



Figure 4.1 A Casio fx-83ES calculator

Now try the following Practice Exercise

**Practice Exercise 12** Addition, subtraction, multiplication and division using a calculator (answers on page 341)

1. Evaluate  $378.37 - 298.651 + 45.64 - 94.562$
2. Evaluate  $25.63 \times 465.34$  correct to 5 significant figures.

3. Evaluate  $562.6 \div 41.3$  correct to 2 decimal places.
4. Evaluate  $\frac{17.35 \times 34.27}{41.53 \div 3.76}$  correct to 3 decimal places.
5. Evaluate  $27.48 + 13.72 \times 4.15$  correct to 4 significant figures.
6. Evaluate  $\frac{(4.527 + 3.63)}{(452.51 \div 34.75)} + 0.468$  correct to 5 significant figures.
7. Evaluate  $52.34 - \frac{(912.5 \div 41.46)}{(24.6 - 13.652)}$  correct to 3 decimal places.
8. Evaluate  $\frac{52.14 \times 0.347 \times 11.23}{19.73 \div 3.54}$  correct to 4 significant figures.
9. Evaluate  $\frac{451.2}{24.57} - \frac{363.8}{46.79}$  correct to 4 significant figures.
10. Evaluate  $\frac{45.6 - 7.35 \times 3.61}{4.672 - 3.125}$  correct to 3 decimal places.

### 4.3 Further calculator functions

#### 4.3.1 Square and cube functions

Locate the  $x^2$  and  $x^3$  functions on your calculator and then check the following worked examples.

**Problem 3.** Evaluate  $2.4^2$

- (i) Type in 2.4
- (ii) Press  $x^2$  and  $2.4^2$  appears on the screen.
- (iii) Press = and the answer  $\frac{144}{25}$  appears.
- (iv) Press the  $S \leftrightarrow D$  function and the fraction changes to a decimal 5.76

Alternatively, after step (ii) press Shift and = . Thus,  $2.4^2 = 5.76$

**Problem 4.** Evaluate  $0.17^2$  in engineering form

- (i) Type in 0.17
- (ii) Press  $x^2$  and  $0.17^2$  appears on the screen.

- (iii) Press Shift and = and the answer 0.0289 appears.
- (iv) Press the ENG function and the answer changes to  $28.9 \times 10^{-3}$ , which is **engineering form**.

Hence,  $0.17^2 = 28.9 \times 10^{-3}$  in engineering form. The ENG function is extremely important in engineering calculations.

**Problem 5.** Change 348620 into engineering form

- (i) Type in 348620
- (ii) Press = then ENG.

Hence,  $348620 = 348.62 \times 10^3$  in engineering form.

**Problem 6.** Change 0.0000538 into engineering form

- (i) Type in 0.0000538
- (ii) Press = then ENG.

Hence,  $0.0000538 = 53.8 \times 10^{-6}$  in engineering form.

**Problem 7.** Evaluate  $1.4^3$

- (i) Type in 1.4
- (ii) Press  $x^3$  and  $1.4^3$  appears on the screen.
- (iii) Press = and the answer  $\frac{343}{125}$  appears.
- (iv) Press the  $S \Leftrightarrow D$  function and the fraction changes to a decimal: 2.744

Thus,  $1.4^3 = 2.744$ .

Now try the following Practice Exercise

### Practice Exercise 13 Square and cube functions (answers on page 341)

1. Evaluate  $3.5^2$
2. Evaluate  $0.19^2$
3. Evaluate  $6.85^2$  correct to 3 decimal places.
4. Evaluate  $(0.036)^2$  in engineering form.
5. Evaluate  $1.563^2$  correct to 5 significant figures.
6. Evaluate  $1.3^3$

7. Evaluate  $3.14^3$  correct to 4 significant figures.
8. Evaluate  $(0.38)^3$  correct to 4 decimal places.
9. Evaluate  $(6.03)^3$  correct to 2 decimal places.
10. Evaluate  $(0.018)^3$  in engineering form.

### 4.3.2 Reciprocal and power functions

The reciprocal of 2 is  $\frac{1}{2}$ , the reciprocal of 9 is  $\frac{1}{9}$  and the reciprocal of  $x$  is  $\frac{1}{x}$ , which from indices may be written as  $x^{-1}$ . Locate the reciprocal, i.e.  $x^{-1}$  on the calculator. Also, locate the power function, i.e.  $x^\square$ , on your calculator and then check the following worked examples.

