

University of Cape Town  
Department of Physics

## **Physics Measurement Questionnaire 2**

### **Coding Schemes**

For each coding scheme, the table headings are:

Code : The alphanumeric code for each category

P/S : The allocation of each category to either the point or set paradigm, if appropriate.

Category : A short description of each category.

## SAG/2

### Code P/S Category

- N00 - No response  
U00 - Not able to code response
- A exactly 433.8 mm, because ...**  
A00 - (no reason given)  
A01 - (not able to code reason given)  
A12 P the edge of the block is exactly in the middle.  
A41 P exact conditions for repeating will result in the exact same distance.
- B approximately 433.8 mm, because ...**  
B00 - (no reason given)  
B01 - (not able to code reason given)  
B10 P of the size of the spot.  
B11 P of the size/shape/movement of block.  
B12 P the edge of the block is between 433.5 and 434.0.  
B13 P closer markings/smaller intervals are needed, scale is too coarse.  
B14 S human judgement is required to estimate reading, error of parallax.  
B15 P a better measuring instrument is needed.  
B21 S measurement/the reading is not exact/perfect, so use 'approximate'.  
B22 S in Science/Physics/ Maths measurements are not exact, so use 'approximate'.  
B23 P the spot/reading is 'more or less' at 436 mm, so use 'approximate'.  
B31 P must repeat to find accurate answer.  
B32 S repeating will allow calculation of average.  
B33 S repeating will confirm range of measurements.  
B40 S the distance/position of spot is influenced by external factors.  
B41 S the distance/position of spot is influenced by experimental procedure/measurement process.  
B50 S it is the number that best represents the interval, or is the best estimate  
B51 S the measurement is approximate with respect to the best estimate and standard uncertainty.  
B60 S cannot know true value, use best estimate/approximation.

## SAG/2 cont.

- C**            **between 433.0 and 434.0 mm because...**
- C00    - (no reason given)
  - C01    - (not able to code reason given)
  - C10    P of the size of the spot.
  - C11    P of the size/shape/movement of block.
  - C12    P the edge of the block is not exactly on a mark.
  - C13    P closer markings/smaller intervals are needed, scale is too coarse, need better calibration.
  - C14    S human judgement is required to estimate reading, error of parallax.
  - C21    S measurement is not exact, use interval to account for standard uncertainty.
  - C40    S external factors cause variations when repeating.
  - C50    S the measurement is in the interval.
  - C51    S the measurement is in the interval, therefore the distance is in the interval.
  - C52    S the measurement/reading is in the interval to account for standard uncertainty.
  - C53    S the true value of the distance is one number in the interval.
  - C54    S distance is best estimate plus standard uncertainty, in interval.
  - C61    S cannot know the true value, is in interval.
  - C62    S no exact/true value, interval accounts for uncertainties.
  - C63    S no exact/true value, best estimate is in interval.
- D**            **approximately 434.0 because...**
- D00    - (no reason given)
  - D01    - (not able to code reason given)
- E**            **I don't agree, because...**
- E00    - (no reason given)
  - E01    - (not able to code reason given)
  - E11    P of the size/shape/movement of block.
  - E14    S human judgement is required to estimate reading, error of parallax.
  - E30    U need to repeat measurements.
  - E31    S must repeat to get best estimate.
  - E32    S must repeat to calculate average.
  - E40    S must account for experimental uncertainties.
  - E50    S must calculate best estimate and standard uncertainty.
  - E52    S distance is in specified interval.
  - E60    U must round to the nearest 10.

