

## UNIT 17 *Units of Measure*

## Teaching Notes

### *Historical Background and Introduction*

The earliest attempts at measurement had two main elements. One was that the unit or its definition indicated what the measurement was needed for; thus distances were given in terms of 'paces' or 'a day's ride', and an acre was thought of as the area of land that could be ploughed by a man and a team of oxen in one day. The other element was that they were based on easily identifiable units such as *feet*, *hand-spans*, etc, which served very well for most purposes but the need for standardisation was also realised very early. For example, in Ancient Egypt, the *cubit* was known as the distance from the elbow to the outstretched tip of the middle finger, but by 2500 BC this had been standardised in a royal master cubit made of black granite which was 254 mm long.

In Britain, though there had been several previous attempts at standardisation, the best and most sustained work really started in the 14th century. Nothing changed overnight - variations and abuse continued for many centuries after that, but a continuous thread in the development of measures in England can be traced from those times. Standards were based on objects, as in this early statute –

"It is ordained that 3 grains of barley, dry and round, make an inch, 12 inches make a foot, 3 feet make an Ulna, 5  $\frac{1}{2}$  Ulnae make a rod, ... "

The *Ulna* later became the *Yard*, and was standardised as being the distance between two marks on a metal bar. Working backwards from the yard, the *inch* was then  $\frac{1}{36}$  part of a yard; barleycorns were thought to be unreliable measures of length!

The use of seeds as a basic measure of weight has had a place in the development of measures over a long time and through many cultures. In Britain, where three systems of weight measurement persisted, (*Avoirdupois*, *Troy* and *Apothecaries*) the '*grain*' served a very useful purpose in that it was common to all three systems and so could be used to convert from one to another. The '*grain*' was not finally abolished until the Weights and Measures Act of 1985.

The metric system was officially started in France in June 1799 with the declared intent of being "For all people for all time". The principle idea behind it was that all the units should be based on natural facts. The *metre* was set at one ten-millionth part of a quarter of the earth's circumference as measured along a great circle passing through Paris. The metre was then divided in the way we know today; and the *gram* was defined as the weight of 1 cubic centimetre of pure water.

As more accurate measurements became possible the inexactness of the metre stood revealed. This led to a search for standards which would be less likely to 'shift' as methods improved. Essentially, these standards are based on physical phenomena which can only be observed (under tightly specified conditions) in a specially equipped laboratory. The *metre* is now defined as the distance travelled in a vacuum by light in  $\frac{1}{299\,792\,458}$  th of a second (the duration of a second is also defined); this is considerably more accurate than two marks scratched on a bar, and can be replicated without having to look at anyone else's standard. The latest system officially came into being in October 1960 with the formal creation of the *Système International* or *S.I.* as it is usually known; it has been adopted by every major country in the world, though rates of actual usage vary considerably.

The whole basis on which the British system of measures was standardised changed with a statute of 1963. Instead of relying on certain artifacts made and kept by a government department, the primary units of the *yard* and the *pound* were defined in terms of the *metre* and the *kilogram* respectively. (The *gallon* is not a primary unit but was defined in terms of the *litre*.) From that date there was no longer an approximate relationship between the metric and imperial systems, but an exact one. The relevant values are given in the conversion tables in Activity 17.2.

As well as the use of metric (i.e. S.I.) units and imperial units, Unit 17 also contains an important section on conversion *between* these units.

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The reasons for needing to convert units can be put under *three* headings:

1. *Commercial* – where trade or exchange takes place between two parties or countries and each has its own system of units. The most obvious example of this is currency.
2. *Familiarisation* – when looking at something new, people want a reference point with which they are familiar in order to make comparisons. People on holiday in a foreign country do this often. An example of this is given in question 3 of Activity 17.2.
3. *Historic* – this covers cases where, in order to make sense of a situation, units inherited from a bygone age have to be put into a modern form.

Metrication is now in place throughout the UK and there can be few who are not aware of metric measures in one way or another. Familiarity with those measure is a much slower process, but it is happening.

Over the last twenty years, legislation has made more and more metric measures compulsory for trading purposes, at the same time banning the use of the equivalent units from our old imperial system. The final date for this changeover was 31 December 1999.

Since 1 January 2000, only metric units of measure may be used for purposes of trade, public health and safety, economic and administrative purposes. There are four exceptions to this legislation, and these have been negotiated (within the EC) *without time limit*. So we may continue to use:

- *miles, yards, feet* and *inches* for road traffic signs and related measurements of speed and distance;
- *pints* for dispensing draught beer and cider, and for milk in returnable containers;
- *acres* for land registration purposes;
- *troy ounces* for transactions in precious metals.

Clearly, the need to convert units will be with us for a long time yet!

### *Routes*

	<b>Standard</b>	<b>Academic</b>	<b>Express</b>
17.1 Estimating Metric Units of Length, Mass and Capacity	✓	✓	✓
17.2 The Metric System: Conversion Between Units	✓	✓	✓
17.3 Estimating Imperial Units of Length, Mass and Capacity	✓	✓	✓
17.4 Metric and Imperial Units	(✓)	✓	✓
17.5 Problems in Context	(✓)	✓	✓

### *Language*

	<b>Standard</b>	<b>Academic</b>	<b>Express</b>
Metric units	✓	✓	✓
Kilos, centi- , milli-	✓	✓	✓
Imperial units	✓	✓	✓

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### *Misconceptions*

Many confusions can arise here, for example:

- confusing  $\frac{1}{100}$  with 100 or  $\frac{1}{1000}$  with 1000, etc.
- confusing the metric tonne (which is 1000 kg) with the imperial ton (2240 pounds, approximately 1016 kg).
- confusing time units with decimal points as in hours : minutes : seconds; e.g. 1.25 minutes means 1 minute 15 seconds, whilst 1:25 minutes is 1 minute 25 seconds, etc.
- realising that we use approximate conversion facts, although exact conversion can actually be achieved (see Activity 17.2 and the information on the Conversion Sheet).

### *Challenging Questions*

The following questions are more challenging than others in the same section:

	<i>Section</i>	<i>Question No.</i>	<i>Page</i>
<i>Practice Book Y8B</i>	17.4	12	105