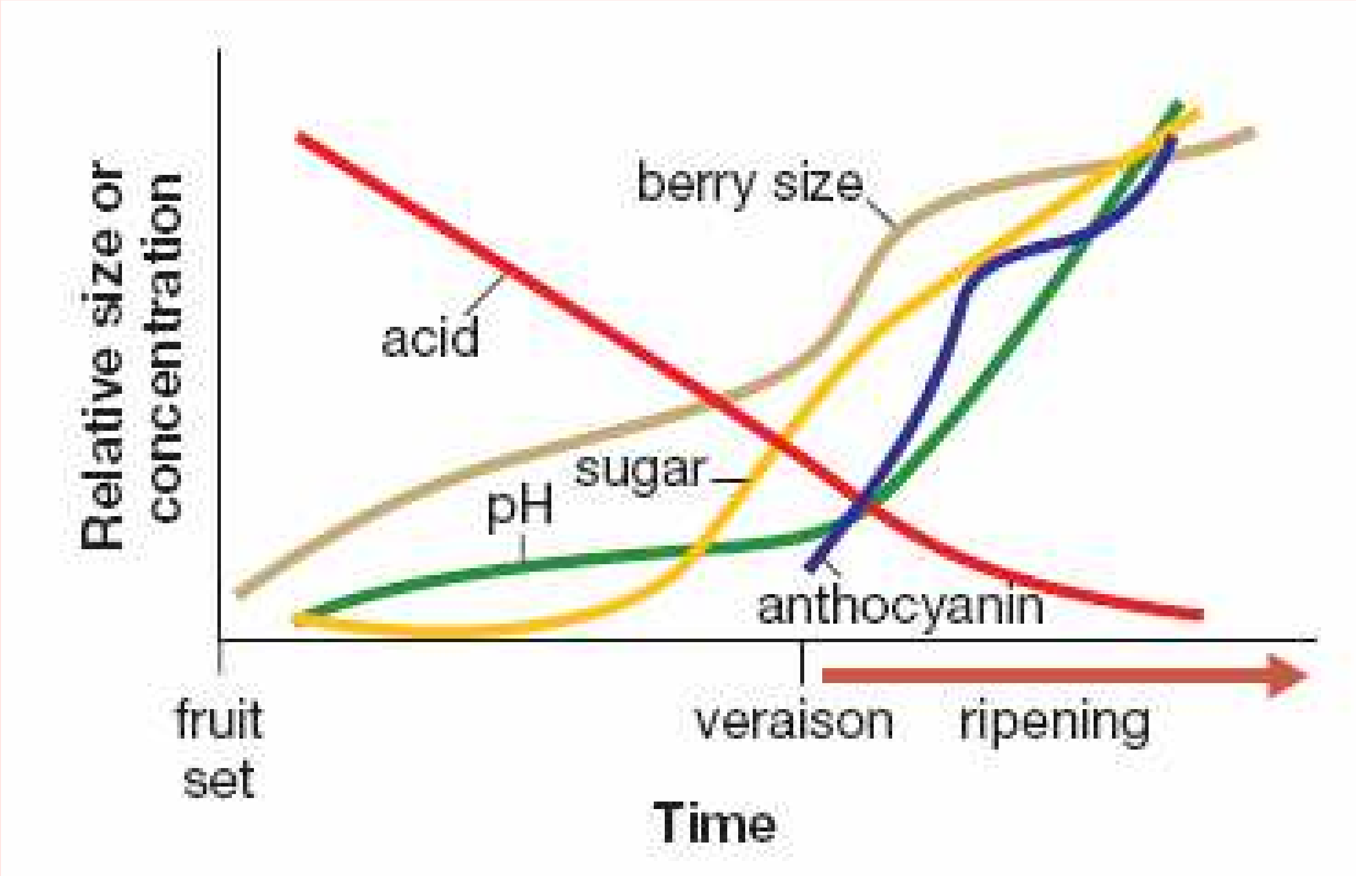
Wine EEI background info

In the beginning...

The decision to harvest the grapes is imminent!
What factors determine when
the grapes are picked and when vinification (wine-making) begins?
The graph below shows what happens to a
number of factors as the grape
develops from the time of fertilisation (fruit set)
until it ripens (veraison).



