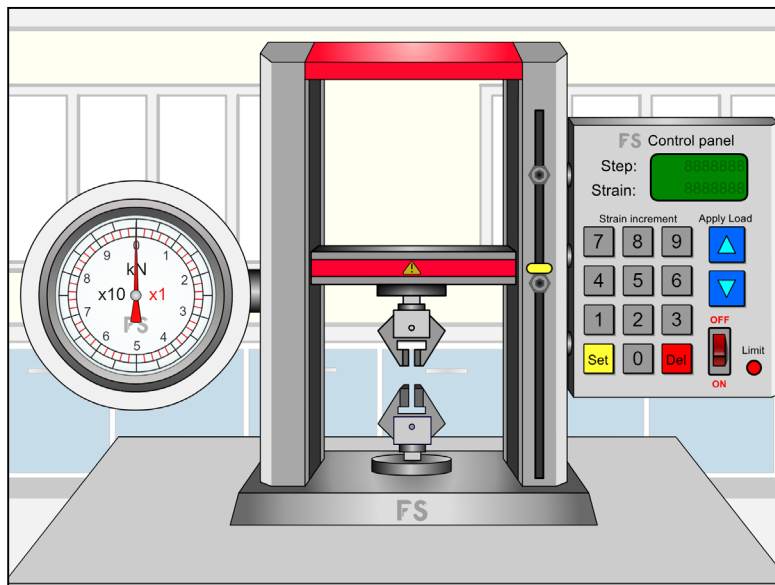


FLASHY SCIENCE

Tensile testing experiment Instructions



The
University
Of
Sheffield.

www.flashyscience.com

Introduction

This virtual experiment allows a number of mechanical tests to be performed on materials, including:

- Determination of full stress-strain curve to fracture, using either ‘engineering’ or ‘true’ values
- Observation of elastic behaviour and calculation of Young’s modulus
- Observation of the onset of plastic behaviour and permanent deformation
- Calculation of moduli of resilience and toughness
- Calculation of strain energy in a system
- Calculation of work done in deforming a sample

This provides full instructions on the background science and operation of the FlashyScience Tensile Testing virtual experiment.

The software requires a browser such as Firefox, Chrome Edge or Safari to run and you need to be connected to the internet.

Conducting the virtual experiment

Overview

There are three elements to this virtual experiment:

1. These instructions
2. The online program
3. Recording data, creating plots and performing analysis

Upon opening the software you will see the experimental equipment. Figure 1 shows a screenshot of the main experimental view. The screen includes:

- A *tensile test frame* for holding samples and applying a tensile load.
- A *Strain Control Unit* for applying strain to samples.
- A *load dial* for measuring the applied load (force) to samples.

