A-level Physics
CPAC – best practice

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January 2017

Overview of this session

- Common Practical Assessment Criteria (CPAC).
- Apparatus and techniques.
- Practical work in action – Physics: planning, assessing and tracking.
- Lab books.
- The Monitoring Visit.

Common Practical Assessment Criteria (CPAC)

1. Follows written procedures.
2. Applies investigative approaches and methods when using instruments and equipment.
3. Safely uses a range of practical equipment and materials.
4. Makes and records observations.
5. Researches, references and reports.

CPAC Pen portraits

A series of pen portraits have been written to clarify what is meant by 'not achieved', 'achieved' and 'achieved at a level of competence exceeding the CPAC standard'.

These exemplars have been developed in collaboration between the four Awarding Bodies: AQA, Eduqas, OCR and Pearson.
They are intended for guidance and training purposes, and to give an indication of the standard necessary for each CPAC statement.

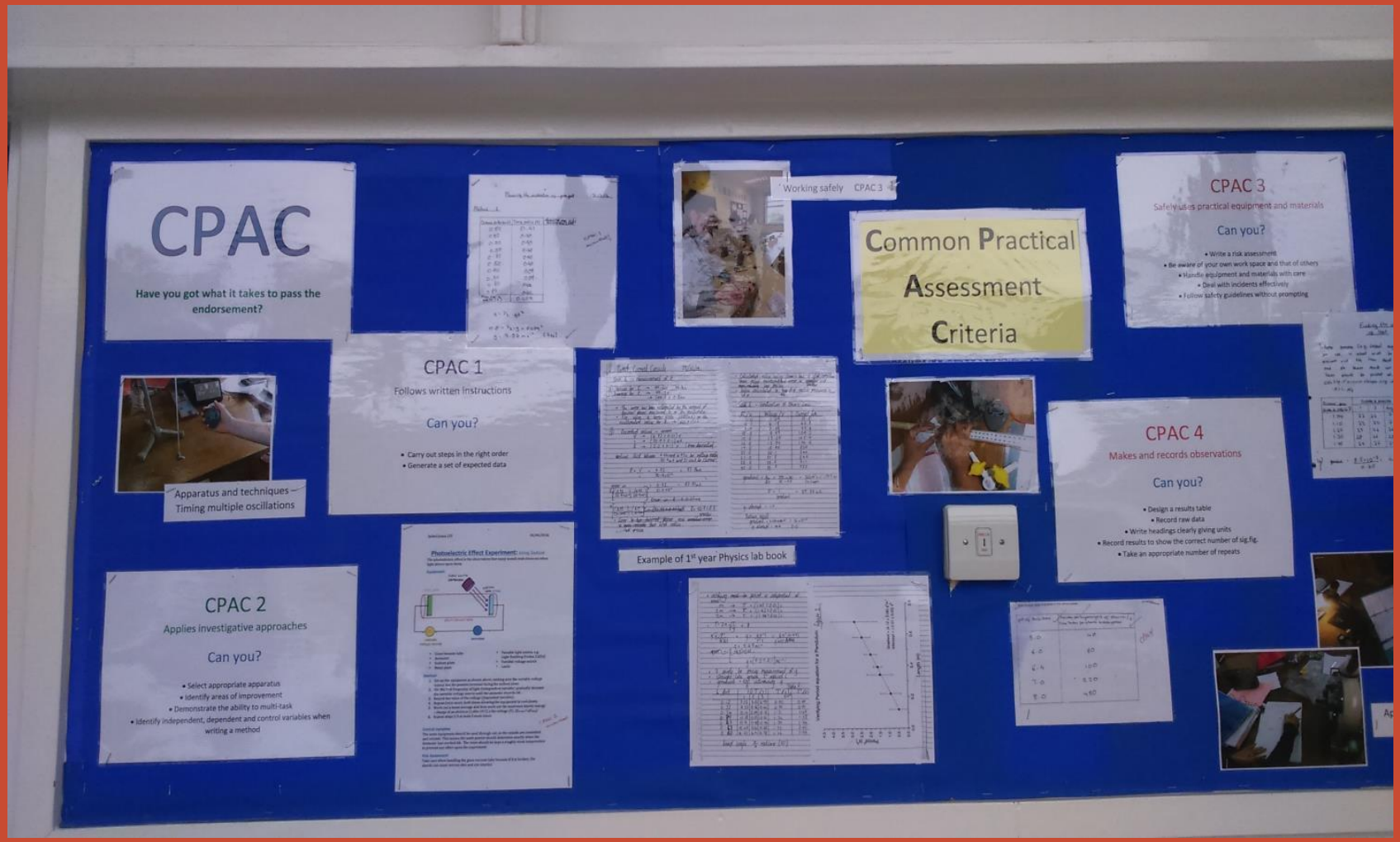
Note that, although these pen portraits show (in the most part) CPAC skills in isolation, many practical exercises are likely to involve CPAC strands being assessed in combination.

12 core practical activities

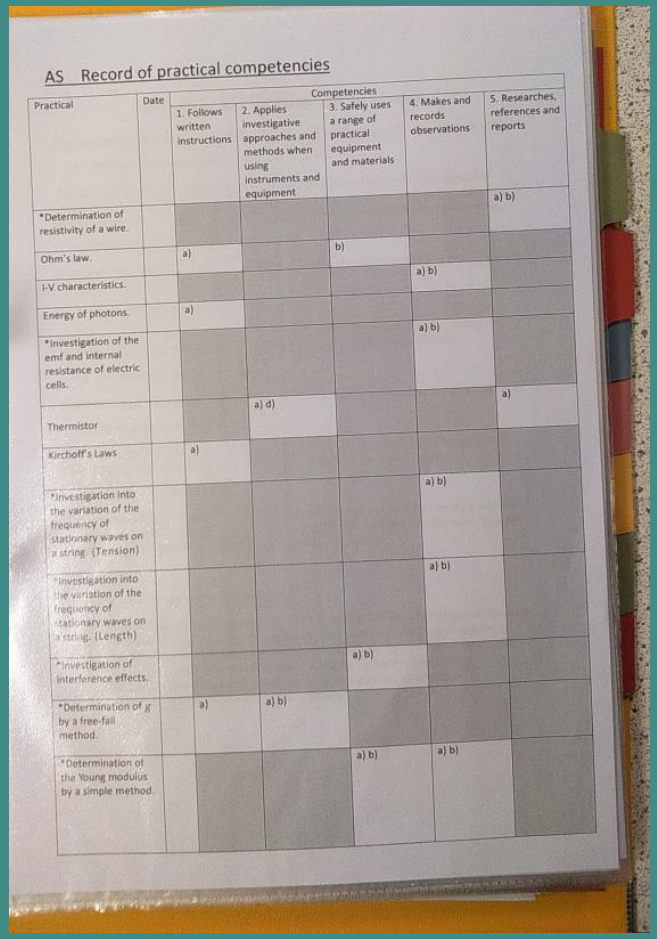
In addition to the five Common Practical Assessment Criteria (CPAC) there are a number of **apparatus and techniques** which must also be addressed.

	apparatus and techniques
ATa	use appropriate analogue apparatus to record a range of measurements (to include length/distance, temperature, pressure, force, angles, volume) and to interpolate between scale markings
ATb	use appropriate digital instruments, including electrical multimeters, to obtain a range of measurements (to include time, current, voltage, resistance, mass)
ATc	use methods to increase accuracy of measurements, such as timing over multiple oscillations, or use of fiduciary marker, set square or plumb line
ATd	use stopwatch or light gates for timing
ATe	use calipers and micrometers for small distances, using digital or vernier scales
ATf	correctly construct circuits from circuit diagrams using DC power supplies, cells, and a range of circuit components, including those where polarity is important
ATg	design, construct and check circuits using DC power supplies, cells, and a range of circuit components
ATh	use signal generator and oscilloscope, including volts/division and time-base
ATi	generate and measure waves, using microphone and loudspeaker, or ripple tank, or vibration transducer, or microwave/radio wave source
ATj	use laser or light source to investigate characteristics of light, including interference and diffraction
ATk	use ICT such as computer modelling, or data logger with a variety of sensors to collect data, or use of software to process data
ATl	use ionising radiation, including detectors

