top and bottom. Each of these consists of five separate sets of five holes each, for a total of 25 holes. These groups of 25 holes are all connected together on either side of the dotted line indicated on Fig.1(a) and needs an external connection if one wishes the entire row to be connected. This makes them ideal for distributing power to multiple ICs or other circuits.

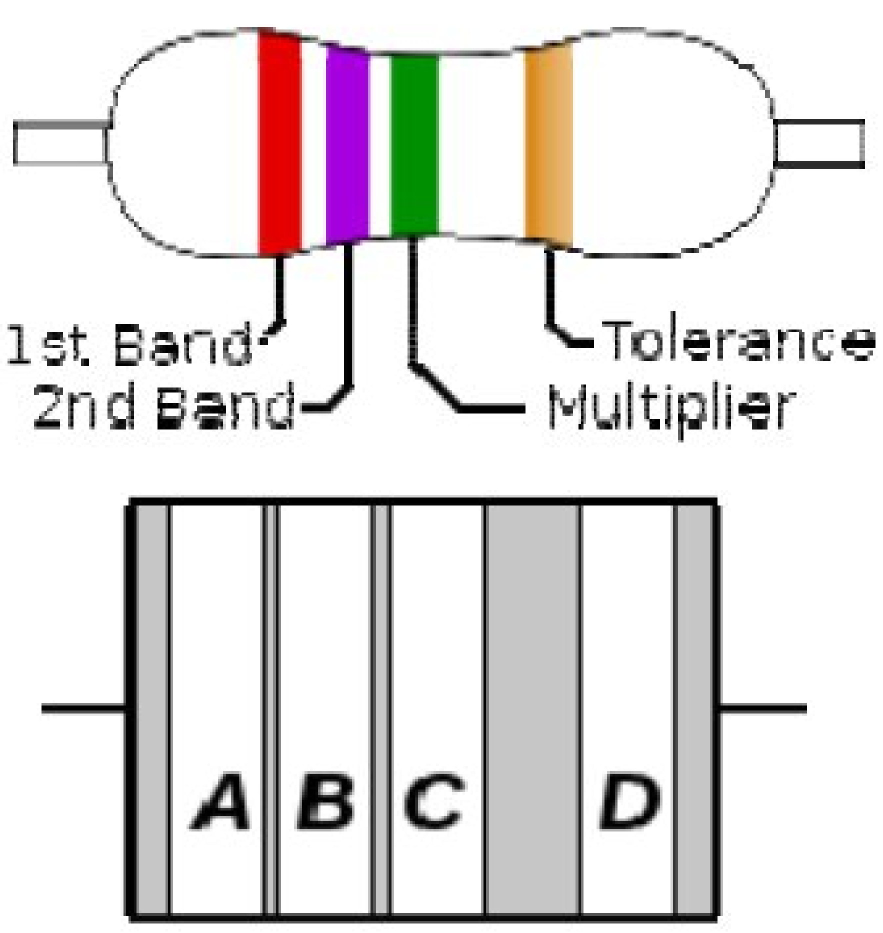
These breadboard sockets are sturdy and rugged, and can take quite a bit of handling. However, there are a few rules you need to observe, in order to extend the useful life of the electrical contacts and to avoid damage to components. These rules are:

- Always make sure power is disconnected when constructing or modifying your experimental circuit. It is possible to damage components or incur an electrical shock if you leave power connected when making changes.
- Never use larger wire as jumpers. #24 wire (used for normal telephone wiring) is an excellent choice for this application. Observe the same limitation with respect to the size of component leads.
- Whenever possible, use ¼ watt resistors in your circuits. ½ watt resistors may be used when necessary; resistors of higher power ratings should never be inserted directly into a breadboard socket.
- Never force component leads into contact holes on the breadboard socket. Doing so can damage the contact and make it useless.
- Do not insert stranded wire or soldered wire into the breadboard socket. If you must have stranded wire (as with an inductor or transformer lead), solder (or use a wire nut to connect) the stranded wire to a short length of solid hookup wire, and insert only the solid wire into the breadboard.

If you follow these basic rules, your breadboard will last indefinitely, and your experimental components will last a long time.

Resistors

Most axial resistors use a pattern of colored stripes to indicate resistance. A 4 band identification is the most commonly used color coding scheme on all resistors. It consists of four colored bands that are painted around the body of the resistor. Resistor values are always coded in ohms (Ω). The color codes are given in the following table in Fig. 1.



Band Color	Digit	Multiplier	Tolerance
Black	0	1	---
Brown	1	10	±1%
Red	2	100	±2%
Orange	3	1,000	±3%
Yellow	4	10,000	±4%
Green	5	100,000	---
Blue	6	1,000,000	---
Violet	7	10,000,000	---
Gray	8	100,000,000	---
White	9	---	---
Gold	---	0.1	±5%
Silver	---	0.01	±10%
None	---	---	±20%

Fig. 1: Color codes of Resistors

- band **A** is first significant figure of component value
- band **B** is the second significant figure
- band **C** is the decimal multiplier
- band **D** if present, indicates tolerance of value in percent (no color means 20%)

For example, a resistor with bands of *yellow, violet, red, and gold* will have first digit 4 (yellow in table below), second digit 7 (violet), followed by 2 (red) zeros: 4,700 ohms. Gold signifies that the tolerance is ±5%, so the real resistance could lie anywhere between 4,465 and 4,935 ohms.

Tight tolerance resistors may have three bands for significant figures rather than two, and/or an additional band indicating temperature coefficient, in units of ppm/K. For large power resistors and potentiometers, the value is usually written out implicitly as "10 kΩ", for instance.

Capacitors:

You will mostly use electrolytic and ceramic capacitors for your experiments.

Electrolytic capacitors

An **electrolytic capacitor** is a type of capacitor that uses an electrolyte, an ionic conducting liquid, as one of its plates, to achieve a larger capacitance per unit volume than other types. They are used in relatively high-current and low-frequency electrical circuits. However, the voltage applied to these capacitors must be polarized; one specified terminal must always have positive potential with respect to the other. These are of two types, axial and radial capacitors as shown in adjacent figure. The arrowed stripe indicates the polarity, with the arrows pointing towards the negative pin.

Fig. 2:Axial and Radial Electrolytic capacitors

Warning: connecting electrolytic capacitors in reverse polarity can easily damage or destroy the capacitor. Most large electrolytic capacitors have the voltage, capacitance, temperature ratings, and company name written on them without having any special color coding schemes.

Axial electrolytic capacitors have connections on both ends. These are most frequently used in devices where there is no space for vertically mounted capacitors.

Radial electrolytic capacitors are like axial electrolytic ones, except both pins come out the same end. Usually that end (the "bottom end") is mounted flat against the PCB and the capacitor rises perpendicular to the PCB it is mounted on. This type of capacitor probably accounts for at least 70% of capacitors in consumer electronics.

Ceramic capacitors are generally non-polarized and almost as common as radial electrolytic capacitors. Generally, they use an alphanumeric marking system. The number part is the same as for SMT resistors, except that the value represented is in pF. They may also be written out directly, for instance, 2n2 = 2.2 nF.

Fig. 3: Ceramic capacitors

Diodes:

A standard specification sheet usually has a brief description of the diode. Included in this description is the type of diode, the major area of application, and any special features. Of particular interest is the specific application for which the diode is suited. The manufacturer also provides a drawing of the diode which gives dimension, weight, and, if appropriate, any identification marks. In addition to the above data, the following information is also provided: a static operating table (giving spot values of parameters under fixed conditions), sometimes a characteristic curve (showing how parameters vary over the full operating range), and diode ratings (which are the limiting values of operating conditions outside which could cause diode damage). Manufacturers specify these various diode operating parameters and characteristics with "letter symbols" in accordance with fixed definitions. The following is a list, by letter symbol, of the major electrical characteristics for the rectifier and signal diodes.

RECTIFIER DIODES

DC BLOCKING VOLTAGE [V_R]—the maximum reverse dc voltage that will not cause breakdown.

AVERAGE FORWARD VOLTAGE DROP [$V_{F(AV)}$]—the average forward voltage drop across the rectifier given at a specified forward current and temperature.

AVERAGE RECTIFIER FORWARD CURRENT [$I_{F(AV)}$]—the average rectified forward current at a specified temperature, usually at 60 Hz with a resistive load.

AVERAGE REVERSE CURRENT [$I_{R(AV)}$]—the average reverse current at a specified temperature, usually at 60 Hz.

PEAK SURGE CURRENT [I_{SURGE}]—the peak current specified for a given number of cycles or portion of a cycle.

SIGNAL DIODES

PEAK REVERSE VOLTAGE [PRV]—the maximum reverse voltage that can be applied before reaching the breakdown point. (PRV also applies to the rectifier diode.)

REVERSE CURRENT [I_R]—the small value of direct current that flows when a semiconductor diode has reverse bias.

MAXIMUM FORWARD VOLTAGE DROP AT INDICATED FORWARD CURRENT [$V_F@I_F$]— the maximum forward voltage drop across the diode at the indicated forward current.

REVERSE RECOVERY TIME [t_{rr}]—the maximum time taken for the forward-bias diode to recover its reverse bias.

The ratings of a diode (as stated earlier) are the limiting values of operating conditions, which if exceeded could cause damage to a diode by either voltage breakdown or overheating.

The PN junction diodes are generally rated for: MAXIMUM AVERAGE FORWARD CURRENT, PEAK RECURRENT FORWARD CURRENT, MAXIMUM SURGE CURRENT, and PEAK REVERSE VOLTAGE

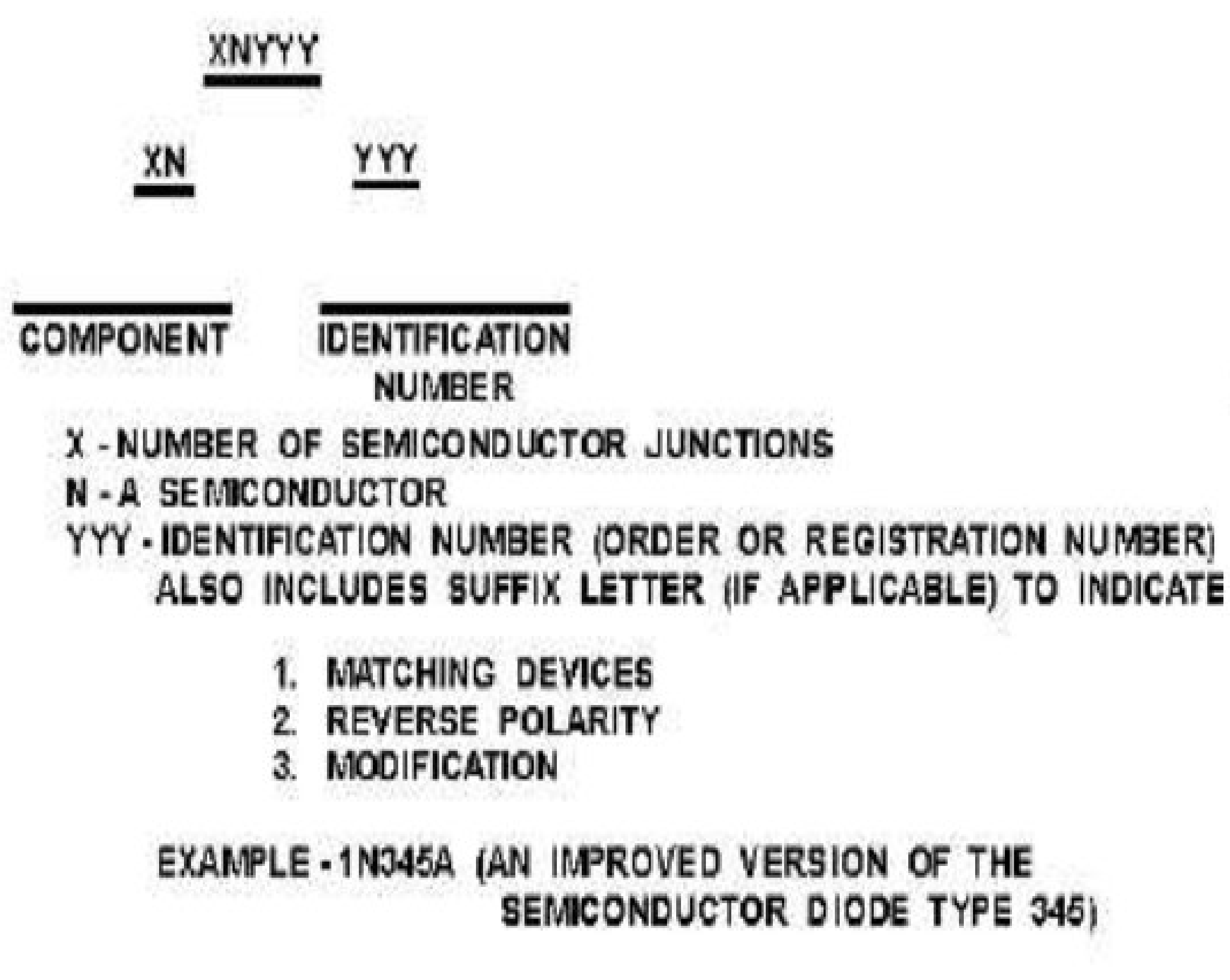
Maximum average forward current is usually given at a special temperature, usually 25° C, (77° F) and refers to the maximum amount of average current that can be permitted to flow in the forward direction. If this rating is exceeded, structure breakdown can occur.

