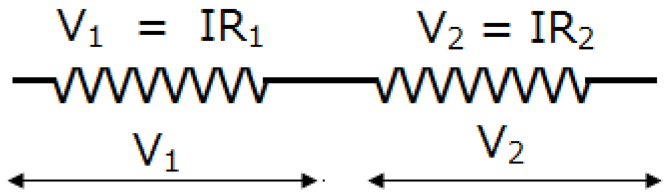
Now in the next topic we discuss about series and parallel connection.

SERIES combination of Resistances

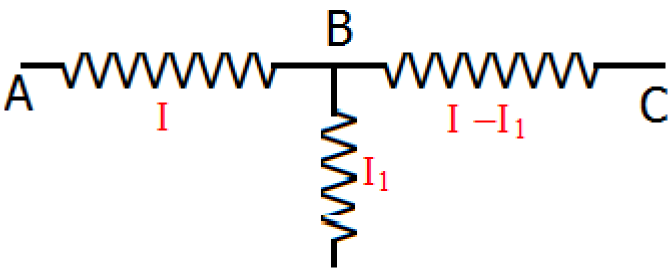
When two resistances are connected END to END we consider it is a series connection. It is TRUE but not ALWAYS. Actually the series concept is basically not for END to END connection but about same current passing in both resistance.

You will understand it by an example now!



Here we derive $V = V_1 + V_2$ hence we get $R = R_1 + R_2$ by knowing formula $V = IR$ in respective resistances

It is OKAY but now you see one more circuit.



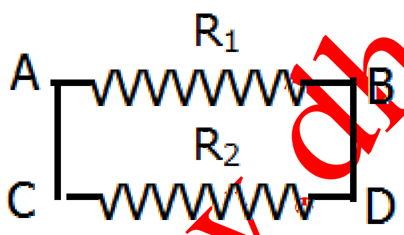
In this circuit also $V_{AC} = V_{AB} + V_{BC}$ but here $R \neq R_1 + R_2$ WHY? Is important to note !

Now you can see though $V_{AC} = V_{AB} + V_{BC}$ but $V_{AB} = IR_1$ but V_{BC} is NOT IR_2 but is equal to $(I - I_1) R_2$

However in a particular case we see that I_1 is ZERO we can CONSIDER both resistances in SERIES.

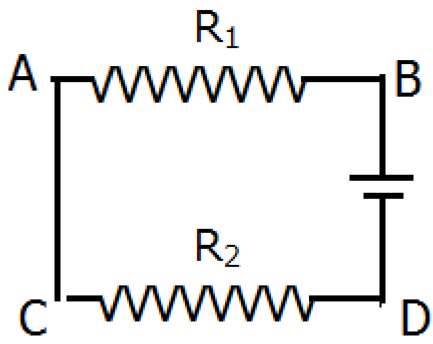
Most important is that the current should be same at times apparently the circuit may seem to be in series but it is either parallel or none

Similarly for potential also we must consider that both the resistors are connected across same terminals only then we may say it is parallel.



In this circuit if we see A has same potential as C and B has same potential as D hence both resistances R_1 and R_2 are connected to same potential hence are parallel.

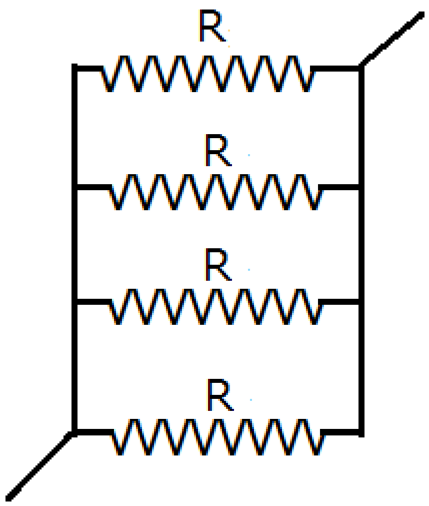
But just view next circuit where A and C have same potential but B and D are not at same potential. The reason is that that an electric source termed as battery is provided there, apart from battery it could be capacitor, or resistance etc in all cases, there is potential developed between B and D, hence B and D are not at same potential. Consequently both resistances are not in parallel, BUT in this case (where Battery is attached) we can see current will be same, hence the resistances are in series.

