

## MARKING CRITERIA AND STUDENT FEEDBACK

This section details the assessment criteria. The *extent* to which these are demonstrated by you determines your mark. The marks available for each criterion are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

| Common Assessment Criteria Applied                                                                                                                                                                     | Marks available | Marks awarded |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------|
| <b>1. Research-informed Literature</b><br>Extent of research and/or own reading; selection of credible sources; application of appropriate referencing conventions.                                    | 10              |               |
| Reference evident                                                                                                                                                                                      |                 | 4.9           |
| <b>2. Knowledge and Understanding of Subject</b><br>Extent of knowledge and understanding of concepts and underlying principles associated with the discipline                                         | 20              |               |
| Knowledge shows good understanding                                                                                                                                                                     |                 | 13.8          |
| <b>3. Analysis</b><br>Analysis, evaluation and synthesis; logic, argument and judgement; analytical reflection; organisation of ideas and evidence                                                     | 20              |               |
| Evidence of logical analysis.                                                                                                                                                                          |                 | 11.8          |
| <b>4. Practical Application and Deployment</b><br>Deployment of methods, materials, tools and techniques; application of concepts; formulation of innovative and creative solutions to solve problems. | 40              |               |
| A very good application of a range of methods.                                                                                                                                                         |                 | 27.6          |
| <b>5. Skills for Professional Practice</b><br>Attributes in professional practice: individual and collaborative working; deployment of appropriate media; presentation and organisation.               | 10              |               |
| Can communicate well.                                                                                                                                                                                  |                 | 6.9           |

**Assignment Mark** (Assessment marks are subject to ratification at the Examinations Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)

Late Submission Penalties (tick if appropriate)

Up to four weeks late

First Attempt?

65

%

# FdSc & HN COMMON ASSESSMENT AND MARKING CRITERIA

| Assessment Criteria                                                                                                                                                                                                                                                                                          | OUTRIGHT FAIL<br>REFER (equivalent to 0-29%)                                                                                                                                                     | UNSATISFACTORY<br>REFER (equivalent to 30-39%)                                                                                                                                                                         | SATISFACTORY<br>PASS (equivalent to 40-49%)                                                                                                                                                                                                                   | GOOD<br>PASS (equivalent to 50-59%)                                                                                                                                                                                                                                                      | VERY GOOD<br>MERIT (equivalent to 60-69%)                                                                                                                                                                                                                                                                      | EXCELLENT<br>DISTINCTION (equivalent to 70-79%)                                                                                                                                                                                                                                                      | EXCEPTIONAL<br>DISTINCTION (equivalent to 80-100%)                                                                                                                                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1. Research-informed Literature</b><br>Extent of research and/or own reading, selection of credible sources, application of appropriate referencing conventions                                                                                                                                           | Little or no evidence of reading. Views and findings unsupported and non-authoritative. Referencing conventions largely ignored.                                                                 | Poor evidence of reading and/or of reliance on inappropriate sources, and/or indiscriminate use of sources. Referencing conventions used inconsistently.                                                               | References to a limited range of mostly relevant sources. Some omissions and minor errors. Referencing conventions evident though not always applied consistently.                                                                                            | Inclusion of a range of research-informed literature, including sources retrieved independently. Referencing conventions mostly consistently applied.                                                                                                                                    | Inclusion of a wide range of research-informed literature, including sources retrieved independently. Selection of relevant and credible sources. Very good use of referencing conventions, consistently applied.                                                                                              | A comprehensive range of research-informed literature embedded in the work. Excellent selection of relevant and credible sources. High-level referencing skills, consistently applied.                                                                                                               | Outstanding knowledge of research-informed literature embedded in the work. Outstanding selection of relevant and credible sources. High-level referencing skills consistently and professionally applied.                                                                     |
| <b>2. Knowledge and Understanding of Subject</b><br>Extent of knowledge and understanding of concepts and underlying principles associated with the discipline.                                                                                                                                              | Major gaps in knowledge and understanding of material at this level. Substantial inaccuracies.                                                                                                   | Gaps in knowledge, with only superficial understanding. Some significant inaccuracies.                                                                                                                                 | Evidence of basic knowledge and understanding of the relevant concepts and underlying principles.                                                                                                                                                             | Knowledge is accurate with a good understanding of the field of study.                                                                                                                                                                                                                   | Knowledge is extensive. Exhibits understanding of the breadth and depth of established views.                                                                                                                                                                                                                  | Excellent knowledge and understanding of the main concepts and key theories. Clear awareness of challenges to established views and the limitations of the knowledge base.                                                                                                                           | Highly detailed knowledge and understanding of the main theories/concepts, and a critical awareness of the ambiguities and limitations of knowledge.                                                                                                                           |
| <b>3. Analysis</b><br>Analysis, evaluation and synthesis; logic, argument and judgement; analytical reflection; organisation of ideas and evidence                                                                                                                                                           | Unsubstantiated generalisations, made without use of any credible evidence. Lack of logic, leading to unsupportable/missing conclusions. Lack of any attempt to analyse, synthesise or evaluate. | Some evidence of analytical intellectual skills, but for the most part descriptive. Ideas/findings sometimes illogical and contradictory. Generalised statements made with scant evidence. Conclusions lack relevance. | Evidence of some logical, analytical thinking and some attempts to synthesise, albeit with some weaknesses. Some evidence to support findings/views, but evidence not consistently interpreted. Some relevant conclusions and recommendations, where relevant | Evidence of some logical, analytical thinking and synthesis. Can analyse new and/or abstract data and situations without guidance. An emerging awareness of different stances and ability to use evidence to support the argument. Valid conclusions and recommendations, where relevant | Sound, logical, analytical thinking; synthesis and evaluation. Ability to devise and sustain persuasive arguments, and to review the reliability, validity & significance of evidence. Ability to communicate ideas and evidence accurately and convincingly. Sound, convincing conclusions / recommendations. | Thoroughly logical work, supported by evaluated evidence. High quality analysis, developed independently or through effective collaboration. Ability to investigate contradictory information and identify reasons for contradictions. Strong, persuasive, conclusions, justifiable recommendations. | Exceptional work; judiciously selected and evaluated evidence. Very high quality analysis, developed independently or through effective collaboration. Ability to investigate contradictory information and identify reasons for contradictions. Highly persuasive conclusions |
| <b>4. Practical Application and Deployment</b><br>Effective deployment of appropriate methods, materials, tools and techniques; extent of skill demonstrated in the application of concepts to a variety of processes and/or contexts; formulation of innovative and creative solutions to solve problems.   | Limited or no use of methods, materials, tools and/or techniques. Little or no appreciation of the context of the application.                                                                   | Rudimentary application of methods, materials, tools and/or techniques but without consideration and competence. Flawed appreciation of the context of the application.                                                | An adequate awareness and mostly appropriate application of well-established methods, materials, tools and/or techniques. Basic appreciation of the context of the application.                                                                               | A good and appropriate application of standard methods, materials, tools and/or techniques. Good appreciation of the context of the application, with some use of examples, where relevant.                                                                                              | A very good application of a range of methods, materials, tools and/or techniques. Very good consideration of the context of the application, with perceptive use of examples, where relevant. Evidence of some innovation and creativity.                                                                     | An advanced application of a range of methods, materials, tools and/or techniques. The context of the application is well considered, with extensive use of relevant examples. Application and deployment extend beyond established conventions. Innovation and creativity evident throughout.       | Outstanding levels of application and deployment skills. Assimilation and development of cutting edge processes and techniques.                                                                                                                                                |
| <b>5. Skills for Professional Practice</b><br>Demonstrates attributes expected in professional practice including: individual initiative and collaborative working; deployment of appropriate media to communicate (including written and oral); clarity and effectiveness in presentation and organisation. | Communication media is inappropriate or misapplied. Little or no evidence of autonomy in the completion of tasks. Work is poorly structured and/or largely incoherent.                           | Media is poorly designed and/or not suitable for the audience. Poor independent or collaborative initiative. Work lacks structure, organisation, and/or coherence                                                      | Can communicate in a suitable format but with some room for improvement. Can work as part of a team, but with limited involvement in group activities. Work lacks coherence in places and could be better structured.                                         | Can communicate effectively in a suitable format, but may have minor errors. Can work effectively as part of a team, with clear contribution to group activities. Mostly coherent work and is in a suitable structure.                                                                   | Can communicate well, confidently and consistently in a suitable format. Can work very well as part of a team, with very good contribution to group activities. Work is coherent and fluent and is well structured and organised.                                                                              | Can communicate professionally and, confidently in a suitable format. Can work professionally within a team, showing leadership skills as appropriate, managing conflict and meeting obligations. Work is coherent, very fluent and is presented professionally.                                     | Can communicate with an exceptionally high level of professionalism. Can work exceptionally well and professionally within a team, showing advanced leadership skills. Work is exceptionally coherent, very fluent and is presented professionally.                            |