During the ripening process, samples of fruit are collected to assess the readiness for harvest. For the wine-maker, the sampling process must be representative of the whole area of grapes intended for use. The grapes are sampled for a number of characteristics, as a combination of these factors has been shown to have the best result. These factors include:

- the sugar content
- the acidity
- the pH
- the colour, fl avour and aroma.

Measuring the sugar content

Because it is illegal for Australian wine-makers to add sugar to the **must** (fermenting juice), sugar content must be assessed. The wine-maker needs to make sure there is sufficient sugar in the grapes to be converted into alcohol by the yeast. If there is insufficient sugar, only grape concentrate can be added as wine-makers are allowed to add only what originally comes from the grape.

The ripening of the grape basically involves an accumulation of sugar (as shown in the graph above). Monitoring the sugar concentration will help the wine-maker assess when the harvest should take place.

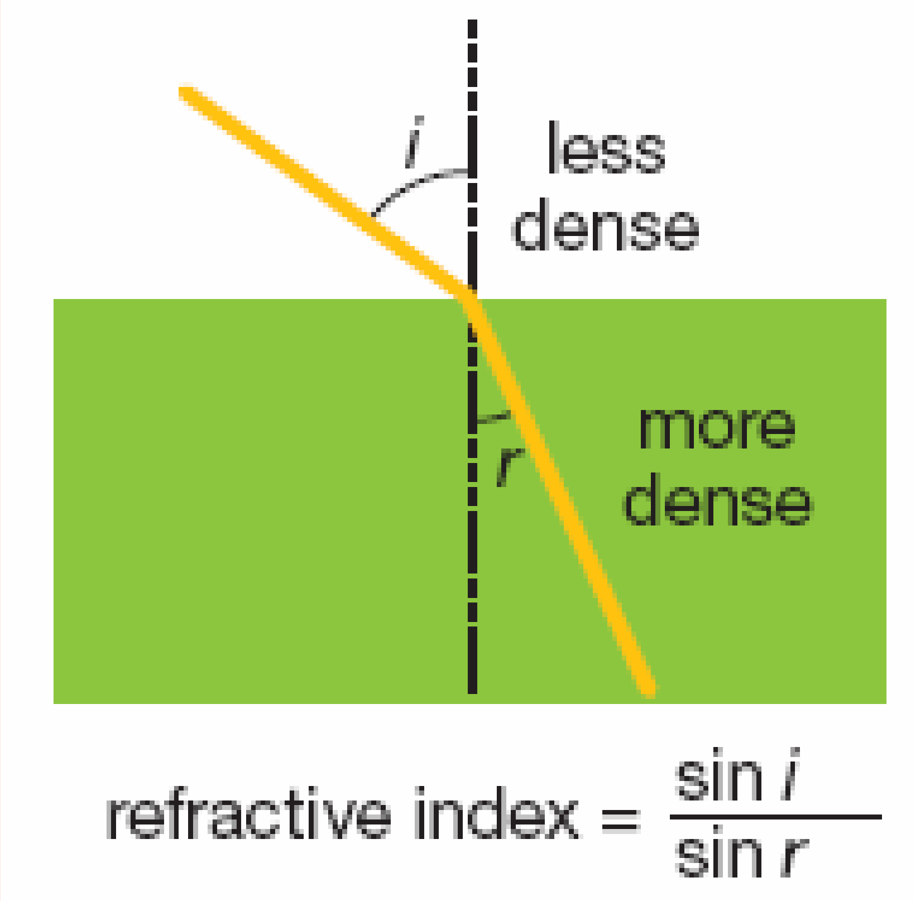
These sugar levels can be assessed by using a **refractometer**, a **hydrometer** or by tasting.