## SAB/2

### Code P/S Category

- N00 - No response  
U00 - Not able to code response
- A exactly 434.0 mm, because ...**  
A00 - (no reason given)  
A01 - (not able to code reason given)  
A11 P the block has travelled exactly 434 mm.  
A12 P the edge of the block/the point Q is exactly on the 434 mm mark.  
A13 P the distance is easily read/seen/observed from scale on ruler.  
A20 P measurement is exact.  
A41 P exact conditions for repeating will result in the exact same distance.
- B approximately 434.0 mm, because ...**  
B00 - (no reason given)  
B01 - (not able to code reason given)  
B11 P of the size/shape/movement of block.  
B12 P the edge of the block/the point Q is not exactly on the 434 mm mark.  
B13 P closer markings/smaller intervals are needed, scale is too coarse.  
B14 S human judgement is required to estimate reading, error of parallax.  
B15 P a better measuring instrument is needed.  
B20 S measurement / the reading is best estimate, so use 'approximate'.  
B21 S measurement/ the reading is not exact/perfect, so use 'approximate'.  
B22 S Physics, (and/or Maths), requires exact numbers, but measurements are not exact, so use 'approximate'.  
B23 P the edge of the block is 'more or less'/approximately at 434.0 mm.  
B24 S measurement/the reading/distance is not exact/perfect, must calculate standard uncertainty.  
B30 U need to repeat measurements.  
B31 P repeating will give a recurring value.  
B32 S repeating will allow calculation of average.  
B33 S repeating will confirm range of measurements.  
B34 S repeating will not necessarily give same value  
B40 S the distance/position of block is influenced by external factors.  
B41 S the distance/position of block is influenced by experimental procedure/measurement process.  
B50 S 434 mm is the best estimate, true value is in interval calculated taking standard uncertainty into account.  
B60 S true/exact value can't be found, use best estimate and associated uncertainty.  
B61 S true/exact value can never be known, so use 'approximate'.  
B62 S true /exact value can never be known since there is always uncertainty associated with experimental conditions/methods

## SAB/2 cont.

- C**            **between 433.0 mm and 435.0 mm, because ...**
- C00    - (no reason given)
  - C01    - (not able to code reason given)
  - C11    P of the size/shape/movement of block.
  - C12    P the edge of the block/the point Q is not exactly on a mark.
  - C21    S reading/measurement is not exact/perfect, or is uncertain, so use interval.
  - C24    S measurement/the reading/distance is not exact/perfect, must calculate standard uncertainty.
  - C40    S the distance/position of block is influenced by external factors.
  - C41    S the distance/position of block is influenced by experimental procedure/measurement process.
  - C50    S best estimate is in given interval, must account for uncertainties.
  - C51    S reading is in given interval, therefore distance is in given interval.
  - C52    S distance is in another, specified interval.
  - C53    S interval accounts for uncertainties.
  - C61    S true/exact value can never be known, is in given interval
  - C62    S true /exact value can never be known since there is always uncertainty associated with experimental conditions/methods
- D**            **exactly 434 mm, because ...**
- D00    - (no reason given)
  - D01    - (not able to code reason given)
  - D11    P the block has travelled exactly 434 mm.
  - D12    P the edge of the block/the point Q is exactly on the 434 mm mark.
  - D13    P the distance is easily read/seen/observed from scale on ruler.
  - D20    P measurement is exact.
- E**            **I don't agree with any of you, because ...**
- E00    - (no reason given)
  - E01    - (not able to code reason given)
  - E14    S human judgement is required to estimate reading, error of parallax.
  - E20    S measurement is always uncertain, can't be sure.
  - E21    S there is no exact answer, (so use approximate)
  - E30    U repeats are necessary.
  - E35    S repeat to get good approximation/best estimate.
  - E40    S of external factors.
  - E41    S of experimental conditions.
  - E50    S reading is best estimate, distance is best estimate  $\pm$  standard uncertainty.
  - E51    S reading is in specified interval
  - E52    S distance is in specified interval
  - E60    S no true value, must calculate best estimate  $\pm$  standard uncertainty.
  - E61    S true/exact value can never be known, use approximate/best estimate

## UR/2

Code	P/S	Category
N00	-	No response
U00	-	Not able to code response
10	S	average of the readings is final result for $d$
11	S	average of the readings is best estimate/most accurate value of $d$
12	P	average is the true/exact value of $d$
20	S	average of the readings, excluding the lowest reading, is final result for $d$
30	P	median reading is final result of $d$
40	S	average $\pm$ standard uncertainty is final result for $d$
41	S	average $\pm$ standard uncertainty, with a coverage probability, is final result for $d$