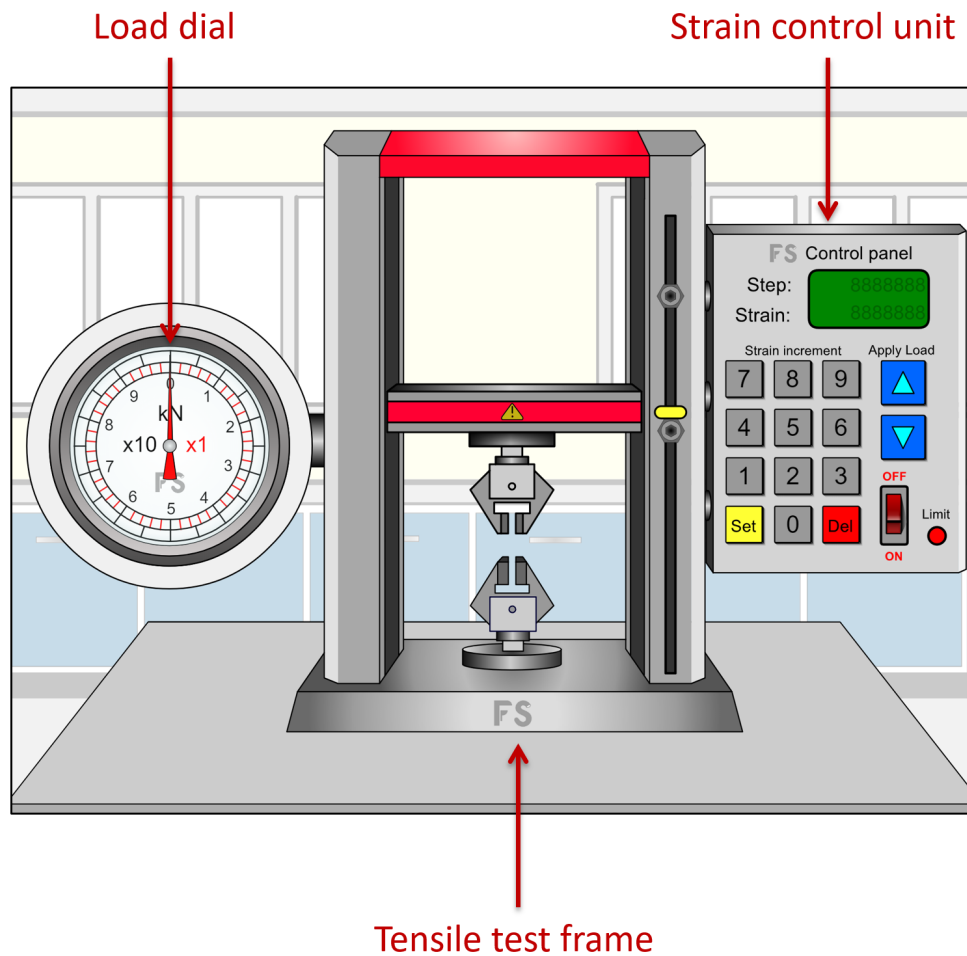


Figure 1. Main components for Tensile Testing experiment

The menu

A menu button is shown in the top left of your screen throughout this experiment (Figure 2).

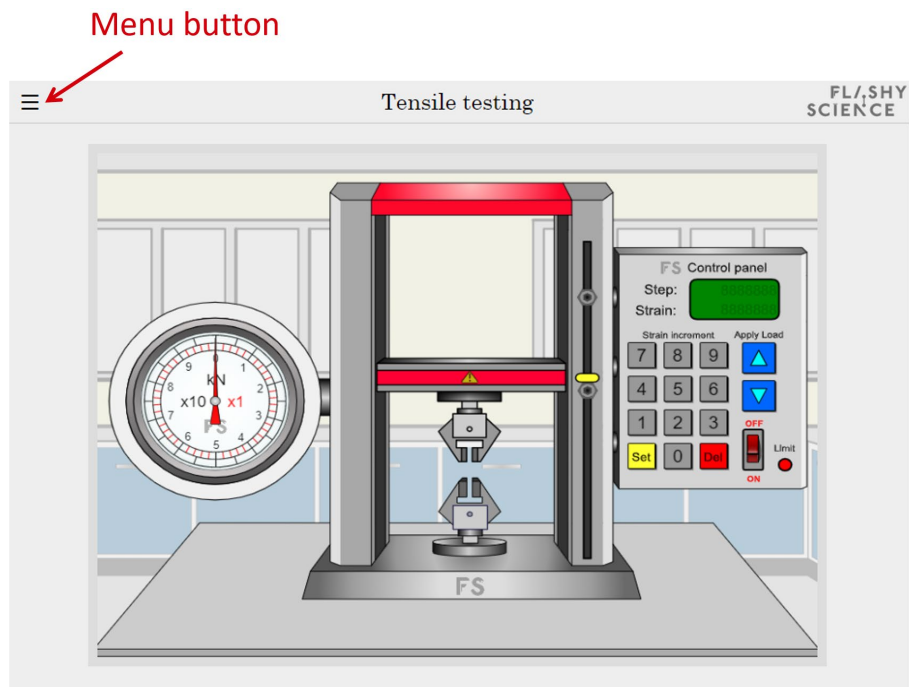


Figure 2. Where to locate the menu button on the main experiment screen.

Clicking on the button opens the menu (Figure 3).

