which will give the most satisfactory performance. How then do we measure the performance of our greenhouse? The primary purpose of a greenhouse is clearly to trap heat from the sun, so we can begin by measuring or calculating the thermal efficiency of a whole range of possible greenhouses. Unfortunately, we are still some way from describing how satisfactory our greenhouse will appear to individual gardeners. They may well also want to know how much it will cost to buy, how long it will last, or how easy it will be to erect and maintain, and probably, what it will look like in the garden. The greenhouse then, must satisfy criteria of solar gain, cost, durability, ease of assembly, appearance and perhaps many others.

If we imagine that we want to assess a number of design solutions so that we can put them in order of preference we would need to begin by assessing each design against each of the criteria and then somehow combining these assessments. This leaves us with three difficulties. First, the various criteria of performance are not likely to be equally important, so some weighting system is needed. Second, performance against some of the criteria can easily be measured while in other cases this is more a matter of subjective judgement. Finally, we then have the problem of combining these judgements together into some overall assessment.

The problem of numbers and counting systems!

Of course what all this means is that measurement in design involves both quantities and qualities. Somehow, then, designers must be able to balance both qualitative and quantitative criteria in their decision-making process. We shall return to this again after a small detour to examine the range of systems available to us for recording judgements.

Quantities and qualities actually turn out not to be so different from each other as we usually assume. This is because it is not sensible to talk of a quantity as if that were a single concept. We normally measure and express quantities by counting using a numerical system. This leads us to believe that all numbers behave in the same way and this is quite untrue. Actually, we commonly employ several quite distinct ways of using numbers, without really being aware of the differences. This carelessness with numbers can be fatal if we are trying to make the sort of judgements

needed in design. Numerical systems differ in the extent to which they impose rules on the way the numbers work as we move along the scale.

Ratio numbers

The numerical system which has the most demanding set of rules is known as the ratio scale. It is this scale which we tend to assume is in operation whenever we see a number, and it is the numerical scale with which we are most familiar (Fig. 5.1).

When counting objects we use this ratio scale of measurement which allows us not only to say that four is twice two but also that eight is twice four. So it is normal and correct to assume that a person on their twentieth birthday is twice as old as someone who is only ten. In turn a forty-year-old will be twice as old as the person celebrating their twentieth birthday. The scale or ruler offers us the most obvious form of ratio measurement, and we can see that the ratio of three centimetres to one centimetre is exactly the same as the ratio of six centimetres to two. This way of using numbers would thus be used in comparing the lengths or sizes of our greenhouses.

Interval numbers

However, not all the scientific measurements we could make on our greenhouse rely on ratio numbers. If we consider, not the amount of light allowed in, but the temperature inside the greenhouse we must be careful! On a sunny winter's day it might be reasonable to expect our greenhouse to achieve an indoor temperature of say

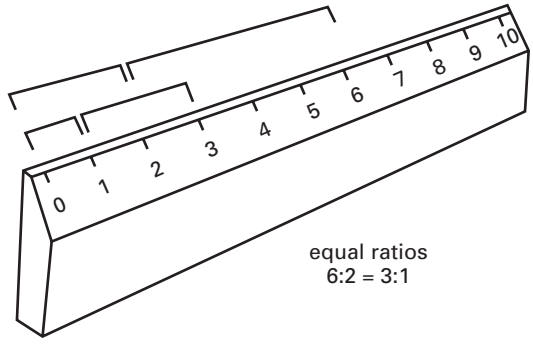

Figure 5.1
Distance is measured using the ratio numerical system