Name: _____ ( ) Class: _____ Date: _____

Biology Practical: Sources of Error

≠ human mistakes

It is very important to understand the difference between experimental errors and 'mistakes'. A mistake is something that you do incorrectly, such as misreading the scale on a thermometer, or taking a reading at the wrong time, or not emptying a graduated pipette fully. Do **not** refer to these types of mistake when you are asked to comment on experimental errors.

Spotting the important sources of error

You should be able to distinguish between significant errors and insignificant ones. For example, a change in room temperature could have a significant effect on the rate of evaporation but it would not have any effect at all on the number of stomata on the upper and lower surface of a leaf.

Every time you do an investigation, think carefully about any errors that may be due to lack of control of variables - which ones might genuinely be significant!

Suggesting improvements

The improvements you suggest could include controlling certain variables that were not controlled, or controlling them more effectively. For example, you may suggest that the investigation could be improved by controlling temperature. To earn a mark, you must also say *how* you would control it, for example by placing sets of test-tubes in a thermostatically controlled water bath.

You could also suggest using better methods of measurement. For example, you might suggest using a colorimeter to measure depth of colour, rather than using your eyes and a colour scale.

It is almost always a good idea to do several repeats in your investigation and then calculate a mean of your results.

Be very precise in suggesting how you could improve the investigation - for example, don't just say you would control a particular variable, but say how you would control it.

Errors may occur when ...	Suggestion to avoid or minimise error
the sample size is small	Increase the sample size or use more samples for each experimental variable
wide range of temperature, pH or concentration is used in original experiment	Use a narrower range of temperature, pH or concentration, or test at more frequent intervals, so that the relationship between the variables can be observed more accurately
instrument or apparatus used to measure a certain quantity is not the most accurate, for example, using a measuring cylinder to measure a volume of liquid	Use a more accurate instrument or apparatus, for example, use a burette to measure a volume of liquid
difficulty in detecting colour changes at a particular wavelength	Use a colorimeter (if available)

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3. Bar charts and histograms

Sometimes, students may be asked to draw a bar chart or a histogram instead of a graph.

(a) Bar charts

- A bar chart is used to represent categories of different things.
- It usually involves discontinuous data.
- Bars should be drawn with a ruler and pencil. The width of the bars is usually the same throughout the chart.
- The bars are usually (but not always) drawn with a space in between them.
- The height of a bar chart represents the number of items in that category.

(b) Histograms

- Histograms are usually used to represent continuous data. Hence, each bar in the histogram represents a range of data.
- The bars should be drawn with a ruler and pencil. The width of the bars is usually the same throughout the histogram.
- The bars of a histogram are always drawn without a space between them.
- The height of a histogram represents the number of items in that category.

Worked Example

A student collected a group of organisms from a leaf litter and categorised them according to the number of legs that they have.

His results are shown in the table below.