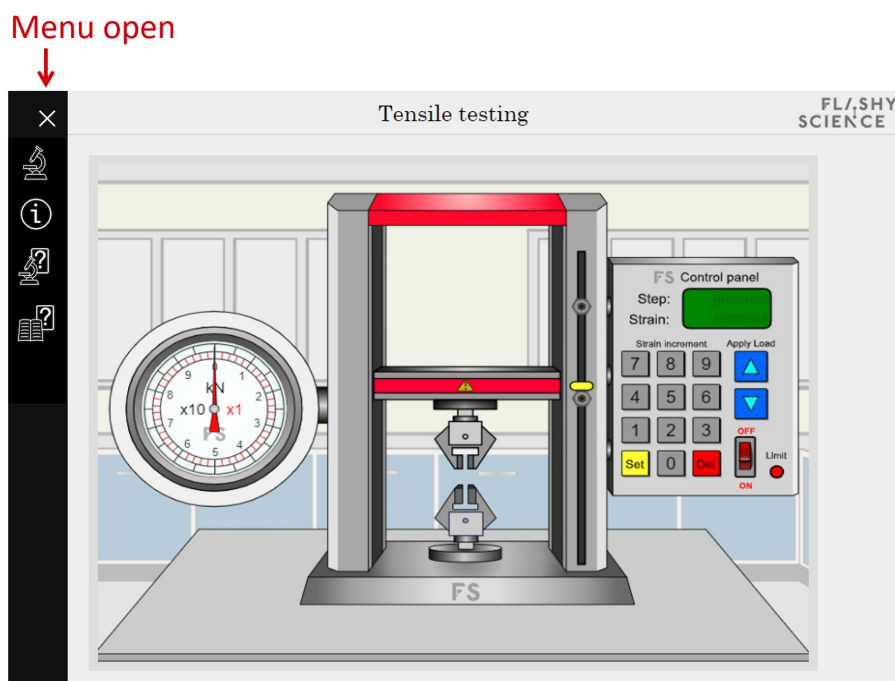


Figure 3. Menu open in main experiment screen.

The menu (Figure 4) has options to:

- Close the menu
- Return from questions to the experiment
- ‘Click information’ to show what can be clicked on the experiment
- Questions directly related to your experiment
- Revision questions on the subject of your experiment

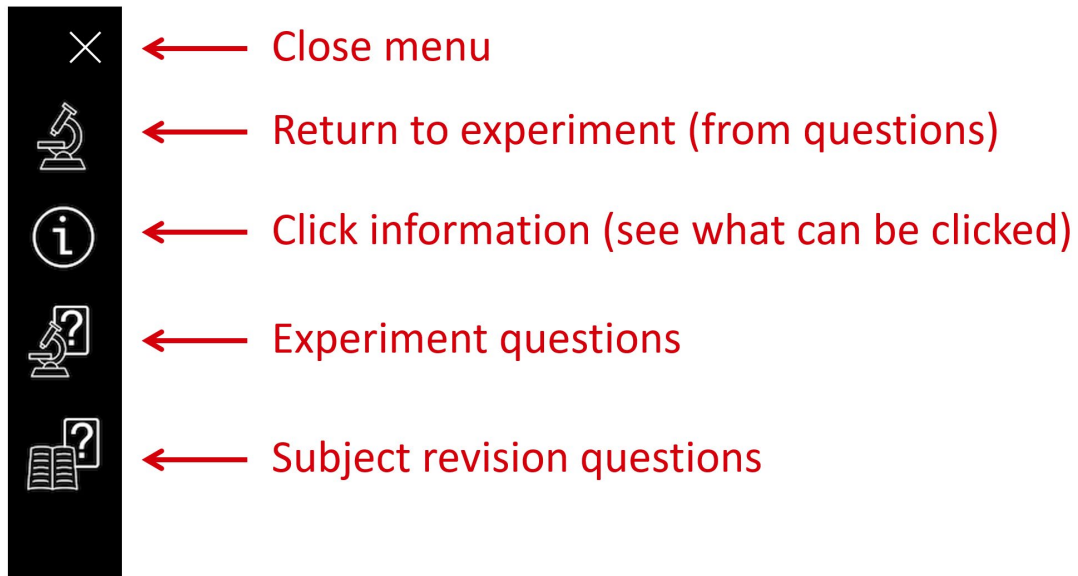


Figure 4. Menu details.

The questions are **automatically answered** and contain randomly-generated values, so you can keep using them again and again!

Choosing a sample and measuring sample width

Figure 5 shows a magnified view of the sample holder, consisting of the *upper and lower sample clamps* but with no sample initially.

To choose a sample, click on the *lower sample clamp* while the *Strain control unit* is off. This opens a new view showing a choice of five samples and a set of Vernier callipers (Figure 6).

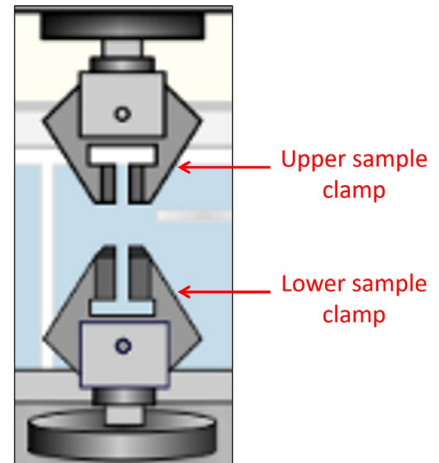


Figure 5. Magnified view of sample holder region.