**Problem 8.** Evaluate  $\frac{1}{3.2}$

- (i) Type in 3.2
- (ii) Press  $x^{-1}$  and  $3.2^{-1}$  appears on the screen.
- (iii) Press = and the answer  $\frac{5}{16}$  appears.
- (iv) Press the  $S \Leftrightarrow D$  function and the fraction changes to a decimal: 0.3125

Thus,  $\frac{1}{3.2} = 0.3125$

**Problem 9.** Evaluate  $1.5^5$  correct to 4 significant figures

- (i) Type in 1.5
- (ii) Press  $x^\square$  and  $1.5^\square$  appears on the screen.
- (iii) Press 5 and  $1.5^5$  appears on the screen.
- (iv) Press Shift and = and the answer 7.59375 appears.

Thus,  $1.5^5 = 7.594$  correct to 4 significant figures.

**Problem 10.** Evaluate  $2.4^6 - 1.9^4$  correct to 3 decimal places

- (i) Type in 2.4
- (ii) Press  $x^\square$  and  $2.4^\square$  appears on the screen.

- (iii) Press 6 and  $2.4^6$  appears on the screen.
  - (iv) The cursor now needs to be moved; this is achieved by using the cursor key (the large blue circular function in the top centre of the calculator). Press  $\rightarrow$
  - (v) Press  $-$
  - (vi) Type in 1.9, press  $x^\square$ , then press 4.
  - (vii) Press  $=$  and the answer 178.07087... appears.
- Thus,  $2.4^6 - 1.9^4 = 178.071$  correct to 3 decimal places.

Now try the following Practice Exercise

**Practice Exercise 14 Reciprocal and power functions (answers on page 341)**

- Evaluate  $\frac{1}{1.75}$  correct to 3 decimal places.
- Evaluate  $\frac{1}{0.0250}$
- Evaluate  $\frac{1}{7.43}$  correct to 5 significant figures.
- Evaluate  $\frac{1}{0.00725}$  correct to 1 decimal place.
- Evaluate  $\frac{1}{0.065} - \frac{1}{2.341}$  correct to 4 significant figures.
- Evaluate  $2.1^4$
- Evaluate  $(0.22)^5$  correct to 5 significant figures in engineering form.
- Evaluate  $(1.012)^7$  correct to 4 decimal places.
- Evaluate  $(0.05)^6$  in engineering form.
- Evaluate  $1.1^3 + 2.9^4 - 4.4^2$  correct to 4 significant figures.

### 4.3.3 Root and $\times 10^x$ functions

Locate the square root function  $\sqrt{\square}$  and the  $\sqrt[\square]{\square}$  function (which is a Shift function located above the  $x^\square$  function) on your calculator. Also, locate the  $\times 10^x$  function and then check the following worked examples.

**Problem 11.** Evaluate  $\sqrt{361}$

- (i) Press the  $\sqrt{\square}$  function.
  - (ii) Type in 361 and  $\sqrt{361}$  appears on the screen.
  - (iii) Press  $=$  and the answer 19 appears.
- Thus,  $\sqrt{361} = 19$ .

**Problem 12.** Evaluate  $\sqrt[4]{81}$

- (i) Press the  $\sqrt[\square]{\square}$  function.
  - (ii) Type in 4 and  $\sqrt[4]{\square}$  appears on the screen.
  - (iii) Press  $\rightarrow$  to move the cursor and then type in 81 and  $\sqrt[4]{81}$  appears on the screen.
  - (iv) Press  $=$  and the answer 3 appears.
- Thus,  $\sqrt[4]{81} = 3$ .

**Problem 13.** Evaluate  $6 \times 10^5 \times 2 \times 10^{-7}$

- (i) Type in 6
- (ii) Press the  $\times 10^x$  function (note, you do not have to use  $\times$ ).
- (iii) Type in 5
- (iv) Press  $\times$
- (v) Type in 2
- (vi) Press the  $\times 10^x$  function.
- (vii) Type in  $-7$
- (viii) Press  $=$  and the answer  $\frac{3}{25}$  appears.
- (ix) Press the  $S \Leftrightarrow D$  function and the fraction changes to a decimal: 0.12

Thus,  $6 \times 10^5 \times 2 \times 10^{-7} = 0.12$

Now try the following Practice Exercise

**Practice Exercise 15 Root and  $\times 10^x$  functions (answers on page 341)**

- Evaluate  $\sqrt{4.76}$  correct to 3 decimal places.
- Evaluate  $\sqrt{123.7}$  correct to 5 significant figures.

