

Basic Skills for Higher Mathematics

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Numeric Fractions

1. $\frac{3}{5} + \frac{2}{3}$

2. $\frac{1}{4} + \frac{1}{3}$

3. $\frac{2}{7} + \frac{1}{2}$

4. $\frac{5}{6} + \frac{1}{3}$

5. $\frac{6}{7} - \frac{1}{2}$

6. $\frac{3}{4} - \frac{2}{7}$

7. $\frac{5}{9} - \frac{1}{2}$

8. $\frac{9}{10} - \frac{3}{4}$

9. $1\frac{2}{3} + 2\frac{1}{2}$

10. $2\frac{1}{3} + 1\frac{3}{4}$

11. $4\frac{2}{5} - 1\frac{1}{2}$

12. $2\frac{3}{4} - 1\frac{7}{8}$

13. $\frac{4}{5} \times \frac{7}{8}$

14. $\frac{7}{9} \times \frac{6}{7}$

15. $\frac{5}{2} \times \frac{4}{9}$

16. $\frac{4}{7} \div \frac{2}{3}$

17. $\frac{5}{8} \div \frac{25}{12}$

18. $\frac{6}{7} \div \frac{14}{9}$

19. $1\frac{3}{4} \div 2\frac{4}{5}$

20. $3\frac{1}{2} \times 1\frac{3}{5}$

21. $2\frac{3}{4} \times 1\frac{1}{7}$

22. $\frac{5}{6} \div 1\frac{2}{3}$

23. $2\frac{1}{3} + 1\frac{1}{6} \times \frac{3}{7}$

24. $\frac{1}{2} + \frac{2}{3} \div 1\frac{1}{5}$

25. $\frac{5}{6} + \left(1\frac{1}{2}\right)^2$

26. $\left(\frac{2}{3}\right)^2 + \frac{1}{2}$

27. $\left(\frac{1}{2} + \frac{3}{4}\right) \div 1\frac{3}{7}$

28. $1\frac{1}{6} - \left(\frac{2}{3}\right)^2$

29. $\frac{2}{3}\left(1\frac{1}{2} - \frac{4}{5}\right)$

30. $\frac{5}{6} \div \left(1\frac{1}{2} + 1\frac{1}{3}\right)$

Algebraic Fractions

Express as a single fraction in its simplest form.

1. $\frac{3}{x} + \frac{1}{x+5}$

2. $\frac{2}{a-3} - \frac{3}{a}$

3. $\frac{4}{3p} - \frac{1}{2p}$

4. $\frac{1}{n} + \frac{3}{2n-1}$

5. $\frac{2}{u^2} + \frac{5}{u}$

6. $\frac{1}{4a-2} - \frac{2}{8a+3}$

7. $\frac{3}{x^2} + \frac{2}{x^3}$

8. $\frac{3}{(t-1)} + \frac{4}{(t+1)}$

9. $\frac{4}{p} - \frac{1}{p^3}$

10. $\frac{2}{8x-1} - \frac{1}{(4x-1)}$

11. $\frac{3}{4x} + \frac{1}{5x}$

12. $\frac{8}{3p} + \frac{1}{7p}$

13. $\frac{3}{2x-3} - \frac{6}{(4x+1)}$

14. $\frac{2}{w} + \frac{5}{8w}$

15. $\frac{1}{n^3} - \frac{1}{n}$

16. $\frac{4}{(2z-3)} - \frac{1}{3z}$

17. $\frac{1}{f-1} - \frac{1}{f+1}$

18. $\frac{3}{7x} + \frac{1}{x^2}$

19. $\frac{3}{a-1} - \frac{6}{2a+4}$

20. $\frac{3}{m^2} + \frac{1}{m^4}$

$$21. \frac{a}{3} + \frac{4}{a+2} \quad 22. \frac{u}{u-1} + \frac{u}{(u+1)} \quad 23. \frac{m}{2m+3} - \frac{1}{m} \quad 24. \frac{1}{x} - \frac{x+2}{2x-1}$$

$$25. \frac{x}{x+2} - \frac{1}{x} \quad 26. \frac{n}{n+12} - \frac{1}{n} \quad 27. \frac{a}{2a+1} - \frac{1}{3a} \quad 28. \frac{3m}{m-1} + \frac{3}{2m}$$

$$29. \frac{x}{x-1} + \frac{4}{3x} \quad 30. \frac{a}{a+3} - \frac{3}{a-5}$$

Expanding a double bracket

Expand each of the brackets below and collect terms.