Providing help for the students

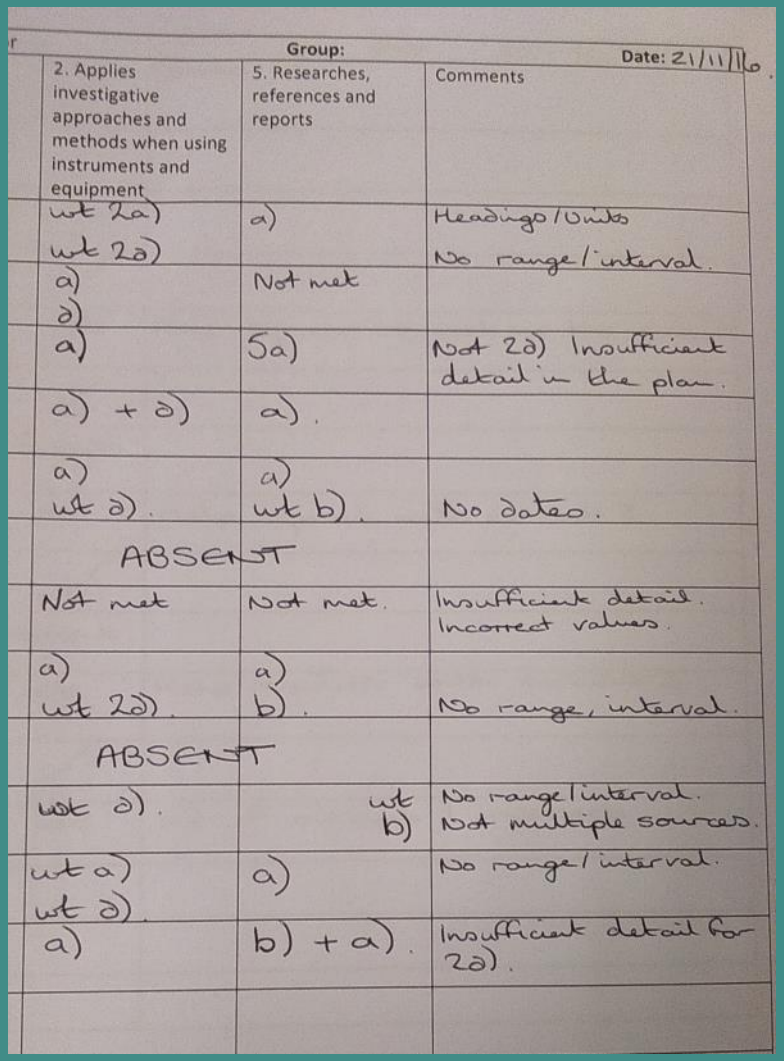


Teacher planning and recording



AS Record of practical competencies

Practical	Date	Competencies				
		1. Follows written instructions	2. Applies investigative approaches and methods when using instruments and equipment	3. Safely uses a range of practical equipment and materials	4. Makes and records observations	5. Researches, references and reports
*Determination of resistivity of a wire.						a) b)
Ohm's law.		a)		b)		
I-V characteristics.					a) b)	
Energy of photons.		a)				
*Investigation of the emf and internal resistance of electric cells.					a) b)	
Thermistor			a) d)			a)
Kirchoff's Laws		a)				
*Investigation into the variation of the frequency of stationary waves on a string. (Tension)					a) b)	
*Investigation into the variation of the frequency of stationary waves on a string. (Length)					a) b)	
*Investigation of interference effects.				a) b)		
*Determination of g by a free-fall method.		a)	a) b)			
*Determination of the Young modulus by a simple method.				a) b)	a) b)	



Group: Date: 21/11/16

2. Applies investigative approaches and methods when using instruments and equipment	5. Researches, references and reports	Comments
wt 2a) wt 2d)	a)	Headings/Units No range/interval.
a) d)	Not met	
a)	5a)	Not 2d) Insufficient detail in the plan.
a) + d)	a)	
a) wt d).	a) wt b).	No dates.
ABSENT		
Not met	Not met.	Insufficient detail. Incorrect values.
a) wt 2d).	a) b).	No range, interval.
ABSENT		
wt d).	wt b)	No range/interval. Not multiple sources.
wt a) wt d).	a)	No range/interval.
a)	b) + a).	Insufficient detail for 2d).

AQA

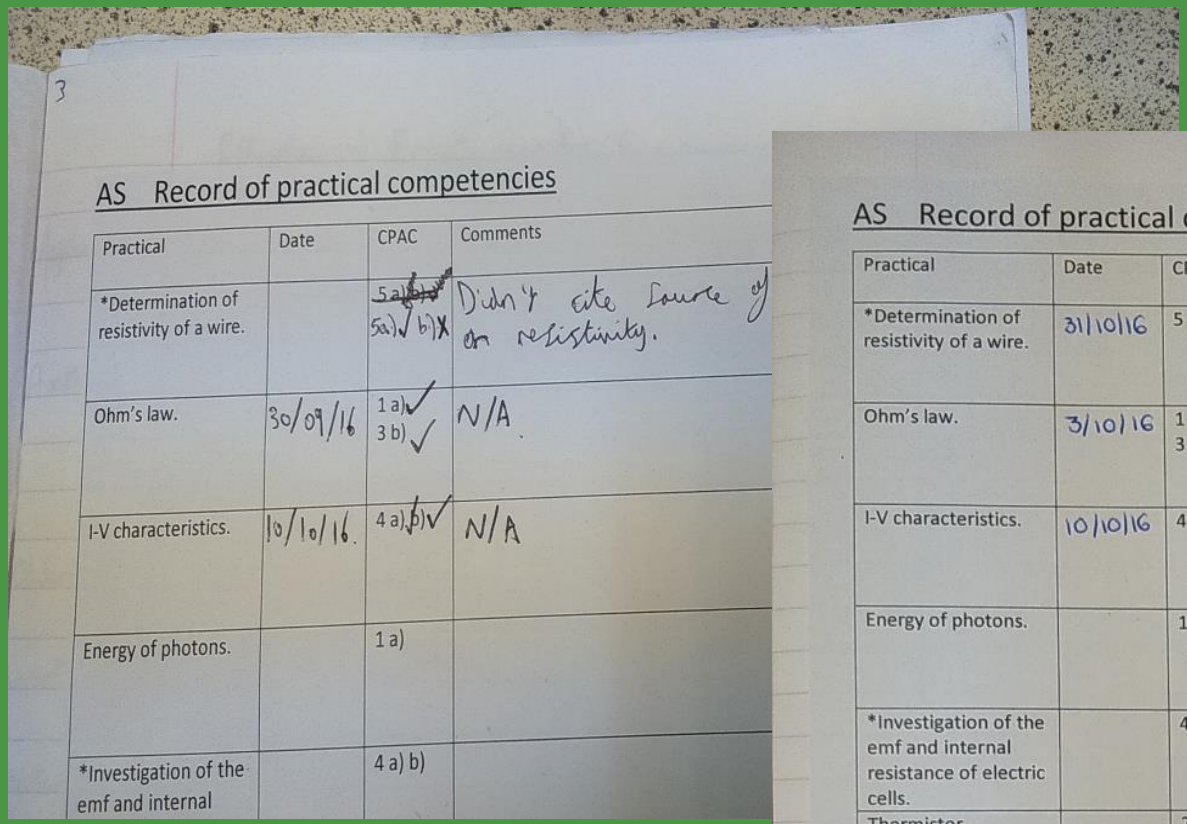
Student lab book

	apparatus and techniques
ATa	use appropriate analogue apparatus to record a range of measurements (to include length/distance, temperature, pressure, force, angles, volume) and to interpolate between scale markings
ATb	use appropriate digital instruments, including electrical multimeters, to obtain a range of measurements (to include time, current, voltage, resistance, mass)
ATc	use methods to increase accuracy of measurements, such as timing over multiple oscillations, or use of fiduciary marker, set square or plumb line
ATd	use stopwatch or light gates for timing
ATe	use calipers and micrometers for small distances, using digital or vernier scales
ATf	correctly construct circuits from circuit diagrams using DC power supplies, cells, and a range of circuit components, including those where polarity is important
ATg	design, construct and check circuits using DC power supplies, cells, and a range of circuit components
ATh	use signal generator and oscilloscope, including volts/division and time-base
ATi	generate and measure waves, using microphone and loudspeaker, or ripple tank, or vibration transducer, or microwave/radio wave source
ATj	use laser or light source to investigate characteristics of light, including interference and diffraction
ATk	use ICT such as computer modelling, or data logger with a variety of sensors to collect data, or use of software to process data
ATl	use ionising radiation, including detectors

