TEACHER NOTES

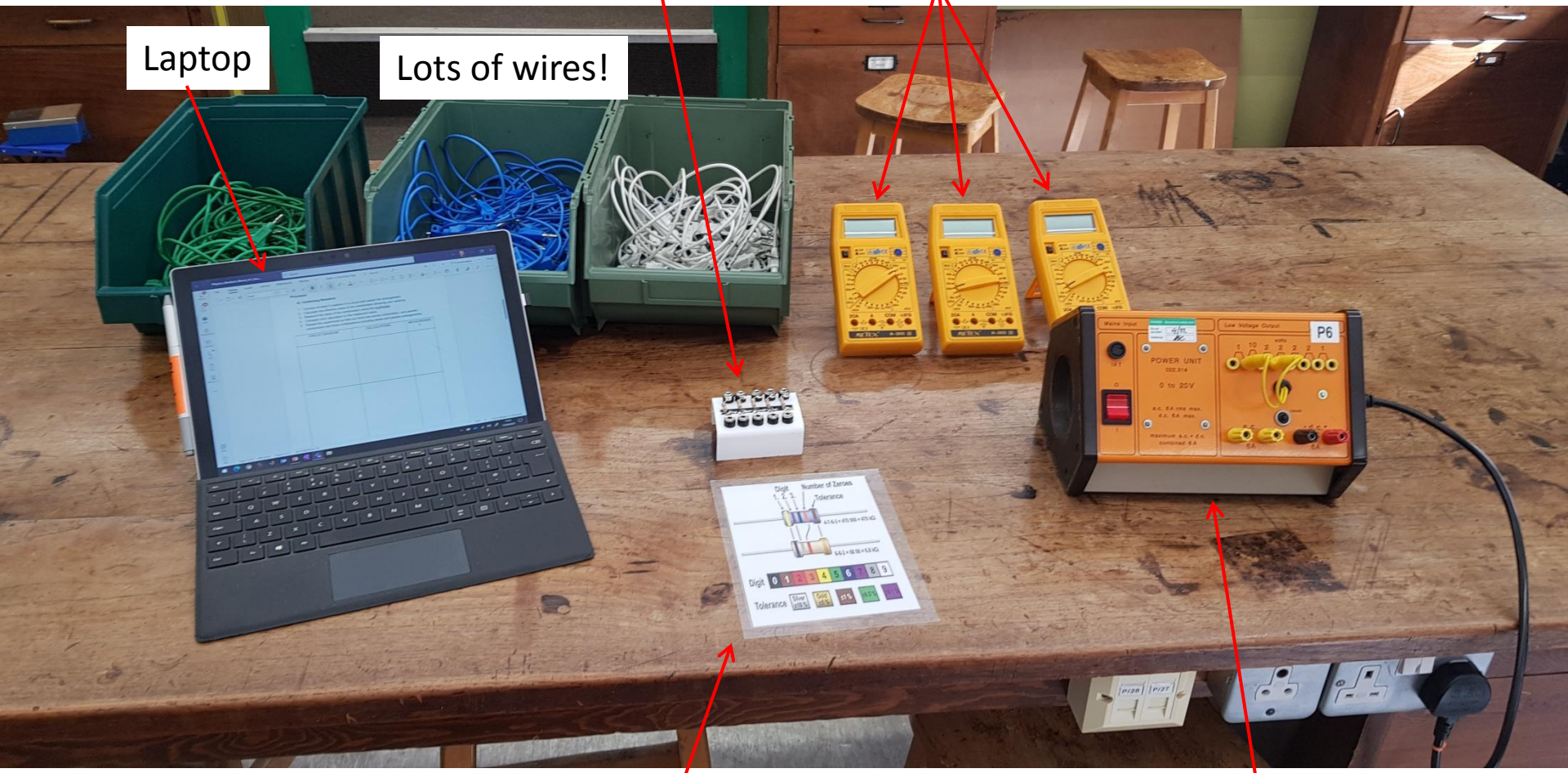
Youtube video1

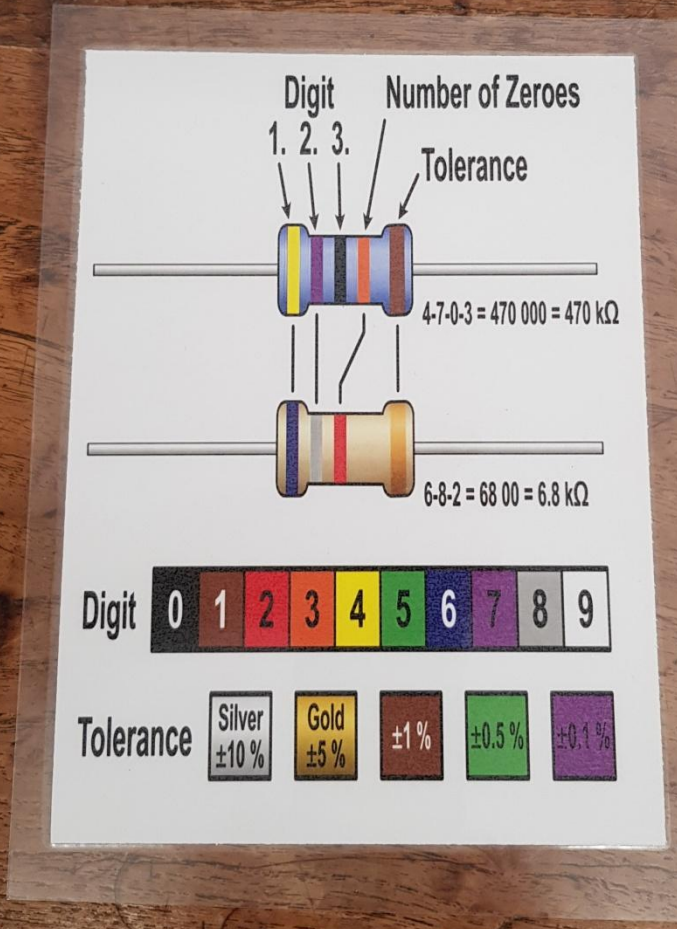
Youtube video2

Investigating combinations of resistors

Dr Andrew French. September 2021.