1. $(x+3)(x+7)$
2. $(p-1)(p+6)$
3. $(u-5)(u-6)$
4. $(2m-2)(m+6)$
5. $(3w-2)^2$
6. $(5t-3)(2t-4)$
7. $(4x+3)^2$
8. $(2r-4)^2$
9. $(5a+6)^2$
10. $(a+c)(a-c)$
11. $(u-2v)(u+3v)$
12. $(5n-3)(2n+1)$
13. $(2p-3q)^2$
14. $(5x+3y)(3x-y)$
15. $(2c-7d)^2$
16. $(1+3r)(2-r)$
17. $(4-2u)(3+u)$
18. $(5-2d)(5+2d)$
19. $(x+2)(x^2+3x-1)$
20. $(p-3)(p^2-3p+2)$
21. $(u-4)(u^2-3u-1)$
22. $(3a-4)(a^2-3a-5)$
23. $(2n-3)(4n^2-n+5)$
24. $(2p-4)(p^2+2p+4)$
25. $(x^2-5x-2)(2x-3)$
26. $(4u^2-3u+1)(u-5)$
27. $(3m^2-2m+2)(2m-5)$
28. $(x^2+3)(x-2)$
29. $(4x-1)(3x^2-x)$
30. $(x^3-x^2)(x-1)$
31. $(x-2)(3x-4)+10x$
32. $(3x-5y)^2-25y^2$
33. $6p-(2p-3)(p-2)$
34. $(2m-5)^2-3(m-1)$
35. $(4x-2)(2x+3)+(x-1)^2$
36. $(4m-n)^2-n(n+3)$
37. $4(x-2)+3(x-1)^2$
38. $(2a+c)^2-(a-c)^2$
39. $(u+3w)^2-u(u-w)$
40. $(x-1)(x^2-3x-4)-x(x^2-4x)$

Solving Equations and Inequalities

Solve the following

1. $6a+3=2a-13$
2. $5(2b-1) > 6b+2$
3. $4(2x-3) < 3(1-x)$
4. $3(4c-1)-10=6c+5$
5. $4-2(d-10)=3d-1$
6. $5-(1-2f) \leq 4(2f+1)$
7. $5g-3(1-2g) \geq 8g$
8. $2-(h-2)=3h-(1-h)$
9. $\frac{1}{2}x-4=6$
10. $\frac{3}{5}u-2=6$
11. $\frac{3}{4}(x-2) > 2x$
12. $6-\frac{5}{8}(2w+3)=3w-4$
13. $5m-\frac{1}{3}(4-m) \leq 2$
14. $\frac{2}{3}(2n-3)=\frac{1}{2}(3n+5)$

15. $\frac{1}{4}(2 - 3t) > \frac{5}{6}(t + 1) - 2$

16. $2 - \frac{1}{2}(3a - 1) < \frac{3}{5}a$

17. $\frac{a + 3}{2} = \frac{a}{5}$

18. $\frac{2p - 3}{4} = \frac{p + 1}{5}$

19. $\frac{c + 3}{2} - 4 > \frac{2c - 1}{5}$

20. $1 - \frac{x - 2}{3} = \frac{2x - 1}{4}$

21. $\frac{2(d-2)}{3} - d = \frac{3d}{2}$

22. $2 + \frac{3m - 1}{3} \leq \frac{1}{2}m$

23. $\frac{4}{5}p - 1 > \frac{2(p + 1)}{3}$

24. $\frac{x - 1}{2} + \frac{x}{3} < 2$

25. $\frac{u}{5} - \frac{2u - 1}{2} = \frac{1}{4}$

26. $\frac{w}{2} \leq \frac{1}{4} - \frac{2(w - 1)}{3}$

Quadratic Equations

1. $x^2 - 9x = 0$

2. $x^2 + 13x + 40 = 0$

3. $a^2 - 81 = 0$

4. $x^2 + 3x - 10 = 0$

5. $x^2 - 10x + 21 = 0$

6. $x^2 - 7x - 18 = 0$

7. $5x^2 + 60x = 0$

8. $x^2 - 6x - 16 = 0$

9. $a^2 - 14a + 40 = 0$

10. $x^2 + 11x - 12 = 0$

11. $2d^2 + 9d - 5 = 0$

12. $2p^2 - 32 = 0$

13. $h^2 + 9h + 8 = 0$

14. $n^2 + 6n - 16 = 0$

15. $5n^2 - 2n - 7 = 0$

16. $2h^2 - 18 = 0$

17. $y^2 + 6y - 27 = 0$

18. $x^2 - 14x + 48 = 0$

19. $m^2 - 2m - 63 = 0$

20. $2x - 10x^2 = 0$

21. $8x = 2x^2$

22. $9d^2 - 9 = 0$

23. $5n^2 + 7n = 6$

24. $9y^2 - 27y = 0$

25. $3u^2 - 12 = 0$

26. $5p^2 - 2p - 16 = 0$

27. $2x^2 + 30x = 0$

28. $2x^2 = 8$

29. $3w^2 + 5w = 8$

30. $18x^2 = 50$

31. $6m^2 = 23m + 4$

32. $3c + 18c^2 = 0$

33. $7u^2 - 3u = 4$

34. $6 - 24h^2 = 0$

35. $2x^2 + 11x = 21$

36. $3x^2 - 2x = 8$

37. $3h^2 - 4h - 15 = 0$

39. $7k - 14k^2 = 0$

41. $5m^2 = 20$

43. $2a^2 + 13a = 24$

38. $\frac{1}{2}x^2 + 2x - 16 = 0$

40. $\frac{1}{2}g^2 - 3g = 8$

42. $(x + 3)(x - 3) = 8x$

44. $(a - 6)(a + 6) = 5a$

45. $\frac{x^2 - 10x}{2} = 12$

46. $\frac{x^2 - 3x}{7} = 4$

47. $\frac{x(x + 5)}{4} = 9$

48. $\frac{x^2}{3} = x + 18$

49. $f(x) = x^2 - 4x$ and $g(x) = x + 36$.