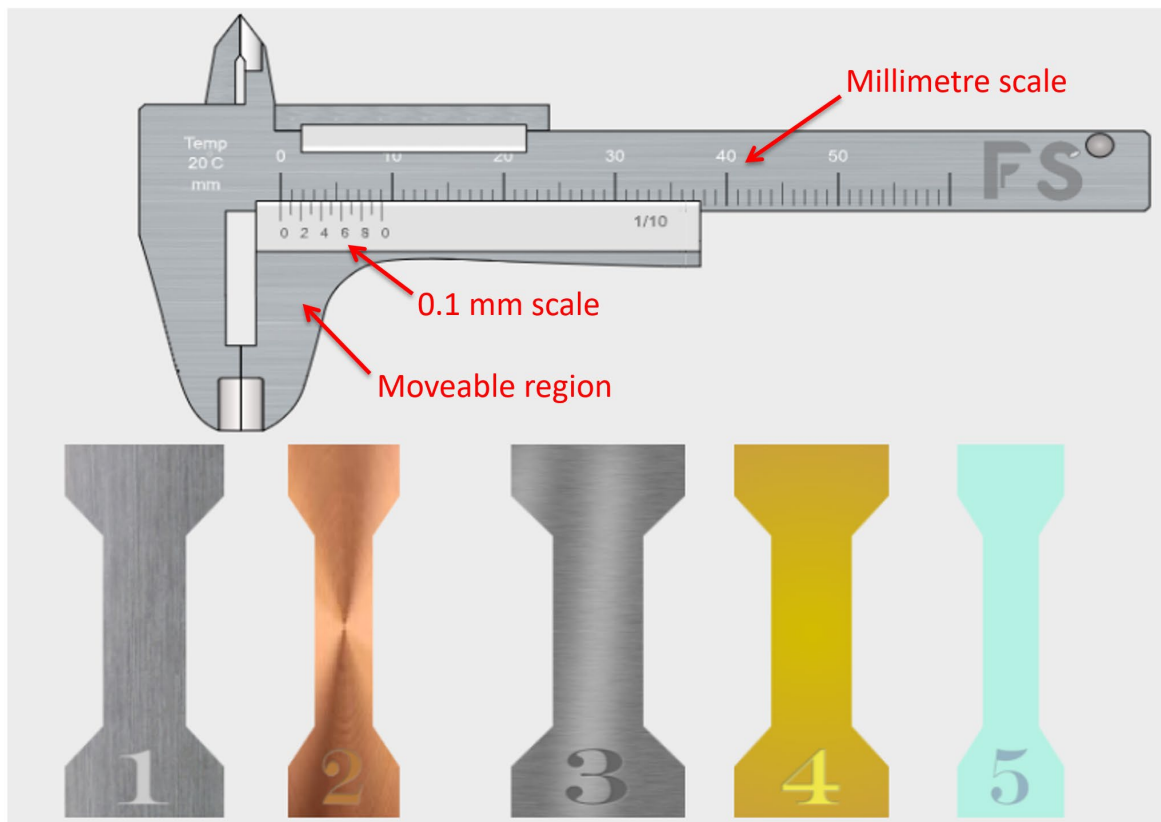


Figure 6. Vernier callipers and set of five samples.

The five numbered samples consist of:

1. Stainless steel
2. Copper
3. Aluminium
4. Kevlar
5. Borosilicate glass

The thickness of all samples is 5 mm but the width varies each time samples are loaded.

To measure the sample width, first click on the lower portion of the Vernier callipers and slide it rightwards to allow a sufficiently wide gap in the callipers for a sample to fit in (Figure 7). Then drop and drag the sample of your choice into the callipers before sliding the bottom part of the calliper leftwards until it meets the sample (Figure 8).

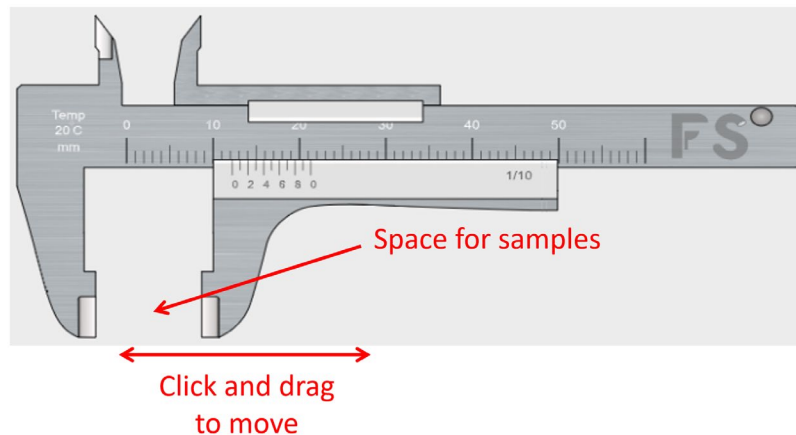


Figure 7. Vernier callipers with lower jaw dragged open.