Equipment


Terminal block
with five resistors
Three multimeters
Laptop
Lots of wires!
Resistor code chart
Power supply



Five different resistors

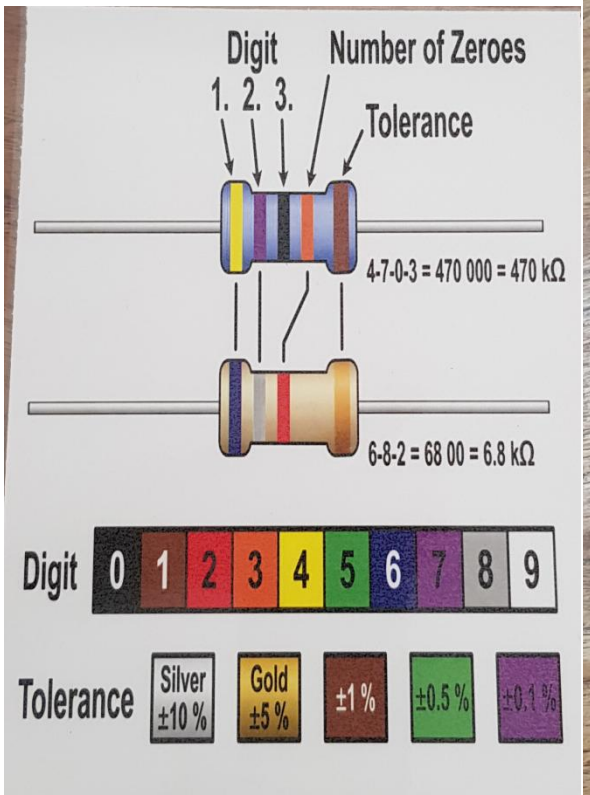
TASK 1: Create a table and work out from the coloured bands the resistances.

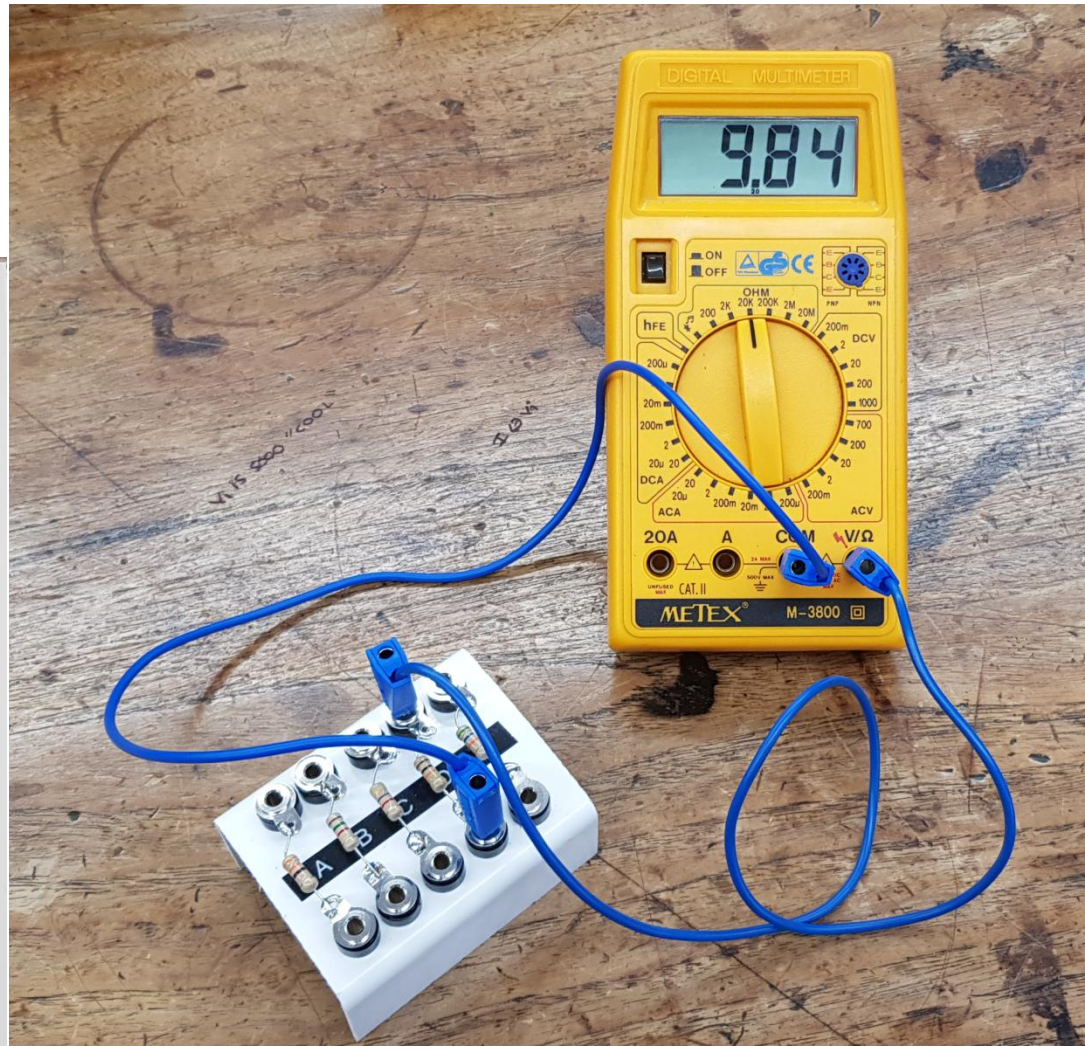
e.g. **A**: orange, orange, brown, gold

So: 330 ohms, +/- 5%

Resistor	Digits	Zeros	Tolerance /%	Colours	Resistance /ohms	Resistance /k ohms	Measured resistance /k ohms	% error
A	33	1	5	Orange Orange Brown Gold	330	0.33	0.334	1.21%
B	15	2	5	Brown Green Red Gold	1500	1.5	1.506	0.40%
C	47	2	5	Yellow Purple Red Gold	4700	4.7	4.63	-1.49%
D	10	3	5	Brown Black Orange Gold	10000	10	9.84	-1.60%
E	56	3	5	Green Blue Orange Gold	56000	56	55.7	-0.54%

TASK 2: Use a multimeter to measure the resistances individually. Compare to nominal values based upon coloured bands.