3. Evaluate  $\sqrt{34528}$  correct to 2 decimal places.
4. Evaluate  $\sqrt{0.69}$  correct to 4 significant figures.
5. Evaluate  $\sqrt{0.025}$  correct to 4 decimal places.
6. Evaluate  $\sqrt[3]{17}$  correct to 3 decimal places.
7. Evaluate  $\sqrt[4]{773}$  correct to 4 significant figures.
8. Evaluate  $\sqrt[5]{3.12}$  correct to 4 decimal places.
9. Evaluate  $\sqrt[3]{0.028}$  correct to 5 significant figures.
10. Evaluate  $\sqrt[6]{2451} - \sqrt[4]{46}$  correct to 3 decimal places.

Express the answers to questions 11 to 15 in engineering form.

11. Evaluate  $5 \times 10^{-3} \times 7 \times 10^8$
12. Evaluate  $\frac{3 \times 10^{-4}}{8 \times 10^{-9}}$
13. Evaluate  $\frac{6 \times 10^3 \times 14 \times 10^{-4}}{2 \times 10^6}$
14. Evaluate  $\frac{56.43 \times 10^{-3} \times 3 \times 10^4}{8.349 \times 10^3}$  correct to 3 decimal places.
15. Evaluate  $\frac{99 \times 10^5 \times 6.7 \times 10^{-3}}{36.2 \times 10^{-4}}$  correct to 4 significant figures.

#### 4.3.4 Fractions

Locate the  $\frac{\square}{\square}$  and  $\square \frac{\square}{\square}$  functions on your calculator (the latter function is a Shift function found above the  $\frac{\square}{\square}$  function) and then check the following worked examples.

**Problem 14.** Evaluate  $\frac{1}{4} + \frac{2}{3}$

- (i) Press the  $\frac{\square}{\square}$  function.
- (ii) Type in 1
- (iii) Press  $\downarrow$  on the cursor key and type in 4

- (iv)  $\frac{1}{4}$  appears on the screen.
- (v) Press  $\rightarrow$  on the cursor key and type in +
- (vi) Press the  $\frac{\square}{\square}$  function.
- (vii) Type in 2
- (viii) Press  $\downarrow$  on the cursor key and type in 3
- (ix) Press  $\rightarrow$  on the cursor key.
- (x) Press = and the answer  $\frac{11}{12}$  appears.
- (xi) Press the  $S \Leftrightarrow D$  function and the fraction changes to a decimal 0.916666...

Thus,  $\frac{1}{4} + \frac{2}{3} = \frac{11}{12} = 0.9167$  as a decimal, correct to 4 decimal places.

It is also possible to deal with **mixed numbers** on the calculator. Press Shift then the  $\square \frac{\square}{\square}$  function and  $\square \frac{\square}{\square}$  appears.

**Problem 15.** Evaluate  $5\frac{1}{5} - 3\frac{3}{4}$

- (i) Press Shift then the  $\square \frac{\square}{\square}$  function and  $\square \frac{\square}{\square}$  appears on the screen.
- (ii) Type in 5 then  $\rightarrow$  on the cursor key.
- (iii) Type in 1 and  $\downarrow$  on the cursor key.
- (iv) Type in 5 and  $5\frac{1}{5}$  appears on the screen.
- (v) Press  $\rightarrow$  on the cursor key.
- (vi) Type in - and then press Shift then the  $\square \frac{\square}{\square}$  function and  $5\frac{1}{5} - \square \frac{\square}{\square}$  appears on the screen.
- (vii) Type in 3 then  $\rightarrow$  on the cursor key.
- (viii) Type in 3 and  $\downarrow$  on the cursor key.
- (ix) Type in 4 and  $5\frac{1}{5} - 3\frac{3}{4}$  appears on the screen.
- (x) Press = and the answer  $\frac{29}{20}$  appears.
- (xi) Press  $S \Leftrightarrow D$  function and the fraction changes to a decimal 1.45

Thus,  $5\frac{1}{5} - 3\frac{3}{4} = \frac{29}{20} = 1\frac{9}{20} = 1.45$  as a decimal.