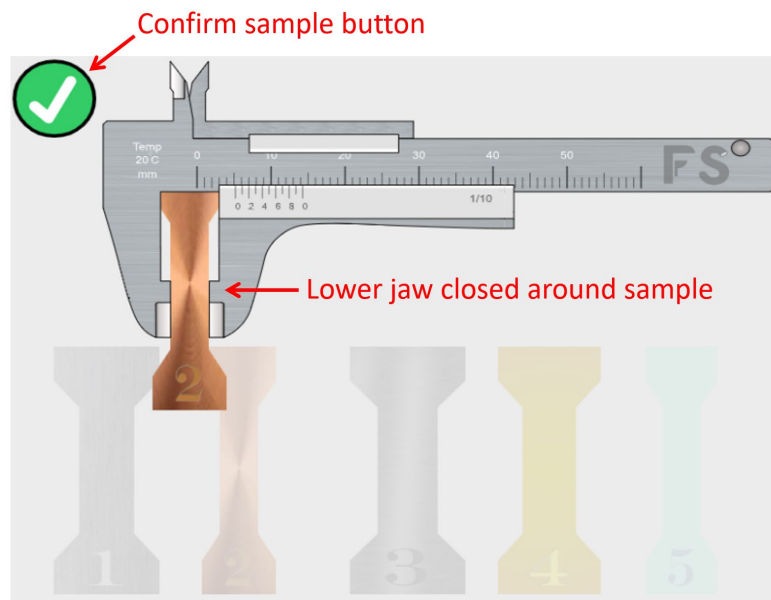


Figure 8. Lower jaw closed around sample and appearance of 'Confirm sample' button in top left of screen.

The Vernier scale is read by first determining where the first zero mark on the lower scale intersects the larger upper scale.

Read to the left the whole largest whole number on the upper scale that the lower scale zero has passed – this provides the whole number of millimetres for the sample width. In Figure 9, this is 5 mm.

The smaller component is determined by observing where the marks on the two scales are best aligned and using the value of the mark on the lower scale at this alignment point. In Fig. 9, this is 0.2 mm, giving an overall width of 5.2 mm. Remember that each mark represents 0.1 mm, which defines the resolution of the measurement.

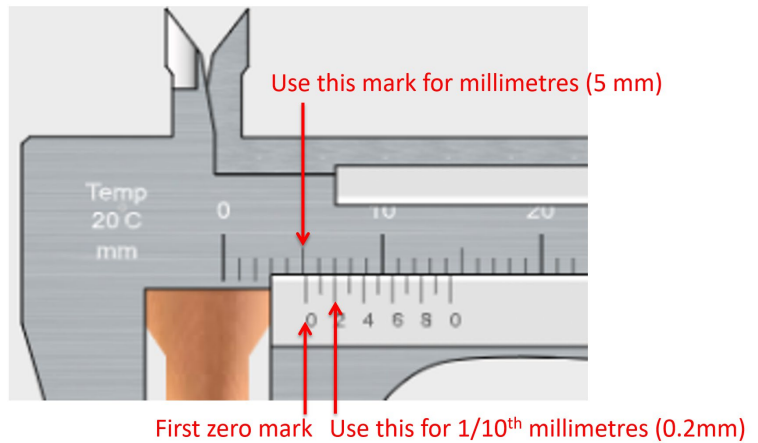


Figure 9. Magnified view of Vernier scale on callipers.

The width measurement can be combined with the (fixed) thickness of 5.0 mm given above to give a value for the initial cross-sectional area of each sample.

Move the chosen sample to the main experiment screen by clicking the green-and-white tick *Confirm* button that appears in the top right of the sample select screen, once the calliper jaws are closed around a sample (Figure 8).

A sample is chosen for tensile testing by clicking on it while it is in the callipers with the jaws closed around it. The screen view will return to the *tensile test frame* and the sample will have appeared in the sample holder (Figure 10).

Alternatively, the calliper jaws can be opened to allow a sample in the callipers to be clicked and dragged back to its original position. This allows any of the other samples to be placed in the callipers.

A new set of samples with different widths is obtained each time the callipers screen is selected.