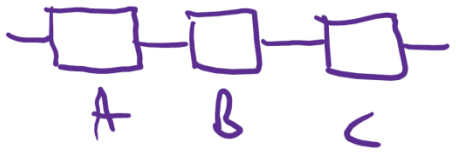


TASK3: Wire up FIVE different arrangements of three resistors. One in series, one in parallel and three in a mixture.

Predict the resistance by calculation (use either nominal resistances, or better, measured resistances) and **compare with direct measurement** using the multimeter.

For each circuit, draw a diagram first.

1



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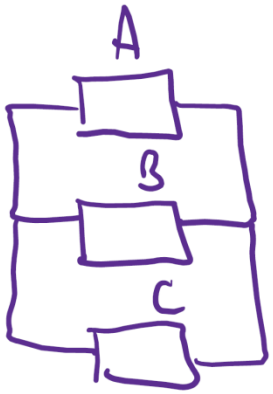

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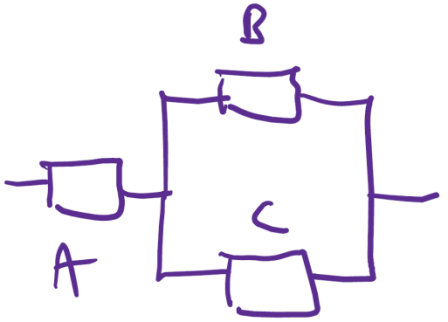

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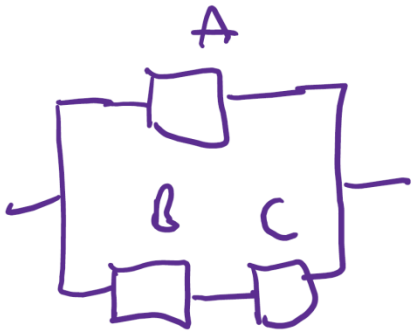

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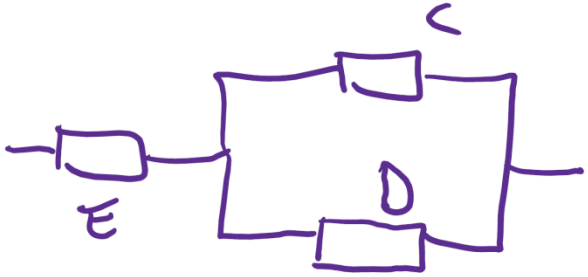
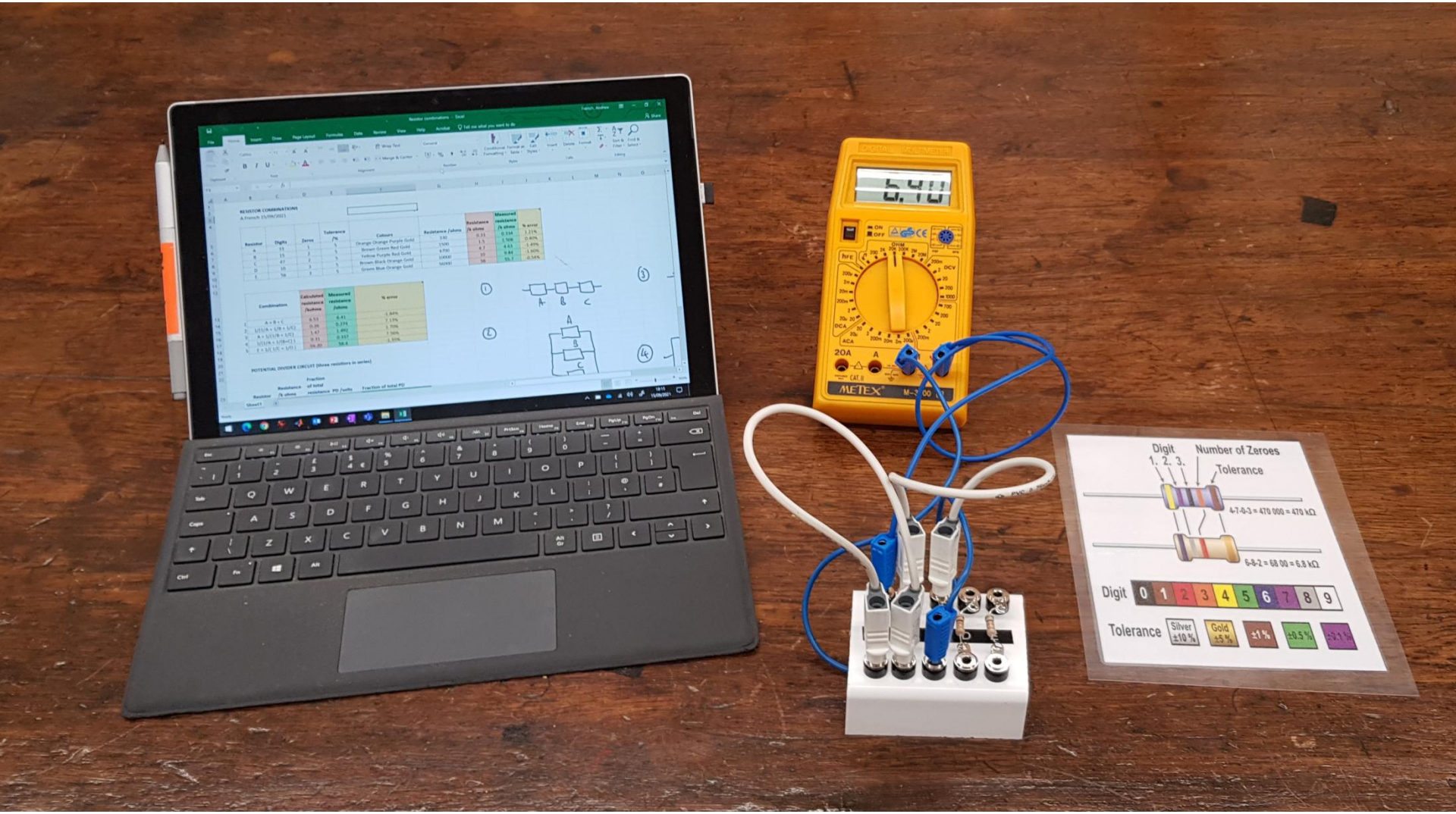


Five examples – other combinations are possible!