Now try the following Practice Exercise

**Practice Exercise 16 Fractions (answers on page 341)**

1. Evaluate  $\frac{4}{5} - \frac{1}{3}$  as a decimal, correct to 4 decimal places.
2. Evaluate  $\frac{2}{3} - \frac{1}{6} + \frac{3}{7}$  as a fraction.
3. Evaluate  $2\frac{5}{6} + 1\frac{5}{8}$  as a decimal, correct to 4 significant figures.
4. Evaluate  $5\frac{6}{7} - 3\frac{1}{8}$  as a decimal, correct to 4 significant figures.
5. Evaluate  $\frac{1}{3} - \frac{3}{4} \times \frac{8}{21}$  as a fraction.
6. Evaluate  $\frac{3}{8} + \frac{5}{6} - \frac{1}{2}$  as a decimal, correct to 4 decimal places.
7. Evaluate  $\frac{3}{4} \times \frac{4}{5} - \frac{2}{3} \div \frac{4}{9}$  as a fraction.
8. Evaluate  $8\frac{8}{9} \div 2\frac{2}{3}$  as a mixed number.
9. Evaluate  $3\frac{1}{5} \times 1\frac{1}{3} - 1\frac{7}{10}$  as a decimal, correct to 3 decimal places.
10. Evaluate  $\frac{\left(4\frac{1}{5} - 1\frac{2}{3}\right)}{\left(3\frac{1}{4} \times 2\frac{3}{5}\right)} - \frac{2}{9}$  as a decimal, correct to 3 significant figures.

### 4.3.5 Trigonometric functions

Trigonometric ratios will be covered in Chapter 21. However, very briefly, there are three functions on your calculator that are involved with trigonometry. They are:

**sin** which is an abbreviation of **sine**

**cos** which is an abbreviation of **cosine**, and

**tan** which is an abbreviation of **tangent**

Exactly what these mean will be explained in Chapter 21.

There are two main ways that angles are measured, i.e. in **degrees** or in **radians**. Pressing Shift, Setup and 3 shows degrees, and Shift, Setup and 4 shows radians.

Press 3 and your calculator will be in **degrees mode**, indicated by a small D appearing at the top of the screen.

Press 4 and your calculator will be in **radian mode**, indicated by a small R appearing at the top of the screen.

Locate the sin, cos and tan functions on your calculator and then check the following worked examples.

**Problem 16.** Evaluate  $\sin 38^\circ$

- (i) Make sure your calculator is in degrees mode.
- (ii) Press sin function and sin( appears on the screen.
- (iii) Type in 38 and close the bracket with) and sin(38) appears on the screen.
- (iv) Press = and the answer 0.615661475... appears.

Thus,  **$\sin 38^\circ = 0.6157$ , correct to 4 decimal places.**

**Problem 17.** Evaluate  $5.3 \tan(2.23 \text{ rad})$

- (i) Make sure your calculator is in radian mode by pressing Shift then Setup then 4 (a small R appears at the top of the screen).
- (ii) Type in 5.3 then press tan function and 5.3 tan( appears on the screen.
- (iii) Type in 2.23 and close the bracket with) and 5.3 tan(2.23) appears on the screen.
- (iv) Press = and the answer -6.84021262... appears.

Thus,  **$5.3 \tan(2.23 \text{ rad}) = -6.8402$ , correct to 4 decimal places.**

Now try the following Practice Exercise

**Practice Exercise 17 Trigonometric functions (answers on page 341)**

Evaluate the following, each correct to 4 decimal places.

1. Evaluate  $\sin 67^\circ$
2. Evaluate  $\cos 43^\circ$
3. Evaluate  $\tan 71^\circ$
4. Evaluate  $\sin 15.78^\circ$
5. Evaluate  $\cos 63.74^\circ$
6. Evaluate  $\tan 39.55^\circ - \sin 52.53^\circ$
7. Evaluate  $\sin(0.437 \text{ rad})$

8. Evaluate  $\cos(1.42 \text{ rad})$
9. Evaluate  $\tan(5.673 \text{ rad})$
10. Evaluate  $\frac{(\sin 42.6^\circ)(\tan 83.2^\circ)}{\cos 13.8^\circ}$

#### 4.3.6 $\pi$ and $e^x$ functions

Press Shift and then press the  $\times 10^x$  function key and  $\pi$  appears on the screen. Either press Shift and = (or = and  $S \Leftrightarrow D$ ) and the value of  $\pi$  appears in decimal form as 3.14159265...

Press Shift and then press the  $\ln$  function key and  $e^\square$  appears on the screen. Enter 1 and then press = and  $e^1 = e = 2.71828182...$

Now check the following worked examples involving  $\pi$  and  $e^x$  functions.

**Problem 18.** Evaluate  $3.57\pi$

- (i) Enter 3.57
- (ii) Press Shift and the  $\times 10^x$  key and  $3.57\pi$  appears on the screen.
- (iii) Either press Shift and = (or = and  $S \Leftrightarrow D$ ) and the value of  $3.57\pi$  appears in decimal as 11.2154857...

Hence,  $3.57\pi = 11.22$  correct to 4 significant figures.

**Problem 19.** Evaluate  $e^{2.37}$

- (i) Press Shift and then press the  $\ln$  function key and  $e^\square$  appears on the screen.
- (ii) Enter 2.37 and  $e^{2.37}$  appears on the screen.
- (iii) Press Shift and = (or = and  $S \Leftrightarrow D$ ) and the value of  $e^{2.37}$  appears in decimal as 10.6973922...