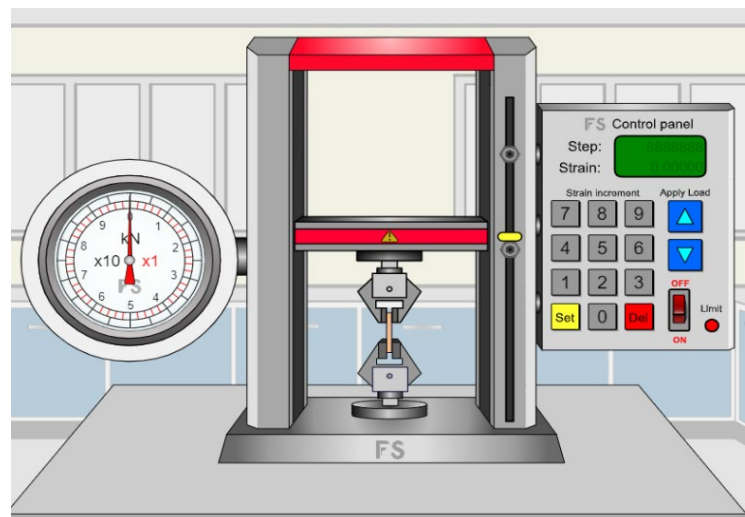


Figure 10. Tensile test frame with sample loaded.

To summarise the sample selection procedure:

- Click the lower sample holder to go to the sample view.
- Open the calliper jaws, drag a sample of choice between the jaw and close the jaws around it.
- Use the Vernier scale to measure the sample width.
- Click the green-and-white *Confirm* button to load the sample into the *tensile testing machine*.

Operating the tensile test machine

The tensile test frame is operated and samples tested by creating a specified amount of **strain** (i.e. elongation) and then measuring the **load** (i.e. force) required to do this. The **stress** can then be calculated knowing the sample cross-sectional area. The sample elongation is specified using the *strain control unit* and the various controls are shown in Figure 11.

Click on the *power switch* to turn on the control unit. The *power switch* and the *strain display* will now be illuminated (Figure 12).

The keypad on the *strain control unit* is used to set the amount by which the strain **changes** for each measurement point. To do this, first press the *Set* button. The top number ('Step') in the display now starts flashing and can be changed by using the keypad numbers. The *Del* key can be used to remove the last digit of the Step number. Once the desired strain increment is shown in the display, the *Set* key should be pressed again to lock in the strain increment (Fig. 13).

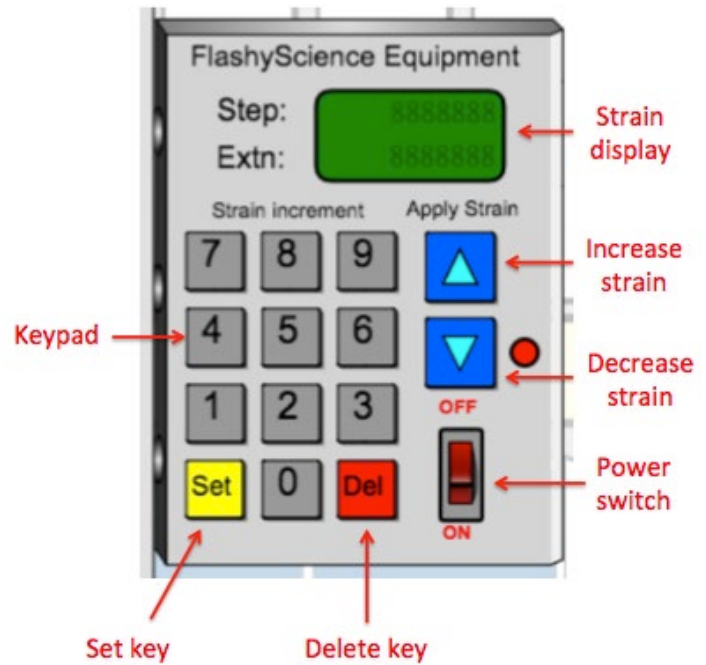


Figure 11. Components of the strain control unit.

To summarise setting the strain increment:

- Click the *Set* button (display starts to flash)
- Use the keypad and the *Del* button to enter the desired *Step* value
- Click the *Set* button again (display stops flashing)

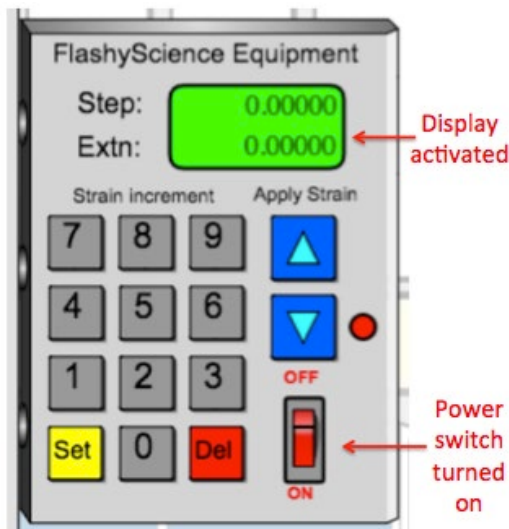


Figure 12. Strain control unit after being turned on.