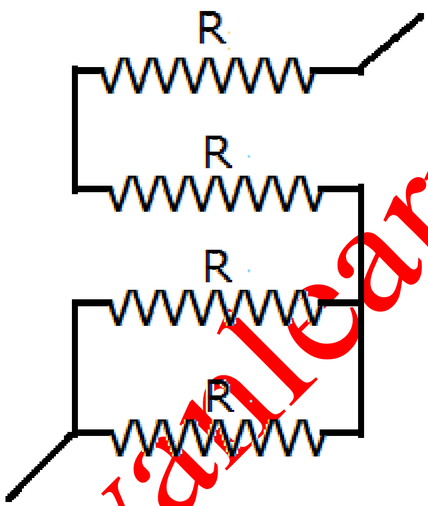


Hope you understood the basics, let us understand with more examples.

Now this circuit has all the four resistances in parallel. And answer for effective resistance is R/4. But in next circuit please SEE the CONNECTIONS

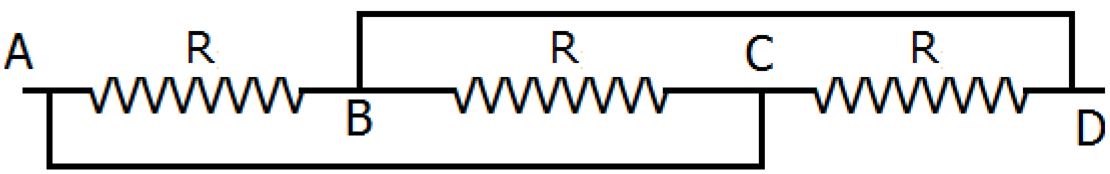
The bottom two are in parallel but the top both resistances are in SERIES. Hence the answer is 2.5 R for effective resistance.





See the circuit here you can see that all resistances are in series because all will carry same current. But the circuit below is not series.

As current gets divided at ALL junctions. Now again if you see, A and C are connected by wire having NO resistance, so they are at same POTENTIAL same is story of B and D in other words all the resistances are connected across PRACTICALLY same points, hence all are in parallel.



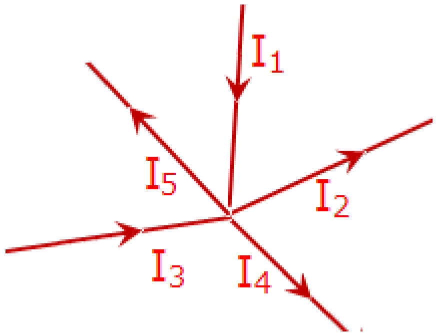
KIRCHOFF LAWS : If we can simplify the circuits we can find the equivalent resistance, current through circuit elements and potential across each current carrying element. But if we get some circuits in which, resistances are neither in series or parallel or we have batteries connections etc. mainly we have complex circuits we then use Kirchhoff's laws for finding the currents and voltages across elements.

KIRCHOFF's FIRST LAW, Kirchoff current Law or Junction Rule, All three names of ONE Law only.

This law is based on principal of conservation of Charge. What is Junction? Any point we have three or more wires joined is called junction.

It states that current entering a junction is equal to current leaving the junction. In other words the algebraic sum of currents entering a junction is zero. Now we can see a junction. We see the current entering a junction is I_1 and rest all are out going, thus we can say as per Kirchoff Rule

$I_1 = I_2 + I_3 + I_4 + I_5$, taking direction into consideration in other words $\Sigma I = 0$

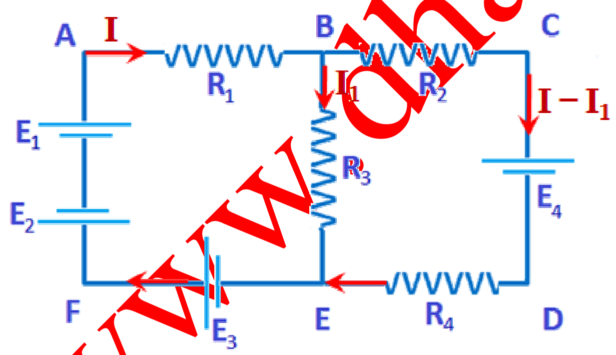


Supposing in any question we are not clear about the direction of current we may arbitrary give any sign and if final answer if opposite, we will take it oppositely. i.e. if we assume I′ coming out of junction and get it negative, it means that I′ is going out from junction.