Hence,  $e^{2.37} = 10.70$  correct to 4 significant figures.

Now try the following Practice Exercise

#### Practice Exercise 18 $\pi$ and $e^x$ functions (answers on page 341)

Evaluate the following, each correct to 4 significant figures.

1.  $1.59\pi$
2.  $2.7(\pi - 1)$

3.  $\pi^2(\sqrt{13} - 1)$
4.  $3e^\pi$
5.  $8.5e^{-2.5}$
6.  $3e^{2.9} - 1.6$
7.  $3e^{(2\pi-1)}$
8.  $2\pi e^{\frac{\pi}{3}}$
9.  $\sqrt{\left[\frac{5.52\pi}{2e^{-2} \times \sqrt{26.73}}\right]}$
10.  $\sqrt{\left[\frac{e^{(2-\sqrt{3})}}{\pi \times \sqrt{8.57}}\right]}$

#### 4.4 Evaluation of formulae

The statement  $y = mx + c$  is called a **formula** for  $y$  in terms of  $m$ ,  $x$  and  $c$ .

$y$ ,  $m$ ,  $x$  and  $c$  are called **symbols**.

When given values of  $m$ ,  $x$  and  $c$  we can evaluate  $y$ .

There are a large number of formulae used in engineering and in this section we will insert numbers in place of symbols to evaluate engineering quantities.

Just four examples of important formulae are:

1. A straight line graph is of the form  $y = mx + c$  (see Chapter 17).
2. Ohm's law states that  $V = I \times R$ .
3. Velocity is expressed as  $v = u + at$ .
4. Force is expressed as  $F = m \times a$ .

Here are some practical examples. Check with your calculator that you agree with the working and answers.

**Problem 20.** In an electrical circuit the voltage  $V$  is given by Ohm's law, i.e.  $V = IR$ . Find, correct to 4 significant figures, the voltage when  $I = 5.36 \text{ A}$  and  $R = 14.76 \Omega$

$$V = IR = (5.36)(14.76)$$

Hence, **voltage  $V = 79.11 \text{ V}$ , correct to 4 significant figures.**

**Problem 21.** The surface area  $A$  of a hollow cone is given by  $A = \pi rl$ . Determine, correct to 1 decimal place, the surface area when  $r = 3.0 \text{ cm}$  and  $l = 8.5 \text{ cm}$

$$A = \pi rl = \pi(3.0)(8.5) \text{ cm}^2$$

Hence, **surface area  $A = 80.1 \text{ cm}^2$ , correct to 1 decimal place.**



**Problem 22.** Velocity  $v$  is given by  $v = u + at$ . If  $u = 9.54 \text{ m/s}$ ,  $a = 3.67 \text{ m/s}^2$  and  $t = 7.82 \text{ s}$ , find  $v$ , correct to 3 significant figures

$$\begin{aligned} v &= u + at = 9.54 + 3.67 \times 7.82 \\ &= 9.54 + 28.6994 = 38.2394 \end{aligned}$$

Hence, **velocity  $v = 38.2 \text{ m/s}$ , correct to 3 significant figures.**

**Problem 23.** The area,  $A$ , of a circle is given by  $A = \pi r^2$ . Determine the area correct to 2 decimal places, given radius  $r = 5.23 \text{ m}$

$$A = \pi r^2 = \pi (5.23)^2 = \pi (27.3529)$$

Hence, **area,  $A = 85.93 \text{ m}^2$ , correct to 2 decimal places.**

**Problem 24.** Density =  $\frac{\text{mass}}{\text{volume}}$ . Find the density when the mass is  $6.45 \text{ kg}$  and the volume is  $300 \times 10^{-6} \text{ cm}^3$

$$\text{Density} = \frac{\text{mass}}{\text{volume}} = \frac{6.45 \text{ kg}}{300 \times 10^{-6} \text{ m}^3} = \mathbf{21500 \text{ kg/m}^3}$$

**Problem 25.** The power,  $P$  watts, dissipated in an electrical circuit is given by the formula  $P = \frac{V^2}{R}$ . Evaluate the power, correct to 4 significant figures, given that  $V = 230 \text{ V}$  and  $R = 35.63 \Omega$

$$P = \frac{V^2}{R} = \frac{(230)^2}{35.63} = \frac{52900}{35.63} = 1484.70390 \dots$$

Press ENG and  $1.48470390 \dots \times 10^3$  appears on the screen.