Digit
Number of Zeroes
Tolerance
4-7-0-3 = 470 000 = 470 kΩ
6-8-2 = 68 00 = 6.8 kΩ
Digit 0 1 2 3 4 5 6 7 8 9
Tolerance
Silver ±10 %
Gold ±5 %
±1 %
±0.5 %
±0.1 %
METEX

Resistor	Digits	Zeros	Tolerance /%	Colours	Resistance /ohms	Resistance /k ohms	Measured resistance /k ohms	% error
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B	15	2	5	Brown Green Red Gold	1500	1.5	1.506	0.40%
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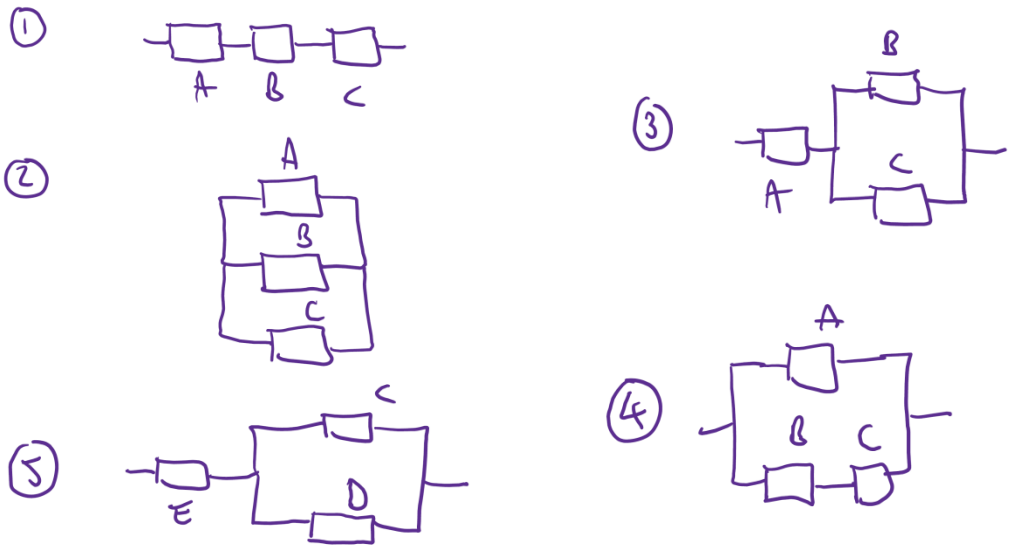
E	56	3	5	Green Blue Orange Gold	56000	56	55.7	-0.54%

	Combination	Calculated resistance /kohms	Measured resistance /ohms	% error
1	A + B + C	6.53	6.41	-1.84%
2	1/(1/A + 1/B + 1/C)	0.26	0.274	7.13%
3	A + 1/(1/B + 1/C)	1.47	1.492	1.70%
4	1/(1/A + 1/(B+C))	0.31	0.337	7.56%
5	E + 1/(1/C + 1/D)	59.20	58.4	-1.35%

- Series resistances add
- *Parallel* resistances add in *reciprocals*



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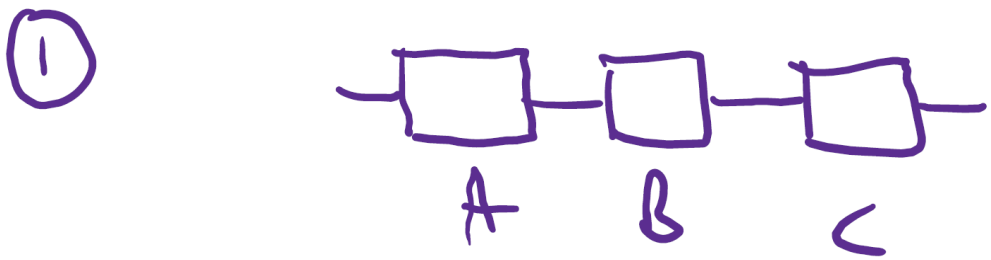
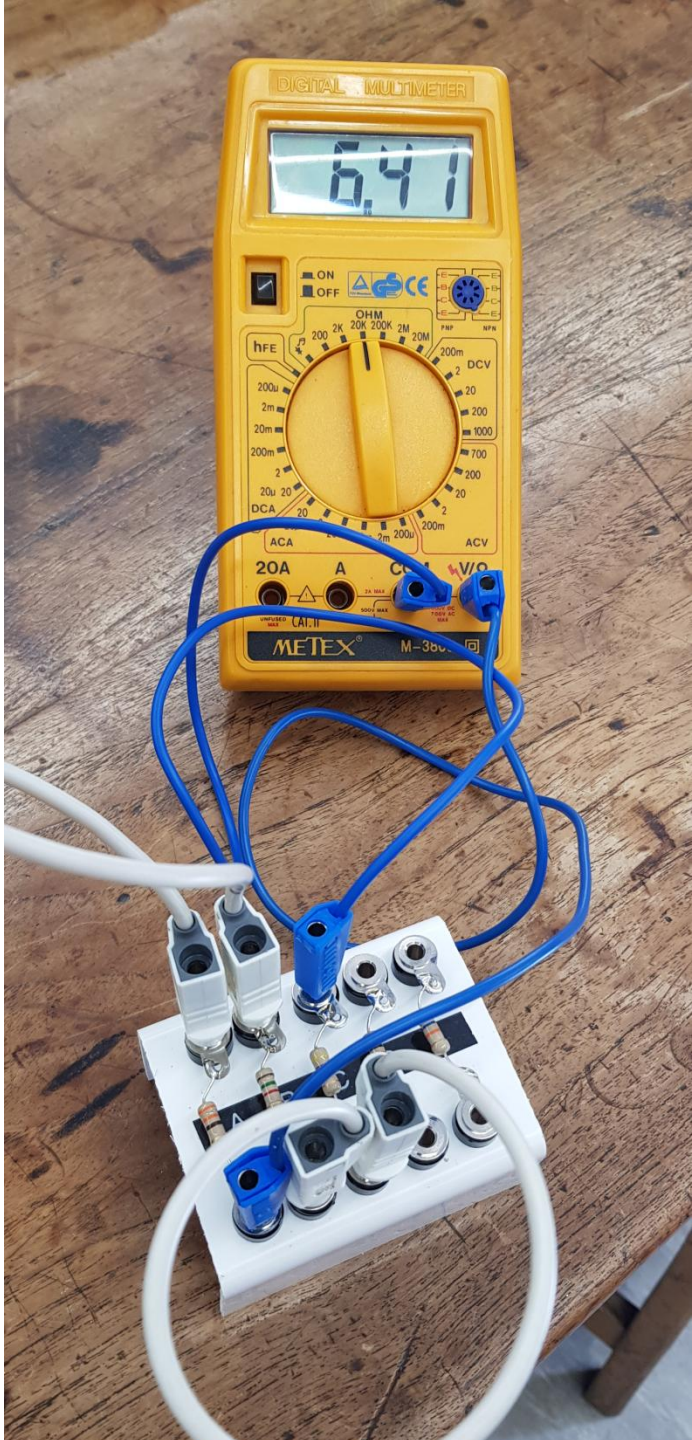
Combination 1. A,B,C wired in series