Peak recurrent forward current is the maximum peak current that can be permitted to flow in the forward direction in the form of recurring pulses.

Maximum surge current is the maximum current permitted to flow in the forward direction in the form of nonrecurring pulses. Current should not equal this value for more than a few milliseconds.

Peak reverse voltage (PRV) is one of the most important ratings. PRV indicates the maximum reverse-bias voltage that may be applied to a diode without causing junction breakdown. All of the above ratings are subject to change with temperature variations. If, for example, the operating temperature is above that stated for the ratings, the ratings must be decreased.

There are many types of diodes varying in size from the size of a pinhead (used in subminiature circuitry) to large 250-ampere diodes (used in high-power circuits). Because there are so many different types of diodes, some system of identification is needed to distinguish one diode from another. This is accomplished with the semiconductor identification system shown in Fig. 4. This system is not only used for diodes but transistors and many other special semiconductor devices as well. As illustrated in this figure, the system uses numbers and letters to identify different types of semiconductor devices. The first number in the system indicates the number of junctions in the semiconductor device and is a number, one less than the number of active elements. Thus 1 designates a diode; 2 designates a transistor (which may be considered as made up of two diodes); and 3 designates a tetrode (a four-element transistor). The letter "N" following the first number indicates a semiconductor. The 2- or 3-digit number following the letter "N" is a serialized identification number. If needed, this number may contain a suffix letter after the last digit. For example, the suffix letter "M" may be used to describe matching pairs of separate semiconductor devices or the letter "R" may be used to indicate reverse polarity. Other letters are used to indicate modified versions of the device which can be substituted for the basic numbered unit. For example, a semiconductor diode designated as type 1N345A signifies a two-element diode (1) of semiconductor material (N) that is an improved version (A) of type 345.



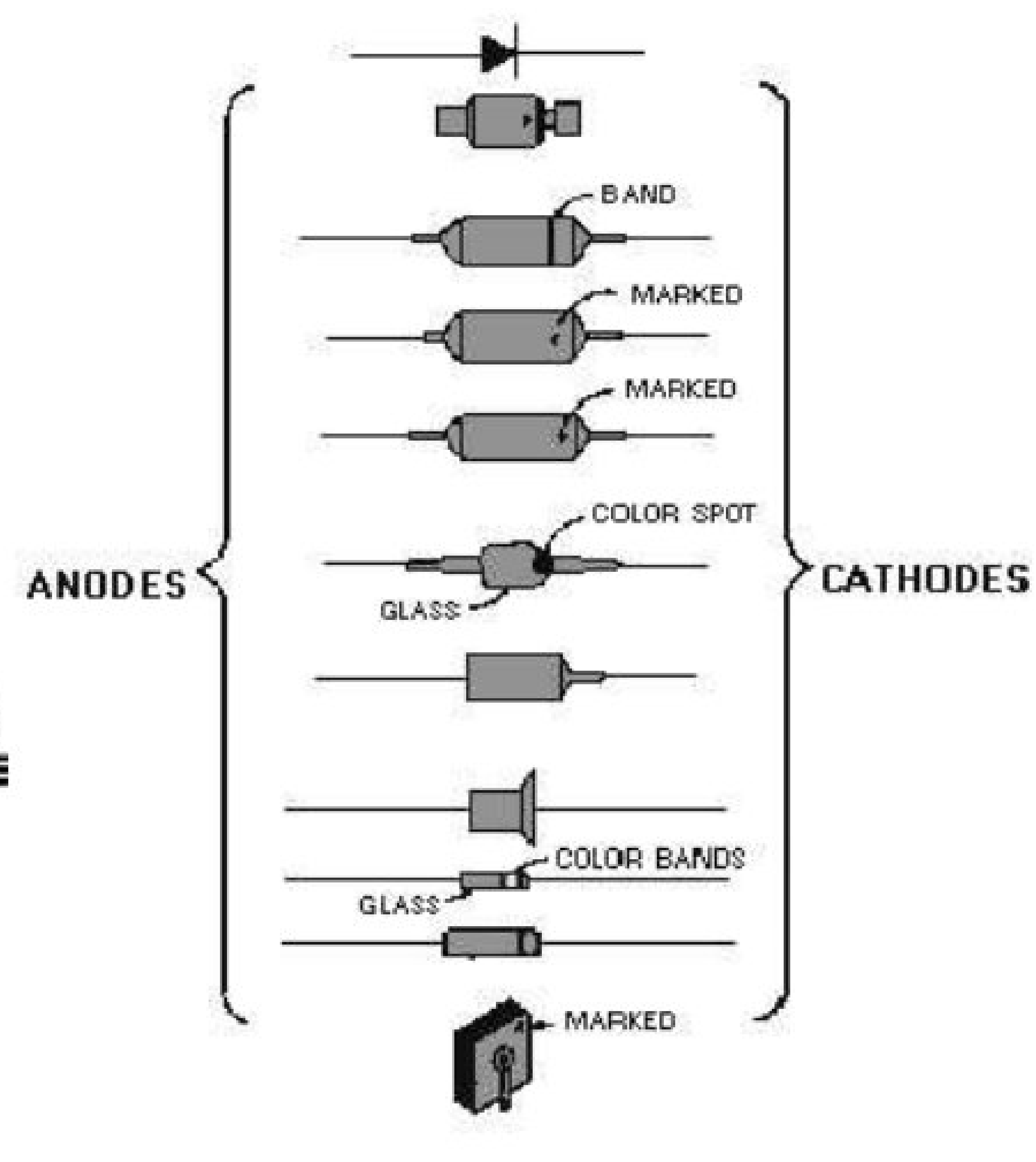


Fig. 4: Identification of Diode

Fig. 5: Identification of Cathode

When working with different types of diodes, it is also necessary to distinguish one end of the diode from the other (anode from cathode). For this reason, manufacturers generally code the cathode end of the diode with a "k," "+," "cath," a color dot or band, or by an unusual shape (raised edge or taper) as shown in Fig. 5. In some cases, standard color code bands are placed on the cathode end of the diode. This serves two purposes: (1) it identifies the cathode end of the diode, and (2) it also serves to identify the diode by number.

Transistors:

Transistors are identified by a Joint Army-Navy (JAN) designation printed directly on the case of the transistor. If in doubt about a transistor's markings, always replace a transistor with one having identical markings, or consult an equipment or transistor manual to ensure that an identical replacement or substitute is used.

Example:

2	N	130	A
NUMBER OF JUNCTIONS (TRANSISTOR)	SEMICONDUCTOR	IDENTIFICATION NUMBER	FIRST MODIFICATION

There are three main series of transistor codes used:

- **Codes beginning with B (or A), for example BC108, BC478**
  The first letter B is for silicon, A is for germanium (rarely used now). The second letter indicates the type; for example C means low power audio frequency; D means high power audio frequency; F means low power high frequency. The rest of the code identifies the particular transistor. There is no obvious logic to the numbering system. Sometimes a letter is added to the end (eg BC108C) to identify a special version of the main type, for example a higher current gain or a different case style. If a project specifies a higher gain version (BC108C) it must be used, but if the general code is given (BC108) any transistor with that code is suitable.
- ***Codes beginning* with TIP, for example TIP31A**
  TIP refers to the manufacturer: Texas Instruments Power transistor. The letter at the end identifies versions with different voltage ratings.
- ***Codes beginning* with 2N, for example 2N3053**
  The initial '2N' identifies the part as a transistor and the rest of the code identifies the particular transistor. There is no obvious logic to the numbering system.

TESTING A TRANSISTOR to determine if it is good or bad can be done with an ohmmeter or transistor tester. PRECAUTIONS should be taken when working with transistors since they are susceptible to damage by electrical overloads, heat, humidity, and radiation. TRANSISTOR LEAD IDENTIFICATION plays an important part in transistor maintenance because before a transistor can be tested or replaced, its leads must be identified. Since there is NO standard method of identifying transistor leads, check some typical lead identification schemes or a transistor manual before attempting to replace a transistor. Identification of leads for some common case styles is shown in Fig. 6.

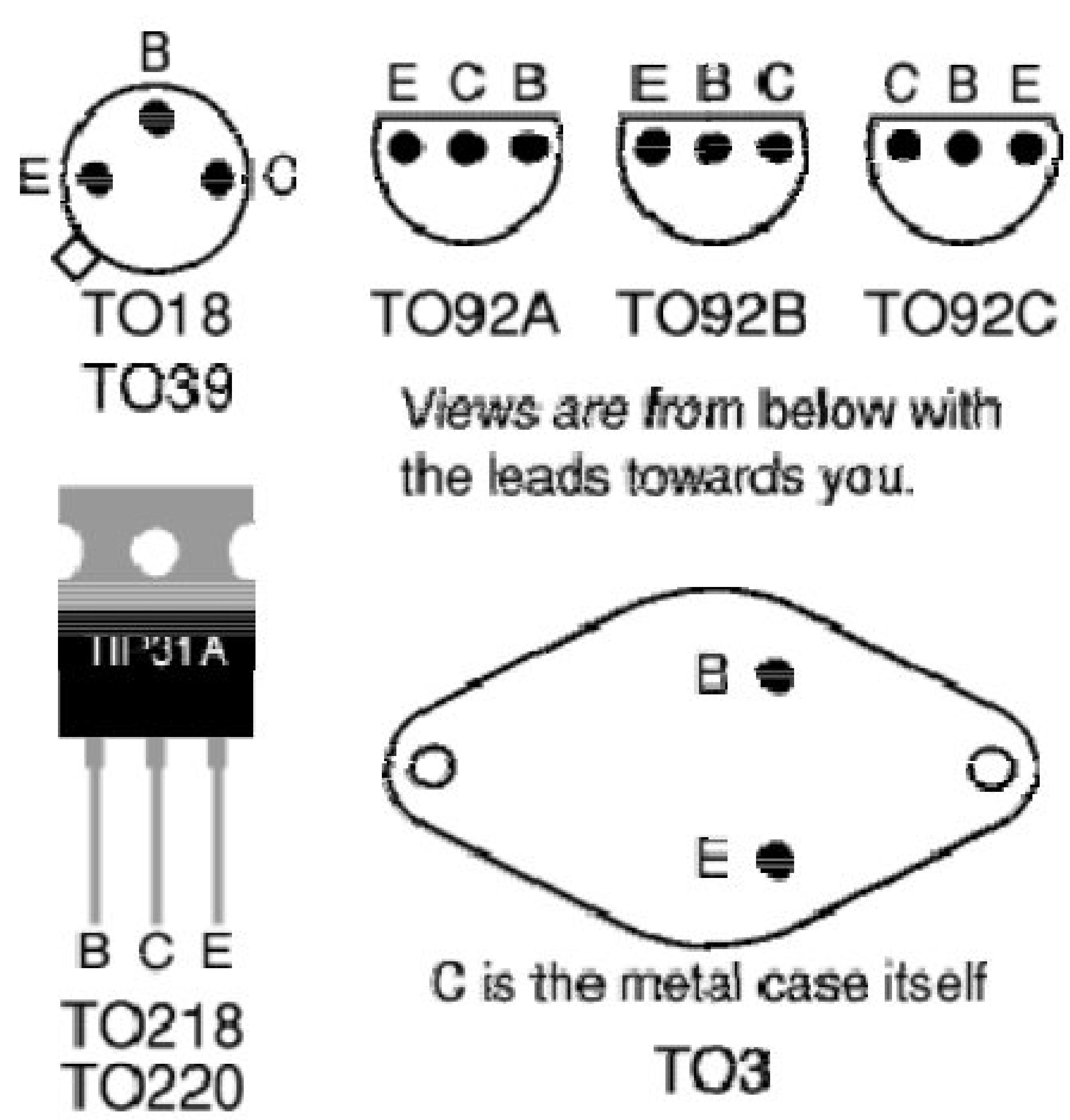


Fig. 6

Testing a transistor

Transistors are basically made up of two *Diodes* connected together back-to-back (Fig. 7). We can use this analogy to determine whether a transistor is of the type PNP or NPN by testing its Resistance between the three different leads,
Emitter, Base and Collector.

