Appendix A

Vernier Scales

Certain measurements require more precision than can be obtained using common measuring devices, e.g. a metre stick for linear quantities, or a protractor for angular quantities. In this laboratory, you will have occasion to use a *vernier scale* to take measurements to a greater precision than is possible with these devices.

Vernier Calipers

Vernier calipers are used to make linear measurements to a precision on the order of 0.001 mm.
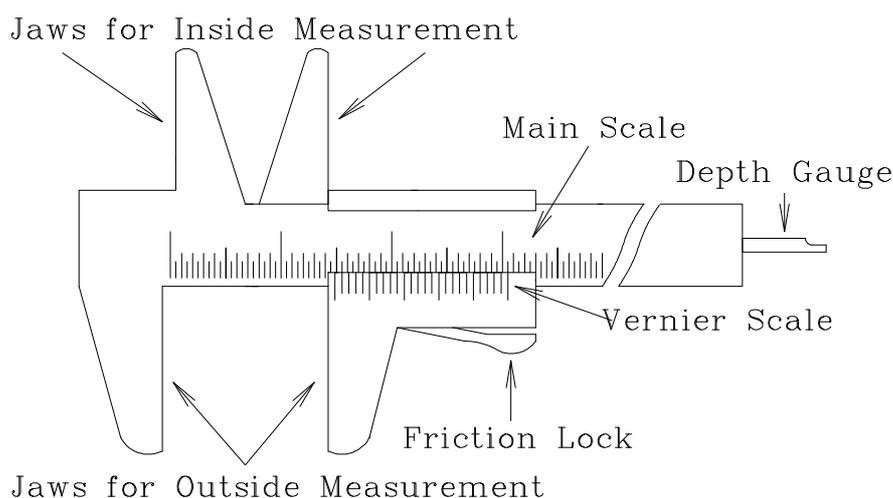

Figure A.1: The Vernier Caliper

Operation of Vernier Calipers

1. Zero Error: Before taking any measurements close the calipers and check for any zero error. If an error exists, record it and adjust any future measurements.

2. Care in Operation: The calipers must be closed gently on the object. Forcing the calipers will result in an error in measurement. They can be closed properly by applying pressure via the friction lock.

3. Cross-Cornered Measurement: It is necessary to check for every measurement that the calipers are perpendicular to the object being measured.

Main and Vernier Scales

The main scale is divided into 0.05 cm (0.5 mm) units, and the vernier scale is divided into 0.002 cm (0.02 mm) units.

Reading the Scales

1. Locate the "0" line on the vernier scale, and note which main scale division it is immediately after, e.g. 7.150 cm on the main scale in Figure A.2.

2. Scan along the line where the main and vernier scales meet, and note which *one* vernier scale division is directly in line with a main scale division, e.g. 0.014 cm on the vernier scale in Figure A.2.

3. Add the main and vernier scale readings to obtain the final reading. In Figure A.2 for example, 7.150 cm + 0.014 cm = 7.164 cm.
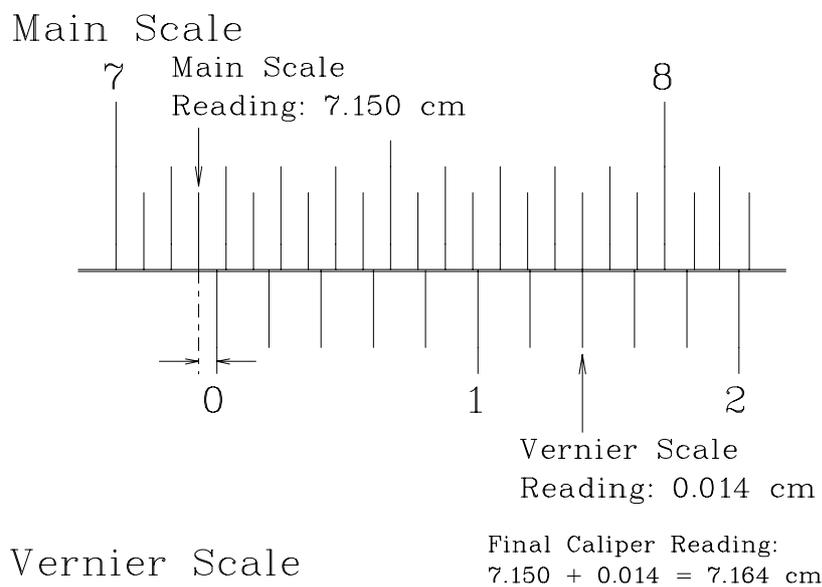

Figure A.2: Example of Vernier Caliper Reading – 7.164 cm
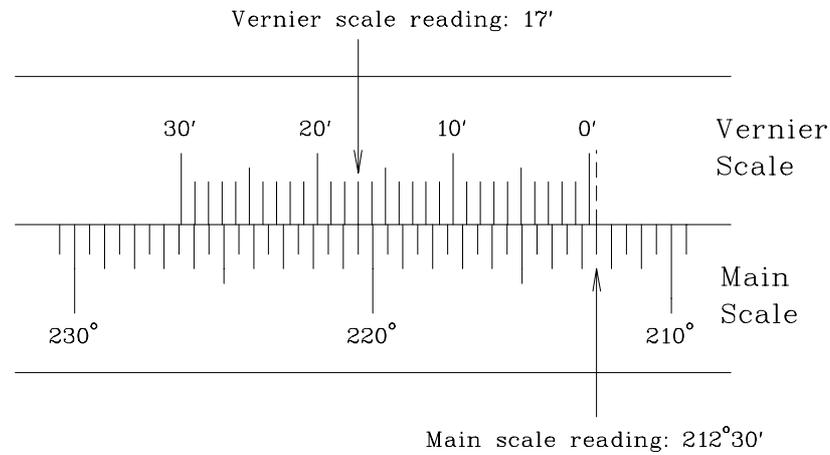
The Angular Vernier

Units of Angular Measure

Your angular measurements will consist of two parts: degrees, and a fraction of a degree called "minutes" (symbol ′). One degree is divided into sixty minutes, and one minute is divided into sixty seconds (symbol ″), although the instrument that you are using has a precision of 1′.

Main and Vernier Scales

As with the calipers, two scales are used. The main scale is circular, divided into 720 half-degree units, permitting measurements from this scale to a precision of 0.5°. The vernier scale allows a precision of 1′ to be obtained.

Reading the Scales

1. Locate the "0" line on the vernier scale, and note which main scale division it is immediately after, e.g. $212°30'$ on the main scale in Figure A.3. Note that the numbers on the main and vernier scales increase from right to left, and not from left to right as you are used to reading.

Figure A.3: Example of Angular Vernier Scale Reading – $212°47'$

2. Scan along the line where the main and vernier scales meet, and note which *one* vernier scale division is directly in line with a main scale division, e.g. $17'$ on the vernier scale in Figure A.3.

3. Add the main and vernier scale readings to obtain the angular scale reading, e.g. $212°30' + 17' = 212°47'$ in Figure A.3.