Electrical Technology

PSDE4021

Assignment 1

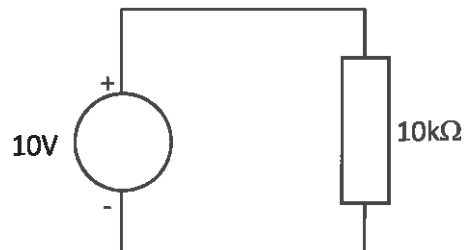
Richie Jones

135712

A)

**Lab 1a - Potential Division****Step 1**

MAKE - the following circuit:

**Step 2**

MEASURE using a multimeter:

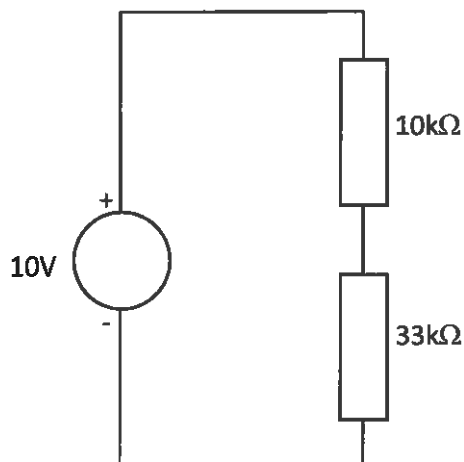
Supply Voltage = 10V ✓

Total Resistance = 9.92KΩ ✓

Current = 0.988mA ✓

**Step 3**

CONNECT:



MEASURE using a multimeter the circuit current.

RECORD your observation:

Measured Current = 0.23mA ✓

**Step 4**

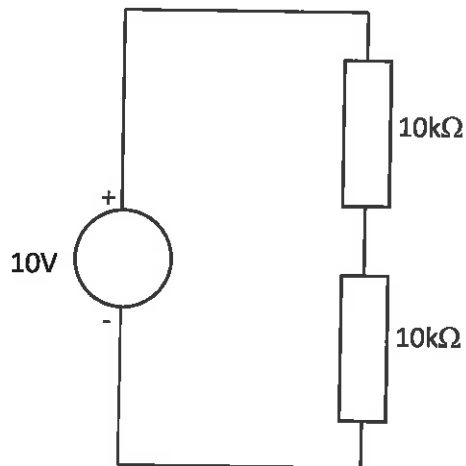
CALCULATE the Voltage across each resistor.