## UA/2

### Code P/S Category

- N00 - No response  
U00 - Not able to code response
- A** ***d* is exactly 432 mm, because ...**  
A00 - (no reason given)  
A01 - (not able to code reason given)  
A10 P average is the true distance  
A30 P average is exactly 432 mm.  
A31 P average is calculated using a formula, and is therefore correct.  
A32 P average remains the same after more repeats.  
A41 P if individual readings differ, then the average is the exact value.
- B** ***d* is approximately 432 mm, because ...**  
B00 - (no reason given)  
B01 - (not able to code reason given)  
B10 S average is closest to exact value/true distance.  
B11 S average is most likely value/best approximation of distance *d*.  
B12 S average is not necessarily the exact/actual/true distance.  
B13 S actual distance could be more or less than the average distance.  
B16 S average is best estimate, can never know true value.  
B20 S error must be accounted for.  
B21 S external factors must be accounted for.  
B30 S average is approximate, not exact.  
B31 S more repeats are necessary to find accurate average/answer.  
B33 S average will/may change after more repeats.  
B41 S individual readings/measurements are not identical, so there is no exact value.  
B42 S readings are close to 432 mm.  
B44 S no reading is 432 mm.  
B50 P of the shape/size/movement of the ball/block.  
B70 S of standard uncertainty.  
B71 S don't know exact interval in which *d* lies, must calculate standard uncertainty of average.
- C** ***d* is between 431.5 mm and 432.5 mm, because ...**  
C00 - (no reason given)  
C01 - (not able to code reason given)  
C11 S average is most likely value/best approximation of *d*, but not exact.  
C13 S actual distance is close to the average.  
C14 S actual distance is in interval.  
C15 S average is actual distance rounded off/ interval accounts for rounding off.  
C16 S can never be sure of the real *d*.  
C20 S allow/account for error/uncertainty.  
C30 S average is approximate/not exact/not accurate.  
C33 S average can/will change after more repeats.  
C70 S interval allows for standard uncertainty of average, (calculate to find best estimate and standard uncertainty)

## UA/2 cont.

- D**            ***d* is between 426 mm and 436 mm, because ...**
- D00    - (no reason given)
  - D01    - (not able to code reason given)
  - D11    S average in interval, so actual distance is also in interval.
  - D14    S actual distance in interval, average is best representation of interval/easy number to work with.
  - D20    S account for error/uncertainty.
  - D30    S average is approximate/not exact.
  - D31    S more repeats are necessary to find accurate average/answer.
  - D33    S average will change after more repeats.
  - D34    S average is in interval.
  - D40    S all readings are in that interval.
  - D41    S readings spread between 426 mm and 436 mm, so can't know exact distance.
  - D44    S no reading is 432 mm, so actual distance is described by the interval/range.
  - D70    S interval accounts for standard uncertainty.
  - D72    S interval found by calculating standard uncertainty of average, is in this interval.

- E**            **I don't agree with any of you, because ...**
- E00    - (no reason given)
  - E01    - (not able to code reason given)
  - E13    S actual distance is close to average.
  - E16    S average provides minimal value of actual distance.
  - E30    S average is approximate, not exact.
  - E31    S need more repeats to find accurate average/answer.
  - E32    P average is the same, whatever the readings.
  - E33    S average will change after more repeats.
  - E42    S readings are close to 432 mm.
  - E60    U average and actual *d* are unrelated.
  - E70    S *d* lies in uncertainty interval about average (best estimate), must calculate.
  - E71    S can't reach conclusion, need additional information about standard uncertainty.