Number of legs	Number of organisms
4	3
6	21
8	7

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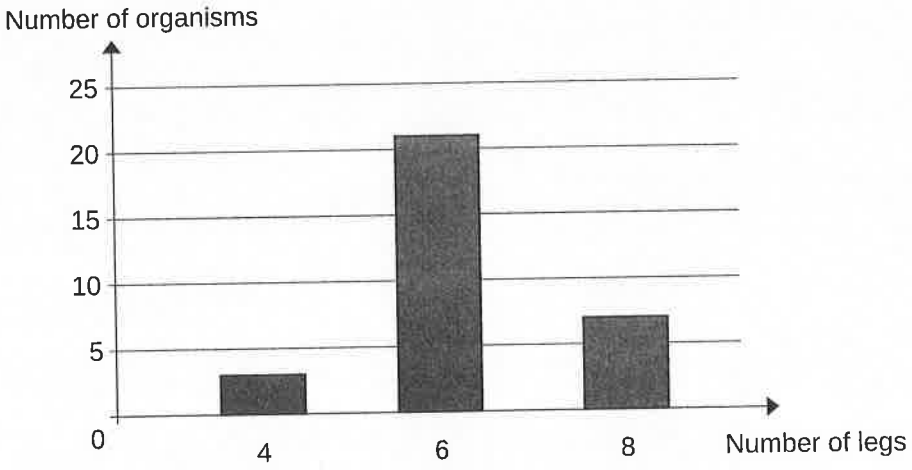
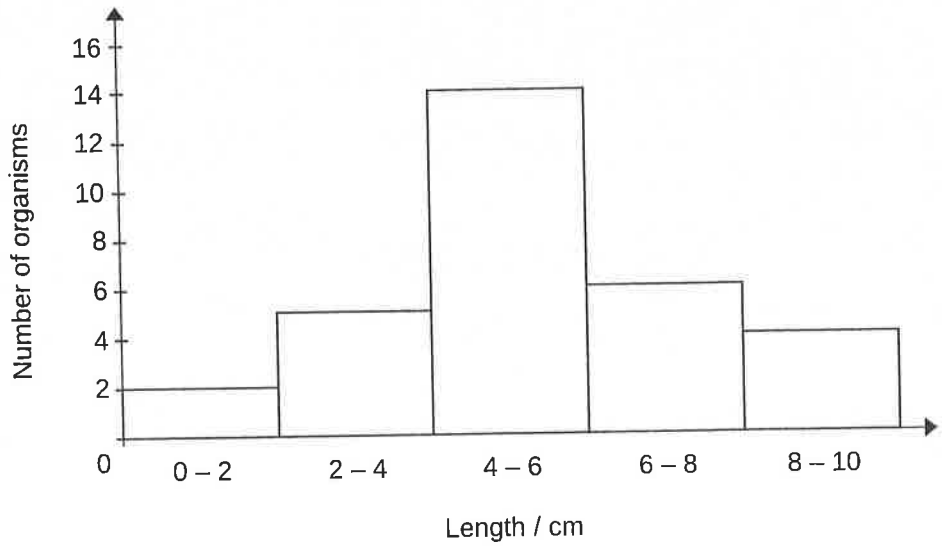
He then draws a bar chart to present his data.



He then measures the length of each organism and records the results in the table below.

Length / cm	Number of organisms
0 - 2	2
2 - 4	5
4 - 6	14
6 - 8	6
8 - 10	4

He draws a histogram to present his data.



Transpiration

You are provided with a branch of a dicotyledonous plant (with at least three broad leaves), petroleum jelly, electronic balance and other common laboratory apparatus and materials.

Plan an experiment that will allow you to compare the rates of transpiration of the upper and lower surfaces of a leaf.

Approach	An investigation can be done by coating surfaces of leaves with petroleum jelly to prevent loss of water by evaporation from the surfaces and comparing the change in mass of the leaves.
Key steps • Independent • Dependent • Constants • Range	• Take three broad freshly plucked leaves of about equal sizes. Coat the petioles with petroleum jelly. • Cover only the **upper surface** of one leaf with petroleum jelly. Cover only the **lower surface** of another leaf with petroleum jelly. Cover **both surfaces** of the last leaf with petroleum jelly. • The controlled are **location and time** of experiment as this will affect transpiration rates. Ensure leaves are placed in the same location and at the same time. • **Measure the mass of each using an electronic balance** and record the readings. • The leaves are then suspended in air using a string/thread. • **After a few hours, measure them again** and record the readings.
Reliability	**Repeat another 2 times to take the average reading.**
Data collection	• **Calculate the percentage change in mass** in the leaves: (final mass – initial mass) / initial mass x 100 • **Calculate the average percentage loss in mass** • The leaf that has the **greatest percentage loss in mass, will have the highest rate of transpiration**. The **uncovered surface** of the leaf is therefore the surface that leads to a higher rate of transpiration.