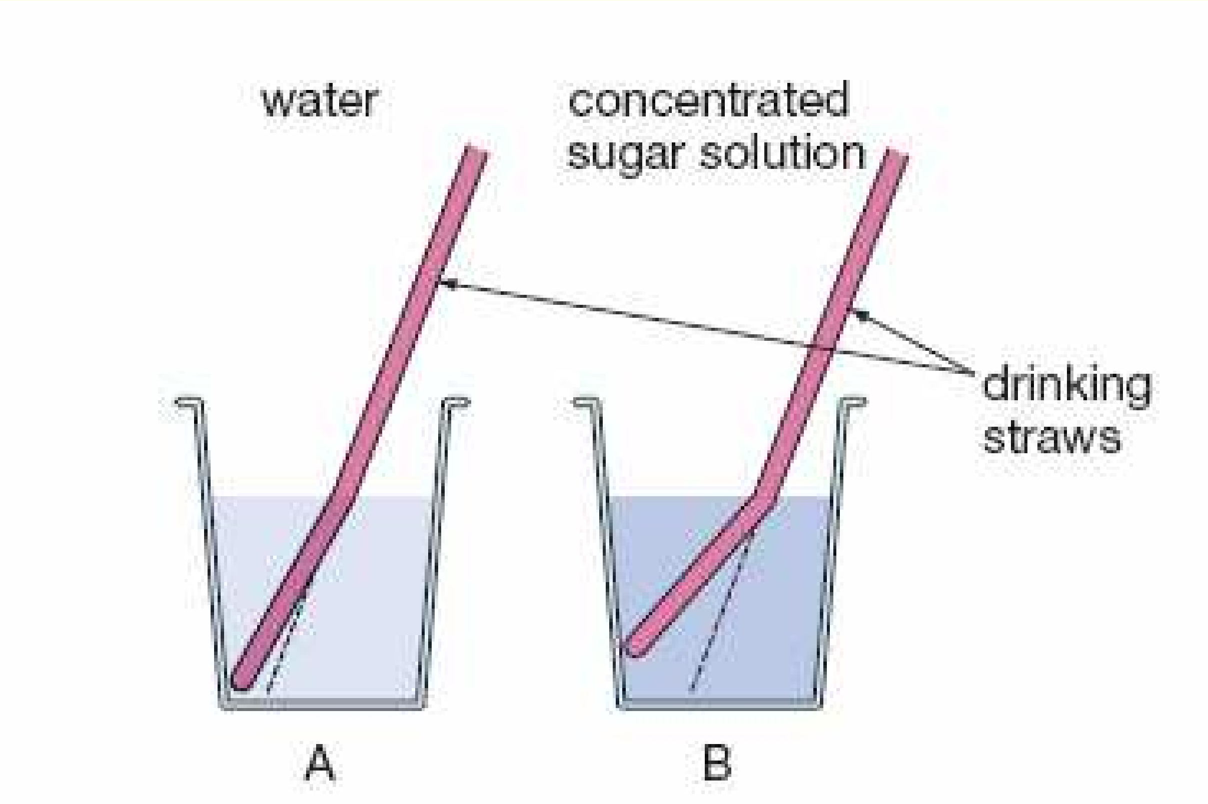
Refractometer

A refractometer measures the refractive index of a solution. Light is passed through
a solution and the degree of light bending by the sample is related to the quantity
of soluble solids present in the solution. (This technique utilises the fact that sugar
is the predominant soluble solid in grape juice.) Consequently, more bending or
increase in the refractive index indicates higher sugar levels.

The refractive index is temperature-dependent. Generally refractometers are calibrated to work at 20℃.

A temperature compensation table should be consulted
to obtain accurate measurements when the refractometer
is used above or below 20℃.





HERE; a simple refraction activity if we can find some plastic cups

This diagram shows the difference in refraction or bending of light in distilled water (A) compared to a concentrated sugar solution (B). The presence of the solute causes increased refraction.

FIGURE 6.3
A cross-section of a hand-held refractometer. Once the solution being tested is correctly in place, the refractometer is positioned so that light will pass through. The scale viewed through the eyepiece allows the concentration of sugar to be observed