Hence, **power,  $P = 1485 \text{ W}$  or  $1.485 \text{ kW}$  correct to 4 significant figures.**

Now try the following Practice Exercise

#### Practice Exercise 19 Evaluation of formulae (answers on page 341)

1. The area  $A$  of a rectangle is given by the formula  $A = lb$ . Evaluate the area when  $l = 12.4 \text{ cm}$  and  $b = 5.37 \text{ cm}$ .

2. The circumference  $C$  of a circle is given by the formula  $C = 2\pi r$ . Determine the circumference given  $r = 8.40 \text{ mm}$ .
3. A formula used in connection with gases is  $R = \frac{PV}{T}$ . Evaluate  $R$  when  $P = 1500$ ,  $V = 5$  and  $T = 200$ .
4. The velocity of a body is given by  $v = u + at$ . The initial velocity  $u$  is measured when time  $t$  is 15 seconds and found to be  $12 \text{ m/s}$ . If the acceleration  $a$  is  $9.81 \text{ m/s}^2$  calculate the final velocity  $v$ .
5. Calculate the current  $I$  in an electrical circuit, where  $I = V/R$  amperes when the voltage  $V$  is measured and found to be  $7.2 \text{ V}$  and the resistance  $R$  is  $17.7 \Omega$ .
6. Find the distance  $s$ , given that  $s = \frac{1}{2}gt^2$  when time  $t = 0.032 \text{ seconds}$  and acceleration due to gravity  $g = 9.81 \text{ m/s}^2$ . Give the answer in millimetres.
7. The energy stored in a capacitor is given by  $E = \frac{1}{2}CV^2$  joules. Determine the energy when capacitance  $C = 5 \times 10^{-6} \text{ farads}$  and voltage  $V = 240 \text{ V}$ .
8. Find the area  $A$  of a triangle, given  $A = \frac{1}{2}bh$ , when the base length  $l$  is  $23.42 \text{ m}$  and the height  $h$  is  $53.7 \text{ m}$ .
9. Resistance  $R_2$  is given by  $R_2 = R_1(1 + \alpha t)$ . Find  $R_2$ , correct to 4 significant figures, when  $R_1 = 220$ ,  $\alpha = 0.00027$  and  $t = 75.6$
10. Density =  $\frac{\text{mass}}{\text{volume}}$ . Find the density when the mass is  $2.462 \text{ kg}$  and the volume is  $173 \text{ cm}^3$ . Give the answer in units of  $\text{kg/m}^3$ .
11. Velocity = frequency  $\times$  wavelength. Find the velocity when the frequency is  $1825 \text{ Hz}$  and the wavelength is  $0.154 \text{ m}$ .
12. Evaluate resistance  $R_T$ , given  $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$  when  $R_1 = 5.5 \Omega$ ,  $R_2 = 7.42 \Omega$  and  $R_3 = 12.6 \Omega$ .

Here are some further practical examples. Again, check with your calculator that you agree with the working and answers.

**Problem 26.** The volume  $V \text{ cm}^3$  of a right circular cone is given by  $V = \frac{1}{3}\pi r^2 h$ . Given that radius  $r = 2.45 \text{ cm}$  and height  $h = 18.7 \text{ cm}$ , find the volume, correct to 4 significant figures

$$\begin{aligned} V &= \frac{1}{3}\pi r^2 h = \frac{1}{3}\pi (2.45)^2 (18.7) \\ &= \frac{1}{3} \times \pi \times 2.45^2 \times 18.7 \\ &= 117.544521 \dots \end{aligned}$$

Hence, **volume,  $V = 117.5 \text{ cm}^3$ , correct to 4 significant figures.**

**Problem 27.** Force  $F$  newtons is given by the formula  $F = \frac{Gm_1m_2}{d^2}$ , where  $m_1$  and  $m_2$  are masses,  $d$  their distance apart and  $G$  is a constant. Find the value of the force given that  $G = 6.67 \times 10^{-11}$ ,  $m_1 = 7.36$ ,  $m_2 = 15.5$  and  $d = 22.6$ . Express the answer in standard form, correct to 3 significant figures

$$\begin{aligned} F &= \frac{Gm_1m_2}{d^2} = \frac{(6.67 \times 10^{-11})(7.36)(15.5)}{(22.6)^2} \\ &= \frac{(6.67)(7.36)(15.5)}{(10^{11})(510.76)} = \frac{1.490}{10^{11}} \end{aligned}$$

Hence, **force  $F = 1.49 \times 10^{-11}$  newtons, correct to 3 significant figures.**