Required activity	Apparatus and technique reference
1 Investigation into the variation of the frequency of stationary waves on a string with length, tension and mass per unit length of the string	a, b, c, i
2 Investigation of interference effects to include the Young's slit experiment and interference by a diffraction grating	a, j
3 Determination of g by a free-fall method	a, c, d, k
4 Determination of the Young modulus by a simple method	a, c, e
5 Determination of resistivity of a wire using a micrometer, ammeter and voltmeter	a, b, e, f
6 Investigation of the emf and internal resistance of electric cells and batteries by measuring the variation of the terminal pd of the cell with current in it	b, f, g

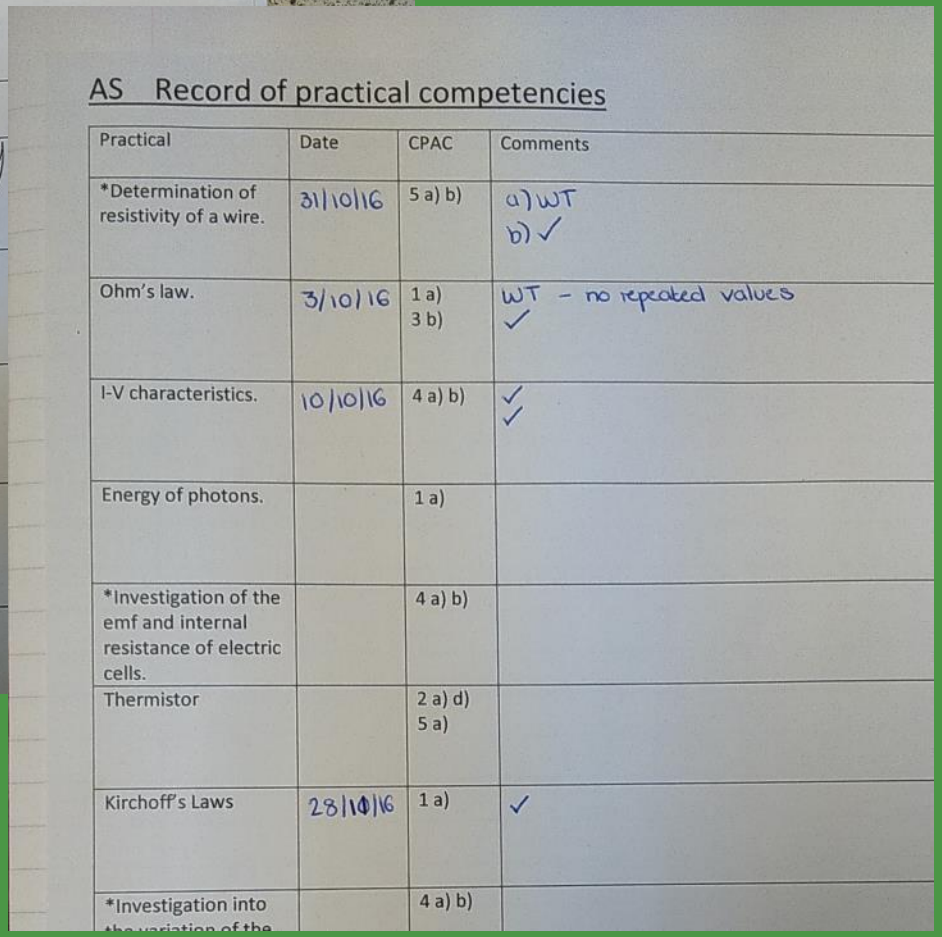
Competency	Practical mastery
1. Follows written procedures	a. Correctly follows instructions to carry out experimental techniques or procedures.
2. Applies investigative approaches and methods when using instruments and equipment	a. Correctly uses appropriate instrumentation, apparatus and materials (including ICT) to carry out investigative activities, experimental techniques and procedures with minimal assistance or prompting. b. Carries out techniques or procedures methodically, in sequence and in combination, identifying practical issues and making adjustments when necessary. c. Identifies and controls significant quantitative variables where applicable, and plans approaches to take account of variables that cannot readily be controlled. d. Selects appropriate equipment and measurement strategies in order to ensure suitably accurate results.
3. Safely uses a range of practical equipment and materials	a. Identifies hazards and assesses risks associated with these hazards, making safety adjustments as necessary, when carrying out experimental techniques and procedures in the lab or field. b. Uses appropriate safety equipment and approaches to minimise risks with minimal prompting.
4. Makes and records observations	a. Makes accurate observations relevant to the experimental or investigative procedure. b. Obtains accurate, precise and sufficient data for experimental and investigative procedures and records this methodically using appropriate units and conventions.
5. Researches, references and reports	a. Uses appropriate software and/or tools to process data, carry out research and report findings. b. Cites sources of information demonstrating that research has taken place, supporting planning and conclusions.

Student records



AS Record of practical competencies

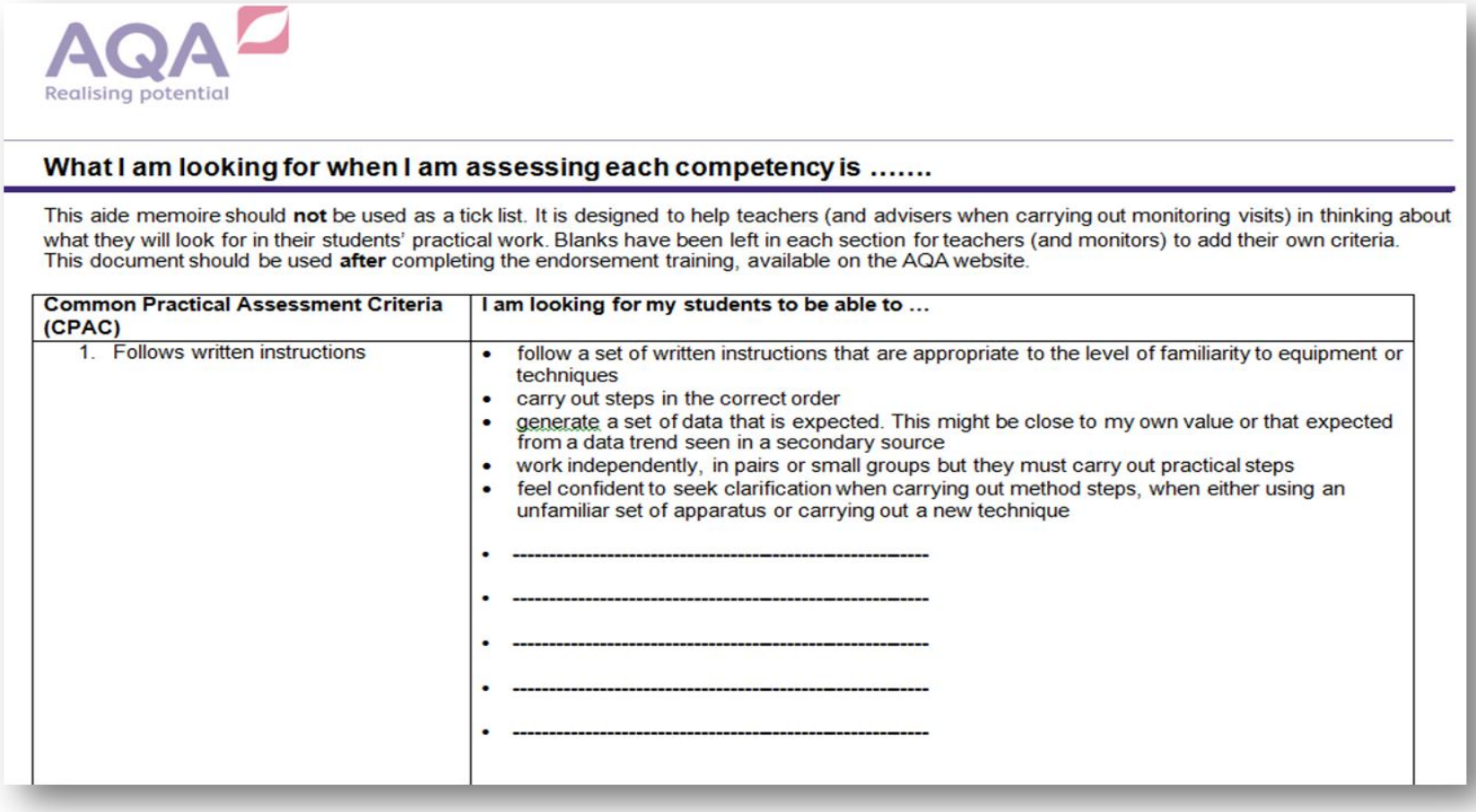
Practical	Date	CPAC	Comments
*Determination of resistivity of a wire.		~~5 a) b)~~ 5a)✓ b)✗	Didn't cite source of on resistivity.
Ohm's law.	30/09/16	1 a)✓ 3 b)✓	N/A
I-V characteristics.	10/10/16	4 a) ~~b)~~✓	N/A
Energy of photons.		1 a)	
*Investigation of the emf and internal		4 a) b)	