RECORD your observations:

Voltage across  $10\text{k}\Omega$  resistor =  $10\text{k}\Omega \times 0.23\text{mA} = 2.30\text{V}$  ✓  
 Voltage across  $33\text{k}\Omega$  resistor =  $33\text{k}\Omega \times 0.23\text{mA} = 7.59\text{V}$  ✓  
 Supply Voltage =  $2.3\text{V} + 7.59\text{V} = 9.89\text{V}$  ✓

**Step 5**

MAKE:

**Step 6a**

DEDUCE, without measurement, the voltages across each resistor.

RECORD your deduction:

Voltage across the top resistor =  $5\text{V}$  ✓  
 Voltage across the bottom resistor =  $5\text{V}$  ✓

**Step 6b**

Measure the voltages across each resistor.

RECORD your measurement:

Voltage across the top resistor =  $4.90\text{V}$  ✓  
 Voltage across the bottom resistor =  $5.03\text{V}$  ✓

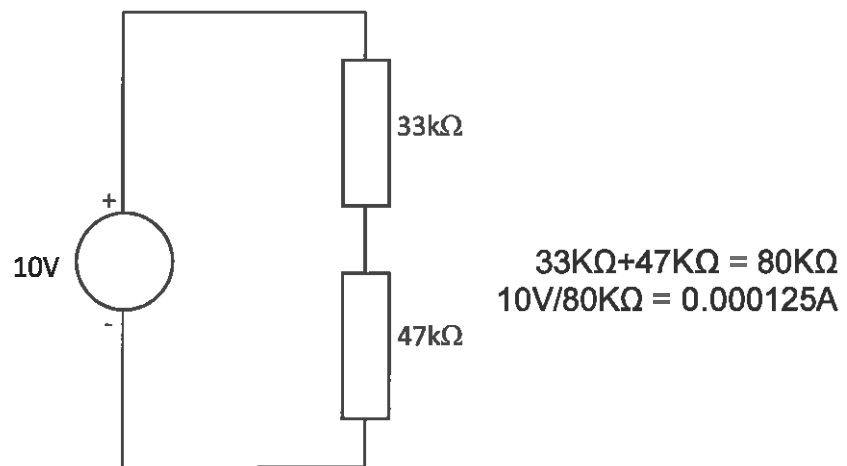
Comment upon the relationship between the voltages and resistance.

The voltage across series connected resistors is determined by the resistance of each resistor and the number of resistors connected in the series. If the resistors all share the same resistance, the voltage across them can be found by dividing the supply voltage by the number of resistors; in this case  $10\text{V}/2 = 5\text{V}$ .

/SDP

**Step 7**

MAKE:

**Step 8**

Calculate

$$\text{Voltage across } 33\text{k}\Omega \text{ resistor} = 0.000125\text{A} \times 33\text{k}\Omega = 4.125\text{V} \quad \checkmark$$

$$\text{Voltage across } 47\text{k}\Omega \text{ resistor} = 0.000125\text{A} \times 47\text{k}\Omega = 5.875\text{V} \quad \checkmark$$

$$4.125\text{V} + 5.875\text{V} = 10\text{V} \quad \checkmark$$

MEASURE the resistor voltages.

RECORD your observations:

$$\text{Voltage across } 33\text{k}\Omega \text{ resistor} = 4.3\text{V}$$

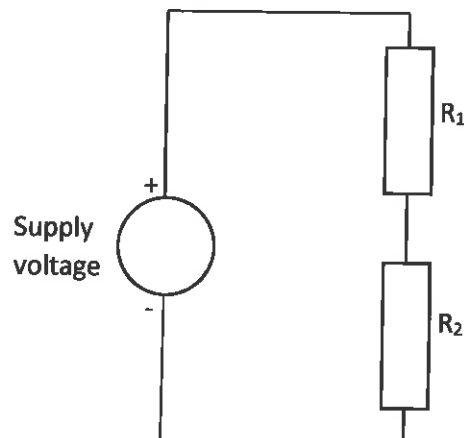
$$\text{Voltage across } 47\text{k}\Omega \text{ resistor} = 5.94\text{V}$$

$$4.3\text{V} + 5.94\text{V} = 10.24\text{V} \quad \checkmark$$

The difference of 0.24V can be attributed to a loss of accuracy when rounding or tolerances of the resistors. ✓

**Step 9**

CONSIDER the following circuit diagram:



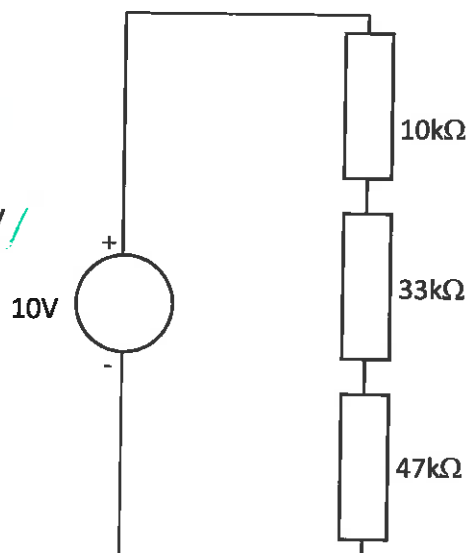
From what you have learnt about Potential Division, whereby a Supply Voltage will divide between resistances according to what proportion of the total resistance each resistor has, complete the following formulae:

$$\begin{aligned} \text{Voltage across } R_1 &= \text{Supply Voltage} \times (R_1 + R_2) / (R_1 \cdot R_2) \\ \text{Voltage across } R_2 &= \quad \times R_2 \end{aligned}$$