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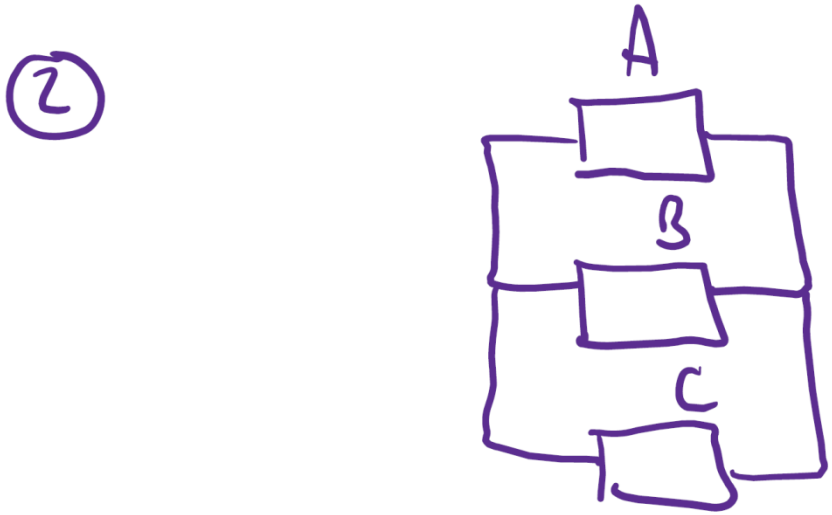
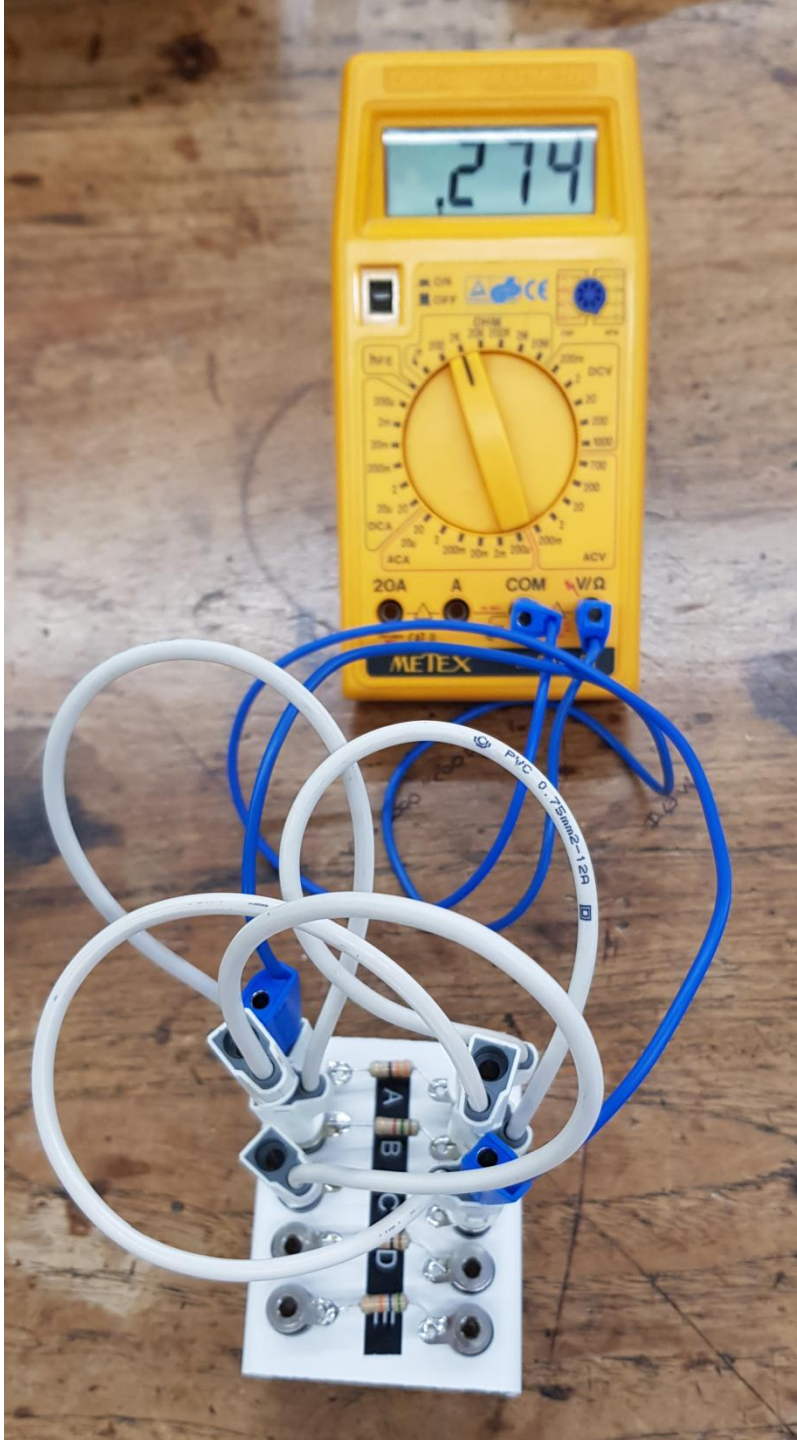
Combination 2. A,B,C wired in parallel