AS Record of practical competencies

Practical	Date	CPAC	Comments
*Determination of resistivity of a wire.	31/10/16	5 a) b)	a) WT b) ✓
Ohm's law.	3/10/16	1 a) 3 b)	WT - no repeated values ✓
I-V characteristics.	10/10/16	4 a) b)	✓ ✓
Energy of photons.		1 a)	
*Investigation of the emf and internal resistance of electric cells.		4 a) b)	
Thermistor		2 a) d) 5 a)	
Kirchoff's Laws	28/10/16	1 a)	✓
*Investigation into		4 a) b)	

AQA practical endorsement online training



AQA
Realising potential

What I am looking for when I am assessing each competency is .....

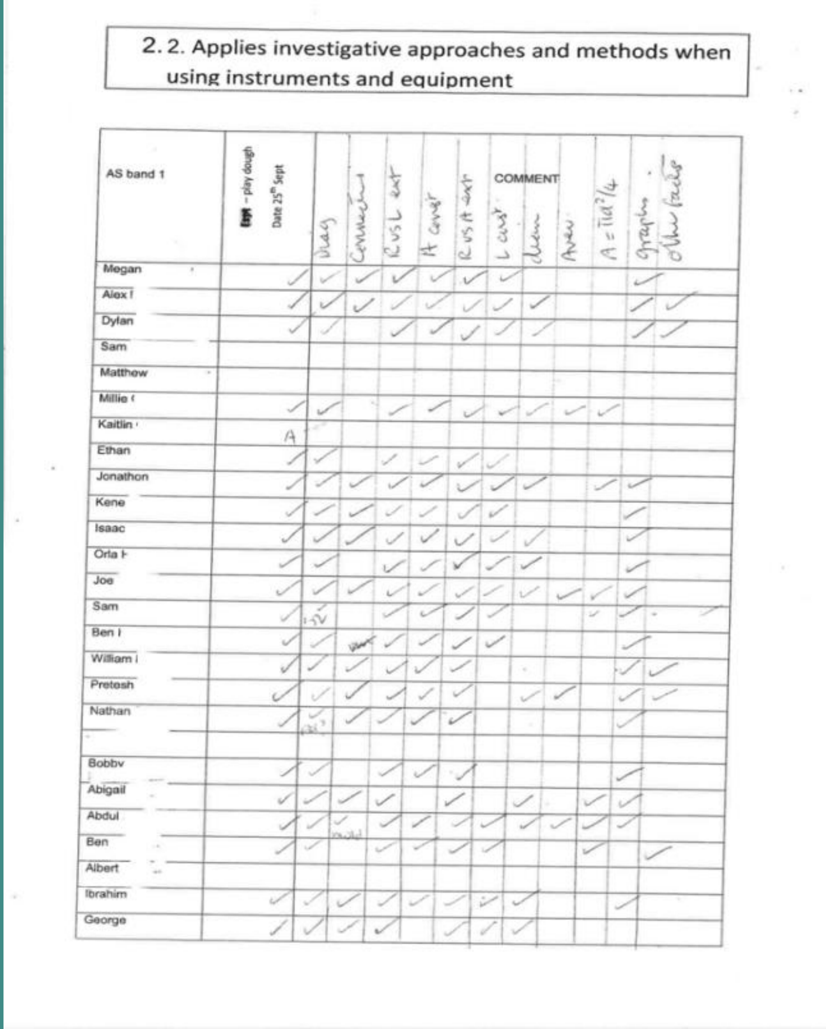
This aide memoire should **not** be used as a tick list. It is designed to help teachers (and advisers when carrying out monitoring visits) in thinking about what they will look for in their students' practical work. Blanks have been left in each section for teachers (and monitors) to add their own criteria. This document should be used **after** completing the endorsement training, available on the AQA website.

Common Practical Assessment Criteria (CPAC)	I am looking for my students to be able to ...
1. Follows written instructions	• follow a set of written instructions that are appropriate to the level of familiarity to equipment or techniques • carry out steps in the correct order • generate a set of data that is expected. This might be close to my own value or that expected from a data trend seen in a secondary source • work independently, in pairs or small groups but they must carry out practical steps • feel confident to seek clarification when carrying out method steps, when either using an unfamiliar set of apparatus or carrying out a new technique • ---------- • ---------- • ---------- • ---------- • ----------

http://www.aqa.org.uk/resources/science/as-and-a-level/teach/practicals

AQA

CPAC 1: assessing in a manageable way



2.2. Applies investigative approaches and methods when using instruments and equipment

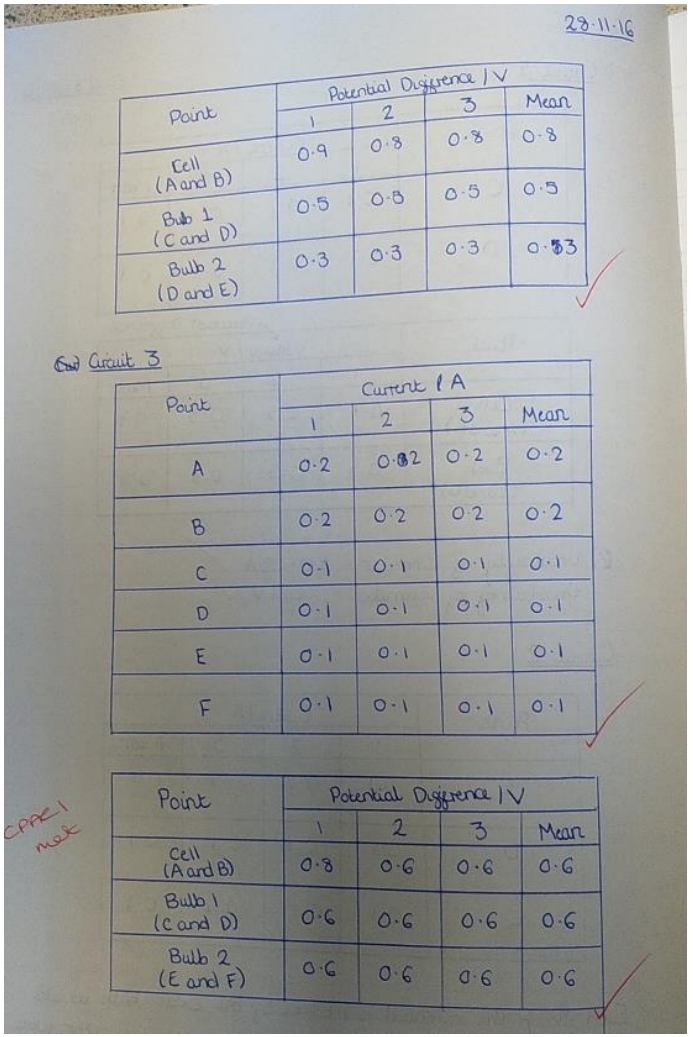
AS band 1
Expt – play dough
Date 25th Sept
Drag
Connection
R vs L ext
A const
R vs A ext
L const
diam
Area
A = πd²/4
Graphs
Other factors
COMMENT

Megan
Alex
Dylan
Sam
Matthew
Millie
Kaitlin
Ethan
Jonathon
Kene
Isaac
Orla
Joe
Sam
Ben
William
Pretesh
Nathan
Bobby
Abigail
Abdul
Ben
Albert
Ibrahim
George

AQA

CPAC 1

Using a teacher practical with sufficient challenge.