## UAA/2

### Code P/S Category

- N00 - No response  
U00 - Not able to code response
- A reading of 432 mm, because ...**  
A00 - (no reason given)  
A01 - (not able to code reason given)  
A30 P average remains unchanged.
- B reading between 431 mm and 432 mm, because ...**  
B00 - (no reason given)  
B01 - (not able to code reason given)  
B16 S sixth reading will be close to fifth reading  
B31 S average between 431 mm and 432 mm.  
B32 S average remains close to 432 mm.  
B40 S reading must be close to average.  
B41 S many repeats stabilize average
- C reading between 426 mm and 436 mm, because ...**  
C00 - (no reason given)  
C01 - (not able to code reason given)  
C10 S all readings in range 426 mm-436 mm.  
C11 S readings have no set pattern.  
C12 S readings vary/change/are not the same.  
C14 S reading can have any value in range, can't predict exactly  
C20 S same experimental conditions, readings in same range.  
C21 S external factors affect readings.  
C31 S average is between 426 mm and 436 mm.  
C41 S more repeats will change average.  
C50 S 434 mm occurs twice, reading likely to be close.  
C61 S next reading in interval given by standard uncertainty about average.  
C70 S interval allows for standard uncertainty of average, (calculate to find best estimate and standard uncertainty)
- D reading can have any value, because ...**  
D00 - (no reason given)  
D01 - (not able to code reason given)  
D11 S readings have no set pattern, so can't predict.  
D12 S readings vary/change/are not all the same, so can't predict.  
D13 S reading can have any value, can't be predicted.  
D14 S reading can have any value in specified/unspecified bigger ranager.  
D15 S reading can have any value, close to previous values.  
D20 S experimental factors affect readings.  
D21 S external factors affect readings.  
D40 S reading will be close to average.  
D41 S reading will change average, so can't predict.

**UAA/2 cont.**

- E**            **I don't agree with any of you, because ...**
- E00    -    (no reason given)
  - E01    -    (not able to code reason given)
  - E10    S    can't predict sixth reading
  - E12    S    readings vary/change/not the same , so can't predict.
  - E14    S    reading can have any value in specified bigger range.
  - E15    S    reading can have any value close to previous values, can't predict exactly.
  - E20    S    experimental conditions affect readings.
  - E21    S    external factors affect readings.
  - E30    P    average remains unchanged.
  - E40    S    readings must be close to average.
  - E41    S    reading will change average, can't predict.
  - E42    S    reading will be greater than average.
  - E60    S    can't know true value of d
  - E61    S    can't know true value of d, need to calculate best estimate and standard uncertainty.

## SMDS/2

Code	P/S	Category
N00	-	No response
U00	-	Not able to code response
<b>A</b>		
<b>A's results are better, because ...</b>		
A00	-	(no reason given)
A01	-	(not able to code reason given)
A10	S	they have a smaller range/spread
A11	S	they have a smaller range/spread because of outside factors
A12	S	they have smaller range/spread because fewer mistakes were made
A13	S	they have smaller range/spread , therefore a more accurate/reliable average
A14	S	they have smaller range/spread, therefore are closer to true value
A15	S	they have smaller range/spread because group A was more skilful
A16	S	they have smaller range/spread, and therefore a smaller uncertainty
A20	S	there is less deviance from the average
A21	S	there is less deviance from the average because of outside factors
A22	S	less deviance from the average because of fewer mistakes made
A25	S	less deviance from the average because group A was more skilful
A40	U	you usually get the results so close together
A50	P	their average (435 mm) is also one of the measurements
A62	S	A's data values are closer to each other
A63	S	A's data values are more accurate/ consistent
A64	S	A's data values are closer to their average
<b>B</b>		
<b>B's results are just as good as A's, because ...</b>		
B00	-	(no reason given)
B01	-	(not able to code reason given)
B10	S	they got more or less the same data values
B11	S	the spread/range of data values overlap
B12	S	sets of data values are equally good - same no. of readings obtained under same experimental conditions
B20	P	they have the same average
B21	P	they have the same average although different outside factors caused deviation
B22	P	they have the same average although mistakes caused deviation
B23	P	they have the same average, and the spread is not important
B24	S	they have the same average, and the same standard uncertainty
B26	P	they have the same average, deviation not important as expected
B27	P	they have the same average, individual data values not important
B29	P	they have the same average and same number of readings
B30	P	they have the same average, although A got 435 mm on their last measurement.
B60	U	there is no exact answer to an experiment like this
B61	P	there is no exact/true answer, the average is the best estimate and is the same
B64	P	different data values but same average
B65	P	the accuracy of individual readings is not under consideration, the average is important
B70	P	it is a natural outcome of the same experiment, the spread is not important)
B81	S	the intervals give by the standard uncertainties about the averages overlap

