Verification of maximum power transfer theorem

**Aim**: To verify the maximum power transfer theorem.

**Apparatus**: Battery, carbon (non-inductive) resistors, voltmeter, milli-ammeter, variable load resistor, multimeter and connecting terminals.

**Formula**: Power \( P = I_L^2R_L = V_L^2/R_L \text{ watt} \)

\[
I_L = \text{Load current.}
\]

\[
R_L = \text{Load resistance.}
\]

\[
V_L = \text{Voltage across the load}
\]

**Description**: Maximum power transfer theorem states that “In two terminal a.c. network the load will absorb maximum power from a generator if the load impedance is the complex conjugate of the internal impedance of the generator.” But in d.c. circuit the load draws maximum power from the source, when the load resistance is equal to the internal resistance of the source i.e. at \( R_L = R_S \) the power consumed by the load is maximum. The power in the load is given by \( P = I_L^2R_L \text{ (OR) } V_L^2/R_L \).

**Procedure**: The circuit is connected as shown in the figure-1. First the load is removed from the circuit. The battery is replaced by its internal impedance (Assume that the internal impedance is equal to zero and the terminals are short-circuited). The resistance between the terminals A and B is measured by using a multi-meter. It is the resistance of the source \( (R_S) \). Now the battery and the load resistance \( R_L \) are connected in their places. By varying the value of \( R_L \) from \( R_L < R_S \) to \( R_L > R_S \), the voltage across the load and current through the load are noted. The values are tabulated as shown.

Now the power is calculated by using the formula \( P = I_L^2R_L \text{ (OR) } V_L^2/R_L \) for each value of current \( I_L \) or \( V_L \). Take the value of \( R_L \) at the maximum power. If \( R_L \) value is equal to the internal resistance of source or generator \( R_S \), then the theorem is proved.
Graph: A graph is drawn between the power $P$ and the load resistance $R_L$, as shown in the figure 2, by taking power $P$ on Y-axis and load $R_L$ on X-axis. The graph shows that the power is maximum when the load resistance is equal to the internal resistance of the source.

Precautions: 1) The load resistance $R_L$ is varied from $< R_S$ to $> R_S$.
2) Internal resistance of the source should be measured before going to the experiment.
3) The battery should be removed and those terminals should be shorted while measuring the source resistance.

Results:

Table

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Load resistance $R_L$ (Ω)</th>
<th>Voltage across load $V_L$ (V)</th>
<th>Current through load $I_L$ (mA)</th>
<th>$P = I_L^2 R_L$ (watt)</th>
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Fig. 1

To measure source resistance

Fig. 2

\[ R_L = R_S \]

Load-resistance