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4	1/(1/A + 1/(B+C))	0.31	0.337	7.56%
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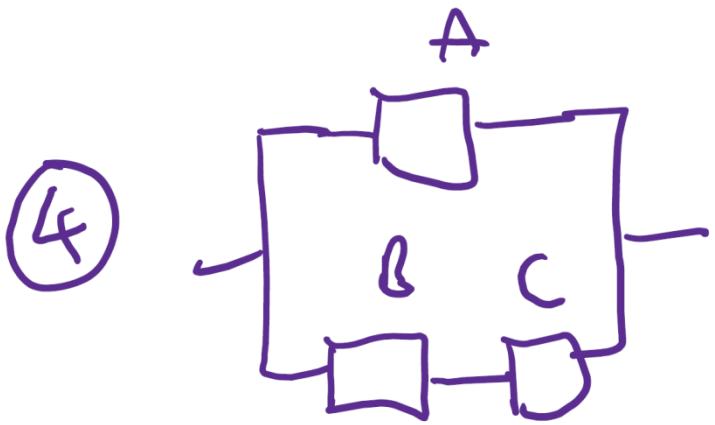
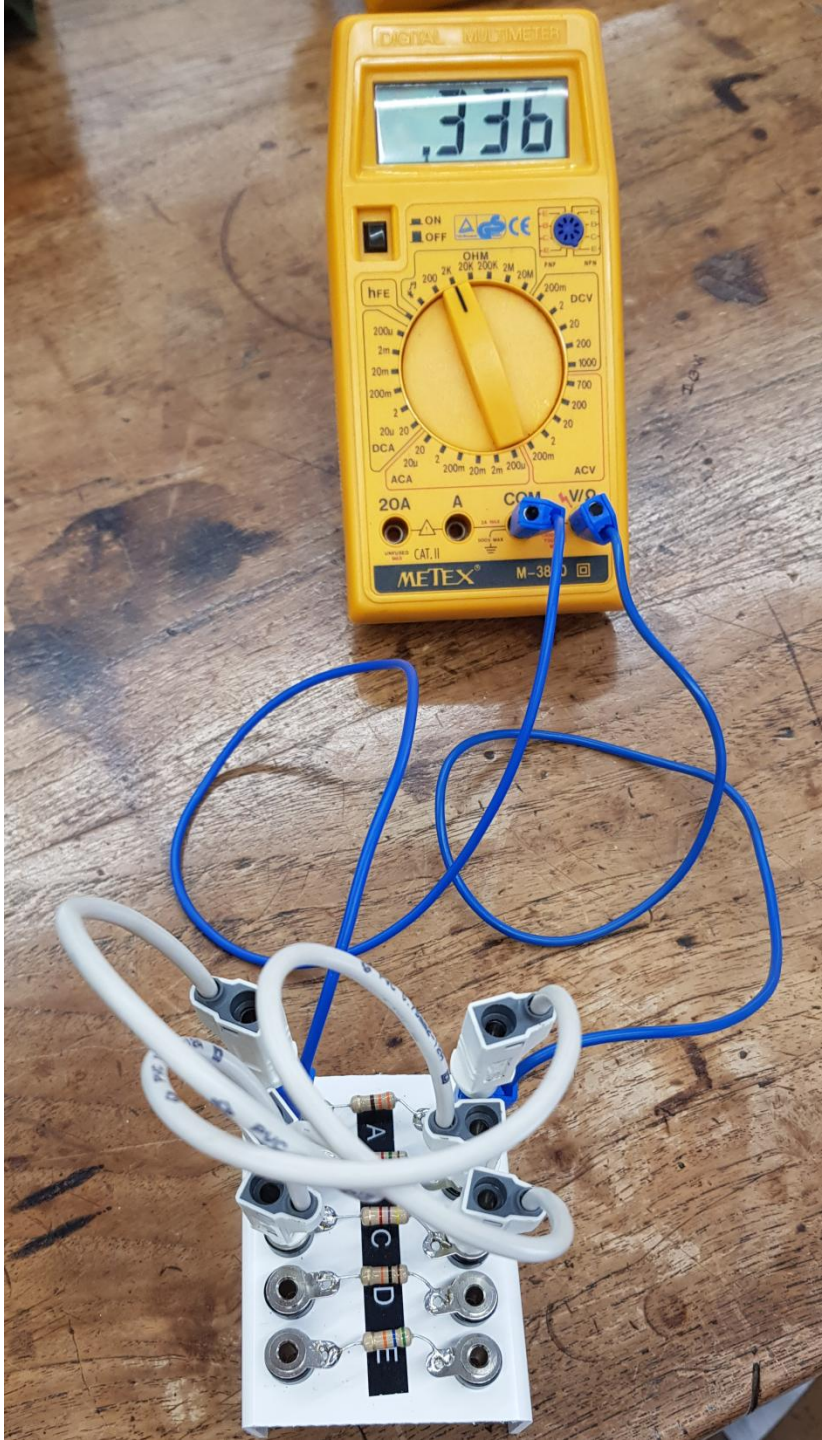
Combination 4.