**SMDS/2 cont.**

<b>C</b>	<b>I don't agree with either of you because ...</b>
C00	- (no reason given)
C01	- (not able to code reason given)
C10	S the data values are far apart/differ
C12	S different spread/range of data values, depend on experimental factors
C40	U you usually get the results so close together
C60	P don't know true value, so can't compare to averages.
C66	S data values inconsistent - affected by external factors
C80	S need standard uncertainties to compare
C90	U B better than A
C91	S B better than A, bigger range but same average

## DMSS/2

Code	P/S	Category
N00	-	No response
U00	-	Not able to code response
<b>A</b>		
<b>Our results <u>agree</u> with yours, because ...</b>		
A00	-	(no reason given)
A01	-	(not able to code reason)
A10	P	the readings/measurements for both sets are more or less the same
A12	S	the readings/measurements for both sets have the same spread
A13	S	the readings/measurements have an overlapping spread
A20	P	the averages are more or less the same
A21	P	the averages are more or less the same, difference due to external factors
A22	P	the averages are more or less the same, difference due to experimental errors
A24	P	the averages are more or less the same, both close to true value
A26	P	the averages are more or less the same as there will always be deviation
A30	S	the uncertainties of the averages may overlap
A31	S	the averages are more or less the same with similar ranges/spreads
A40	P	three out of five (the majority) of readings are the same
A50	P	if you round off the averages, then they are identical
<b>B</b>		
<b>No, your results <u>do not agree</u> with ours, because ...</b>		
B00	-	(no reason given)
B01	-	(not able to code response)
B10	P	the readings are not the same.
B12	S	the spreads of both sets are different
B20	P	the averages are different
B21	P	the averages are different due to different conditions/external factors
B22	P	the averages are different due to experimental errors
B24	P	the averages different – uncertain about where the true value lies
B25	P	the averages are different, absolute accuracy/identical results required to agree
B26	P	the averages are too different even though deviation is taken into consideration
B30	S	the averages are too far apart for the uncertainties to overlap
B31	P	average is different and all individual readings are not the same
B32	S	the spread differs between the two
B40	P	both groups got some different measurements
B50	P	if you round off the averages, then they are very different
B60	P	an average is only true if the average value also appears as one of the measurements
B80	P	group B is more accurate than group A

**DMSS/2 cont.**

<b>C</b>		<b>I don't agree with either of you</b>
C00	-	(no reason given)
C01	-	(not able to code response)
C20	S	can't compare averages, need standard uncertainties.
C30	S	intervals may/may not overlap - need standard uncertainties to compare.
C40	P	groups have some common data values
C60	P	don't know true value, so can't compare to averages.
C70	S	different experimental technique - need standard uncertainties to account, then compare.
C71	S	different experimental conditions - need standard uncertainties to account, then compare.

## SD/2

### Code P/S Category

- N00 - No response  
U00 - Not able to code response
- A exactly 433.0 mm, because ...**  
A00 - (no reason given)  
A01 - (not able to code reason given)  
A11 P the ball has travelled exactly 433.0 mm.  
A12 P the reading is 433.0 mm.  
A15 P electronic meter gives exact/accurate answers.  
A41 P exact conditions for repeating will result in the exact same distance.
- B approximately 433.0 mm, because ...**  
B00 - (no reason given)  
B01 - (not able to code reason given)  
B10 P of the size of the spot.  
B11 P of the size/shape/movement of block.  
B12 P the reading is approximate.  
B13 P meter not sensitive enough, need better calibration.  
B14 S human judgement is required to estimate reading, error of parallax.  
B15 P a better measuring instrument is needed.  
B21 S measurement/the reading is not exact/perfect, so use 'approximate'.  
B22 S in Science/Physics/Maths measurements are not exact, so use 'approximate'.  
B24 S measurement close to true value, so use approximate.  
B30 U need to repeat measurements.  
B31 P repeating to confirm, get recurring value.  
B32 S repeating to account for scatter by calculation of average.  
B34 S there are variations when repeating.  
B40 S variations caused by external factors.  
B60 S can never know true value, always uncertainty.  
B62 S can never know true value, uncertainty associated with internal calibration of meter.  
B63 S can never know true value, uncertainty associated with sensitivity of meter.