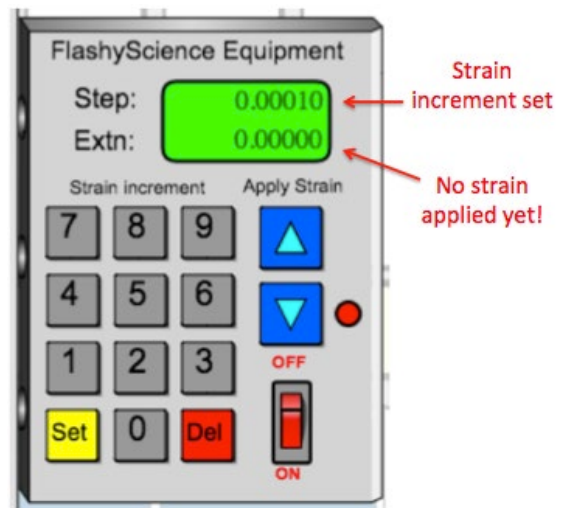


Figure 13. Strain control unit with strain increment set.

Clicking arrows on the *strain control unit* allow strain to be applied. Click the up arrow (▲) to increase the strain and the down arrow (▼) to decrease the strain. The applied strain is updated by the *Step* increment amount and shown in the *Extn* value in the *strain control unit* (Figs. 14 and 15). The force required to achieve this strain is shown in the *Load Dial* with a fast moving red needle (showing load in kN) and a black needle that responds ten times less sensitively (Figs. 14 and 16). A combination of the two needles can be used to determine load values when the red needle has undergone more than one complete revolution of the *Load Dial*.

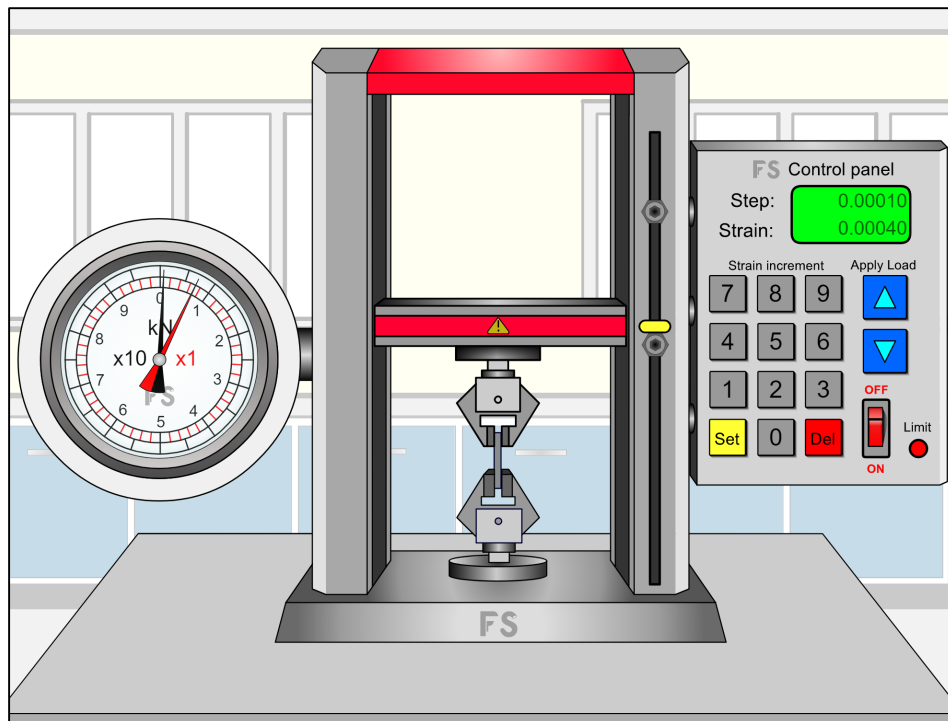


Figure 14. Tensile test system after four steps increasing extension.

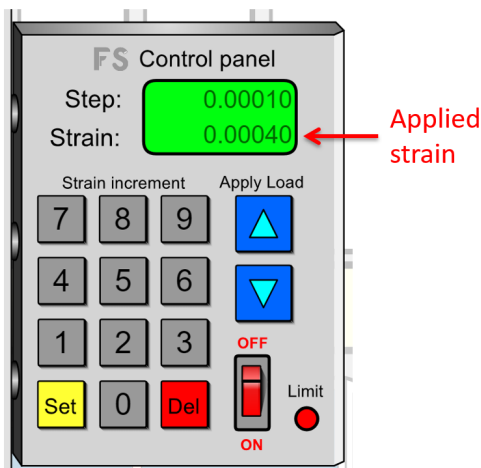


Figure 15. Strain control unit showing applied strain.

