E1
Basic Electrical Skills

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B.Sc in Applied Physics.

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10:00 A.M - 1:00 P.M

EXPERIMENT 1

Q1.1 Complete the following table.

The colour of the **Live** wire is	Brown or Red
The **Neutral** wire colour is	Blue or Black
The colour of the **Earth** wire is	Green & Yellow

Q1.2 In a mains electrical circuit which wire(s) carry the current ?

Both the **Live** and **Neutral** wire carry current

Q1.3 What is the function of the Earth wire ?

The **Earth** wire is included in EU plugs as a safety precaution to prevent the user from electric shocks of any unintentional current passing through the plug by grounding it.

Q1.4 On which wire should the fuse be placed and why?

The **Live** wire is known for carrying the majority of the current for an appliance, the fuse is used to prevent more current than is required from entering a circuit by blowing if the current is too high.

Q1.5 The electrical power required by an appliance can be calculated using the following equation.

$$\mathbf{P\ (watts) = V\ (volts) \times A\ (Amps)}$$

A light bulb draws 250mA of current where the main voltage is 230 volts. What power does it draw?

$$(230\ \text{V}) \times (250 \times 10^{-3}\ \text{A}) = 57.5\ \text{W}$$

Q1.6 Fuses have standard ratings of 1A, 3A, 5A, 7A & 13A.What would be the appropriate plug fuse for each of the following appliances?

Allow for at least 50% additional current rating for start up surge current.

Power of appliance (W)	Mains voltage (V)	Current drawn (A)	Suitable fuse (A)
100 W Lamp	230	0.43	1
1.8 kW Kettle	230	7.83	13
200W TV	230	0.87	3
800 W Hair drier	230	3.48	7

Q1.7 On to which part of the cable should the plug cable clamp be screwed down?

The plug cable clamp should be screwed down onto the beginning of the fully insulated cable, just before each of the three component wires are exposed.

Q1.8 How much mechanical strain should there be on each of the three conductors?

There should be minimal mechanical strain on any of the three conductors in the plug, you want to ensure that everything fits properly but isn't being stretched or crushed.

Q1.9 What resistance should you measure in a fuse ?

A fully working fuse that hasn't been blown should have a low resistance which is expected from the closed system used inside a fuse to pass current, a fuse which has been blown will read OL as the system would now be open and the resistance of air is being taken into account.

EXPERIMENT 2

Q2.1 What is displayed when the two probe leads are shorted together?
What is the technical term for this? What is displayed when the two leads are left "open circuit"? What is the resistance of a good conductor (e.g. a 4mm banana lead)? Note the units of resistance!

Two probes placed together will display a low resistance, typically around 1 ohm, this is consistent with a short circuit. An open circuit will display OL or Overload as the resistance created by the air is too great to measure. A good conductor is one with a low resistance, the recorded resistance will be measured in Ohms as apposed to Kilo Ohms (KΩ) or Mega Ohms (MΩ)

Q2.1 Fill in the following table Box Number = 1

Terminals	Resistance Ohms Ω / KΩ / MΩ	Comments: Open circuit, closed, resistive etc.
A - B	OL	Open circuit
C - D	68.1 Ω	Closed circuit
E - F	OL	Open circuit
G - H	7.08 MΩ	Closed circuit, resistive

EXPERIMENT 3

Q3.1 First, measure the resistances of each of the resistors used and insert in an appropriate table as below.

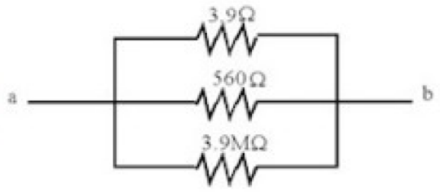
Nominal Resistance (Ω)	Record Colour of bands [4 or 5]	Tolerance %	Measured Resistance (Ω)	Percentage Difference (%)
15	Brown, Green, Black, Gold	5%	15.7	4.6%
39×10^5	Orange, White, Green, Gold	5%	3.9×10^6	0%
820	Grey, Red, Brown, Gold	5%	800	2.5%
39	Orange, White, Black, Gold	5%	39	0%
560	Green, Blue, Brown, Gold	5%	500	10%
39×10^{-1}	Orange, White, Gold, Gold	5%	4.9	25%
3600	Orange, Blue, Black, Brown, Brown	1%	3500	2.7%
4300	Yellow, Orange, Black, Brown, Brown	1%	4300	0%
2700	Red, Purple, Black, Brown, Brown	1%	2600	3.7%

Q3.2 Calculate the resistance between a and b in each network and confirm this value using the multimeter.

1 

$$39\Omega + 15\Omega = 54\Omega$$

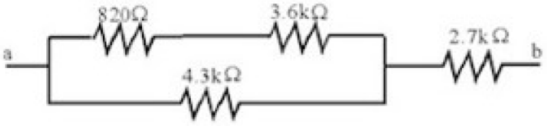
2



$$\frac{1}{3.9\Omega} + \frac{1}{560\Omega} + \frac{1}{3.9\times10^6\Omega} = \frac{1}{R_{\text{total}}}$$

$$R_{\text{total}} = 3.9\Omega$$

3



$$\left(\frac{1}{820\Omega + 3600\Omega} + \frac{1}{4300\Omega} = \frac{1}{R_{\text{total}}}\right) + 2700\Omega =$$

$$2180\Omega + 2700\Omega = 4880\Omega$$

Q3.3 What is the temperature of the soldering iron tip ? Compare this to the temperature of boiling water and melting ice, respectively.

The soldering tip was sitting at 329°C, This is 229°C hotter than the temperature needed to boil water, and 328°C greater than the temperature needed to melt ice.

Q3.4 Explain how some melted solder on the tip of the soldering iron helps heat transfer from the iron to the component lead.

The solder allows for the passage of electrons from the iron to the component lead

Q3.5 When two resistors are connected in series the total resistance is (a) smaller than either, (b) equal to the biggest, (c) equal to the smallest or (d) equal to the sum ?

(d) equal to the sum

The total resistance R_T is then given by (a) R_T =(R_1 -R_2)/2, (b) R_T = R_1 - R_2, (c) R_T = R_1 + R_2 or (d) R_T = smaller of (R_1, R_2)?

(c) R_T = R_1 + R_2

Q3.6 When two resistors are connected in parallel, the total resulting resistance RT is (a) smaller than either, (b) larger than either, (c) equal to the largest or (d) equal to the smallest?

(a) smaller than either

Its value is then given by $R_T = R_1 + R_2$, $R_T = R_1 - R_2$ or $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$?

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$

Q3.7 Using your results from **Q3.5** and **Q3.6** fill in the following table for the three resistor networks. Explain the difference, if any, between the calculated and measured resistance values.

	Calculated Resistance (Ω)	Measured Resistance (Ω)	Percentage Difference (%)
Circuit 1	54	55	1.9%
Circuit 2	3.9	4	2.6%
Circuit 3	4880	4800	1.6%

Conclusion

Most of the variations between calculated resistances and measured resistances were within a reasonable percentage difference, however certain resistors exist as outliers, the 3.9 Ω resistor had a percentage difference of 25%, this is most likely due to the lower resistances being harder to pinpoint on the multimeter as the values are constantly changing.

If I were to continue this experiment I would repeatedly measure any of the resistances that currently exist outside of the percentage tolerance and get an average value, which would hopefully increase the measured resistances accuracy.