28.11.16

Point	Potential Difference / V			
	1	2	3	Mean
Cell (A and B)	0.9	0.8	0.8	0.8
Bulb 1 (C and D)	0.5	0.5	0.5	0.5
Bulb 2 (D and E)	0.3	0.3	0.3	0.33

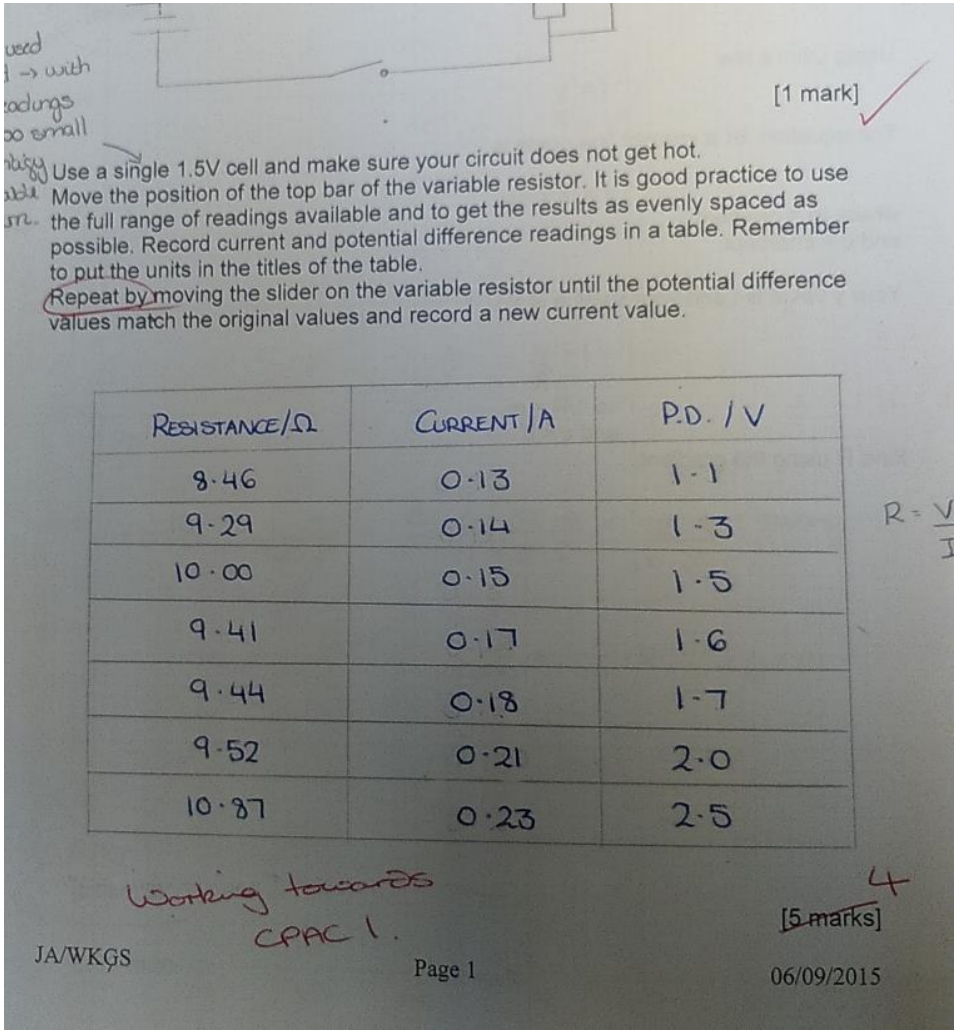
Circuit 3

Point	Current / A			
	1	2	3	Mean
A	0.2	0.22	0.2	0.2
B	0.2	0.2	0.2	0.2
C	0.1	0.1	0.1	0.1
D	0.1	0.1	0.1	0.1
E	0.1	0.1	0.1	0.1
F	0.1	0.1	0.1	0.1

CPAC 1 mark

Point	Potential Difference / V			
	1	2	3	Mean
Cell (A and B)	0.8	0.6	0.6	0.6
Bulb 1 (C and D)	0.6	0.6	0.6	0.6
Bulb 2 (E and F)	0.6	0.6	0.6	0.6

CPAC 1 and CPAC 2b



[1 mark]

Use a single 1.5V cell and make sure your circuit does not get hot.
Move the position of the top bar of the variable resistor. It is good practice to use the full range of readings available and to get the results as evenly spaced as possible. Record current and potential difference readings in a table. Remember to put the units in the titles of the table.
Repeat by moving the slider on the variable resistor until the potential difference values match the original values and record a new current value.

Resistance/Ω	Current/A	P.D./V
8·46	0·13	1·1
9·29	0·14	1·3
10·00	0·15	1·5
9·41	0·17	1·6
9·44	0·18	1·7
9·52	0·21	2·0
10·87	0·23	2·5

Working towards CPAC 1.

4

[5 marks]

