

Uncertainties and Practical Work

- 1 A student recorded a value of 0.003050 in an experiment. The number of decimal places and significant figures in this value are

	Decimal places	Significant figures
A	6	3
B	4	3
C	6	4
D	6	6

- 2 A student recorded the following values for temperature in an experiment:

initial temperature / °C	21.0±0.5
maximum temperature / °C	48.0±0.5

The temperature change should be quoted as:

- A 27±1 °C
 B 27.0±0.5 °C
 C 27.0±1.0 °C
 D 27.0±1 °C
- 3 A student worked out the number of moles in a solution using the following data:

Volume of solution: 10.0±0.1 cm³
 Concentration of solution: 1.00x10⁻²±1.00x10⁻⁴ mol dm⁻³

The absolute uncertainty of the number of moles is:

- A ±0.1001 mol
 B ±2x10⁻⁶ mol
 C ±2x10⁻³ mol
 D ±2
- 4 A student carried out a calculation to determine the rate of reaction from data they obtained from a colorimetry experiment. Their data is shown in the table:

initial concentration of bromine /mol dm ⁻³ ±0.0001	0.0200
final concentration of bromine /mol dm ⁻³ ±0.0001	0.0100
time taken /s ±2	32

Determine the rate of reaction and the absolute uncertainty in mol dm⁻³ s⁻¹ [4]

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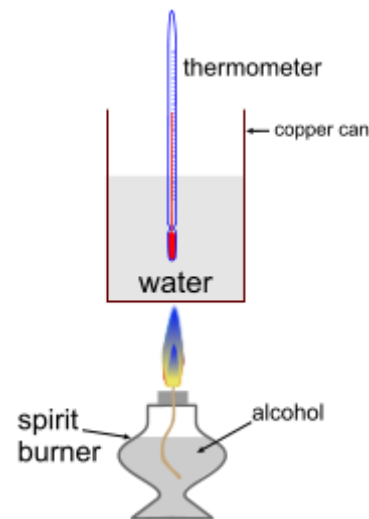
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5 A student designed an experiment to measure the standard enthalpy changes of combustion (ΔH_c) of propan-1-ol. They used the experimental set-up shown:



Their experimental data is shown below:

ALCOHOL	Volume of water /cm ³ ±0.5 cm ³	Initial mass of alcohol /g ±0.01g	Final mass of alcohol /g ±0.01g	Initial temperature of water /°C ±0.5 °C	Maximum temperature of water /°C ±0.5 °C
Propan-1-ol	100.0	233.61	232.57	19.0	44.0

(a) The student carried out the following calculation to work out the heat energy given out in the experiment

$$\text{Energy} = (233.61 - 232.57) \times 4.18 \times [(44.0 - 19.0) + 273] = 1295 \text{ J}$$

Describe two major errors in this calculation.

[2]

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(b) The student measured the volume of water using a measuring cylinder but a friend suggested that he would have had a smaller percentage error if he had used a different piece of apparatus. Suggest a suitable piece of apparatus he could have used to reduce the percentage uncertainty on the volume of water.

[1]

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(c) (i) Using the data in the table calculate the enthalpy change of combustion of propan-1-ol.

[2]

(ii) Calculate the percentage uncertainty on the temperature change

[2]

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(iii) Calculate the percentage uncertainty on the energy released in this experiment [2]

(iv) Calculate the absolute uncertainty for the enthalpy change of combustion of propan-1-ol [3]

(v) Use the values you obtained in (i) and (ii) to quote the enthalpy change of combustion to the appropriate number of significant figures. [1]

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(vi) The literature values for the enthalpy change of combustion is $\Delta H_c = -2021 \text{ kJ mol}^{-1}$
Calculate the percentage error for the experiment and suggest sources of systematic error in the experiments. [5]

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6 A student designed an experiment to measure the enthalpy change of solution of magnesium chloride. They followed the following procedure:

- measure out 25.0 cm³ of water in a 100 cm³ measuring cylinder and transfer it to a 250 cm³ glass beaker.
- measure the initial temperature of the water
- add 2.00 g of magnesium chloride and stir rapidly
- measure the maximum temperature reached.

Their data is shown below.

Mass of MgCl ₂ /g ±0.01	Volume of H ₂ O /cm ³ ±0.5	Initial Temperature of water/°C ±0.2	Maximum Temperature of solution/°C ±0.2
2.00	25.0	19.0	36.0

(a) Suggest why the reaction mixture must be *stirred rapidly*. [1]

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(b) The student calculate the enthalpy change of solution (ΔH_{sol}) using the following equation:

$$\Delta H_{\text{sol}} = - \frac{25.0 \times 4.18 \times 17.0}{(2.00/95.21)}$$

Suggest two assumptions that the student made when carrying out the calculation. [2]

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(c) (i) Calculate the absolute uncertainty of the temperature change. [1]

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(ii) Calculate the percentage uncertainty of the enthalpy change of solution [3]

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(d) The literature value for the enthalpy change of solution of magnesium chloride is -155 kJ mol^{-1} .

(i) Calculate the percentage error for the student's experiment [2]

(ii) The student suggested the following improvements to the procedure:

- I use a 25 cm^3 pipette instead of a measuring cylinder to measure the volume of water*
- II use an insulated cup instead of a glass beaker to reduce heat loss to the surroundings*

Explain whether each suggestion would increase the accuracy or the precision of the student's results. [2]

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II

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(iii) The student also suggested that using 10 g of magnesium chloride instead of 2 g would reduce random errors. Discuss the student's suggestion with regard to both random and systematic errors. [3]

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