Testing with a multimeter

Use a multimeter or a simple tester (battery, resistor and LED) to check each pair of leads for conduction. Set a digital multimeter to diode test and an analogue multimeter to a low resistance range.

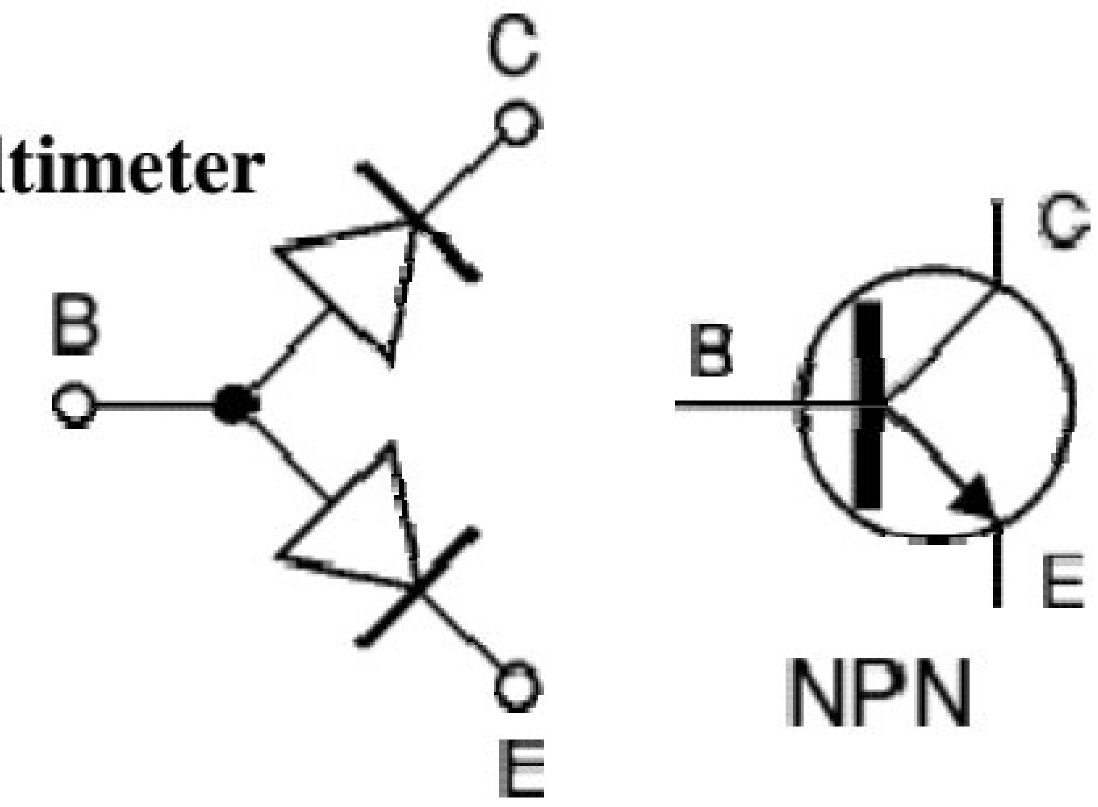


Fig. 7: Testing an NPN transistor

Test each pair of leads both ways (six tests in total):

- The **base-emitter (BE)** junction should behave like a diode and conduct one way only.
- The **base-collector (BC)** junction should behave like a diode and conduct one way only.
- The **collector-emitter (CE)** should not conduct either way.

The diagram shows how the junctions behave in an NPN transistor. The diodes are reversed in a PNP transistor but the same test procedure can be used.

Transistor Resistance Values for the PNP and NPN transistor types

Between Transi tor Terminals		PNP	NPN
Collector	Emitter	R_{HIGH}	R_{HIGH}
Collector	Base	R_{LOW}	R_{HIGH}
Emitter	Collector	R_{HIGH}	R_{HIGH}
Emitter	Base	R_{LOW}	R_{HIGH}
Base	Collector	R_{HIGH}	R_{LOW}
Base	Emitter	R_{HIGH}	R_{LOW}

Experiment-02

Connect resistors in series and parallel combination on bread board and measure its value using digital multimeter

Objective:

In this experiment you will set up three circuits: one with resistors in series, one with resistors in parallel, and one with some of each. You will be building circuits .

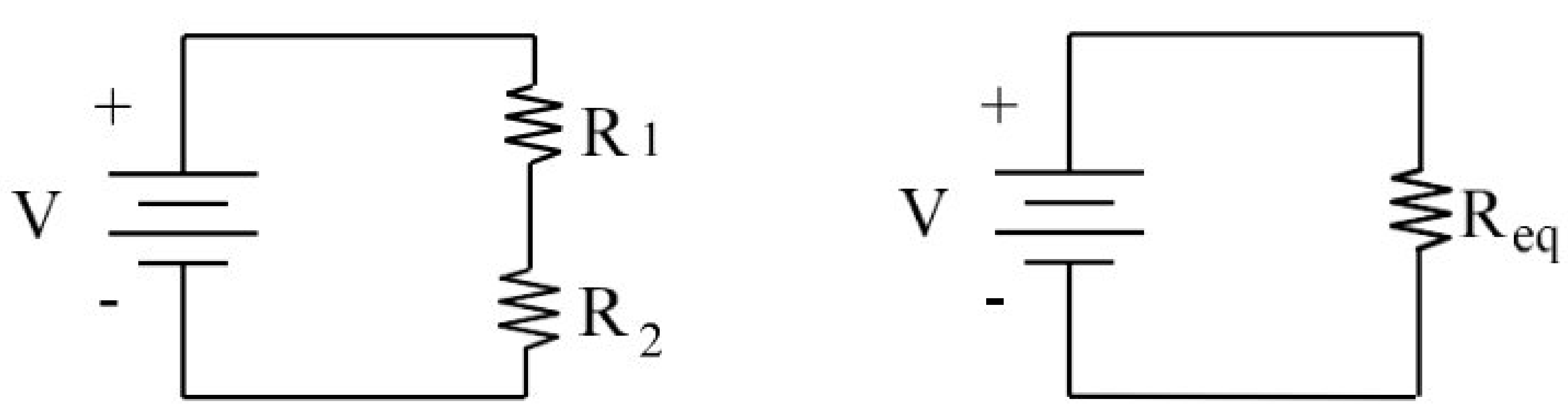
Equipment:

Resistors (R_1 = 2.2 k∧, R_2 = 6.8 k∧, and R_3 = 4.7 k∧), multimeter, and DC power supply.

Theory:

In the first part of this experiment we will study the properties of resistors, which are connected "in series". Figure 1 shows two resistors connected in series (a) and the equivalent circuit with the two resistors replaced by an equivalent single resistor (b), as we discussed in the lecture. Remember from lecture that, when resistors are connected in series, each one "sees" the same current. Recall the water analogy: If you have two pipes that have different diameters but are connected in series and you send water through them, each receives the same amount of water, there are no branches into which the water can split. In lecture, we showed that the equivalent resistance for resistors in series is

$$\mathbf{R_{eq} = R_1 + R_2}.$$



(a) The actual circuit. *(b) The equivalent circuit*

Figure 1. Resistors connected in series.

Of course, this equation can be extend to any number of resistors in series, so that for N resistors the equivalent resistance is given by

$$\mathbf{R_{eq} = \Sigma R_i} \quad \text{(for i=1,2,3,...,N)}$$

or

$$\mathbf{R_{eq} = R_1 + R_2 + R_3 + ... + R_N}.$$

You (hopefully!) remember from lecture this isn't the only way to hook up resistors in a circuit. In the second part of this lab we'll hook them together as in Figure 2.

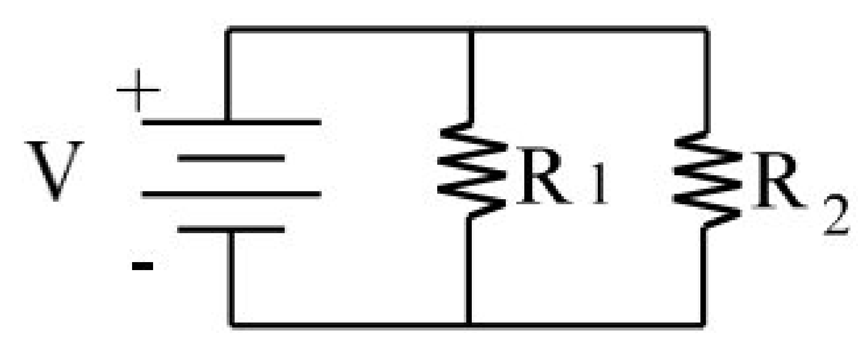


Figure 2: Two resistors in parallel

We say these resistors are connected in parallel. In series they were connected one after the other, but in parallel, as the name suggests, they are 'side by side' in the circuit. When resistors are in parallel, the current flowing from the battery will come to a junction where it has a "choice" as to which branch to take. Therefore, they "see" different amounts of current, just the way water branching into two different pipes will flow more through the larger pipe (lower resistance) than through the narrower pipe (greater resistance). Resistors in parallel "see" different currents, but they each experience the same potential difference (voltage). In lecture, we used this property of resistors in parallel to derive an equation for calculating the equivalent resistance. In this case, the equation is a bit more complicated than for resistors in series. Instead of the resistances adding directly, we calculate

$$\mathbf{\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}}$$

It's important to remember that after you do this calculation, you will have gotten $\mathbf{1/R_{eq}}$. You have to flip that over in order to get $\mathbf{R_{eq}}$! Here's an example: If we have $\mathbf{R_1}$ = 270∧ and $\mathbf{R_2}$ = 330∧ we would find $\mathbf{R_{eq}}$ as follows:

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{270\wedge} + \frac{1}{330\wedge}$$

$$= .0037037\wedge^{-1} + .003030\wedge^{-1}$$

$$= .006734\wedge^{-1}$$

So, $R_{eq} \approx 148\wedge$

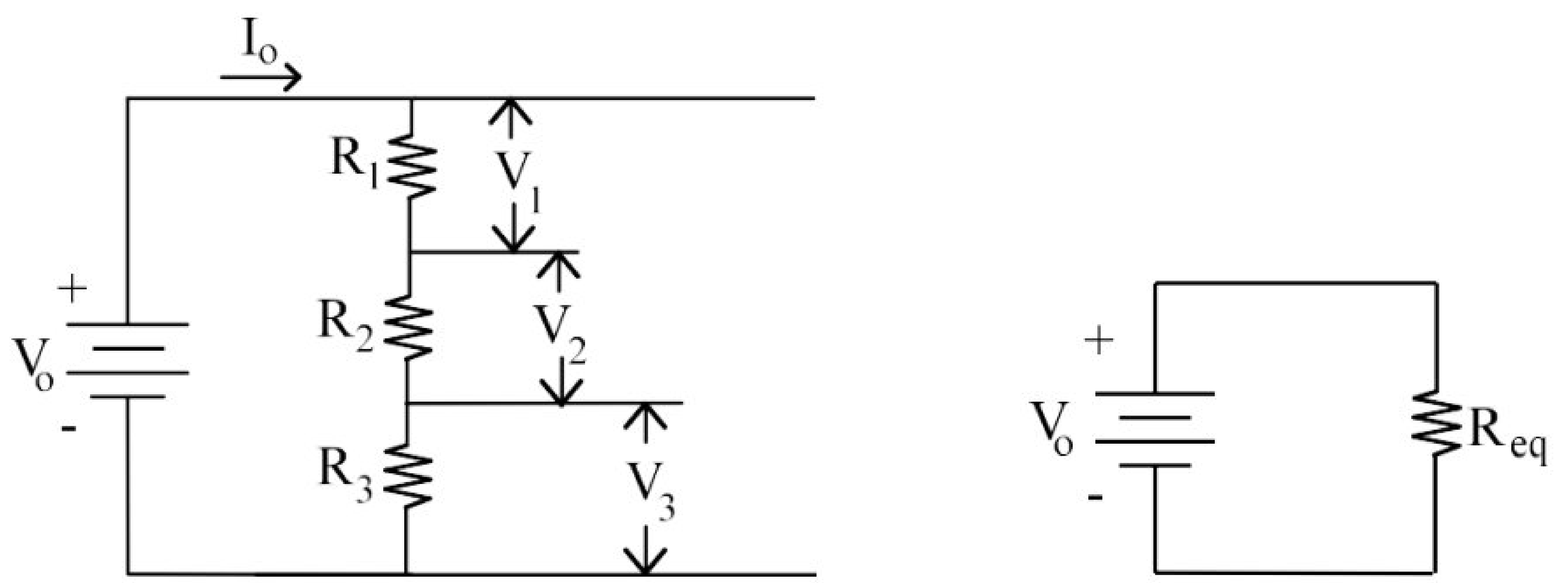
We can generalize this equation to any number of resistors, just the way we did for resistors in series. As in the case for series we can generalize this law to any number of resistors:

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots + \frac{1}{R_N} = \sum_{i=1}^{N} \frac{\mathbf{1}}{\mathbf{R_i}}$$

The Experiment

Part 1

1. Take three resistors. Measure the resistance of each resistor individually using the ohmmeter (i.e., the multimeter). Record the values in Data Table 1.
2. Determine the resistance of each resistor, using the Resistor Color Code Chart on page 17. Record the values in Data Table 1.
3. Now, connect the resistors in series, as shown in Figure 3a, and connect them to the power supply that is set at 12 V. Record the voltage across each resistor, using the multimeter. Record the measured values in Data Table 1.