**Step 10**

MAKE:

$$\begin{aligned} 10\text{V}/90\text{k}\Omega &= 0.000111\text{A} \\ 0.000111\text{A} \cdot 10\text{k}\Omega &= 1.11\text{V} \\ 0.000111\text{A} \cdot 33\text{k}\Omega &= 3.66\text{V} \\ 0.000111\text{A} \cdot 47\text{k}\Omega &= 5.22\text{V} \\ 1.11\text{V} + 3.66\text{V} + 5.22\text{V} &= 9.99\text{V} \end{aligned}$$

**Step 11**

Measure:

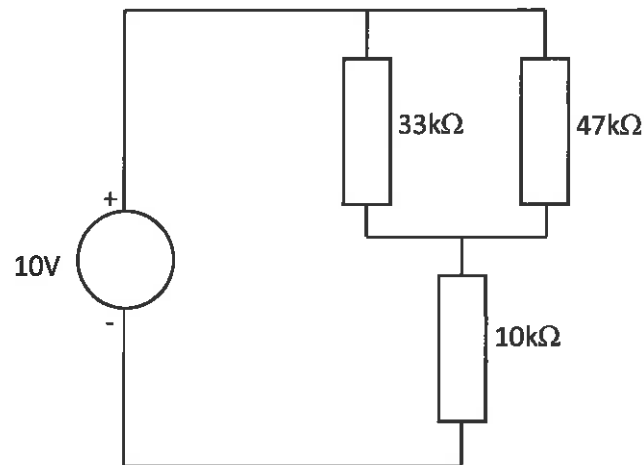
$$\begin{aligned} \text{Voltage across } 10\text{k}\Omega &= 1.16\text{V} \\ \text{Voltage across } 33\text{k}\Omega &= 3.86\text{V} \\ \text{Voltage across } 47\text{k}\Omega &= 5.45\text{V} \end{aligned}$$

$$\text{Supply voltage} = 1.16\text{V} + 3.86\text{V} + 5.45\text{V} = 10.27\text{V}$$

/ SDP

**Step 12**

MAKE:

**Step 13**

Calculate the voltage across the 10kΩ resistor and the voltage across the 47kΩ/33kΩ parallel combination.

RECORD your calculations:  $(33\text{K}\Omega + 47\text{K}\Omega) / (33\text{K}\Omega \times 47\text{K}\Omega) = 19.39\text{K}\Omega$

Voltage across 10kΩ =

$$10\text{V} \times (10\text{K}\Omega / (10\text{K}\Omega + 19.39\text{K}\Omega)) = 3.4\text{V} \quad \checkmark$$

Voltage across parallel combination =

$$10\text{V} \times (19.39\text{K}\Omega / (10\text{K}\Omega + 19.39\text{K}\Omega)) = 6.6\text{V} \quad \checkmark$$

CONFIRM your calculations by measurement.

10KΩ resistor = 3.37V  $\checkmark$

Parallel combination = 6.55V  $\checkmark$

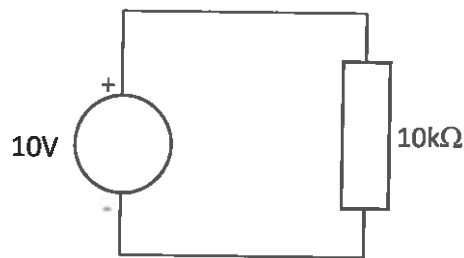
**CONCLUSION**

Voltage divider rule:  $V_{\text{out}} = (V_{\text{in}} \times R_2) / (R_1 + R_2)$   $\checkmark$

for  $V_{R2}$

**Lab 1b - Current Division****Step 1**

MAKE the following circuit:



CALCULATE, using Ohm's Law, the current in the circuit.  
RECORD your observations:

$$\text{Calculated Current} = 10\text{V}/10\text{k}\Omega = 1\text{mA}$$

**Step 2**

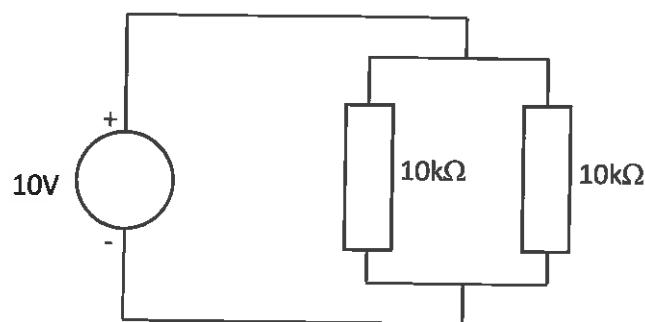
MEASURE, using a multimeter the circuit current.  
RECORD your observation:

$$\text{Measured Current} = 0.98\text{mA}$$

The two values agree and only differ by 2%, which can be attributed to the internal resistance of the multimeter.

**Step 4**

MAKE:

**Step 5**

DEDUCE, without measurement, the 2 branch currents.  
RECORD your deduction:

$$I_1 = 1\text{mA}$$

$$I_2 = 1\text{mA}$$

$$10\text{V}/10\text{k}\Omega = 1\text{mA}$$

MEASURE the supply and branch currents using a multimeter.