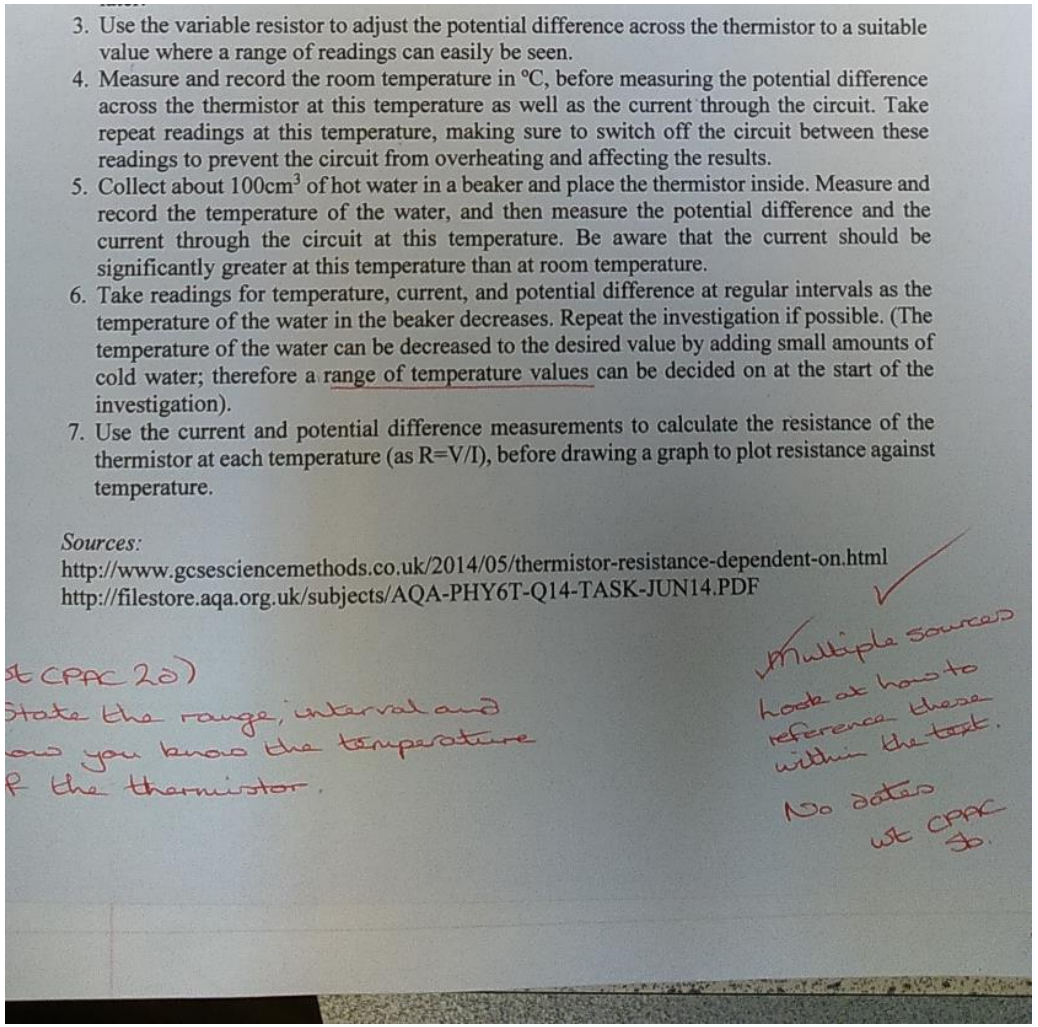
JA/WKGS Page 1 06/09/2015

Planning for CPAC 2 assessment

What AQA is looking for	Use the equipment properly, without much prompting. Work methodically and show ability to multi-task.	Have adapted method/ equipment during the practical and have justified reasons for this.	Have listed the main variables and have explained how control variables will be kept the same.	Have selected the most appropriate equipment and explained reasons for choosing each piece in order to gather accurate results.
CPAC 2: make choices about appropriate element examples	Use equipment to measure volumes and time.	At least two adaptations to the method provided with justifications.	Independent and dependent identified and state how to control two variables.	Chosen equipment with fewest uncertainties and justified.

CPAC 2c

No intention to assess 2c on this occasion but feedback prompts the student to be able to access it when it is assessed.



3. Use the variable resistor to adjust the potential difference across the thermistor to a suitable value where a range of readings can easily be seen.
4. Measure and record the room temperature in °C, before measuring the potential difference across the thermistor at this temperature as well as the current through the circuit. Take repeat readings at this temperature, making sure to switch off the circuit between these readings to prevent the circuit from overheating and affecting the results.
5. Collect about 100cm^3 of hot water in a beaker and place the thermistor inside. Measure and record the temperature of the water, and then measure the potential difference and the current through the circuit at this temperature. Be aware that the current should be significantly greater at this temperature than at room temperature.
6. Take readings for temperature, current, and potential difference at regular intervals as the temperature of the water in the beaker decreases. Repeat the investigation if possible. (The temperature of the water can be decreased to the desired value by adding small amounts of cold water; therefore a range of temperature values can be decided on at the start of the investigation).
7. Use the current and potential difference measurements to calculate the resistance of the thermistor at each temperature (as R=V/I), before drawing a graph to plot resistance against temperature.

Sources:
http://www.gcsesciencemethods.co.uk/2014/05/thermistor-resistance-dependent-on.html
http://filestore.aqa.org.uk/subjects/AQA-PHY6T-Q14-TASK-JUN14.PDF

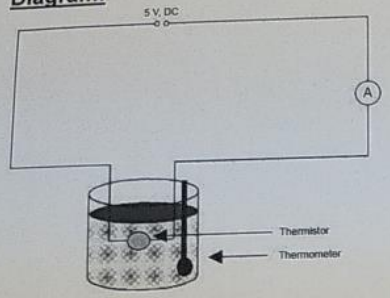
t CPAC 2d)
State the range, interval and
ow you know the temperature
f the thermistor.

Multiple sources
look at how to
reference these
within the text.
No dates
at CPAC
2d.

Assessing multiple CPAC

resistance decreases as the temp

Diagram:



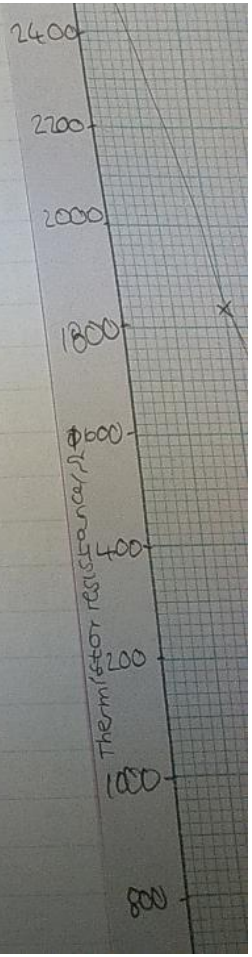
Equipment:
Timer or clock
Leads, 4 mm
Crocodile clip holder
Thermometer -10°C to 110°C
Thermistor
Power supply, 5 V, DC or four 1.5 V cells
Beaker, 250 ml
Kettle to provide hot water
Digital multimeter, used as a milliammeter
Heat-resistant mat
Power supply, low voltage, DC, continuously variable [1] [2]

Instructions:
- Set up the circuit as shown in diagram.
- Pour boiling water into the beaker and take readings of the current through the thermistor as the temperature falls. Record the results. [1] [3]
- Plot a graph of current/A (y-axis) against temperature/°C (x-axis). [1] [3]

Variables:
Independent – Temperature/°C
Dependent – Current/A
Control – power supply, thermistor, wires, ammeter

Nice referenced CPAC 5b)

References:
[1]http://practicalphysics.org/effect-temperature-thermistor.html 14.11.2016
[2]https://www.google.co.uk/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8# 14.11.2016
[3]http://www.loretobalbriggan.ie/physics/Experiment%20worksheets/Resitance%20v%20Temp%20for%20thermistor.PDF 14.11.2016
[4] http://www.myclassbook.org/experiment-for-characteristics-of-thermistor/ 14.11.2016



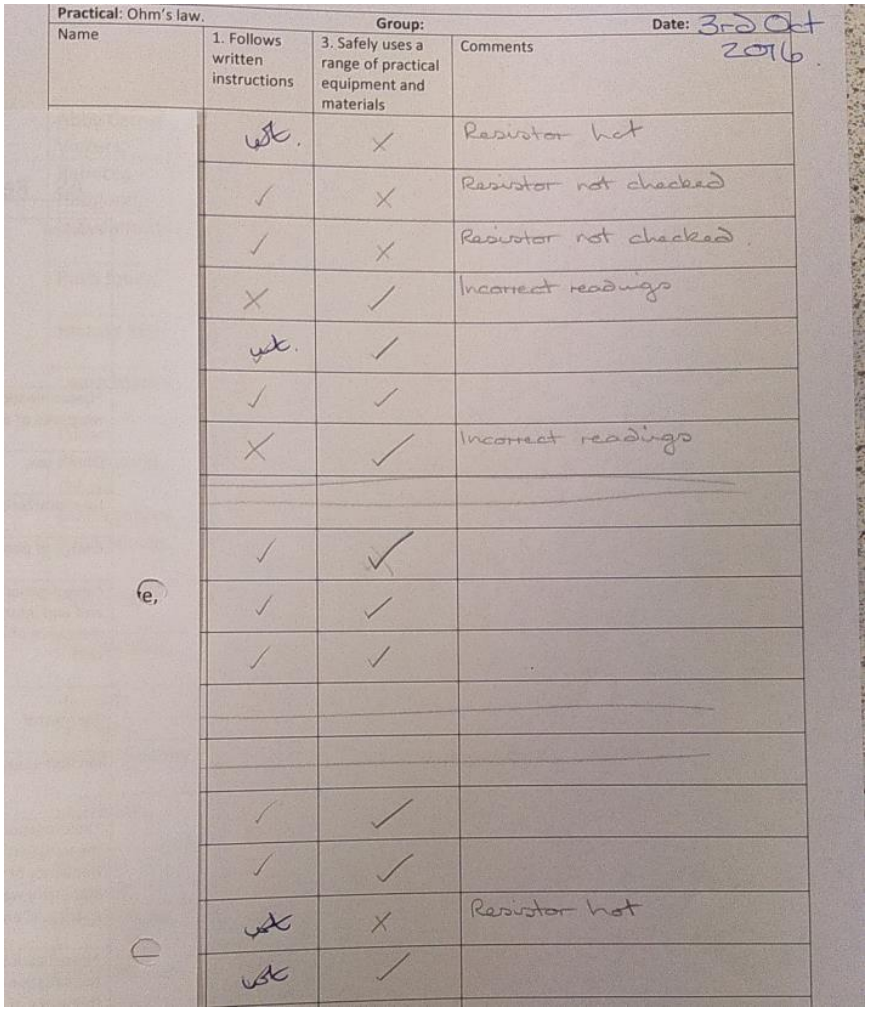
CPAC 3: safe use of a range of practical equipment and materials

- It’s not robust enough to say that students are reaching the pass standard because ‘nothing went wrong’.