**SD/2 cont.**

- C**            **between 432.5 mm and 433.5 mm, because ...**
- C00    - (no reason given)
  - C01    - (not able to code reason given)
  - C13    P need better calibration, more sensitive.
  - C15    P need better measuring device, meter inaccurate.
  - C16    S uncertainty associated with reading off meter
  - C20    S reading is not exact/reading is best estimate, use interval to account for uncertainties.
  - C21    S meter gives reading which is best estimate, can't be sure
  - C33    S repeats will confirm range, readings will fall in interval.
  - C40    S of external factors
  - C41    S of experimental method/measuring process.
  - C50    S must calculate standard uncertainty to get best approximation of d.
  - C51    S must calculate standard uncertainty associated with digital scale to get best approximation of d.
  - C60    S can never know true value, always uncertainty.
  - C62    S can never know true value, uncertainty associated with internal calibration of meter.
  - C63    S can never know true value, uncertainty associated with sensitivity of meter.
- D**            **between 431 mm and 432 mm, because ...**
- D00    - (no reason given)
  - D01    - (not able to code reason given)
- E**            **I don't agree with any of you, because ...**
- E00    - (no reason given)
  - E01    - (not able to code reason given)
  - E15    S of mistakes of the measuring device.
  - E20    S measurement is always uncertain, can't be sure.
  - E21    S meter gives reading which is best estimate, can't be sure
  - E30    U repeats are necessary.
  - E31    P repeat to confirm, find recurring value.
  - E32    S repeat to account for scatter and calculate average.
  - E34    S repeat to account for external factors and approximate.
  - E40    S of external factors.
  - E50    S must calculate standard uncertainty to get best approximation of d.
  - E51    S must calculate standard uncertainty associated with digital scale to get best approximation of d.
  - E60    S can never know true value.
  - E61    S can never know true value, calculate most likely interval.
  - E62    S can never know true value, uncertainty associated with internal calibration of meter.
  - E63    S can never know true value, uncertainty associated with sensitivity of meter.



## UU/2

Code	P/S	Category
------	-----	----------

- |     |   |                           |
|-----|---|---------------------------|
| N00 | - | No response               |
| U00 | - | Not able to code response |

<b>A</b>		<b>Can never know the real value of <math>d</math>, because ...</b>
----------	--	---

- |     |   |  |
|-----|---|--|
| A00 | - | (no reason given)  |
| A01 | - | (not able to code reason)  |
| A10 | S | all measurements are approximate.                                |
| A20 | S | true value can't be known.                                       |
| A21 | S | true value can't be known, only approximate value/best estimate. |
| A22 | S | true value can't be known, only most likely interval.            |
| A30 | S | there are always uncertainties, can't be reduced to zero.        |
| A31 | S | there are always uncertainties due to experimental conditions.   |
| A32 | S | there are always uncertainties due to external factors.          |
| A33 | S | there are always uncertainties due to human judgement.           |
| A40 | S | can never have a good/sensitive enough scale/measuring device.   |

<b>B</b>		<b>If we had money we could design an experiment to give the real value of <math>d</math>, because...</b>
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- |     |   |  |
|-----|---|--|
| B00 | - | (no reason given)  |
| B01 | - | (not able to code response)  |
| B10 | P | create an instrument good/sensitive enough to measure true/exact/real value.   |
| B11 | P | create an instrument good/sensitive enough so that uncertainty can be ignored. |