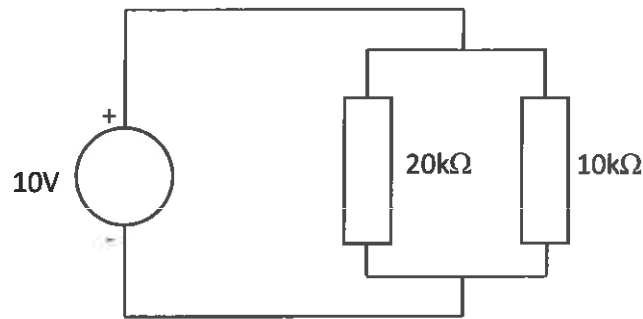
$$\text{Measured Current} = 2.01\text{mA}$$

$$\text{Measured Current in Branch 1} = 1.01\text{mA}$$

$$\text{Measured Current in Branch 2} = 1\text{mA}$$

**Step 6**

MAKE:

**Step 7**

CALCULATE the 2 branch currents using Ohm's Law.

RECORD your results:

$$\text{Current in Branch 1} = 10\text{V}/20\text{k}\Omega = 0.5\text{mA}$$

$$\text{Current in Branch 2} = 10\text{V}/10\text{k}\Omega = 1\text{mA}$$

$$\text{Supply Current} = 0.5\text{mA} + 1\text{mA} = 1.5\text{mA}$$

CONFIRM your results by measurement using a multimeter.

Branch 1: 0.49mA

Branch 2: 1mA

Supply current: 1.49mA

CALCULATE the fraction of the supply current that is in the 20kΩ branch as follows:

$$\text{Fraction in } 20\text{k}\Omega \text{ resistor} = \frac{\text{Current in } 20\text{k}\Omega}{\text{Supply Current}} = 0.49/1.49 = \frac{1}{3}$$

COMPARE the FRACTION obtained with the following result:

$$\begin{aligned} \text{Fraction in } 20\text{k}\Omega \text{ resistor} &= \frac{\text{Value of R in OTHER branch}}{\text{Sum of the 2 resistances}} \\ &= \frac{10\text{k}\Omega}{10\text{k}\Omega + 20\text{k}\Omega} = \frac{1}{3} \end{aligned}$$

DEDUCE the current in Branch 2.

RECORD your deduction:

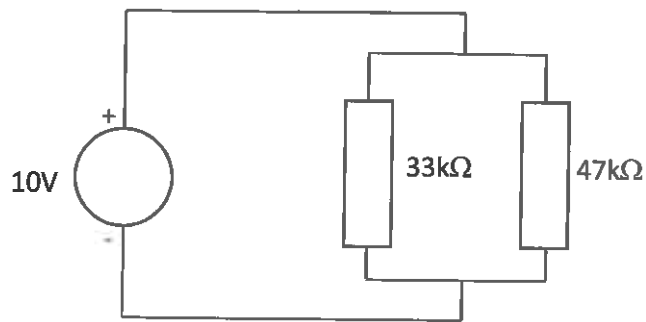
$$\text{Current in Branch 2} = \frac{2}{3} \times \text{Supply Current} = 1\text{mA}$$

and, from before:

$$\text{Current in Branch 1} = \frac{1}{3} \times \text{Supply Current} = 0.5\text{mA}$$

**Step 8**

MAKE:

**Step 9**

MEASURE the Supply Current using a multimeter.

CALCULATE, using the concept of CURRENT DIVISION that was introduced at **step 7**, the 2 branch currents.

RECORD your results:

$$\begin{aligned}
 \text{Supply Current} &= 515.8\mu\text{A} \\
 \text{Current in } 47\text{k}\Omega &= 10\text{V}/47\text{K}\Omega = 212.77\mu\text{A} \quad \checkmark \\
 \text{Current in } 33\text{k}\Omega &= 10\text{V}/33\text{K}\Omega = 303.03\mu\text{A} \quad \checkmark
 \end{aligned}$$

CONFIRM your results by measurement.

$$\begin{aligned}
 \text{Current in } 47\text{k}\Omega &= 217\mu\text{A} & \text{Current in } 33\text{k}\Omega &= 286\mu\text{A} \\
 \text{Supply current} &= 503\mu\text{A}
 \end{aligned}$$

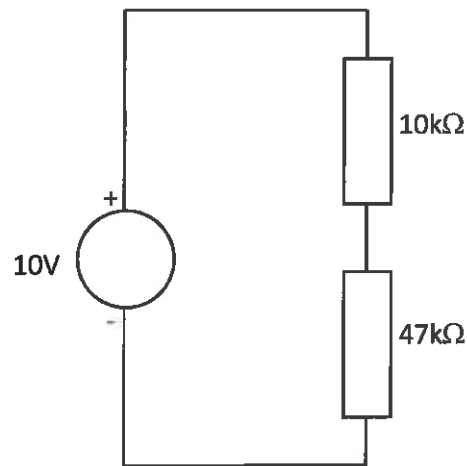
**CONCLUSION**

Construct a mathematical expression that can be used to find the branch current in a two branch parallel network if the supply current is known.

$$I_1 = (I \cdot R_2) / (R_1 + R_2) \quad \checkmark \quad I_2 = (I \cdot R_1) / (R_1 + R_2) \quad \checkmark$$

**Lab 1c--The Product / Sum Rule****Step 1**

MAKE the following circuit:

**Step 2**

MEASURE using a multimeter the current in the circuit.  
RECORD your observations:

Supply voltage = 10.02V  
Current = 1.8mA

CALCULATE the circuit resistance.  
RECORD your result:

Calculated resistance =  $10.02V / 0.0018A = 55.67K\Omega$  X

DISCONNECT the multimeter and power supply.  
MEASURE the circuit resistance.  
RECORD your result:

Measured resistance = 56.5KΩ /

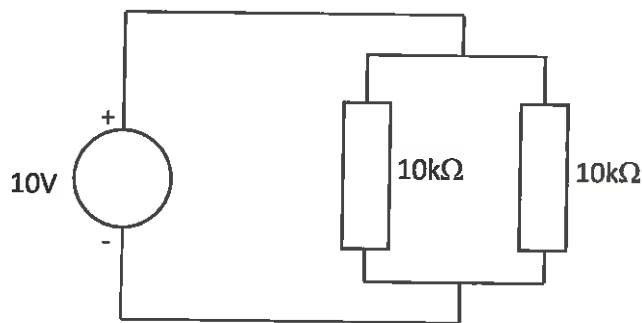
COMPARE the value calculated using Ohm's Law with the measured value.  
RECORD your comparisons:

Calculated value of resistance = 55.67KΩ  
Measured value of resistance = 56.5KΩ

The calculated value and measured value are most likely different due to accuracy being lost when rounding and the tolerances of the resistors used, respectively.

**Step 3**

MAKE:

**Step 4**

MEASURE using a multimeter the supply current.

RECORD your observation:

Supply Current = 2mA  
 Supply voltage = 10.03V

CALCULATE the circuit resistance using Ohm's Law.

RECORD your result:

Calculated resistance =  $10.03V / 0.002A = 5015\Omega = 5.015K\Omega$

DISCONNECT the multimeter and the power supply.

MEASURE the circuit resistance.

RECORD your measurement:

Measured resistance = 4.93K $\Omega$

FIND the PRODUCT of the 2 resistances and divide it by their SUM.

RECORD this operation:

Product =  $10K\Omega \times 10K\Omega$   
 Sum =  $10K\Omega + 10K\Omega$       Result = 5K $\Omega$

COMPARE the value calculated, the measured value and the value found by the PRODUCT/SUM Rule.

RECORD your comparisons:

Ohm's Law value of resistance = 5.015K $\Omega$   
 Measured value of resistance = 4.93K $\Omega$   
 Product/Sum value of resistance = 5K $\Omega$

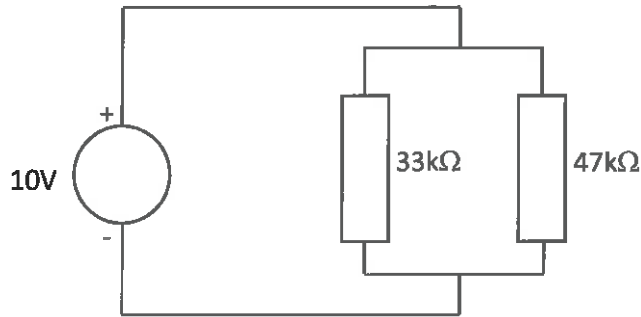
COMMENT on any discrepancy:

The differences between the three values is likely the result of rounding up/down, the tolerances of the resistors and the internal resistance of the multimeter.

/SDP

**Step 5**

MAKE:

**Step 6**

MEASURE the supply current using a multimeter.

RECORD your observation:

Supply Current = 0.518mA ✓

Supply Voltage = 9.96V ✓

CALCULATE the circuit resistance.

RECORD your result:

Calculated resistance =  $9.96\text{V} / 0.000518 = 19.23\text{K}\Omega$  ✓

DISCONNECT the multimeter and power supply.

MEASURE the circuit resistance.

RECORD your measurement:

Measured resistance = 19.3KΩ ✓

FIND the PRODUCT of the 2 resistances and divide it by their SUM.

RECORD this operation:

Product =  $33\text{K}\Omega \times 47\text{K}\Omega$ Sum =  $33\text{K}\Omega + 47\text{K}\Omega$ 

Result = 19.39KΩ ✓

COMPARE the value calculated the measured value and the value found by the PRODUCT/SUM Rule.

RECORD your comparisons:

Ohm's Law value of resistance = 19.23KΩ ✓

Measured value of resistance = 19.3KΩ ✓

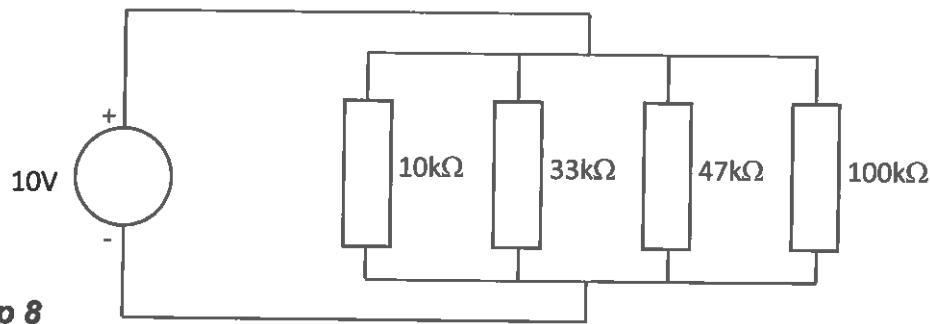
Product/Sum value of resistance = 19.39KΩ ✓

COMMENT on any discrepancy:

The differences between the three values could be caused by the rounding of values during calculations, human error and the tolerances of the components used.

**Step 7**

MAKE:



MEASURE the supply current using a multimeter.  
RECORD your observation:

Supply Current = 1.6mA ✓  
Supply Voltage = 10V ✓

CALCULATE the circuit resistance.  
RECORD your result:

Calculated resistance =  $10V / 0.0016A = 6.25K\Omega$

DISCONNECT the multimeter and power supply. ✓  
MEASURE the circuit resistance.  
RECORD your measurement:

Measured resistance = 6.2KΩ ✓

FIND the PRODUCT of one pair of the 4 resistances and divide it by the SUM of the same pair.  
RECORD this operation:

First pair: Product =  $10K\Omega \times 33K\Omega$   
Sum =  $10K\Omega + 33K\Omega$  Result = 7.67KΩ ✓

FIND the PRODUCT of the other pair of the 4 resistances and divide it by the SUM of the same pair.

