Estimating Uncertainty

1. A group of students is investigating the reaction between copper hydroxide and sulfuric acid. They are discussing the best volume of acid to use and how they will measure it for this investigation.

Each student uses a different instrument to measure the volume.

Volume (cm^3)	**Uncertainty (cm^3)**	**Minimum volume**	**Maximum volume**
35	$\pm$ 0.5		
32.5	$\pm$ 0.25		
30	$\pm$ 1		

a. Use the uncertainty to determine the maximum and minimum volumes that the students could have measured.

b. Explain which of the instruments should be used for the investigation.

2. The students investigate how long it takes for copper hydroxide to react fully with different concentrations of sulfuric acid. They recorded their results in the table below.

	Time taken for reaction to finish (s)					
Concentration of sulfuric acid (g/dm^3)	Trial 1	Trial 2	Trial 3	Trial 4	Mean	Range
10	98	99	104	101		
20	76	78	75	78		
30	50	52	56	49		
40	24	25	27	25		

a. Identify the independent and dependent variables in this investigation.

b. Identify any control variables.

c. Explain why repeat measurements were taken.

d. Calculate the mean and range for each value of the independent variable. Round your answers to 2 decimal places.

e. Calculate the uncertainty for each mean.

f. State the mean for each value with its uncertainty.

g. Suggest reasons for the variation in these measurements.

h. Suggest ways to reduce the uncertainty of the measurements in this investigation.

i. Draw a suitable graph of the results.