NEXT comes the Kirchhoff's Voltage Rule/Loop Rule : By this rule we can say that it is in accordance to conservation of energy. As per this law or rule, the sum of product of respective resistances and currents is equal to the net emf in any closed loop. Here before applying the loop rule we MUST see that Junction RULE is satisfied at all junctions.

Then when we apply loop rule we must try to get summation of IR's , if the current is moving as the loop progresses we can say that product IR is positive, and if loop and current are opposite IR for that resistor is negative,

At this time we are not using the Emf's of cell. When adding the emf, if loop is entering in negative terminal and coming out of positive we get positive emf and when we see loop entering the positive and coming out of negative we take emf as negative



In example of circuit given above we see that there are two junctions B and E. Now we take the currents as shown, You can see that first of all the junction are satisfied with JUNCTION RULE.

Then we apply loop rule on loops

For example

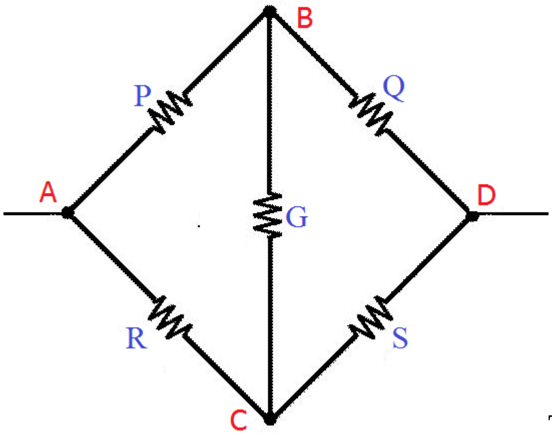
ABEFA $IR_1 + I_1R_3 = E_3 + E_1 - E_2$, Please note the usage of positive and negative

BCDEB $(I - I_1)R_2 + (I - I_1) R_4 - I_1R_3 = -E_4$, Please note the usage of positive and negative

If we take loop ABCDEFA we will get equation as we get from sum of above equations

$IR_1 + (I - I_1)R_2 + (I - I_1)R_4 = -E_4 + E_3 - E_2 + E_1$

Then comes the principal of Wheat Stone Bridge : What is wheat Stone Bridge ? It is special arrangement of 5 Resistances such that NO TWO are in series or Parallel



This is an example of WHEAT STONE BRIDGE !

Please check NO two Resistances are either in series or parallel. But even in this case suppose NO CURRENT FLOWS on resistance G. Then the current flowing in P and Q will be same and in R and S also the current will be same. Now P and Q can be taken as series and R and S also in series. Final two resistances as equivalent can be combined in parallel.