(a) The actual circuit

(b) The equivalent circuit

Figure 3 : The voltages across series resistors.

Data Table 1

R_1 (measured)		R_1 (from color code)		V_1 (measured)		I_1 (calculated)	
R_2 (measured)		R_2 (from color code)		V_2 (measured)		I_2 (calculated)	
R_3 (measured)		R_3 (from color code)		V_3 (measured)		I_3 (calculated)	

Questions: Part 1

1. Are the voltages V_1, V_2 and V_3 equal to each other? Why or why not?

2. Calculate the total voltage $V = V_1 + V_2 + V_3$. Explain why it has the value it does.

3. Use Ohm's law to calculate the current through each resistor. (e.g., $V_1=I_1*R_1$, so $I_1=V_1/R_1$). For this calculation, use the measured value of the resistances. Record these calculated values in the table above. Is the result what you expected? Why?

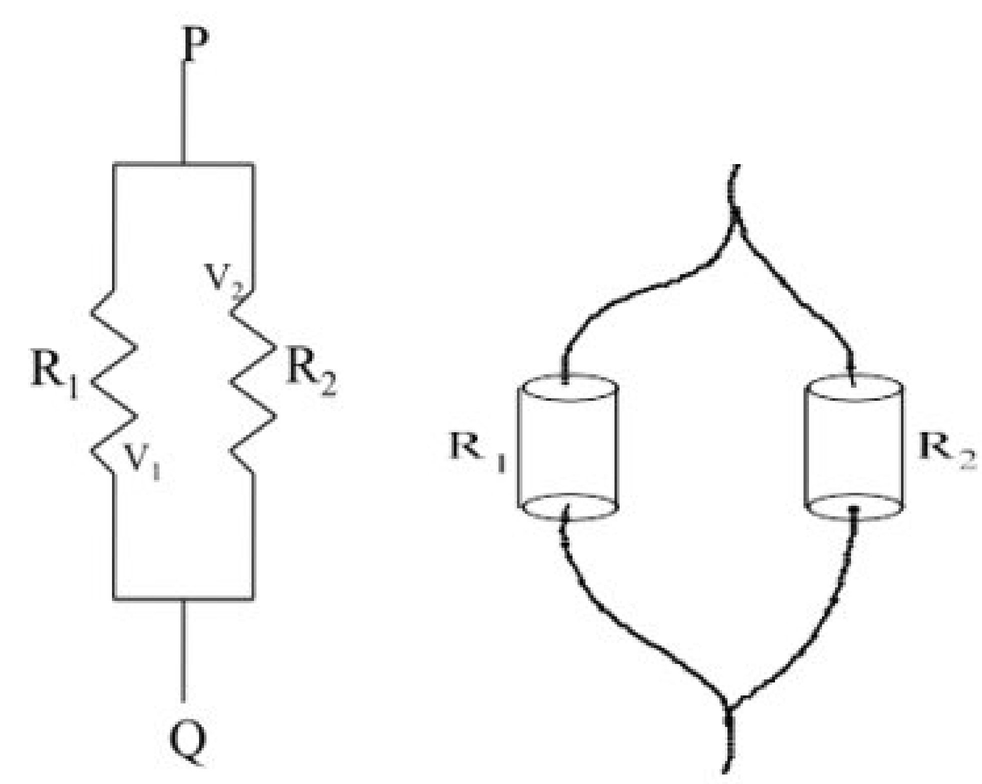


Figure 4: Two resistors attached in parallel

Part 2

In this part of the experiment, you will experimentally test the addition law for resistors in parallel.

1. Take two resistors. Measure the resistance of each resistor individually using the digital multimeter (i.e., the multimeter). Record the values in Data Table 2.
2. Calculate the resistance of each resistor, using the Resistor Color Code Chart on page 17. Record the values in Data Table 2.
3. Now, connect the resistors in parallel, as shown in Figure 4, and connect them to the power supply that is set at 12 V. Record the voltage across each resistor, using the multimeter. Record the measured values in Data Table 2.
4. Calculate the equivalent resistance (**R_{eq}**) of the circuit, based on your *measured* values of R_1 and R_2. Enter the value at the top of Data Table 2.
5. Measure the equivalent resistance of the circuit using the ohmmeter. This is the resistance between points **P** and **Q** in Figure 4a. Record the value at the top of Data Table 2.
6. Use Ohm's law, with your *measured* value of R_{eq}, to calculate the total current in the circuit. Enter the value at the top of Data Table 2.

Data Table 2

R_1 (measured)		R_1 (from color code)		V_1 (measured)		I_1 (calculated)	
R_2 (measured)		R_2 (from color code)		V_2 (measured)		I_2 (calculated)	

R_{eq} (calculated) ________ R_{eq} (measured) ________ I_{total}__________

Questions: Part 2

4. Are the measured values of R_1 and R_2 equal to the values calculated using the color code chart? How much do they differ (calculate percent error)? Is this within the specified tolerance?

5. Is your measured value of R_{eq} similar to your calculated value? Explain.

6. Are V_1 and V_2 equal to each other? Explain.

7. Are I_1 and I_2 equal to each other? Explain.

8. Compare I_{total} to the I_1 and I_2. What do you notice?

Part 3

Now for the grand conclusion. We are going to use our techniques on a circuit that has resistors in **both series and parallel** connections. Below we have a circuit with three resistors. The two which are connected in parallel, R_1 and R_3, are in series with R_1.

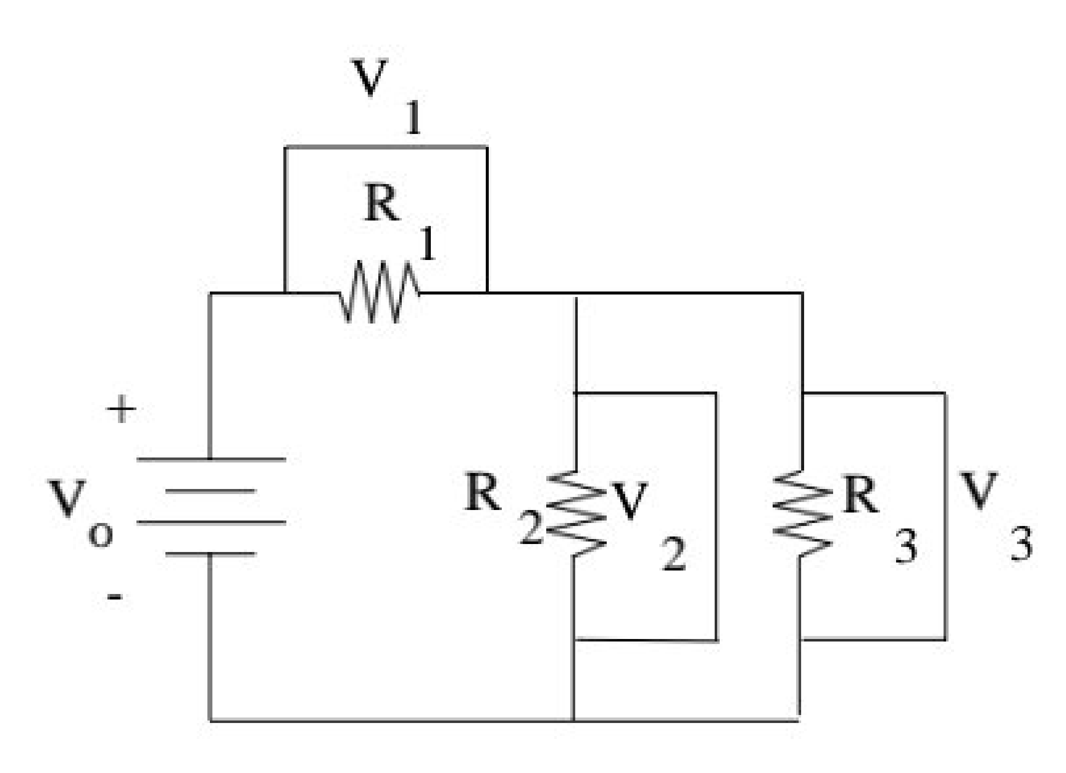


Figure 5: A series/parallel combination

1. Write down the resistor values from their color codes in Table 3.
2. Measure their individual resistances using your multimeter and record these values in Table 3.
3. Calculate the equivalent resistance, R_{eq}, for the three resistors hooked up as in Figure 5, first using your measured resistances (record as Measured R_{eq} in Table 3), and then using the values from the color code chart (record as Color Code R_{eq} in Table 3).
4. Now connect them to the power supply that is set at 12V.
5. Measure the voltage across R_1 and then across R_2 and R_3.

Data Table 3

				V_0 (measured)	
R_1 (measured)		R_1 (from color code)		V_1 (measured)	
R_2 (measured)		R_2 (from color code)		V_2 (measured)	
R_3 (measured)		R_3 (from color code)		V_3 (measured)	
R_{eq} (measured)		R_{eq} (from color code)		V_1+V_2	

Connect capacitors in series and parallel combination on bread board and measure its value using multimeter

I. OBJECTIVE:

The objective of this experiment is to measure the equivalent capacitance of sev- eral capacitors connected in series and parallel. First the individual capacitances and their equivalent will be measured. Then we will charge the capacitors by con- necting the combination to a battery and then measuring the voltage across each capacitor. This will allow us to calculate the charge on the capacitors and then

calculate the equivalent capacitance using the equation $C = Q/V$.

INTRODUCTION:

A capacitor consists of two conducting objects (plates) separated by a nonconduct- ing medium (dielectric). Figure (1) shows a capacitor connected to a battery. The capacitance of this capacitor is defined as the ratio of the magnitude of the charge on one of the conducting plates to the potential difference across them.

$$C = Q/V \tag{1}$$

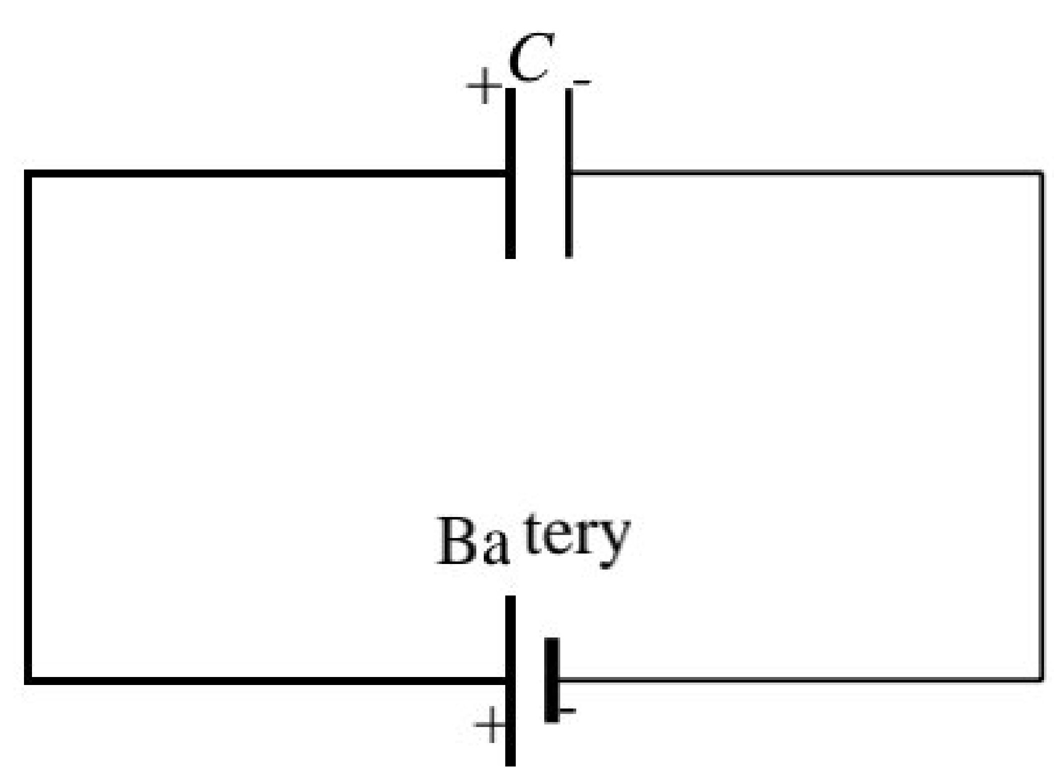


Figure 1: Capacitor Connected to a Battery

Capacitors may be combined in series or parallel. Figure (2a) shows three capac- itors connected in series and connected to a battery. Figure (2b) shows three ca- pacitors connected in parallel and connected to a battery. Note the polarity in each case. Theoretically the equivalent capacitance for the series connection is given by

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \tag{2}$$

and that for the parallel connection is given by

$$C_{eq} = C_1 + C_2 + C_3. \tag{3}$$

II. APPARATUS:

3 capacitors of different values, 6-volt battery, voltmeter, capacitance meter and connecting wires (leads).