RECORD this operation:

Second pair: Product =  $47K\Omega \times 100K\Omega$   
Sum =  $47K\Omega + 100K\Omega$  Result = 31.97KΩ ✓

REPEAT the PRODUCT/SUM rule on the results for the 2 pairs.  
RECORD this operation:

Product of 2 results =  $7.67K\Omega \times 31.97K\Omega$   
Sum of 2 results =  $7.67K\Omega + 31.97K\Omega$  Final Result = 6.19KΩ ✓

/SDP

COMPARE the value calculated using Ohm's Law with the measured value and the value found by the PRODUCT/SUM Rule.

RECORD your comparisons:

|                                   |                |
|-----------------------------------|----------------|
| Ohm's Law value of resistance =   | 6.25K $\Omega$ |
| Measured value of resistance =    | 6.2K $\Omega$  |
| Product/Sum value of resistance = | 6.19K $\Omega$ |

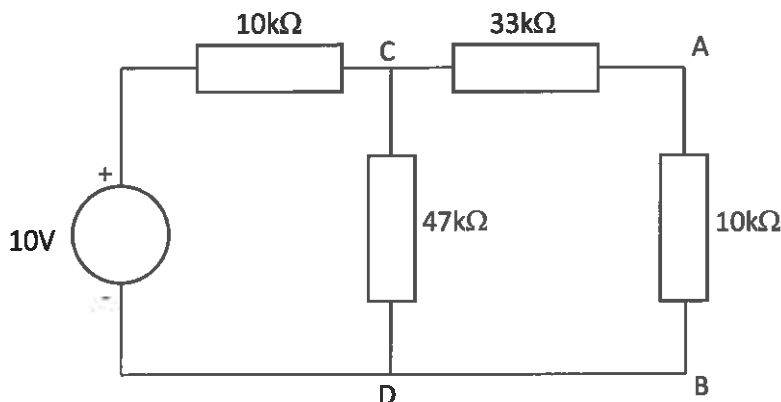
COMMENT on any discrepancy:

Using product/sum gives the theoretical resistance of the circuit, which would be observed when measured if factors such as percentage tolerances and rounding weren't present. The differences between the three values can be attributed to these factors, since some degree of rounding occurs when finding the resistance via Ohm's law, and measuring the circuit directly gives results that could be up to 10% more or less than the expected resistance, depending on the tolerance of the resistors.

### Lab 1d-Thevenin's Theorem

#### **Step 1**

MAKE:



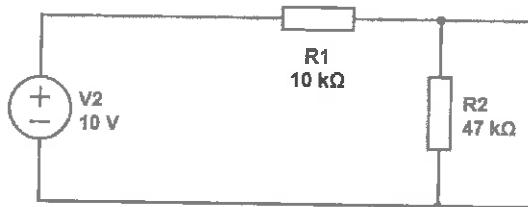
#### **Step 2**

STATE the steps that would be applied to the circuit when using Thevenin's theorem.

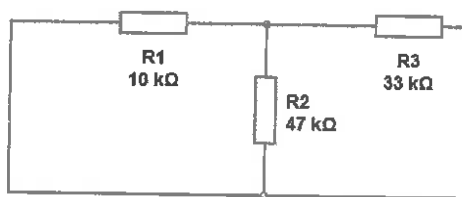
1. Open the load resistor.
2. Calculate / measure the Open Circuit Voltage.
3. Open Current Sources and Short Voltage Sources.
4. Calculate /measure the Open Circuit Resistance.
5. Redraw the circuit with the measure open circuit Voltage as the voltage Source and measure open circuit resistance ( $R_{TH}$ ) as a series resistance and connect the load resistor.
6. Find the Total current flowing through Load resistor by using the Ohm's Law.

**Step 3**

DRAW the Thevenin equivalent circuit.

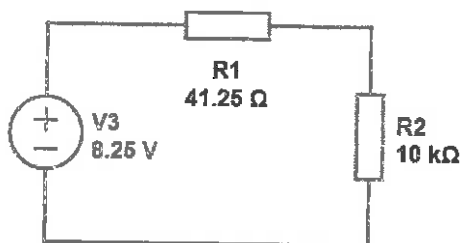


$$V_{th} = (10V \cdot 47K\Omega) / (10K\Omega + 47K\Omega) = 8.25V$$



$$R_{th} = (10K\Omega \cdot 47K\Omega) / (10K\Omega + 47K\Omega) = 8.25K\Omega$$

$$8.25K\Omega + 33K\Omega = 41.25K\Omega$$



$$8.25V / (41.25K\Omega + 10K\Omega) = 160.98\mu A$$

**Step 4**

MAKE the Thevenin equivalent circuit that you have drawn, in addition to the original circuit:

**Step 5**

FIT the resistor removed from AB across the terminals of your Thevenin Equivalent circuit.

/SDP

MEASURE the actual current through the resistor using a multimeter.

Current = 161.4 $\mu$ A /

MOVE the resistor from its position in the equivalent circuit to its position in the original circuit.

MEASURE the actual current through the resistor using a multimeter.