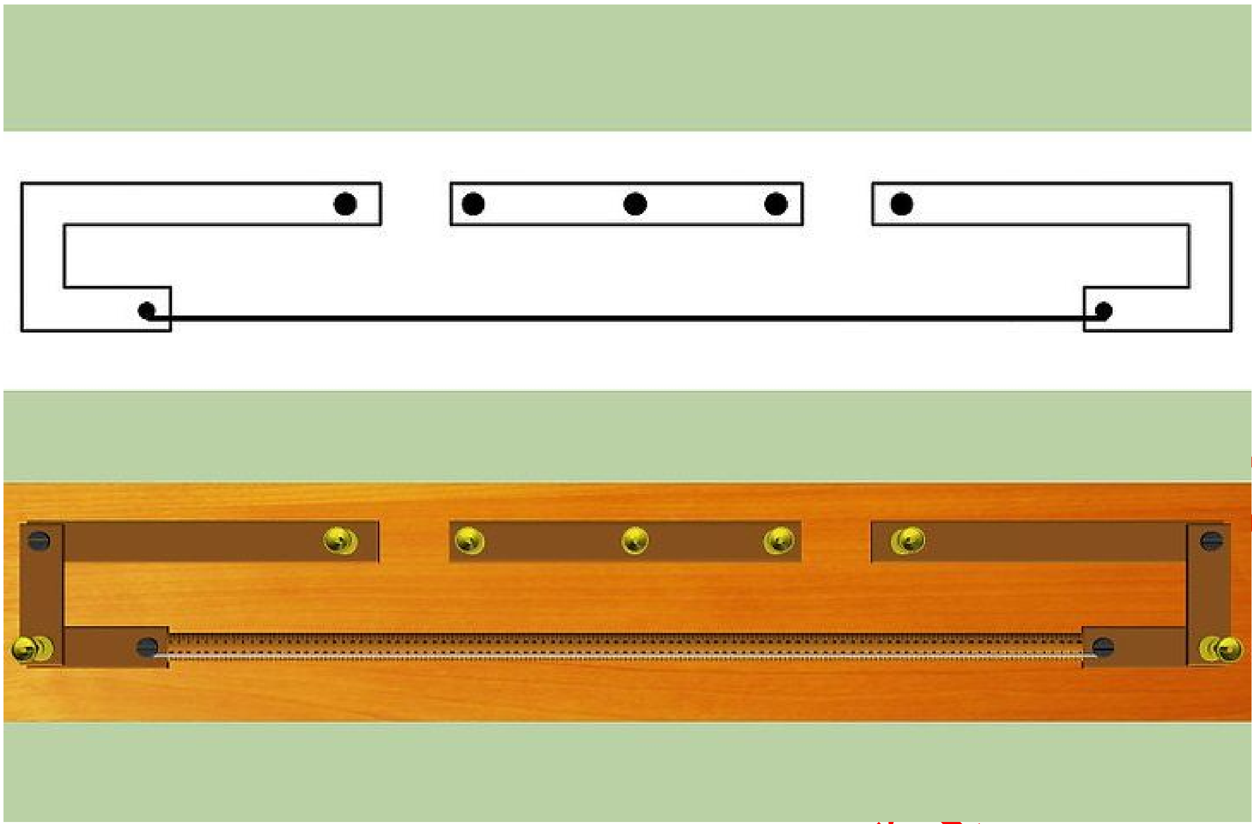
In such a case potential at B must be equal to potential at C (No current between B and C) If current between A and B is given as I and between A and C is I_1. Since no current between B and C current through B and D is also I and current through C and D is I_1 .

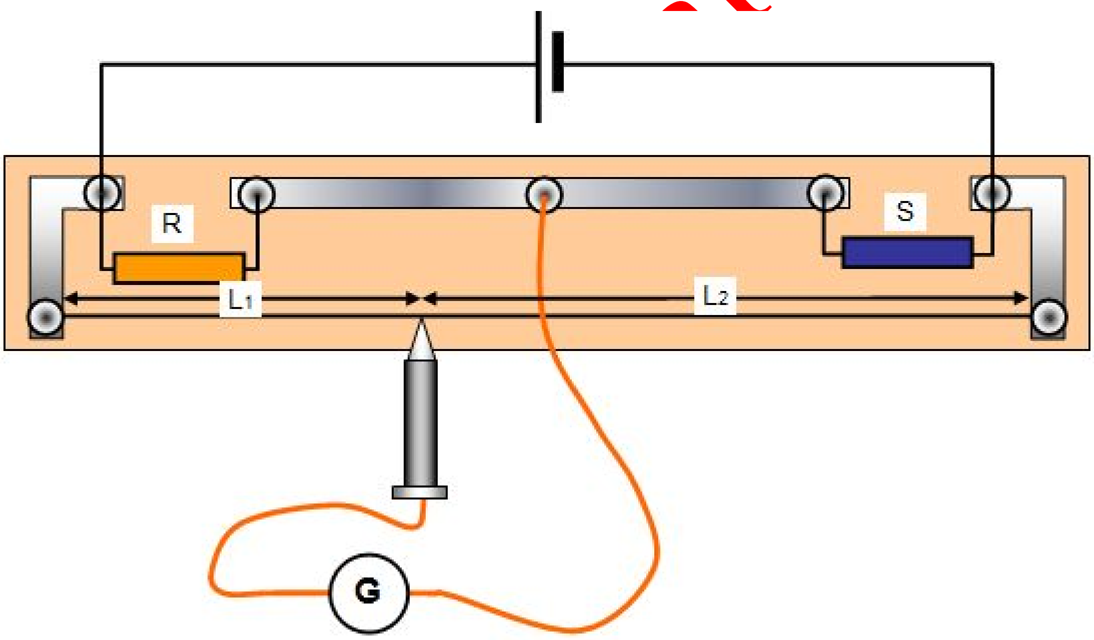
V_{BA} = IP and V_{CA} = I_1R

V_{BD} = IQ and V_{CD} = I_1S

Dividing both equation we get the conditions of balanced wheat stone bridge.