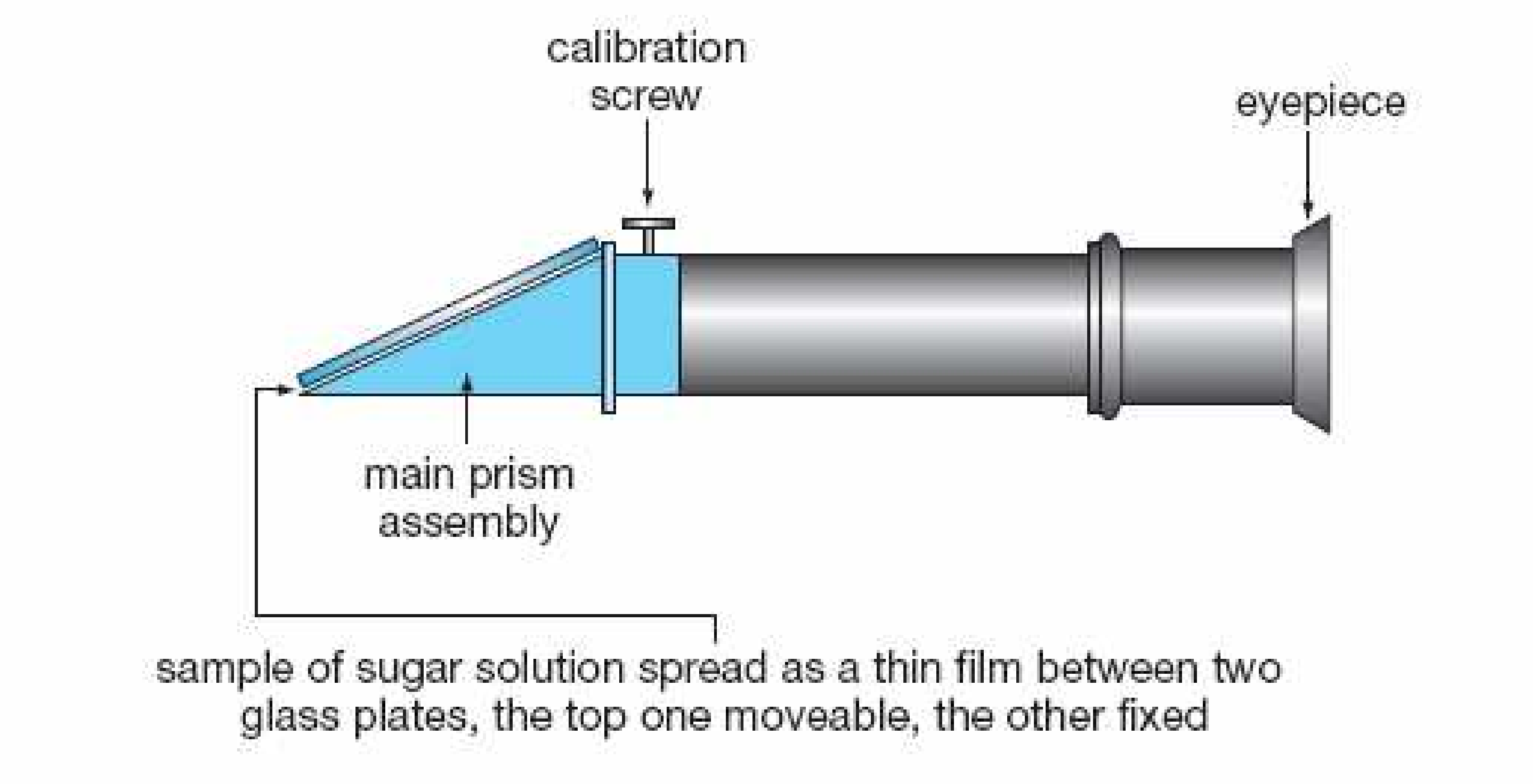
http://hyperphysics.phy-astr.gsu.edu/Hbase/Tables/indrf.html

Index of Refraction

Material	Index
Vacuum	1.00000
Air at STP	1.00029
Ice	1.31
Water at 20 C	1.33
Acetone	1.36
Ethyl alcohol	1.36
Sugar solution(30%)	1.38
Fluorite	1.433
Fused quartz	1.46
Glycerine	1.473
Sugar solution (80%)	1.49
Typical crown glass	1.52
Crown glasses	1.52-1.62
Spectacle crown, C-1	1.523
Sodium chloride	1.54
Polystyrene	1.55-1.59
Carbon disulfide	1.63
Heavy flint glass	1.65
Extra dense flint, EDF-3	1.7200
Methylene iodide	1.74
Sapphire	1.77
Rare earth flint	1.7-1.84
Lanthanum flint	1.82-1.98
Arsenic trisulfide glass	2.04
Diamond	2.417

Which material will refract light the most?

