Problem 1. If $\vec{p} = 2\hat{\imath} + \hat{\jmath} - \hat{k}$ and $\vec{q} = \hat{\imath} - 3\hat{\jmath} + 2\hat{k}$.

1. Represent the two vectors in a three dimensional orthonormal coordinate system.
2. Find $\vec{p} + \vec{q}$. Then represent it on the same coordinate system.
3. Find $|\vec{p}|, |\vec{q}|$ and $|\vec{p} + \vec{q}|$.
4. Find $\vec{p} \cdot \vec{q}$, then find the angle between $\vec{p}$ and $\vec{q}$

Problem 2. If $\vec{p} = 4\hat{\imath} + \hat{\jmath} - 2\hat{k}$, $\vec{q} = 3\hat{\imath} - 2\hat{\jmath} + \hat{k}$ and $\vec{r} = \hat{\imath} - 2\hat{\jmath}$

1. Represent the three vectors in a three dimensional orthonormal coordinate system.
2. Find $(\vec{p} - 2\vec{q}) \times \vec{r}$.
3. Find $\vec{p} \times (2\vec{r} \times 3\vec{q})$

Problem 3. For the vectors $\vec{a} = \hat{\imath} + 4\hat{\jmath} - 2\hat{k}$ and $\vec{b} = 2\hat{\imath} - \hat{\jmath} + 3\hat{k}$.

1. Represent the two vectors in a three dimensional orthonormal coordinate system.
2. Find $\vec{a} \times \vec{b}$. Then represent it on the same coordinate system.

Problem 4. Represent the two vectors $\vec{a} = 2\hat{\imath} - \hat{\jmath} + 3\hat{k}$ and $\vec{b} = -\hat{\imath} + \hat{\jmath} - 3\hat{k}$. in a three-dimensional orthonormal coordinate system.

Find the angle between the two vectors. Then

Find $\vec{a} \times \vec{b}$. Then represent it on the same coordinate system.

Problem 5. For the vector $\vec{r} = 2\hat{\imath} + 5\hat{\jmath} + 13\ \hat{k}$

1) Sketch the vector in a three-dimensional orthonormal coordinate system.

2) Find its length. Then

3) Find the direction cosines and the angles the vector makes with coordinate axes.

Problem 6. sketch the three vectors: $\vec{a} = 2\hat{\imath} + \hat{\jmath} - \hat{k}$, $\vec{b} = \hat{\imath} - 3\hat{\jmath} + 2\hat{k}$ and $\vec{c} = 2\hat{\imath} - \hat{\jmath} + 3\hat{k}$, then find the oriented volume (الحجم الموجه) of the parallelepiped (متوازي سطوح) defined by these vectors.

Problem 7. If $\vec{p} = 2\hat{\imath} + \hat{\jmath} + \hat{k}$ and $\vec{q} = \hat{\imath} + 2\hat{\jmath} + 2\hat{k}$.

1. Represent the two vectors in a three dimensional orthonormal coordinate system.
2. Find $\vec{p} + \vec{q}$. Then represent it on the same coordinate system.
3. Find $|\vec{p}|, |\vec{q}|$ and $|\vec{p} + \vec{q}|$.
4. Find $\vec{p} \cdot \vec{q}$, then find the angle between $\vec{p}$ and $\vec{q}$

Problem 8. If $\vec{p} = 4\hat{\imath} + \hat{\jmath} - \hat{k}, \vec{q} = 3\hat{\imath} - \hat{\jmath} + \hat{k}$ and $\vec{r} = \hat{\imath} - \hat{\jmath}$

1. Represent the three vectors in a three dimensional orthonormal coordinate system.
2. Find $(\vec{p} - 2\vec{q}) \times \vec{r}$.
3. Find $\vec{p} \times (2\vec{r} \times 3\vec{q})$

Problem 9. For the vectors $\vec{a} = -\hat{\imath} + \hat{\jmath} - \hat{k}$ and $\vec{b} = 2\hat{\imath} - \hat{\jmath} + \hat{k}$.

1. Represent the two vectors in a three dimensional orthonormal coordinate system.
2. Find $\vec{a} \times \vec{b}$. Then represent it on the same coordinate system.

All calculators have **+, −, x and ÷ functions** and these functions will, no doubt, already have been used in calculations.

Problem 1. Evaluate $364.7 \div 57.5$ correct to 3 decimal places

(i) Type in 364.7

(ii) Press ÷.

(iii) Type in 57.5

(iv) Press = and the fraction $\frac{3647}{575}$ appears.

(v) Press the $S \Leftrightarrow D$ function and the decimal answer 6.34260869... appears.

Alternatively, after step (iii) press Shift and = and the decimal will appear.

Hence, **$364.7 \div 57.5 = 6.343$, correct to 3 decimal places.**

Problem 2. Evaluate $\frac{12.47 \times 31.59}{70.45 \times 0.052}$ correct to 4 significant figures

(i) Type in 12.47

(ii) Press ×.

(iii) Type in 31.59

(iv) Press ÷.

(v) The denominator must have brackets; i.e. press (.

(vi) Type in 70.45×0.052 and complete the bracket; i.e. press)

(vii) Press = and the answer 107.530518... appears.

Hence, **$\frac{12.47 \times 31.59}{70.45 \times 0.052} = 107.5$, correct to 4 significant figures.**

Now try the following Practice Exercise

Practice Exercise 12 Addition, subtraction, multiplication and division using a calculator (answers on page 1149)

1. Evaluate $378.37 - 298.651 + 45.64 - 94.562$
2. Evaluate 25.63×465.34 correct to 5 significant figures.
3. Evaluate $562.6 \div 41.3$ correct to 2 decimal places.
4. Evaluate $\dfrac{17.35 \times 34.27}{41.53 \div 3.76}$ correct to 3 decimal places.
5. Evaluate $27.48 + 13.72 \times 4.15$ correct to 4 significant figures.
6. Evaluate $\dfrac{(4.527 + 3.63)}{(452.51 \div 34.75)} + 0.468$ correct to 5 significant figures.
7. Evaluate $52.34 - \dfrac{(912.5 \div 41.46)}{(24.6 - 13.652)}$ correct to 3 decimal places.
8. Evaluate $\dfrac{52.14 \times 0.347 \times 11.23}{19.73 \div 3.54}$ correct to 4 significant figures.
9. Evaluate $\dfrac{451.2}{24.57} - \dfrac{363.8}{46.79}$ correct to 4 significant figures.
10. Evaluate $\dfrac{45.6 - 7.35 \times 3.61}{4.672 - 3.125}$ correct to 3 decimal places.

4.3 Further calculator functions

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, $\mathbf{2.4^2 = 5.76}$

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 28.9×10^{-3}, which is **engineering form**.

Hence, $\mathbf{0.17^2 = 28.9 \times 10^{-3}}$ **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 1149)

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.

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, $\mathbf{2.4^2 = 5.76}$

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 28.9×10^{-3}, which is **engineering form**.

Hence, $\mathbf{0.17^2 = 28.9 \times 10^{-3}}$ **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, $\mathbf{348620 = 348.62 \times 10^3}$ **in engineering form.**

Problem 6. Change 0.0000538 into engineering form

(i) Type in 0.0000538

(ii) Press = then ENG.

Hence, $\mathbf{0.0000538 = 53.8 \times 10^{-6}}$ **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, $\mathbf{1.4^3 = 2.744}$

Now try the following Practice Exercise

Practice Exercise 13 Square and cube functions (answers on page 1149)

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.

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 →

(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 1149)

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