- Clear statements outline that students must:
  - identify main hazards and associated risks
  - use appropriate safety equipment and approaches with minimal prompting
  - make adjustments when issues are identified.

CPAC 3

Checking safety.



Practical: Ohm's law. **Group:** **Date:** 3rd Oct 2016

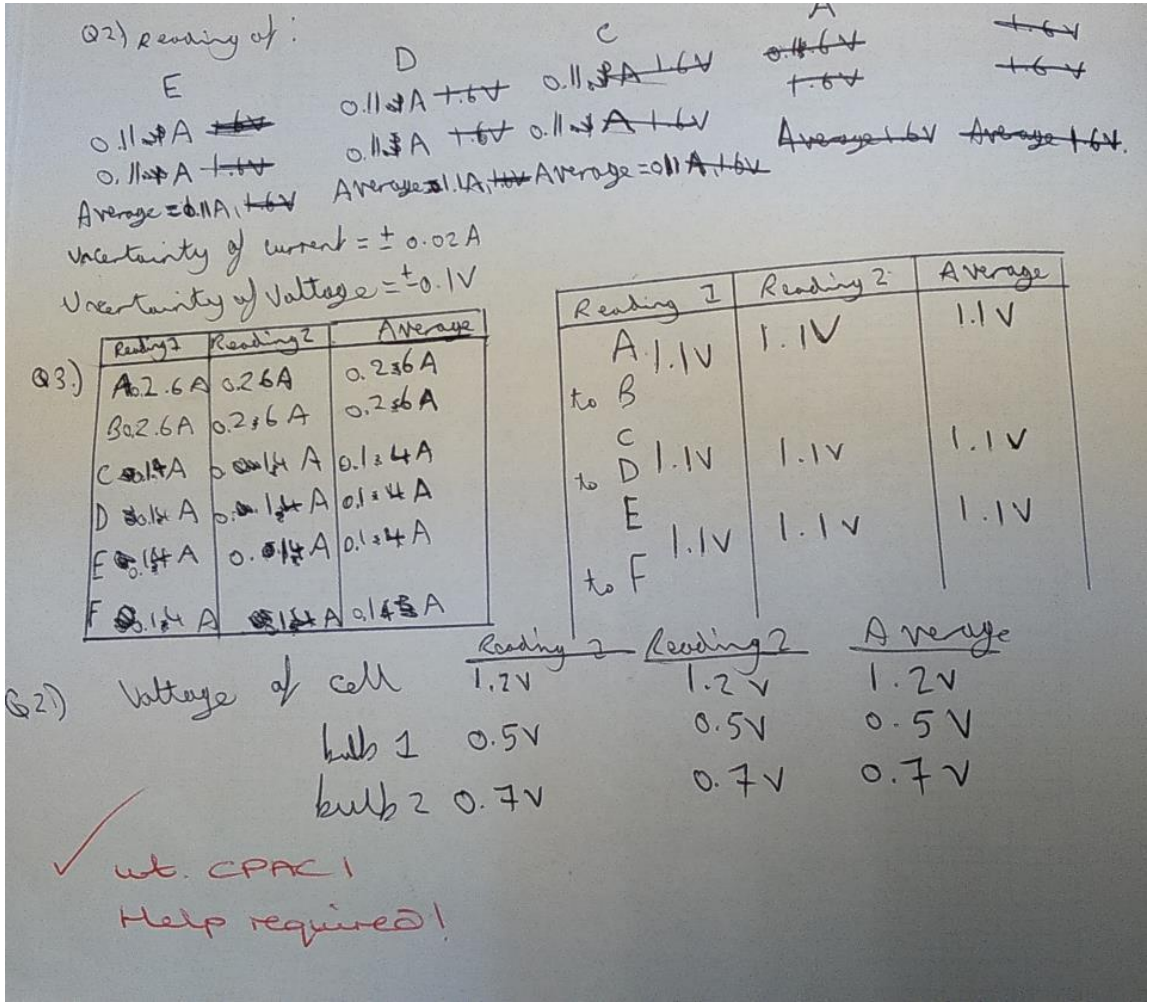
Name	1. Follows written instructions	3. Safely uses a range of practical equipment and materials	Comments
	✓	✗	Resistor hot
	✓	✗	Resistor not checked
	✓	✗	Resistor not checked
	✗	✓	Incorrect readings
	✓	✓	
	✓	✓	
	✗	✓	Incorrect readings
	✓	✓	
	✓	✓	
	✓	✓	
	✓	✓	
	✓	✓	
	✓	✗	Resistor hot
	✓	✓	

CPAC 4: makes and records observations

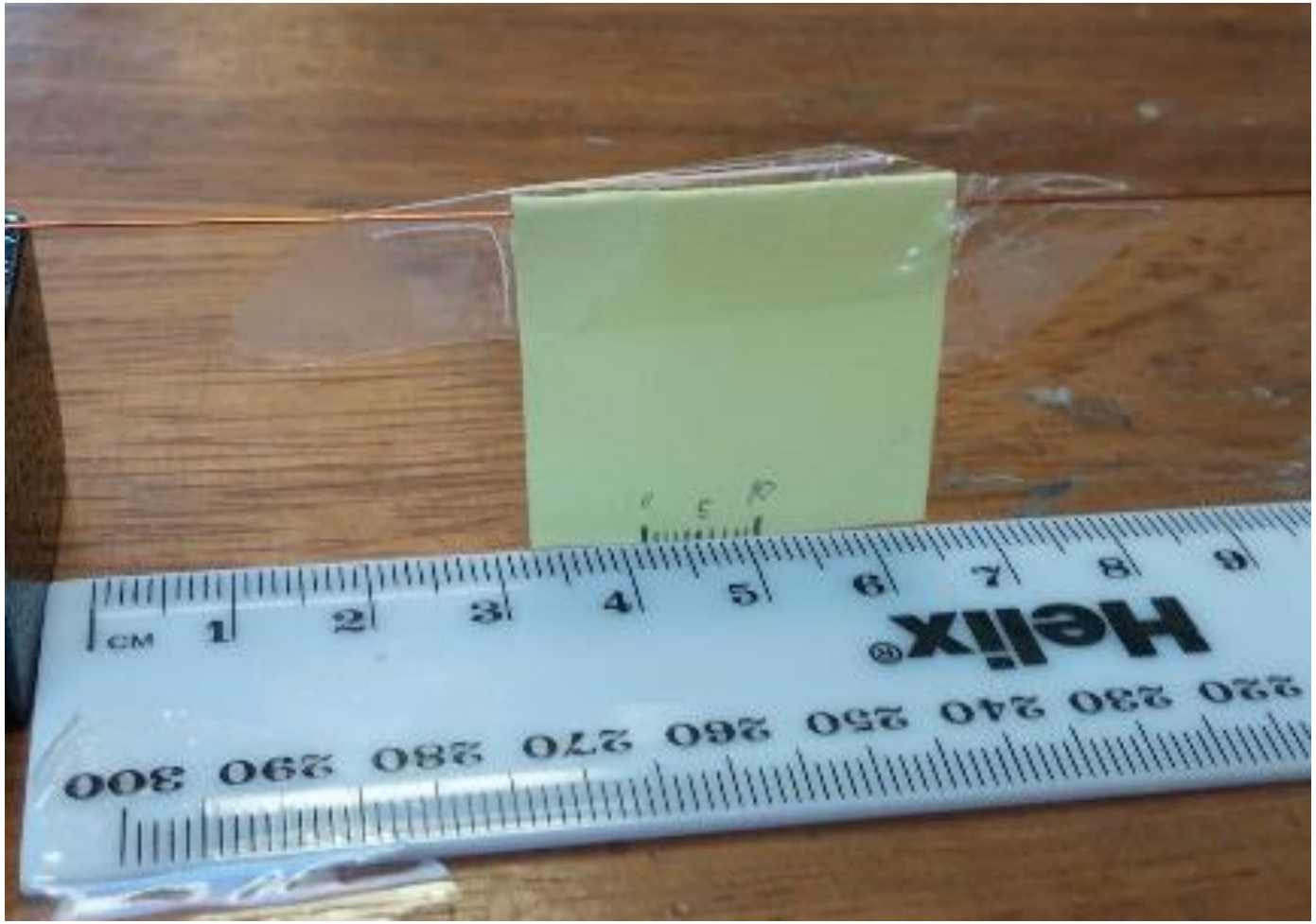
- Data can be qualitative or quantitative.
- Note that students must make accurate, relevant observations.
- They are also required to obtain accurate, precise and sufficient data before recording it methodically, using appropriate units and conventions.