How does the refractive index change as you increase the concentration of sugar in solution



refractive index
Measure of the bending or refraction of a beam of light on entering a denser medium (the ratio between the sine of the angle of incidence of the ray of light and the sine of the angle of refraction). It is constant for pure substances under standard conditions. Used as a measure of sugar or total solids in solution, purity of oils, etc.

The scale observed through the refractometer converts the refractive index to a sugar concentration. Sugar concentration is measured in °Brix. The Brix scale was developed by Adolf Brix in 1854.

Each degree Brix is equivalent to 1 gram of sugar per 100 grams of liquid (% w/w). The unit, % w/w, is an abbreviation for percentage weight of a substance of the total weight at a specified temperature, usually 20°C. As an example, 10°Brix, or 10% w/w = 10 g glucose ($C_6H_{12}O_6$) in 90 g (90 mL) water. The Brix scale is used widely in food and beverage industries to help maintain quality assurance of the products.

Historically in the wine industry, the alcohol content has been measured in units of volume percentage (% v/v). The unit, % v/v, is an abbreviation for percentage volume of a substance of the total volume, for example 12.5% v/v ethanol = 12.5 mL ethanol in approximately 87.5 mL water. The theoretical yield of the reaction of alcoholic fermentation is higher than the practical yield. The practical yield is infl uenced by factors including the strain of yeast and the fermentation temperature. There are a number of formulae which have been developed to estimate the alcohol concentration of the finished wine from the sugar concentration of the grape juice (must). One such formula is

Potential Alcohol (%v/v) = 0.6 └ °Brix - 1 ... (6.1)

This formula is derived from observed measurements of alcohol produced during fermentations. This quantity is less than the theoretical calculation because the process is not 100% efficient.

Typically the fruit used for a table wine is picked when sugar levels are between 22°Brix and 24°Brix.

Here is a sample calculation:

Consider a juice with 22°Brix.

Predicted alcohol % = $0.6 \times$ °Brix - 1

$= 0.6 \times 22 - 1$

= 12.2% v/v

ACTIVITY 6.4

a What percentage alcohol would be produced from a must of 18°Brix?

b Determine the °Brix that existed in the must if 10% alcohol was produced.

c i Calculate, using the equation for fermentation given, what mass of alcohol would be produced from 22°Brix:

$$C_6H_{12}O_6 \longrightarrow 2CH_3CH_2OH + 2CO_2$$

ii Convert this mass to a volume using the density of ethanol 0.789 g/L.

iii Using the specific gravity for a solution of 22°Brix (SG = 1.093), calculate the volume of 100 g of solution.

iv Using the values obtained for ii and iii, calculate the alcohol concentration in % v/v.

d Compare this to the sample calculation above and suggest reasons that may account for differences.

e The °Brix is temperature dependent so for every degree Celsius above 20°C, 0.05°Brix must be added and for every degree Celsius below 20°C, 0.05°Brix must be subtracted. Suggest a reason for this.