III. EXPERIMENTAL PROCEDURE:

1. Make sure that each capacitor is discharged (V=0) by connecting a wire lead across the capacitor for about 30 seconds.
2. Use the capacitance meter to measure the capacitance of each capacitor. Record the values in your data table.
3. Make sure each capacitor is still discharged by repeating step (1) here.
4. Wire the capacitors in series as shown in Fig (2a) (**but do not connect them to the battery)**. Pay close attention to the polarity of the capacitors and the way they are connected. The capacitors used in this experiment are electrolytic capacitors and the polarity of the plates is important. Make sure the ends of the lead wires do not come in contact with each other.

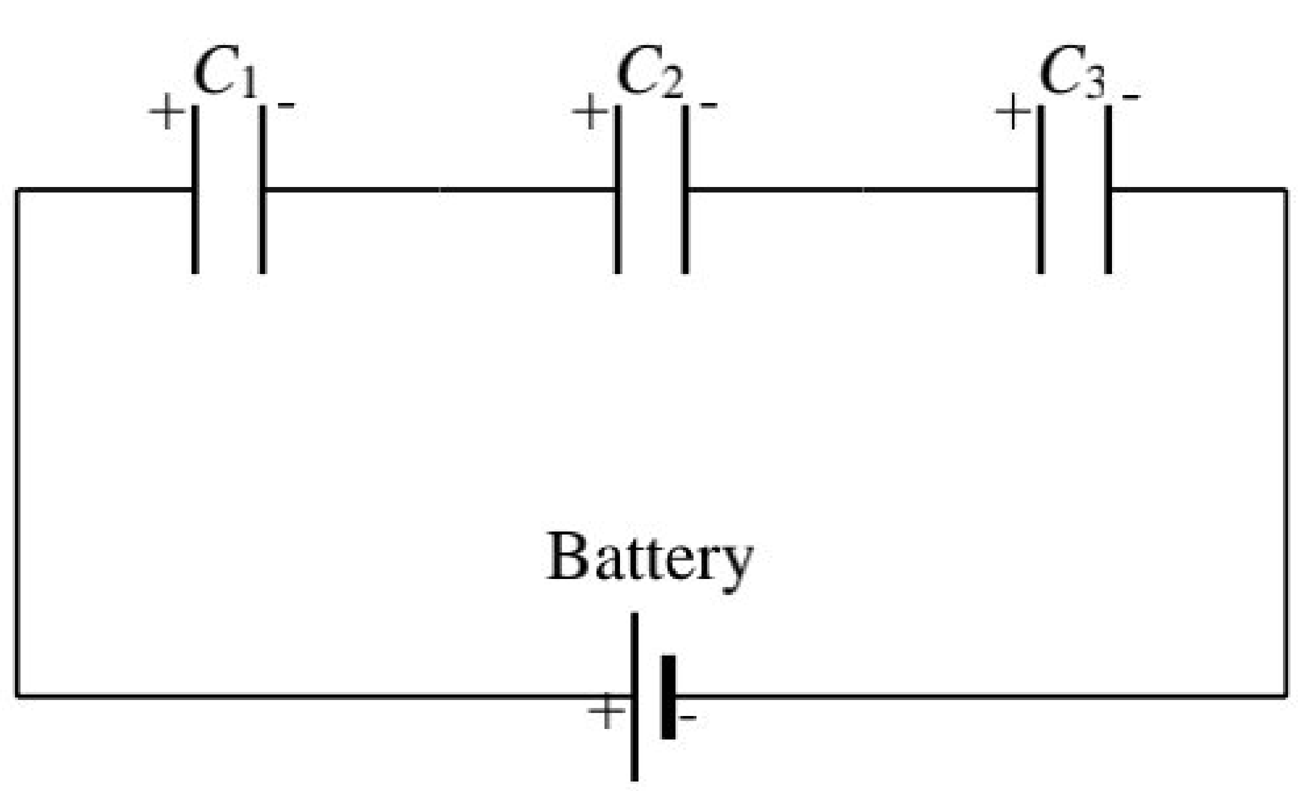


Figure (2a): Capacitors in Series

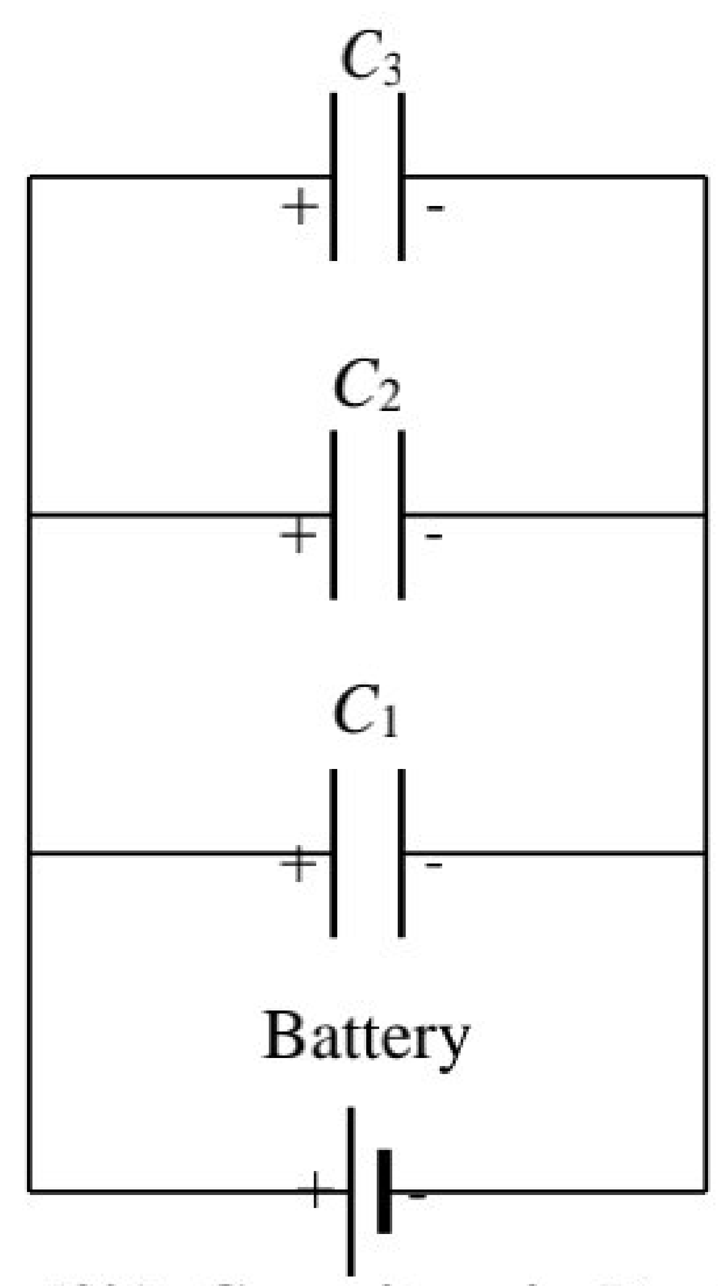


Figure (2b): Capacitors in Parallel

5. Using a capacitance meter, measure the capacitance of the series combination (connect the meter to the free ends). This is $C_{eq,measured}$.
6. Connect the battery to the series combination of capacitors.
7. Measure the voltage across each capcitor and the battery voltage and record these values in your data table. You are finished with the series compbina- tion.

8. Disconnect the capacitors, discharge each capacitor as you did before and wire the circuit in parallel as shown in Fig. (2b) (**but do not connect them to the battery**).

9. Using a capacitance meter, measure the capacitance of the parallel combina- tion. This is $C_{eq,measured}$.

10. Connect the battery to the parallel combination of capacitors.

11. Measure the voltage across each capacitor and the voltage across the battery and record in your data table.

12. Show your data to the intructor or the lab assistant to make sure your data are OK. If so, you are finished with the experimental procedure.

IV. ANALYSIS:

Series connection:

1. For each case calculate the charge on each capacitor using the relation $Q_i = C_i V_i$ where i=1, 2, 3.

2. The values of the charges should be the same within the limits of experimen- tal error. Find the average value of the charge

$$Q_{ave} = \frac{1}{3}(Q_1 + Q_2 + Q_3) \quad (4)$$

This is the charge on the equivalent capacitor.

3. Calculate the experimental equivalent capacitance $C_{eq} = Q_{ave}/V_{batt}$ and record it in the data table.

4. Use eq. (2) to calculate the equivalent capacitance predicted by theory, $C_{eq,predicted}$ and record it in the data table.

5. Calculate the percent difference between the equivalent capacitance predicted by theory and the measured equivalent capacitance

$$\%\ \text{difference} = \left(\frac{\left| C_{eq,measured} - C_{eq,predicted} \right|}{\frac{1}{2}\left(C_{eq,measured} + C_{eq,predicted} \right)} \right) \times 100 \quad (5)$$

6. Calculate the percent difference between the equivalent capacitance predicted by theory and the experimental equivalent capacitance, C_{eq}.

Parallel connection:

1. For each case calculate the charge on each capacitor.

2. Calculate the total charge, $Q_{total} = Q_1 + Q_2 + Q_3$.

3. Calculate the experimental equivalent capacitance $C_{eq} = Q_{total}/V_{batt}$ and record it in the data table.

4. Use eq. (3) to calculate the equivalent capacitance predicted by theory, $C_{eq,predicted}$ and record it in the data table.

5. Calculate the percent difference between the equivalent capacitance predicted by theory and the measured equivalent capacitance

$$\% \text{ difference} = \left(\frac{\left| C_{eq,measured} - C_{eq,predicted} \right|}{\frac{1}{2}\left(C_{eq,measured} + C_{eq,predicted} \right)} \right) \times 100 \qquad (6)$$

6. Calculate the percent difference between the equivalent capacitance predicted by theory and the experimental equivalent capacitance, C_{eq}.

7. Write a conclusion summarizing your results. Comment on the success of this experiment. Explain any percent differences larger than 10%. Is your result consistent with theoretical predictions? What do you think are the two most important sources of error?

Experiment (3) Data Table		
SERIES CONNECTION		
Capacitance C (mF)	Voltage V (Volts)	Charge Q (mC)
$C_{eq} = \frac{Q_{ave}}{V_{batt}} =$	$V_{batt} =$	$Q_{ave} =$
$C_{eq,measured} =$		
$C_{eq\ predicted} =$		
PARALLEL CONNECTION		
$C_{eq} = \frac{Q_{total}}{V_{batt}} =$	$V_{batt} =$	$Q_{total} =$
$C_{eq,measured} =$		
$C_{eq\ predicted} =$		

EXPERIMENT-04

Determine the value of given resistor using digital multimeter to confirm with colour code.

Apparatus

1. Set of wires.
2. Carbon Resistors.
3. Digital A.V.O. meter.

Theory

There are two ways to find the resistance value of a resistor. The color bands on the body of the resistor tell how much resistance it has. As shown in the following diagrams figure (1), there are 5-band resistors and 4-band resistors. Form both 5- and 4-band resistors, the last band indicates tolerance in table (1). Consult with the "Resistor Tolerance" in table (2) chart for finding the tolerance value.