CPAC 4

The same practical that you saw the results table for on slide 12.



Make your own vernier scale

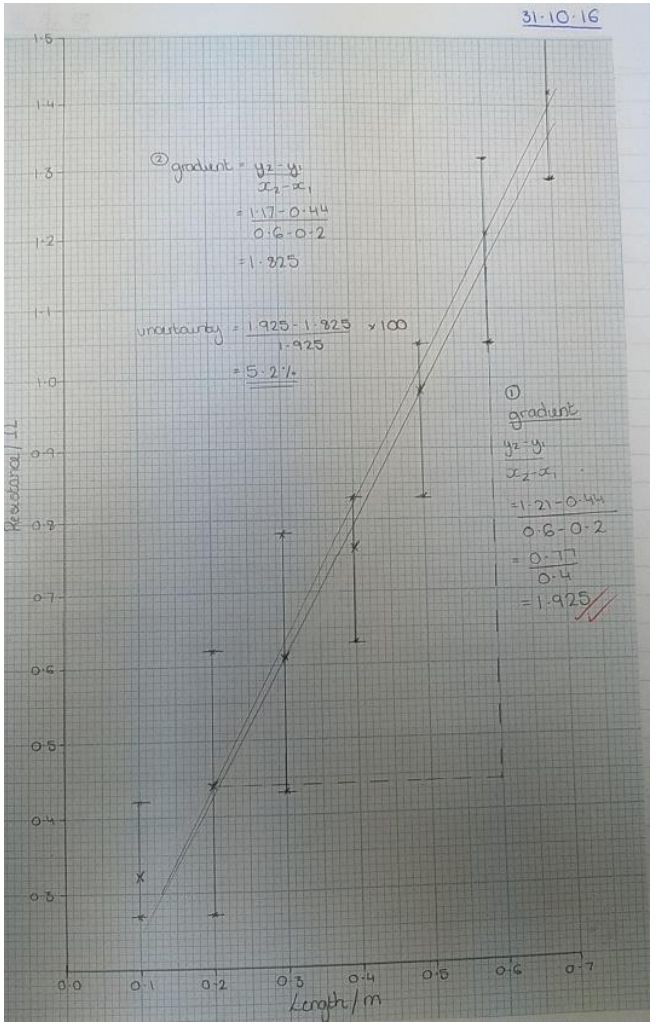


CPAC 5: researches, references and reports

- CPAC 5 is being evidenced as soon as students begin to process their raw data.
- Research must be used to inform further practical work or to support a conclusion being made.
- It may also be used well to evaluate a practical method, to inform adjustments for next time.

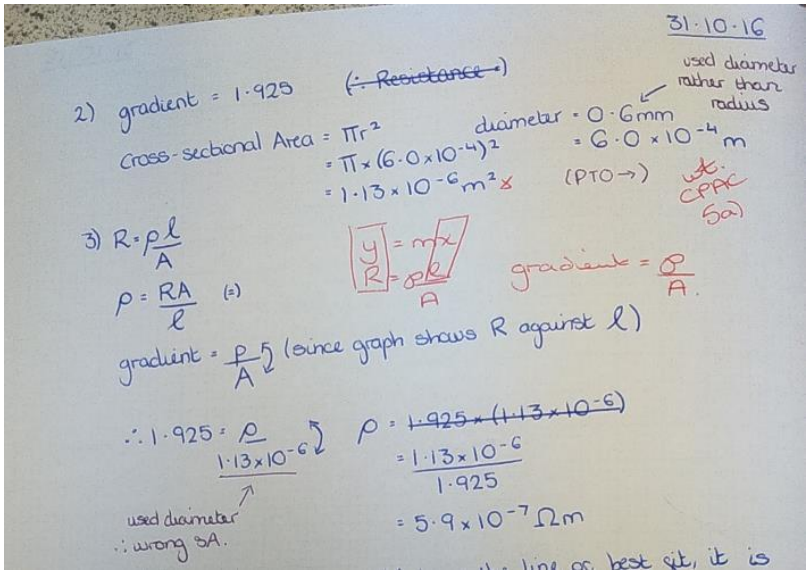
CPAC 5a

Processing data.



CPAC 5

Processing data and using multiple sources.



31·10·16

2) gradient = 1·925 (∴ ~~Resistance~~)

Cross-sectional Area = πr^2
$= \pi \times (6.0\times10^{-4})^2$
$= 1.13\times10^{-6}\ m^2$ ✗ (PTO →)

used diameter rather than radius
diameter = 0·6mm
$= 6.0\times10^{-4}$ m

wt. CPAC 5a)

3) $R = \frac{\rho l}{A}$

$\rho = \frac{RA}{l}$ (=)

$\frac{y}{R} = mx$, $\frac{\rho l}{A}$

gradient = $\frac{\rho}{A}$.

gradient = $\frac{\rho}{A}$ (since graph shows R against l)

$\therefore 1.925 = \frac{\rho}{1.13\times10^{-6}}$ $\rho = \frac{1.925\times(1.13\times10^{-6})}{}$

$= \frac{1.13\times10^{-6}}{1.925}$

$= 5.9\times10^{-7}\ \Omega m$

used diameter
∴ wrong SA.

∴ wrong SA.

4) When calculating the gradient for the line of best fit, it is important to use as large a triangle as possible because the answer will then be more accurate as it has taken into account a greater amount of data, rather than just a small section of the line of best fit.

Smaller % uncertainty ✓

5) Pure Constantan has a resistivity of $4.9\times10^{-7}\ \Omega m$ ✓ at room temperature, according to both HyperPhysics' and engineering toolbox²:

¹ $49\times10^{-8}\ \Omega m$ – hyperphysics.phy-astr.gsu.edu/hbase/tables/resitiv.html (accessed at 3:09pm, 2/11/16)

² $49\times10^{-8}\ \Omega m$ – www.engineeringtoolbox.com/resistivity-conductivity-d_418.html (accessed at 3:11pm, 2/11/16)

Percentage difference = $\frac{(5.9\times10^{-7}) - (4.9\times10^{-7})}{(4.9\times10^{-7})} \times 100$

$= 20.4\%$

Since my result for the resistivity of pure constantan has a greater percentage difference (20.4%) than the acceptable 10% ✓ my result is not very accurate.

CPAC 5b)

AQA

Your turn to ask the questions…

Thank you

For qualification information, resources and support, please visit

aqa.org.uk/science