A in parallel with B and C wired in series





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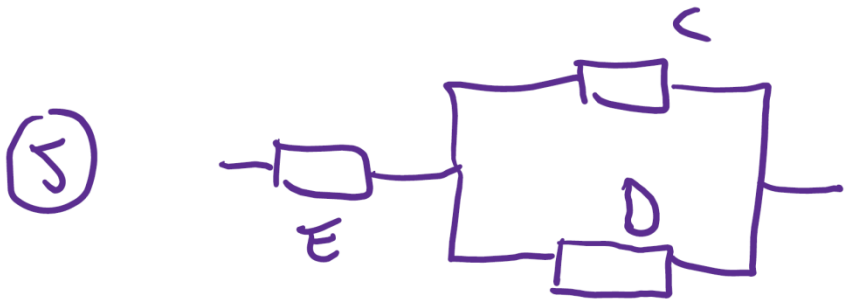
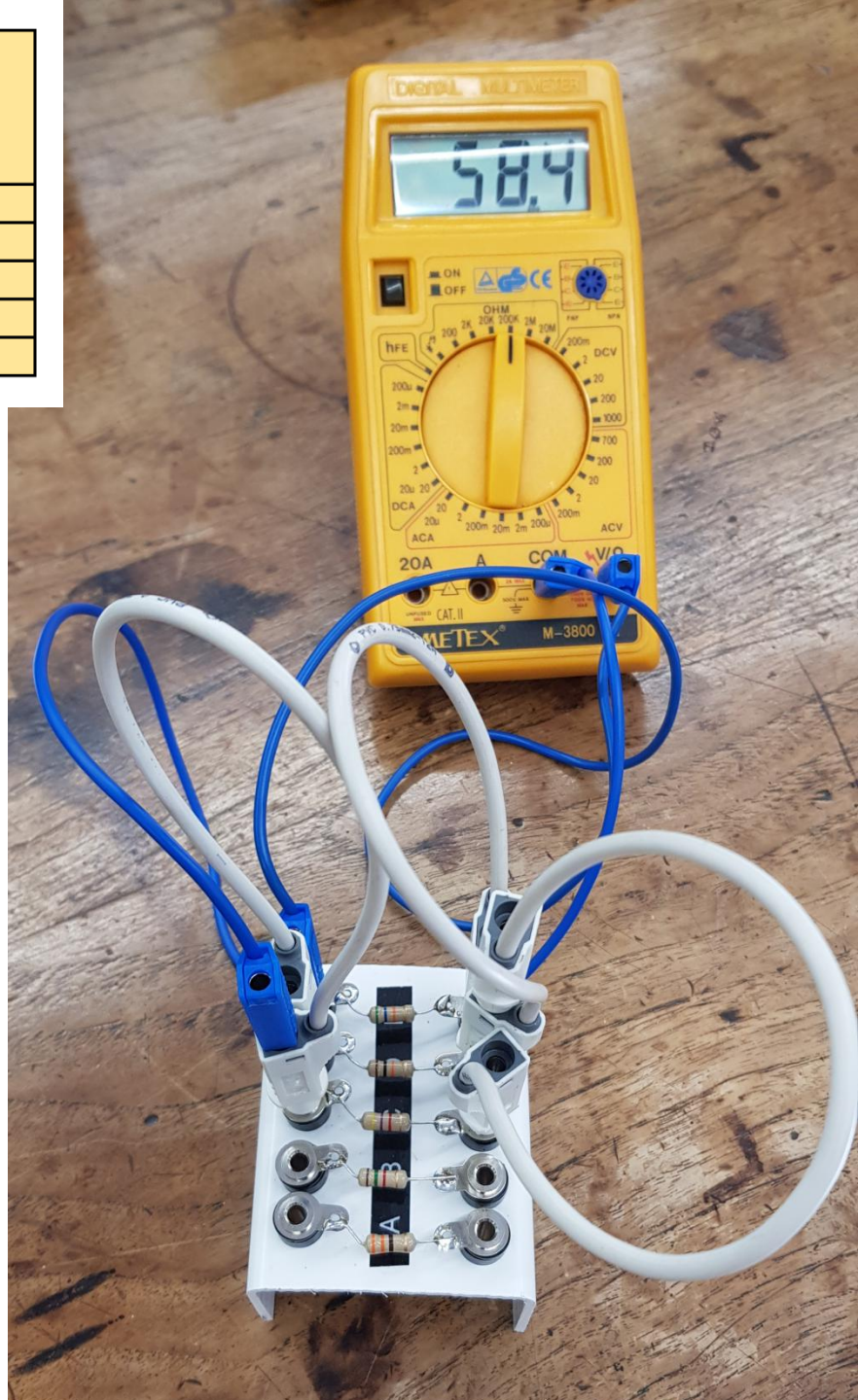
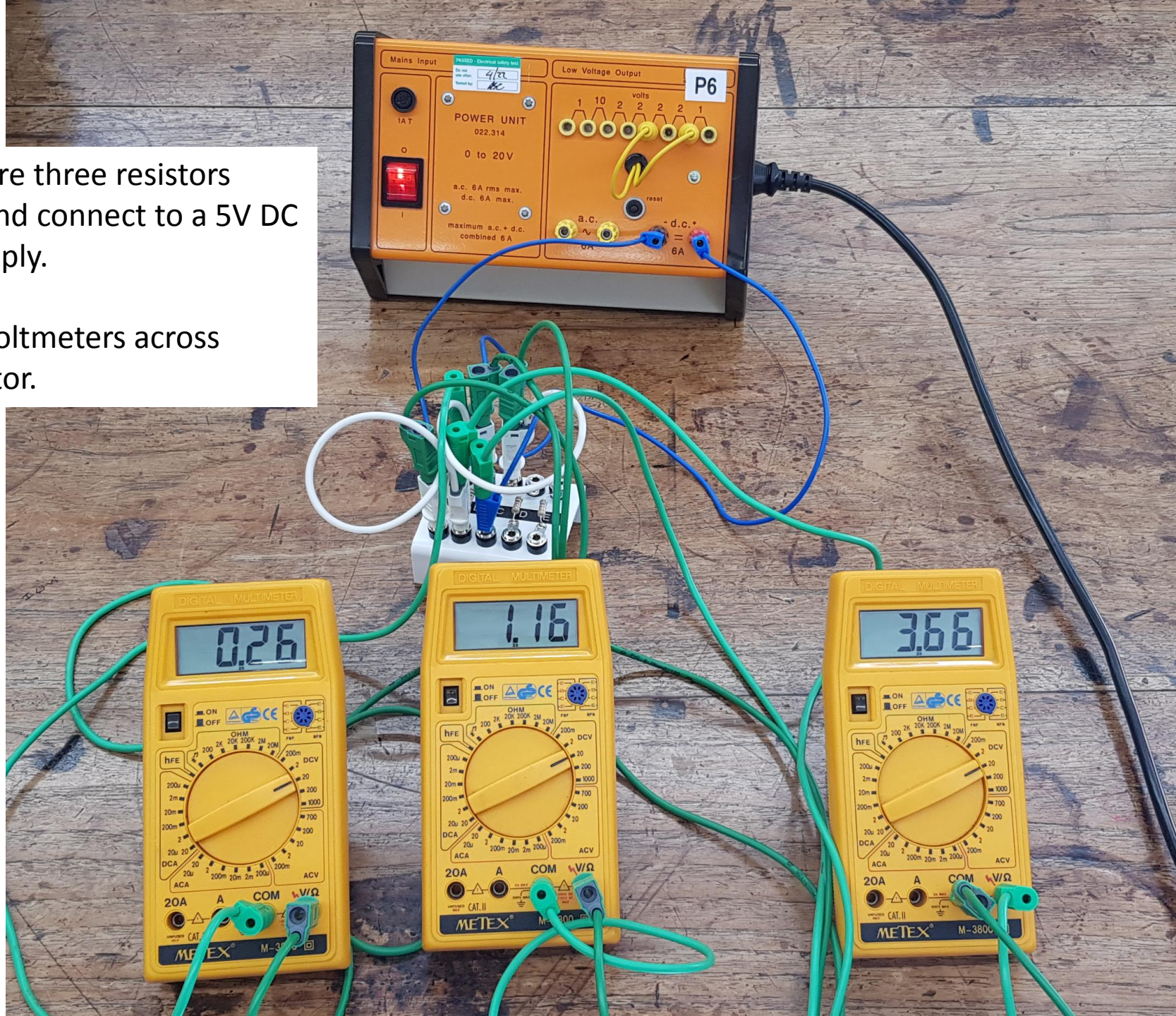
5	E + 1/(1/C + 1/D)	59.20	58.4	-1.35%