**Problem 28.** The time of swing,  $t$  seconds, of a simple pendulum is given by  $t = 2\pi\sqrt{\frac{l}{g}}$ . Determine the time, correct to 3 decimal places, given that  $l = 12.9$  and  $g = 9.81$

$$t = 2\pi\sqrt{\frac{l}{g}} = (2\pi)\sqrt{\frac{12.9}{9.81}} = 7.20510343 \dots$$

Hence, **time  $t = 7.205$  seconds, correct to 3 decimal places.**

**Problem 29.** Resistance,  $R \Omega$ , varies with temperature according to the formula  $R = R_0(1 + \alpha t)$ . Evaluate  $R$ , correct to 3 significant figures, given  $R_0 = 14.59$ ,  $\alpha = 0.0043$  and  $t = 80$

$$\begin{aligned} R &= R_0(1 + \alpha t) = 14.59[1 + (0.0043)(80)] \\ &= 14.59(1 + 0.344) \\ &= 14.59(1.344) \end{aligned}$$

Hence, **resistance,  $R = 19.6 \Omega$ , correct to 3 significant figures.**

**Problem 30.** The current,  $I$  amperes, in an a.c. circuit is given by  $I = \frac{V}{\sqrt{R^2 + X^2}}$ . Evaluate the current, correct to 2 decimal places, when  $V = 250 \text{ V}$ ,  $R = 25.0 \Omega$  and  $X = 18.0 \Omega$ .

$$I = \frac{V}{\sqrt{R^2 + X^2}} = \frac{250}{\sqrt{(25.0)^2 + (18.0)^2}} = 8.11534341 \dots$$

Hence, **current,  $I = 8.12 \text{ A}$ , correct to 2 decimal places.**

Now try the following Practice Exercise

#### Practice Exercise 20 Evaluation of formulae (answers on page 341)

- Find the total cost of 37 calculators costing £12.65 each and 19 drawing sets costing £6.38 each.
- Power =  $\frac{\text{force} \times \text{distance}}{\text{time}}$ . Find the power when a force of 3760 N raises an object a distance of 4.73 m in 35 s.
- The potential difference,  $V$  volts, available at battery terminals is given by  $V = E - Ir$ . Evaluate  $V$  when  $E = 5.62$ ,  $I = 0.70$  and  $R = 4.30$
- Given force  $F = \frac{1}{2}m(v^2 - u^2)$ , find  $F$  when  $m = 18.3$ ,  $v = 12.7$  and  $u = 8.24$
- The current  $I$  amperes flowing in a number of cells is given by  $I = \frac{nE}{R + nr}$ . Evaluate the current when  $n = 36$ ,  $E = 2.20$ ,  $R = 2.80$  and  $r = 0.50$
- The time,  $t$  seconds, of oscillation for a simple pendulum is given by  $t = 2\pi\sqrt{\frac{l}{g}}$ . Determine the time when  $l = 54.32$  and  $g = 9.81$



7. Energy,  $E$  joules, is given by the formula  $E = \frac{1}{2}LI^2$ . Evaluate the energy when  $L = 5.5$  and  $I = 1.2$
8. The current  $I$  amperes in an a.c. circuit is given by  $I = \frac{V}{\sqrt{(R^2 + X^2)}}$ . Evaluate the current when  $V = 250$ ,  $R = 11.0$  and  $X = 16.2$
9. Distance  $s$  metres is given by the formula  $s = ut + \frac{1}{2}at^2$ . If  $u = 9.50$ ,  $t = 4.60$  and  $a = -2.50$ , evaluate the distance.
10. The area,  $A$ , of any triangle is given by  $A = \sqrt{[s(s-a)(s-b)(s-c)]}$  where  $s = \frac{a+b+c}{2}$ . Evaluate the area, given  $a = 3.60$  cm,  $b = 4.00$  cm and  $c = 5.20$  cm.
11. Given that  $a = 0.290$ ,  $b = 14.86$ ,  $c = 0.042$ ,  $d = 31.8$  and  $e = 0.650$ , evaluate  $v$  given that  $v = \sqrt{\left(\frac{ab}{c} - \frac{d}{e}\right)}$
12. Deduce the following information from the train timetable shown in Table 4.1.
  - (a) At what time should a man catch a train at Fratton to enable him to be in London Waterloo by 14.23 h?
  - (b) A girl leaves Cosham at 12.39 h and travels to Woking. How long does the journey take? And, if the distance between Cosham and Woking is 55 miles, calculate the average speed of the train.
  - (c) A man living at Havant has a meeting in London at 15.30 h. It takes around 25 minutes on the underground to reach his destination from London Waterloo. What train should he catch from Havant to comfortably make the meeting?
  - (d) Nine trains leave Portsmouth harbour between 12.18 h and 13.15 h. Which train should be taken for the shortest journey time?