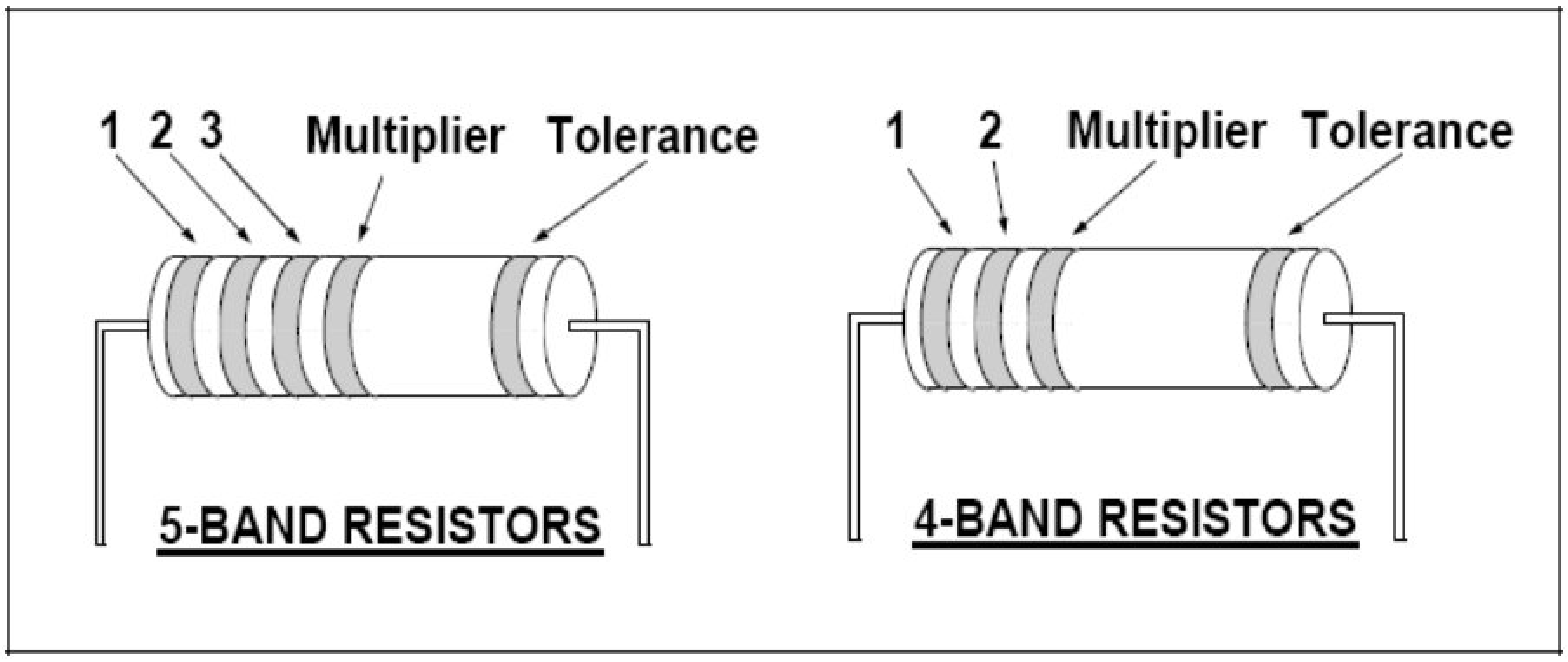


Fig.(1) 5- Band and 4- Band resistors

The first method for read resistor colors in Fig.(2)

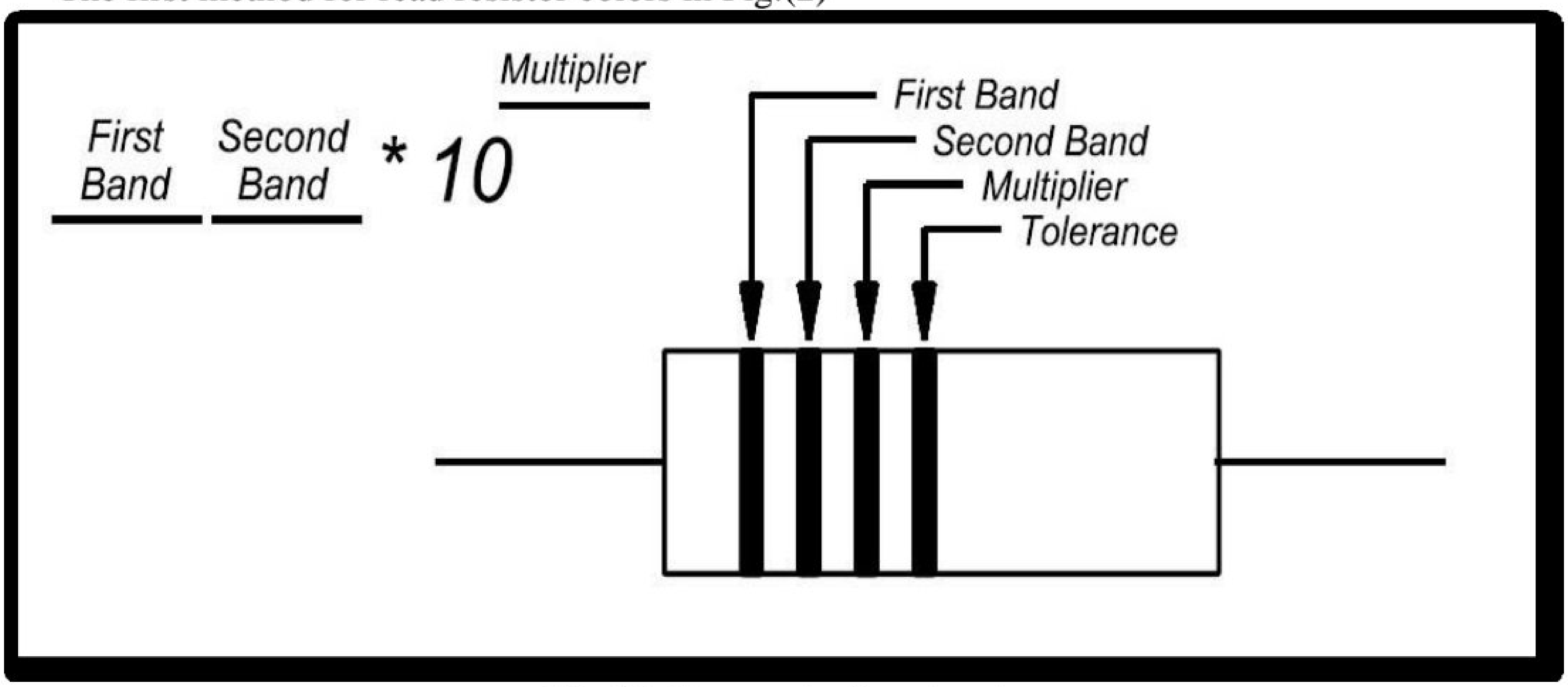


Fig.(2) First method read resistor

COLOR	FIRST BAND	SECOND BAND	MULTIPLIER	TOLERANCE
BLACK		0	$10^0 = 1$	
BROWN	1	1	$10^1 = 10$	
RED	2	2	$10^2 = 100$	
ORANGE	3	3	$10^3 = 1000$	
YELLOW	4	4	$10^4 = 10000$	
GREEN	5	5	$10^5 = 100000$	
BLUE	6	6	$10^6 = 1000000$	
VIOLET	7	7	$10^7 = 10000000$	
GREY	8	8	$10^8 = 100000000$	
WHITE	9	9	$10^9 = 1000000000$	
GOLD			$10^{-1} = 0.1$	5%
SILVER			$10^{-2} = 0.01$	10%
NO COLOR				20%

The first litter word to represent color resistor code in table (1)

Better **B**e **R**eady **O**r **Y**our **G**reat **B**ig **V**enture **G**oes **W**rong, **G**o **S**tudy **N**ow

Color	Tolerance
Silver	± 10%
Gold	± 5%
Red	± 2%
Brown	± 1%
Green	± 0.5%
Blue	± 0.25%
Violet	± 0.1%
Gray	± 0.05%

Table (2) Resistor Tolerance

View the resistors and based on the color bands determine its value. Below is an example:

Table 2-1		
Band	Color Code	Numeric Value
1^{st} Band	Brown	1
2^{nd} Band	Black	0
3^{rd} Band	Orange	10^3
4^{th} Band	Gold	±5%
The Resistor Value is 10K		**The tolerance is ±5%**

The first band is a one (1), the second band is a zero (0), and the multiplier band or third band is

one time text to the third power ( ) or one thousand (1000). Multiply 10 times 1000.

Another way to tell the resistance value of a resistor is to actually measure it with the ohmmeter. The explanation of how to measure the resistance is given in the later tip.

Where:-

$R_{max} = R+(R * T)$

Procedure

1. Measure and record twenty resistors with value of 1 Kohm.
2. Find the R max. , R min. then calculate the percentage error.
3. Repeat the steps (1,2) with resistor value of 10K ohm.
4. Repeat the steps (1,2) with resistor value of 100K ohm.

Discussion

1. Comment for your results.
2. Determine the value and tolerance of the 10 resistors as shown in the following tables for chart fig. (3):

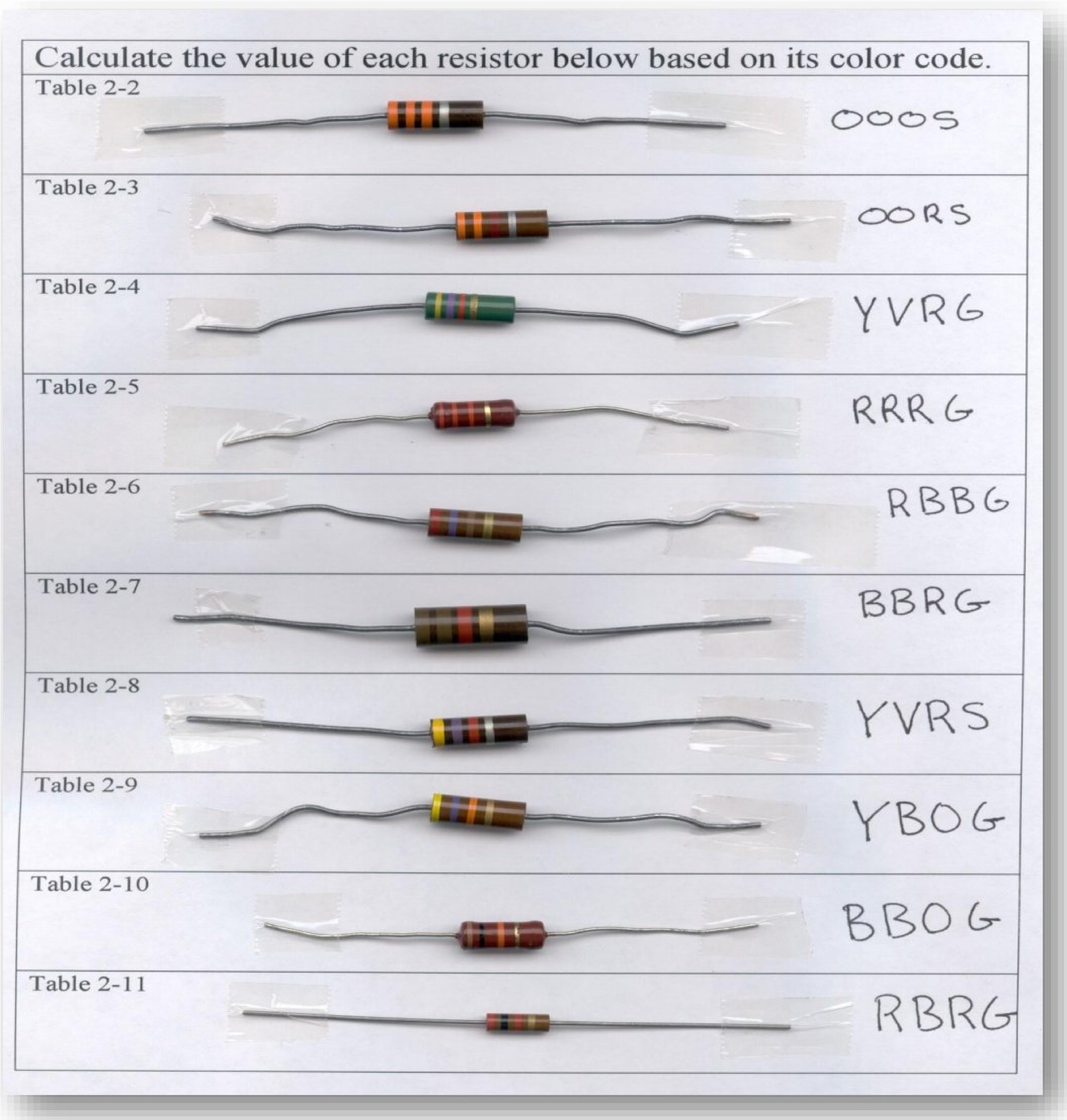
Table 2-2		
Band	Color Code	Numeric Value
1st Band	Orange	
2nd Band	Orange	
3rd Band	Orange	
4th Band	Silver	
The Resistor Value is____________		**The Tolerance is ______%**