Combination 5.

E in series with C and D wired in parallel







TASK4: Wire three resistors in series and connect to a 5V DC power supply.

Connect voltmeters across each resistor.

POTENTIAL DIVIDER CIRCUIT (three resistiors in series)

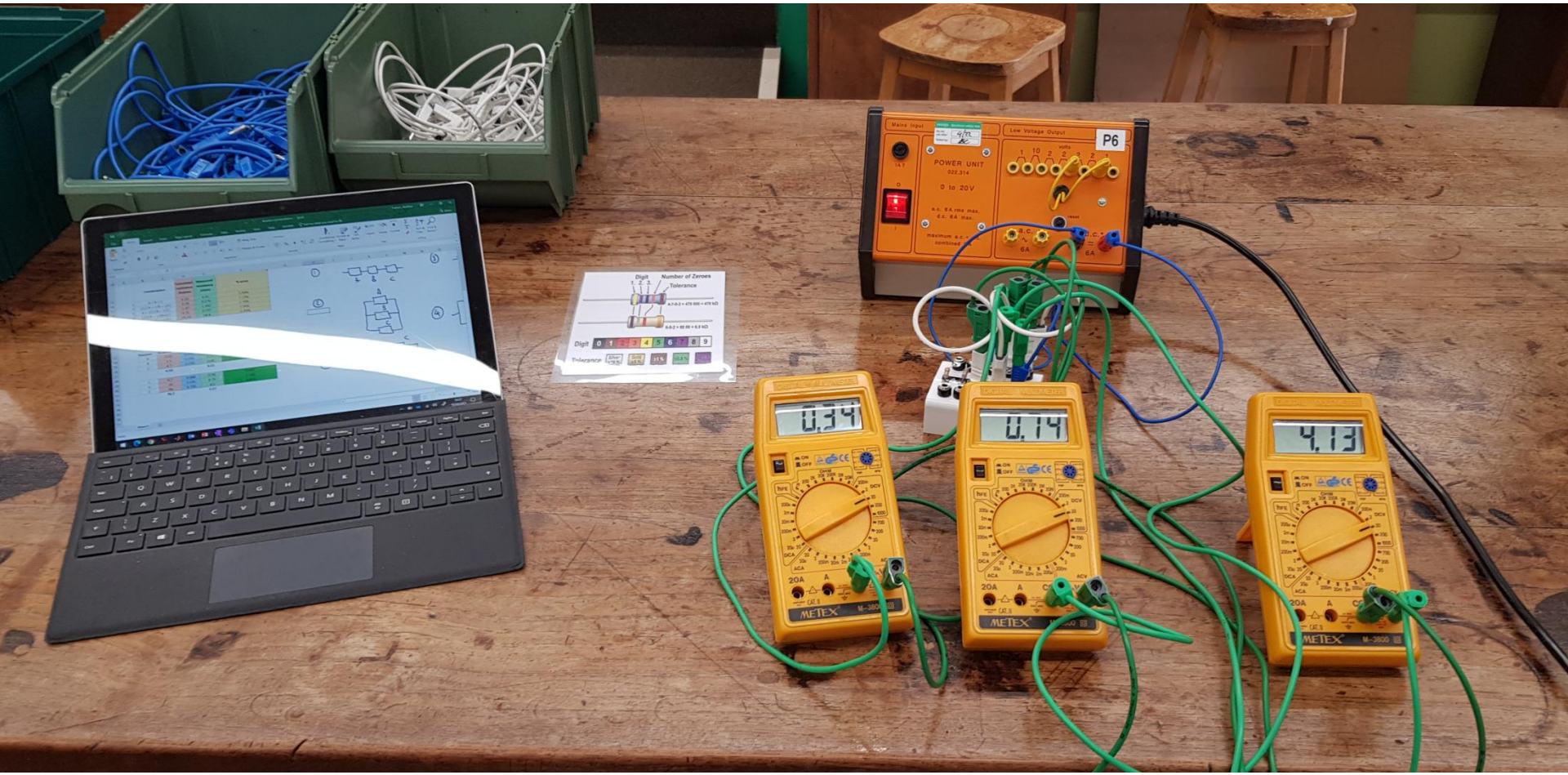
These columns should match

Resistor	Resistance /k ohms	Fraction of total resistance	PD /volts	Fraction of total PD
A	0.334	0.052	0.26	0.051
B	1.506	0.233	1.17	0.229
C	4.63	0.716	3.68	0.720
	6.47		**5.11**	

C	4.63	0.066	0.34	0.067
D	9.84	0.140	0.73	0.143
E	55.7	0.794	4.1	0.802
	70.17		**5.17**	

Confirm the **potential divider** idea (since the same current flows through each resistor when wired in the same series loop).

$$\frac{V_{A,B,C}}{V_A + V_B + V_C} = \frac{R_{A,B,C}}{R_A + R_B + R_C}$$


POWER UNIT
0 to 20V
P6
0.34
0.14
4.13
METEX