$\% = 0.6 \times {}^\circ Brix - 1$

$10 = 0.6 \times {}^\circ B - 1$

$11 = 0.6 \times {}^\circ B$

${}^\circ B = 18.3\ {}^\circ Brix$

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22°Brix

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

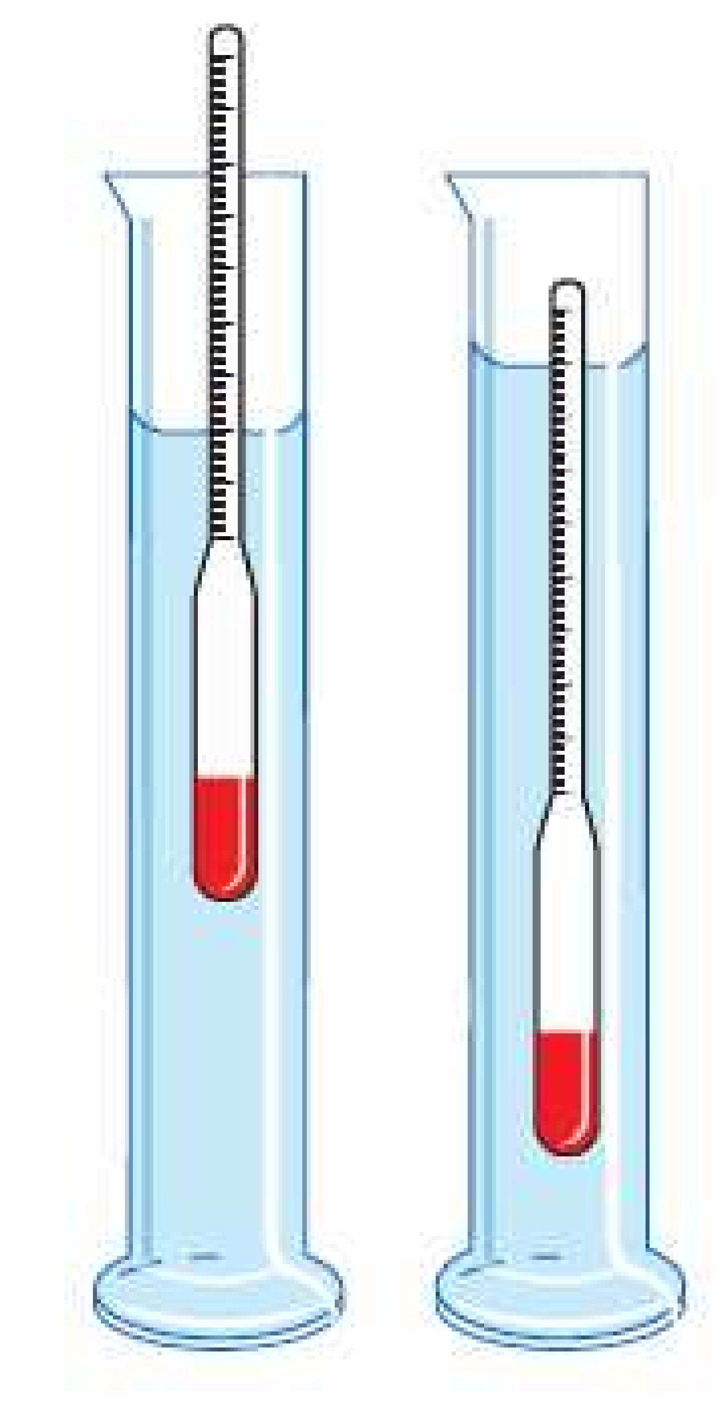
22g

22g of glucose

0.1222

$0.24\bar{4}$

$11.24\bar{4}$ g



The hydrometer will ‘float high’ in the grape juice and sink lower as the sugars are converted to alcohol during fermentation. Typically the specific gravity readings for the grape juice will be in the range 1.050–1.120

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Hydrometer

The hydrometer is a simple instrument that compares the weight (the force due to gravity) of a liquid in relation to the weight of the same volume of water. At 20℃ the density of water is 1.000 g/mL. When the density of a substance is divided by the density of water, the result is called the specifi c gravity (SG). The specifi c gravity has no units.
A hydrometer consists of an elongated, enclosed glass tube, weighted at one end to ensure the instrument sits upright in the fluid, enabling the scale on the side to be read (see Fig. 6.4).
Hydrometer readings are also temperature-dependent. Generally they are calibrated to work at 20℃. A temperature compensat ion table should be consulted to obtain accurate measurements when the hydrometer is used above or below 20℃.
The specifi c gravity of sugar solution increases as the amount of dissolved solute increases. The relationship is a linear one. By measuring the specifi c gravity of sugar solutions of known concentrations (°Brix) and plotting °Brix against specifi c gravity (SG) it can be shown tha

$$^{\circ}\text{Brix} = 220 \times (SG - 1) + 1.6$$

The specific gravity of pure water is 1.000; therefore, increasing the dissolved sugar will increase the specific gravity above 1.000.

The specific gravity of ethanol is 0.789. Forming a mixture of ethanol and water (which occurs during fermentation) will result in a specifi c gravity of less than 1.000.