**Table 4.1** Train timetable from Portsmouth Harbour to London Waterloo  
**Portsmouth Harbour - London Waterloo**

Saturdays										
	OUTWARD	Time	Time	Time	Time	Time	Time	Time	Time	Time
	Train Alterations	S04	S03	S08	S02	S03	S04	S04	S01	S02
Portsmouth Harbour	dep	12:18 <sup>SW</sup>	12:22 <sup>GW</sup>	12:22 <sup>GW</sup>	12:45 <sup>SW</sup>	12:45 <sup>SW</sup>	12:45 <sup>SW</sup>	12:54 <sup>SW</sup>	13:12 <sup>SN</sup>	13:15 <sup>SW</sup>
Portsmouth & Southsea	arr	12:21	12:25	12:25	12:48	12:48	12:48	12:57	13:15	13:18
Portsmouth & Southsea	dep	12:24	12:27	12:27	12:50	12:50	12:50	12:59	13:16	13:20
Fratton	arr	12:27	12:30	12:30	12:53	12:53	12:53	13:02	13:19	13:23
Fratton	dep	12:28	12:31	12:31	12:54	12:54	12:54	13:03	13:20	13:24
Hilsea	arr	12:32						13:07		
Hilsea	dep	12:32						13:07		
Cosham	arr		12:38	12:38				13:12		
Cosham	dep		12:39	12:39				13:12		
Bedhampton	arr	12:37								
Bedhampton	dep	12:37								
Havant	arr	12:39			13:03	13:03	13:02		13:29	13:33
Havant	dep	12:40			13:04	13:04	13:04		13:30	13:34
Rowlands Castle	arr	12:46								
Rowlands Castle	dep	12:46								
Chichester	arr								13:40	
Chichester	dep								13:41	
Barnham	arr								13:48	
Barnham	dep								13:49	
Horsham	arr								14:16	
Horsham	dep								14:20	
Crawley	arr								14:28	
Crawley	dep								14:29	
Three Bridges	arr								14:32	
Three Bridges	dep								14:33	
Gatwick Airport	arr								14:37	
Gatwick Airport	dep								14:38	
Horley	arr								14:41	
Horley	dep								14:41	
Redhill	arr								14:47	
Redhill	dep								14:48	
East Croydon	arr								15:00	
East Croydon	dep								15:00	
Petersfield	arr	12:56			13:17	13:17	13:17			13:47
Petersfield	dep	12:57			13:18	13:18	13:18			13:48
Liss	arr	13:02								
Liss	dep	13:02								
Liphook	arr	13:09								
Liphook	dep	13:09								
Haslemere	arr	13:14C			13:31	13:31	13:30C			14:01
Haslemere	dep	13:20 <sup>SW</sup> <sub>R</sub>			13:32	13:32	13:36 <sup>SW</sup> <sub>R</sub>			14:02
Guildford	arr	13:55C			13:45	13:45	14:11C			14:15
Guildford	dep	14:02 <sup>SW</sup>			13:47	13:47	14:17 <sup>SW</sup> <sub>R</sub>			14:17
Portchester	arr							13:17		
Portchester	dep							13:17		
Fareham	arr		12:46	12:46				13:22		
Fareham	dep		12:47	12:47				13:23		
Southampton Central	arr			13:08C						
Southampton Central	dep			13:30 <sup>SW</sup>						
Botley	arr							13:30		
Botley	dep							13:30		
Hedge End	arr							13:34		
Hedge End	dep							13:35		
Eastleigh	arr		13:00C					13:41		
Eastleigh	dep		13:09 <sup>SW</sup>					13:42		
Southampton Airport Parkway	arr			13:37						
Southampton Airport Parkway	dep			13:38						
Winchester	arr		13:17	13:47				13:53		
Winchester	dep		13:18	13:48				13:54		
Micheldever	arr							14:02		
Micheldever	dep							14:02		
Basingstoke	arr		13:34					14:15		
Basingstoke	dep		13:36					14:17		
Farnborough	arr							14:30		
Farnborough	dep							14:31		
Woking	arr	14:11		14:19	13:57	13:57	14:25	14:40		14:25
Woking	dep	14:12		14:21	13:59	13:59	14:26	14:41		14:26
Clapham Junction	arr	14:31	14:12					15:01	15:11C	
Clapham Junction	dep	14:32	14:13						15:21 <sup>SW</sup>	
Vauxhall	arr								15:26	
Vauxhall	dep								15:26	
London Waterloo	arr	14:40	14:24	14:49	14:23	14:27	14:51	15:13	15:31	14:51