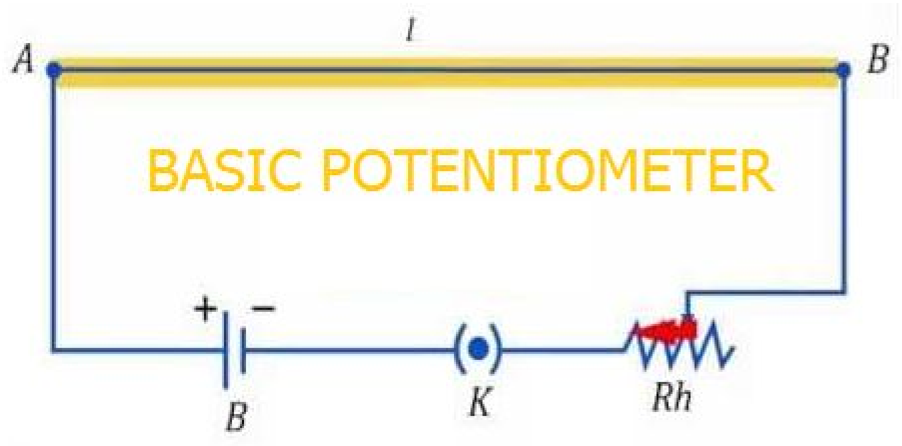
METER BRIDGE : Below shown is diagram of meter bridge. It works on the principal of balance wheat stone bridge. Hence in this case again balance conditions are obtained



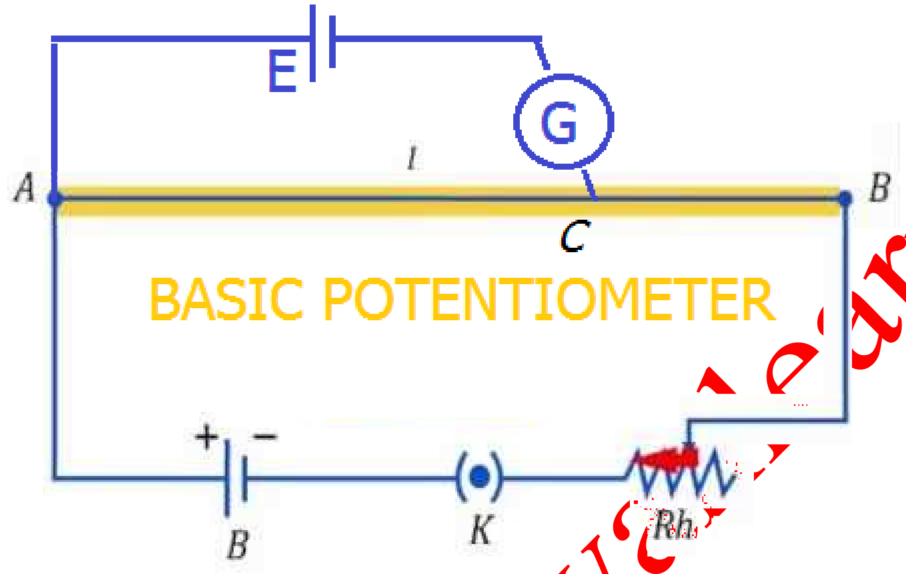


The above diagram explains how it is connected to resistance circuit. You may see that in this case, one of the resistance is known and also the ratio is known we may get the answer for unknown, say S or R in this case.

Lastly we have the logic and experiment of potentiometer.



In the basic potentiometer we have some voltage divided or distributed over a length. In the above circuit you can see that total voltage of Battery B is distributed across Rh Rheostat and wire AB. Now whatever voltage is across AB, we get the potential gradient across AB.



Now we have added another cell across AC and we find that galvanometer shows no deflection. Thus voltage across AC will be equal to emf of cell. This is the basic of potentiometer.

We have go the experiment of finding internal resistance of cell and of comparison of emf of two primary cells

In the complete potentiometer it is to be understood that there are two circuits primary one is, making of potentiometer and than other is secondary in which galvanometer is attached and experiment preformed .