Current = 174 $\mu$ A /

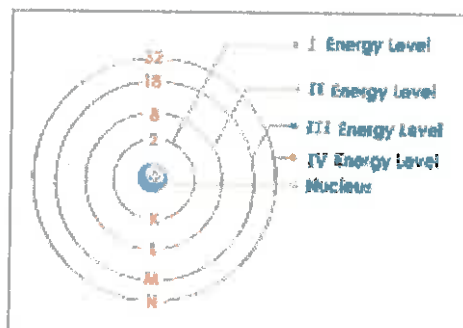
Thevenin's theorem can be used to simplify a circuit in terms of calculations to find the current flowing through a resistor, such as in the above example. Using Thevenin's theorem however will result in some loss of accuracy due to rounding to 2 or 3 decimal places. The results obtained differ from the measured current by 12.6 $\mu$ A, which can be attributed to a combination of loss of accuracy when rounding and tolerances of components. While Thevenin's theorem is a straightforward method of calculating the current, the combination of these two factors when using the theorem with measured results would potentially give an even more inaccurate value.

B)

At an atomic level, all materials have a degree of conductivity and resistance. This is due to the atomic structure of the material/element and can be measured in relation to each other as a result. Conductivity is the measure of how well a material can transfer energy, and resistance is the measure of how a material can resist the transfer of energy.

Electricity is essentially the flow of free electrons through a material. The ease or difficulty of this is what determines the conductivity or resistance of a material, respectively.

Atoms consist of three subatomic particles, being protons, neutrons, and electrons. Electrons orbit the nucleus of the atom and carry a negative charge, which balances out the charge of the atom.

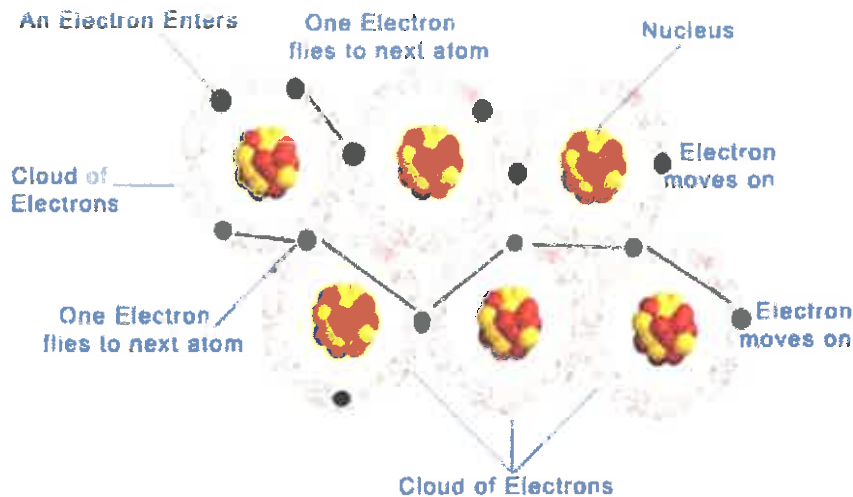


<http://www.tutorvista.com/content/science/science-i/structure-atom/arrangement-electrons-atom.php>

This diagram shows how electrons orbit the centre of the atom in different energy levels, or 'shells'. The electrons in the furthestmost shell of an atom have more energy and travel faster and further from the nucleus, as well as a weaker bond to it. These are known as valence electrons, and are responsible for the flow of electricity since they are the electrons which can most easily move and bond to different atoms.

Conductive materials typically have one valence electron in its outermost shell, since it will take less energy for it to move to other atoms. Resistive materials on the other hand will have a full outermost shell, and the electrons in it will need much more energy to move. The conductivity and resistance of a material can be found this way, with the most conductive materials having fewer valence electrons and the most resistive having more.

/SDP



<https://www.electrical4u.com/electrical-conductor/>

This diagram shows how electrons flow through a material by bonding with its' atoms. Materials like rubber have a full outer shell, making them good resistors due to the electrons needing a lot of energy to bond to different atoms.

C)

The temperature of a resistive material will affect its ability to resist the flow of electrons through itself. Heat, or thermal energy, causes atoms to vibrate. At relatively high temperatures, the electrons of the material will have enough energy to break free and move between atoms, resulting in an electrical charge.

Such materials are said to have a positive temperature coefficient.

$$R = R_{ref} [1 + \alpha(T - T_{ref})]$$

Where,

$R$  = Conductor resistance at temperature "T"

$R_{ref}$  = Conductor resistance at reference temperature  
 $T_{ref}$ , usually 20° C, but sometimes 0° C.

$\alpha$  = Temperature coefficient of resistance for the conductor material.

$T$  = Conductor temperature in degrees Celcius.

$T_{ref}$  = Reference temperature that  $\alpha$  is specified at for the conductor material.

<https://www.cirris.com/learning-center/general-testing/special-topics/177-temperature-coefficient-of-copper>

This formula can be used to find the effects of temperature on a material's resistance.

E)

Thevenin's theorem states that a circuit with any number of resistors and sources with two terminals is equivalent to a single source and series resistor.

"The e.m.f of the source is equal to the open-circuit voltage at the terminals of the network; the value of the resistor is equal to the resistance measured between the terminals of the network when all generators are replaced by their internal resistances." (Electric Circuit Theory, pg14 J.M.Iverson)

The procedure for using this is as follows:

1. Open the load resistor.
2. Calculate / measure the Open Circuit Voltage.
3. Open Current Sources and Short Voltage Sources.
4. Calculate /measure the Open Circuit Resistance.
5. Redraw the circuit with the measure open circuit Voltage as the voltage Source and measure open circuit resistance (RTH) as a series resistance and connect the load resistor.
6. Find the Total current flowing through Load resistor by using the Ohm's Law.

/

/SDP

Bibliography:

J.M.Iverson (1977), *Electric Circuit Theory*

Van Nostrand Reinhold Company Ltd.

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