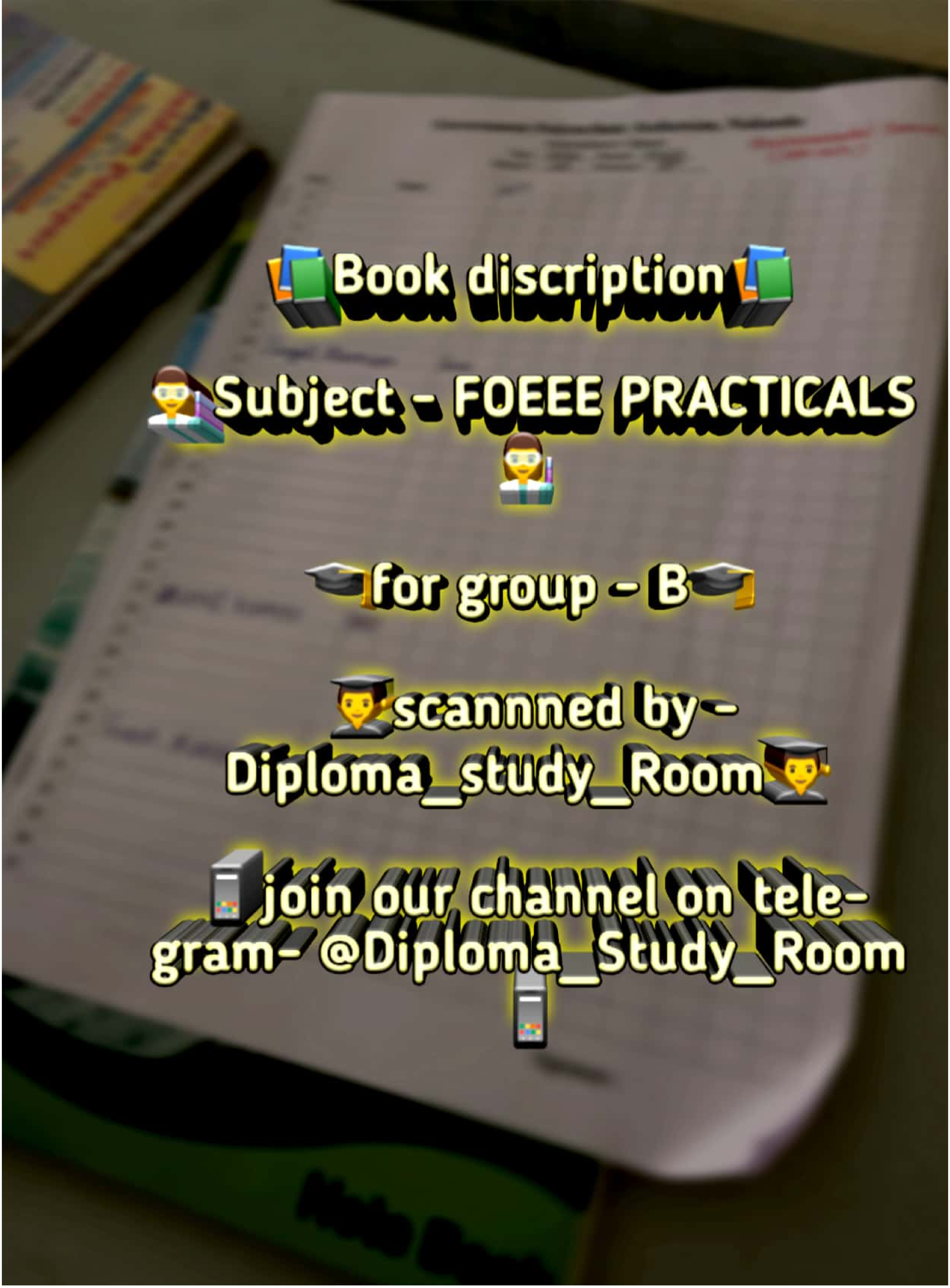
Table 2-3		
Band	Color Code	Numeric Value
1st Band	Orange	
2nd Band	Orange	
3rd Band	Red	
4th Band	Silver	
The Resistor Value is____________		**The Tolerance is ______%**

Table 2-6		
Band	Color Code	Numeric Value
1st Band	Red	
2nd Band	Violet	
3rd Band	Brown	
4th Band	Gold	
The Resistor Value is____________		**The Tolerance is ______%**

Table 2-7		
Band	Color Code	Numeric Value
1st Band	Brown	
2nd Band	Brown	
3rd Band	Red	
4th Band	Gold	
The Resistor Value is____________		**The Tolerance is ______%**

Table 2-8		
Band	Color Code	Numeric Value
1st Band	Yellow	
2nd Band	Violet	
3rd Band	Red	
4th Band	Silver	
The Resistor Value is____________		**The Tolerance is ______%**


Calculate the value of each resistor below based on its color code.
Table 2-2
OOOS
Table 2-3
OORS
Table 2-4
YVRG
Table 2-5
RRRG
Table 2-6
RBBG
Table 2-7
BBRG
Table 2-8
YVRS
Table 2-9
YBOG
Table 2-10
BBOG
Table 2-11
RBRG


Book discription
Subject - FOEEE PRACTICALS
for group - B
scannned by - Diploma_study_Room
join our channel on tele-gram- @Diploma_Study_Room

[Type text]

Experiment -05

Test the PN-junction diodes using digital multimeter.

Aim:

1. To plot V-I Characteristics of Silicon and Germanium P-N Junction Diodes.
2. To find cut-in voltage for Silicon and Germanium P-N Junction diode

Components:

Name	Quantity
Diodes 1N4007(Si)	1
Diodes DR-25(Ge)	1
Resistor 1K Ω	1

Equipment:

Name	Range	Quantity
Bread board		1
Regulated power supply	0-30V	1
Digital Ammeter	0-200μA/200mA	1
Digital Voltmeter	0-20V	1
Connecting Wires		

Specifications:

Silicon Diode 1N 4007:	**Germanium Diode DR 25:**
Max Forward Current = 1A	Max Forward Current = 250mA
Max Reverse Current = 5.0μA	Max Reverse Current = 200μA
Max Forward Voltage = 0.8V	Max Forward Voltage = 1V
Max Reverse Voltage = 1000V	Max Reverse Voltage = 25V
Max Power Dissipation = 30mW	Max Power Dissipation = 250mW
Temperature = -65 to 200° C	Temperature = -55 to 75° C

Theory:

Donor impurities (pentavalent) are introduced into one-side and acceptor impurities into the other side of a single crystal of an intrinsic semiconductor to form a p-n diode with a junction called depletion region (this region is depleted off the charge carriers). This region gives rise to a potential barrier called Cut-in Voltage. This is the voltage across the diode at which it starts conducting. The P-N junction can conduct beyond this potential.

The P-N junction supports uni-directional current flow. If +ve terminal of the input supply is connected to anode (P-side) and –ve terminal of the input supply is connected the cathode. Then diode is said to be **forward biased**. In this condition the height of the potential barrier at the junction is lowered by an amount equal to given forward biasing voltage. Both the holes from p-side and electrons from n-side cross the junction simultaneously and constitute a forward current from n-side (injected minority current – due to holes crossing the junction and entering P- side of the diode). Assuming current flowing through the diode to be very large, the diode can be approximated as short- circuited switch.

If –ve terminal of the input supply is connected to anode (p-side) and +ve terminal of the input supply is connected to cathode (n-side) then the diode is said to be **reverse biased**. In this condition an amount equal to reverse biasing voltage increases the height of the potential barrier at the junction. Both the holes on P-side and electrons on N-side tend to move away from the junction there by increasing the depleted region. However the process cannot continue indefinitely, thus a small current called reverse saturation current continues to flow in the diode. This current is negligible hence the diode can be approximated as an open circuited switch.

The volt-ampere characteristics of a diode explained by the following equations

$$I = I_O \; e^{\frac{V_D}{\eta \, V_T}} - 1$$

Where I = current flowing in the diode, I_0 = reverse saturation current V_D = Voltage applied to the diode

V_T = volt- equivalent of temperature = k T/q = T/ 11,600 = 26mV (@ room temp)

η = 1(for Ge) and 2 (for Si)

It is observed that **Ge** diodes has smaller cut-in-voltage when compared to **Si** diode. The reverse saturation current in **Ge** diode is larger in magnitude when compared to silicon diode.

Circuit Diagrams:

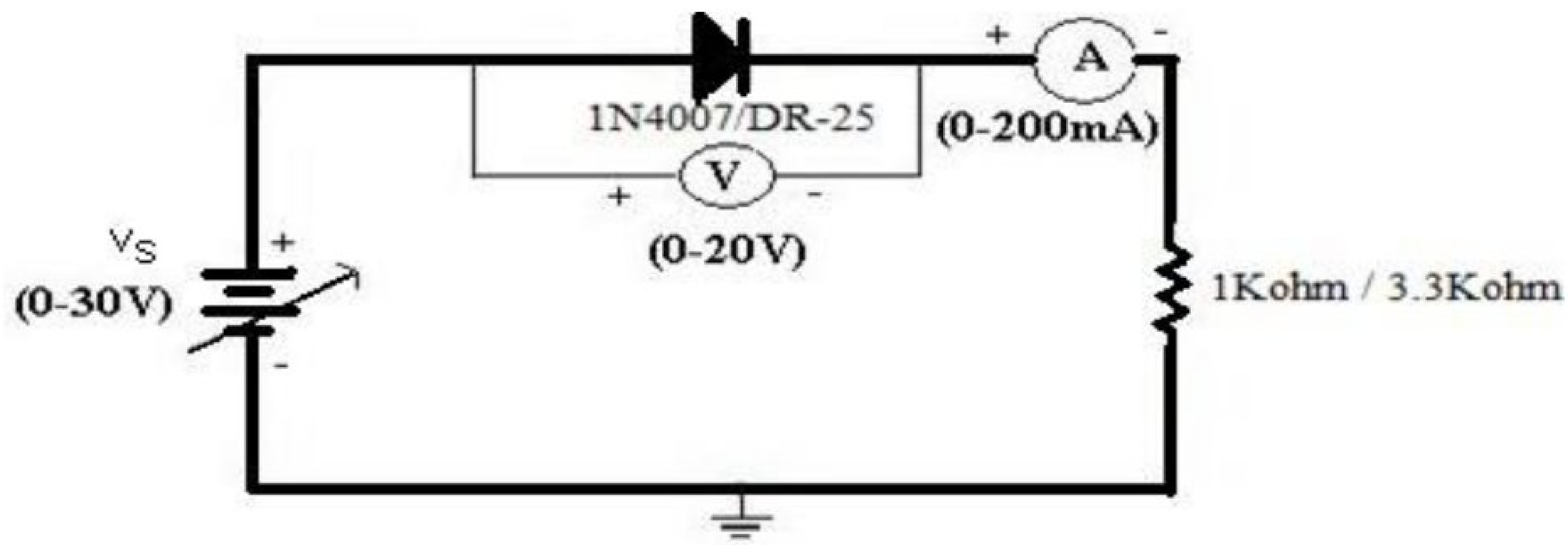


Fig. 1: Forward Bias Condition

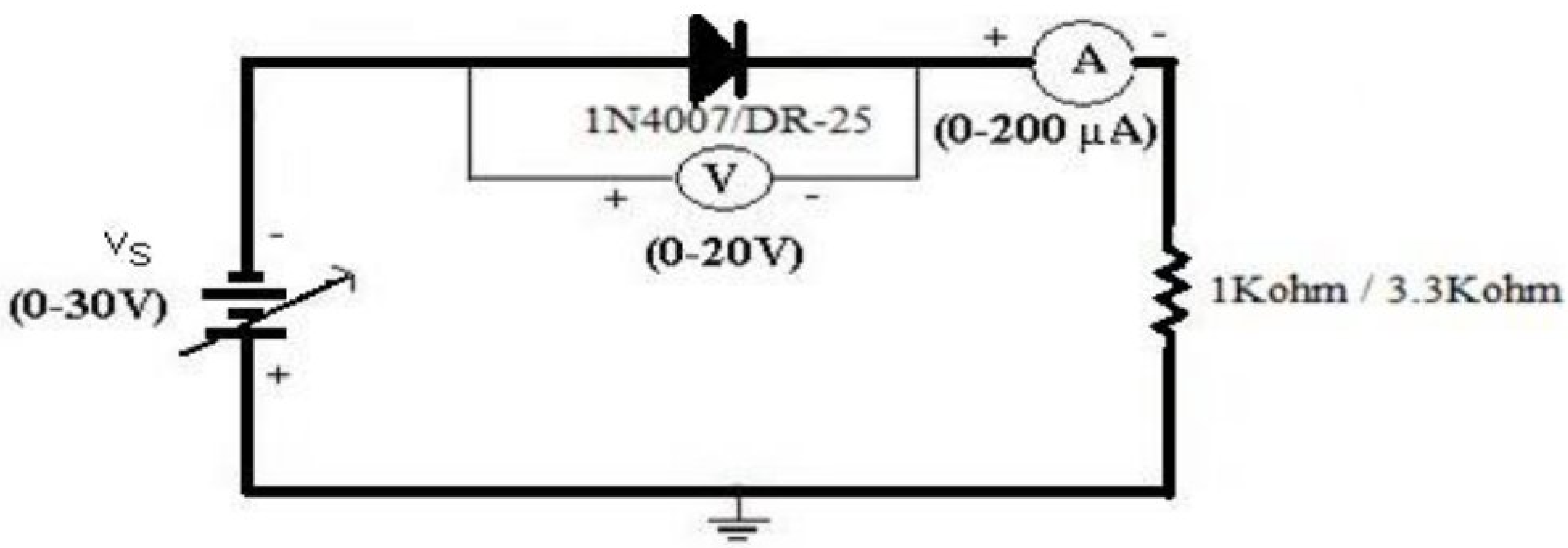


Fig. 2: Reverse Bias Condition

Procedure:

Forward Bias Condition:

1. Connect the components as shown in the Fig.1.
2. Vary the supply voltage such that the voltage across the Silicon diode varies from 0 to 0.6 V in steps of 0.1 V and in steps of 0.02 V from 0.6 to 0.76 V. In each step record the current flowing through the diode as I.
3. Repeat the above steps for Germanium diode too but with the exception that the voltage across the diode should be varied in steps of 0.01 V from 0.1 to 0.3 V in step-2.

Reverse Bias Condition:

1. Connect the diode in the reverse bias as shown in the Fig.2.
2. Vary the supply voltage such that the voltage across the diode varies from 0 to 10V in steps of 1 V. Record the current flowing through the diode in each step.
3. Repeat the above steps for Germanium diode too and record the current in each step.
4. Now plot a graph between the voltage across the diode and the current flowing through the diode in forward and reverse bias, for Silicon and Germanium diodes on separate graph sheets. This graph is called the V-I characteristics of the diodes.
5. Calculate the static and dynamic resistance of each diode in forward and reverse bias using the following formulae.

Static resistance, $R = V/I$

Dynamic resistance, $r = \Delta V/\Delta I$

Observations:

(a) Forward & Reverse bias characteristics of Silicon diode

Forward Bias Condition:

S. No.	Forward Voltage across the diode V_d (Volt)	Forward Current through the diode I_d (mA)

Reverse Bias Condition:

S. No.	Reverse Voltage across the diode V_R (Volt)	Reverse Current through the diode I_R (μA)

(b) Forward & Reverse bias characteristics of Germanium diode

Forward Bias Condition:

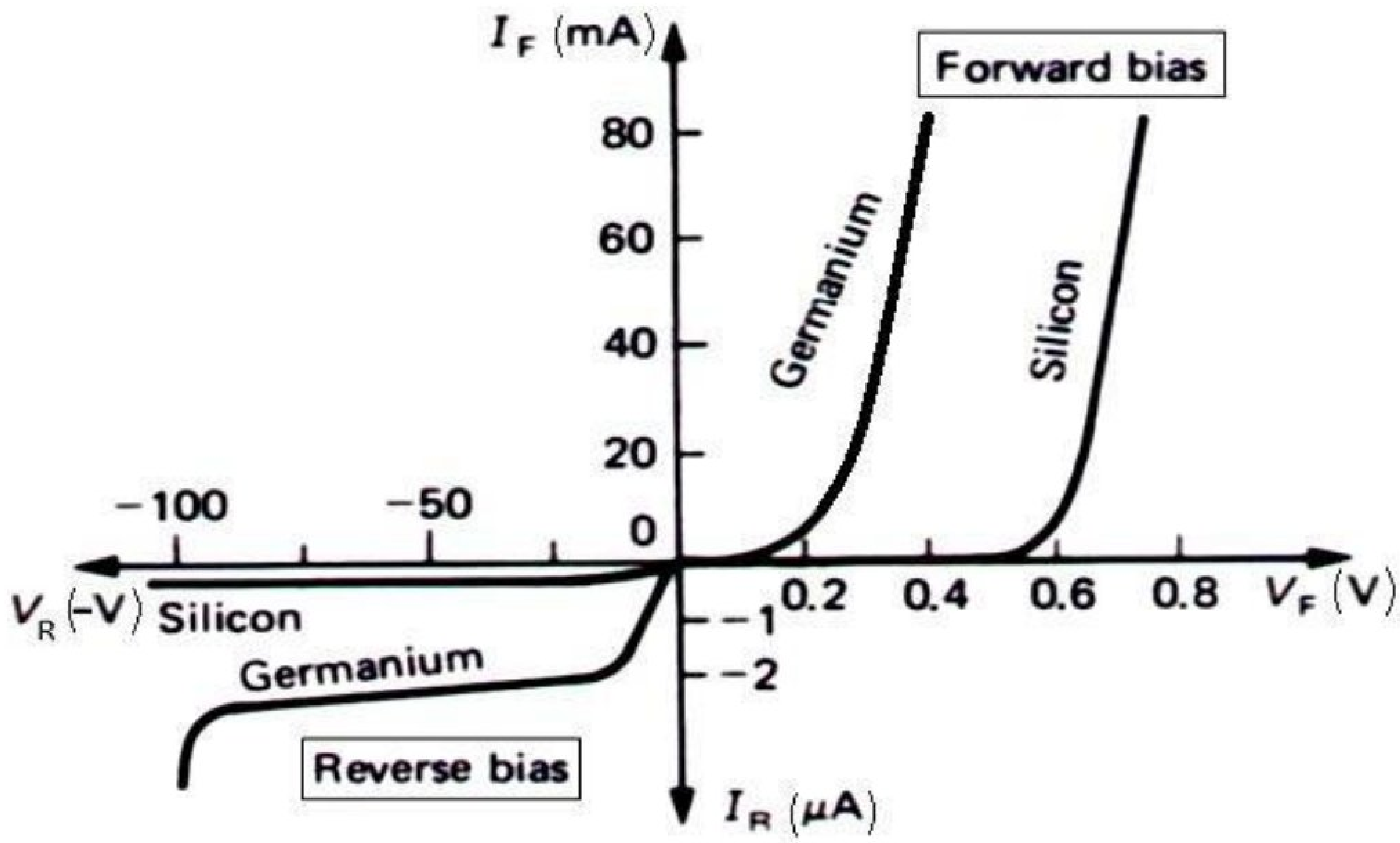
S. No.	Forward Voltage across the diode V_d (Volt)	Forward Current through the diode I_d (mA)

Reverse Bias Condition:

S. No.	Reverse Voltage across the diode V_r (Volt)	Reverse Current through the diode I_R (μA)

Graphs:

1. Take a graph sheet and divide it into 4 equal parts. Mark origin at the center of the graph sheet.
2. Now mark +ve X-axis as V_f, -ve X-axis as V_R, +ve Y-axis as I_f and –ve Y-axis as I_R.
3. Mark the readings tabulated for Si forward biased condition in first Quadrant and Si reverse biased condition in third Quadrant.
4. Repeat the same procedure for plotting the Germanium characteristics.



Calculations from Graph:

Static forward Resistance

$R_{dc} = V_f / I_f \Omega$

Dynamic Forward Resistance

$r_{ac} = \Delta V_f / \Delta I_f \Omega$

Static Reverse Resistance

$R_{dc} = V_r / I_r \Omega$

Dynamic Reverse Resistance

$r_{ac} = \Delta V_r / \Delta I_r \Omega$

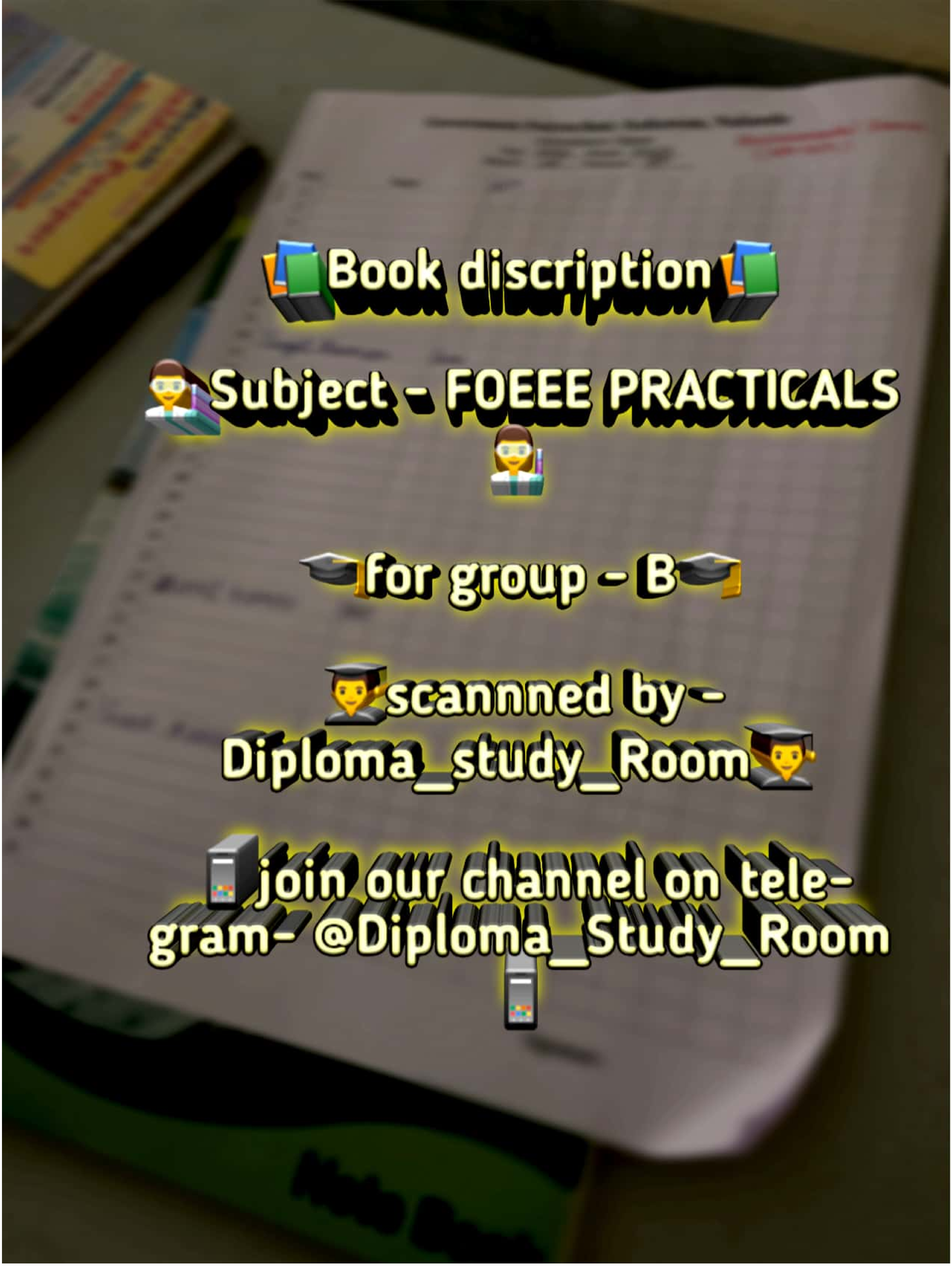
Precautions:

1. While doing the experiment do not exceed the readings of the diode. This may lead to damaging of the diode.
2. Connect voltmeter and ammeter in correct polarities as shown in the circuit diagram.
3. Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

Results:

Cut in voltage = ________________V

Static Forward Resistance = ________________Ω


Book discription
Subject - FOEEE PRACTICALS
for group - B
scannned by -
Diploma_study_Room
join our channel on tele-
gram- @Diploma_Study_Room