20 degrees centigrade when the outside air was only 10 degrees. Confusingly, we cannot say that the temperature inside the greenhouse is twice that outside (Fig. 5.2)!

Why this should be can be seen by using both our common temperature scales together. The outside temperature of 10 degrees centigrade can also be described as 50 degrees Fahrenheit, whilst the inside temperature of 20 degrees centigrade corresponds to about 68 degrees Fahrenheit. Thus these two temperatures give a ratio of 20 to 10 or 2 to 1 on the centigrade scale, but a ratio of 68 to 50 on the Fahrenheit scale.

This is because the zero point on these scales is not absolute but entirely arbitrary. The centigrade scale is actually defined as having one hundred equal intervals between the freezing and boiling temperatures of water. We could equally easily use the freezing and boiling temperatures of any other substance and, of course, any number of intervals between. These temperature scales are described as interval measurement. Although 20 degrees cannot be described as twice as hot as 10 degrees the difference, or interval, between 20 and 10 is exactly equal to the interval between 10 and 0.

Interval scales are frequently used for subjective assessment. Psychologists recommend that such scales should be fairly short, up to seven intervals, to retain the reliability of the interval. Thus to return to our greenhouse, we might ask a number of gardeners to assess the ease of assembly or maintenance on five-point scales. We must be careful to remember, then, that we are not justified in regarding a greenhouse assessed as four for assembly as being twice as easy to assemble as one assessed as only two.

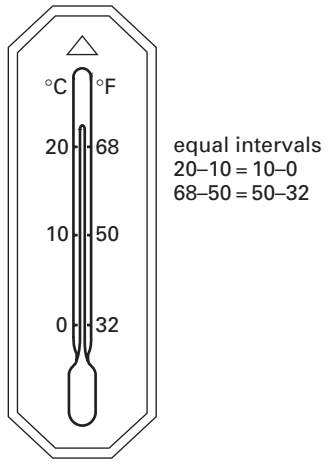

Figure 5.2
Temperature must be measured using the interval numerical system

Ordinal numbers

Sometimes we use an even more cautious scale of measurement where not even the interval is considered to be reliably consistent. Such scales are called ordinal, for they represent only a sequence or order (Fig. 5.3). If we take the final league table for the English Football league in 1930 (a year chosen purely at random!) we find that Leeds finished fifth, Aston Villa fourth, Manchester City third, Derby were second and Sheffield Wednesday were first. However, closer inspection reveals that the finishing positions of these teams, which are measured on an ordinal scale, are rather misleading compared to the number of points they scored, which are

FIRST DIVISION

	P	W	D	L	F	A	Pts
1 Sheff Wed	42	26	8	8	105	57	60
2 Derby	42	21	8	13	90	82	50
3 Man City	42	19	9	14	91	81	47
4 Aston Villa	42	21	5	16	92	83	47
5 Leeds	42	20	6	16	79	63	46
6 Blackburn	42	19	7	16	99	93	45
7 West Ham	42	19	5	18	86	79	43
8 Leicester	42	17	9	16	86	90	43
9 Sunderland	42	18	7	17	76	80	43
10 Huddersfield	42	17	9	16	63	69	43
11 Birmingham	42	16	9	17	67	62	41
12 Liverpool	42	16	9	17	63	79	41
13 Portsmouth	42	15	19	17	66	62	40
14 Arsenal	42	14	11	17	78	66	39
15 Bolton	45	15	9	18	74	74	39
16 Middlesbrough	42	16	6	20	82	84	38
17 Man United	42	15	8	19	67	88	38
18 Grimsby	42	15	7	20	73	89	37
19 Newcastle	42	15	7	20	71	92	37
20 Sheff United	42	15	6	21	91	96	36
21 Burnley	42	14	8	20	79	97	36
22 Everton	42	12	11	19	80	92	35

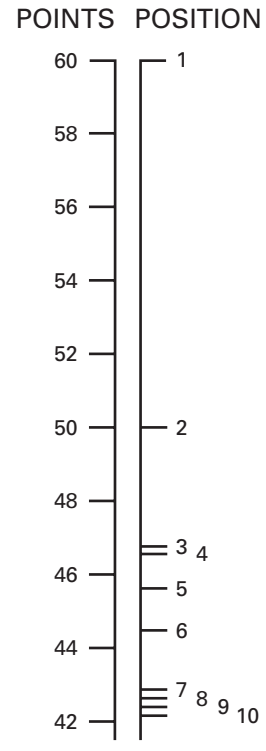

Figure 5.3
Rankings are an example of ordinal numbers

measured on a ratio scale. The third, fourth and fifth placed teams were only separated by one point, while Derby were three points clear of them, but Sheffield Wednesday were a massive ten points ahead of Derby. Regulations require that the materials used in buildings should not allow flame to spread across their surface in case of fire. Materials can belong to one of five surface spread of flame classes which range from class 0 to class 4. On this ordinal scale the higher the number the more rapidly flame will spread, but the difference between class 1 and class 2 is not necessarily the same as the difference between class 2 and class 3.

We also get ordinal scales when we ask people to rank order their preferences. Thus we could ask our gardeners to place a number of greenhouses in order of attractiveness of appearance. Whether ordinal or interval scales of assessment are appropriate remains a matter of judgement but, generally, ordinal scales should be used where the assessment may depend on many factors or where the factors cannot easily be defined. Thus while it seems reasonable to ask our gardeners how much easier it is to assemble one greenhouse than another, it does not seem reasonable to ask how much more attractive it may be. Academic