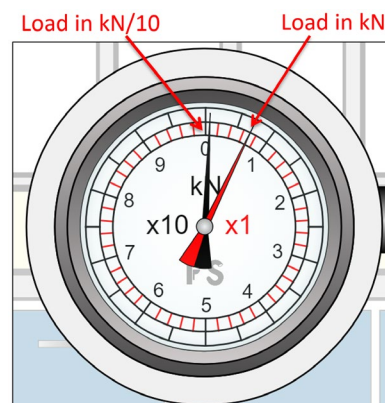


Figure 16. Load dial showing force of 0.7 kN applied to a sample.

The strain can be increased, to stretch a sample, or decreased, in order to relax a sample. When the applied stress is greater than the fracture toughness, the sample fractures (Fig. 17).

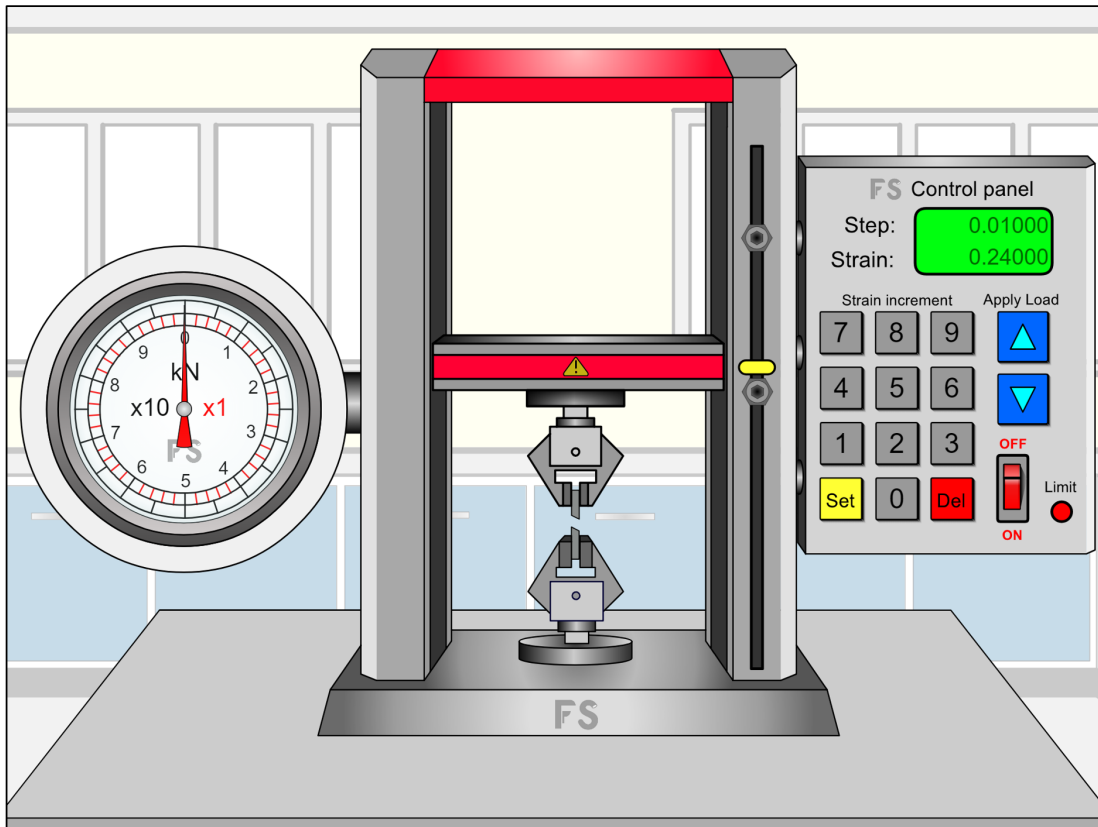


Figure 17. Tensile test system with a fractured sample.

To change samples, the tensile test machine must first be turned off by clicking the *power switch* on the *strain control unit*. Clicking on the sample then returns to the view of Vernier callipers and sample selection described above.

To summarise applying strain to samples:

- **Set the strain increment value as described above.**
- **Click the up arrow to increase the applied strain by the *Step* increment value.**
- **Click the down arrow to decrease the applied strain by the *Step* increment value.**
- **Measure (and record) the applied load (force) using the needles on the *Load dial*.**
- **Turn off the *strain control unit* and click on the lower sample holder to select a new sample.**

You are now ready to perform tensile testing experiments!