This means a hydrometer will float higher in a denser liquid, such as one with a quantity of sugar dissolved in it, and lower in a liquid with less specific gravity,

such as water or alcohol. Many hydrometers have

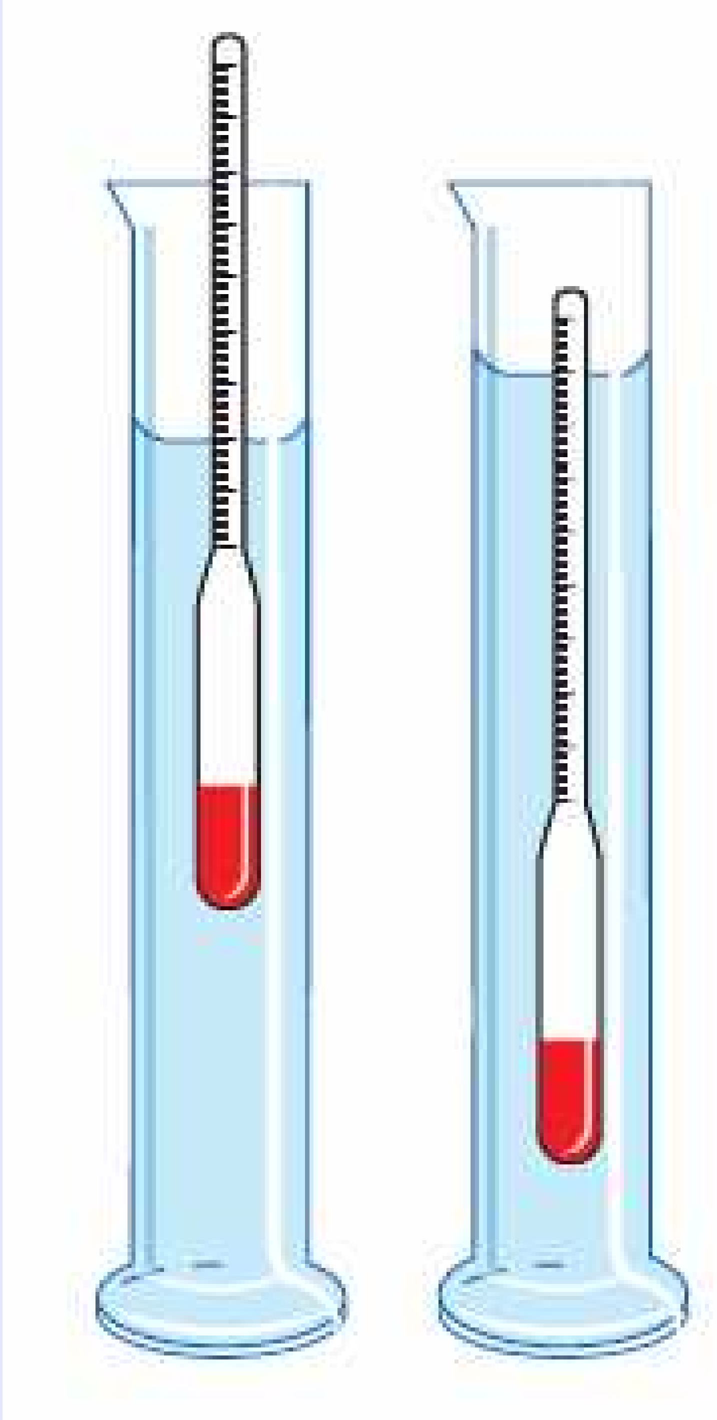

TABLE 6.1 An hydrometer table

Specific gravity (SG)	°Brix [(SG − 1) × 220] + 1.6	Potential alcohol (PA) (%) 0.6 × °Brix − 1
1.000	1.6	0.0
1.010	3.8	1.3
1.020	6.0	2.6
1.030	8.2	3.9
1.040	10.4	5.2
1.050	12.6	6.6
1.060	14.8	7.9
1.070	17.0	9.2
1.080	19.2	10.5
1.090	21.4	11.8
1.100	23.6	13.2
1.110	25.8	14.5
1.120	28.0	15.8
1.130	30.2	17.1
1.140	32.4	18.4
1.150	34.6	19.8
1.160	36.8	21.1