50. $f(x) = 5x^2 - 2x$ and $g(x) = 2x + 4$.

Find x given $f(x) = g(x)$.Find x given $f(x) = 2g(x)$.

51. $h(x) = 2x^2 - 3x + 1$ and $k(x) = x^2 + 4x - 11$.

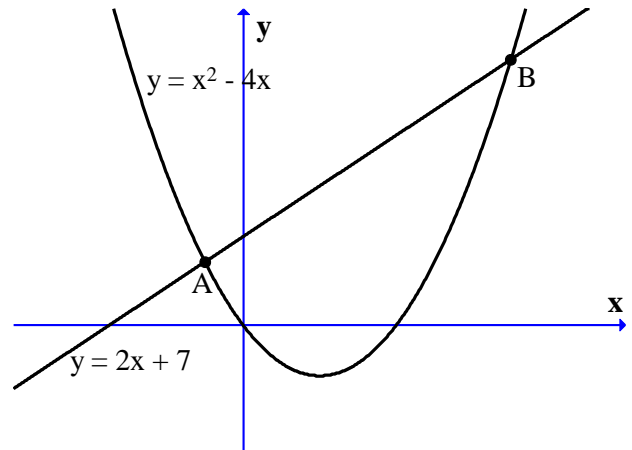
Find x given $h(x) = k(x)$.

52. $h(x) = 6x^2 - 5x - 3$ and $k(x) = x^2 - x + 3$.

Find x given $h(x) = 4k(x)$.

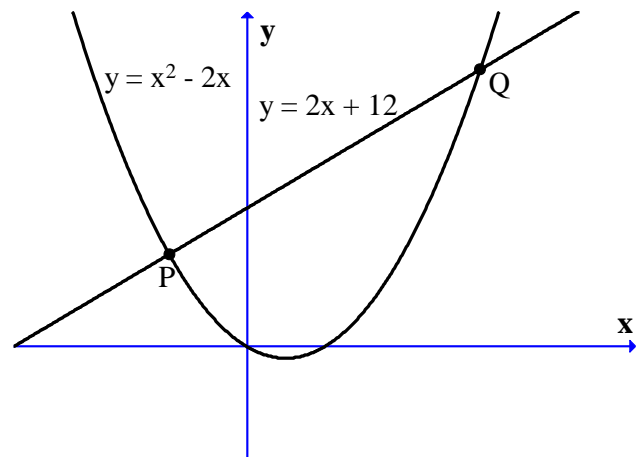
53. The diagram opposite shows the parabola $y = x^2 - 4x$ and the straight line $y = 2x + 7$.

Find the coordinates of A and B the points of intersection of the parabola and the line.



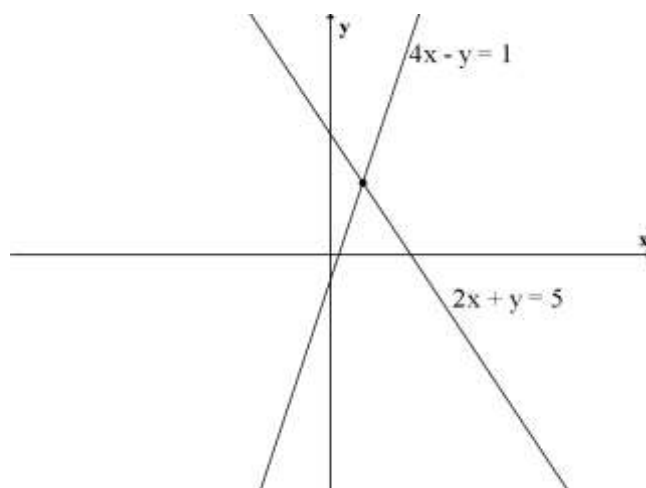
54. The diagram opposite shows the parabola $y = x^2 - 2x$ and the straight line $y = 2x + 12$.

Find the coordinates of P and Q the points of intersection of the parabola and the line.



Simultaneous Equations

1. Find the coordinates of the point of intersection of the pair of lines .



2. Solve the following simultaneous equations by substitution

a) $y = 2x$	b) $y = 3x$	c) $y = 2x - 8$	d) $y = 3x + 1$
$y = x + 10$	$y = 20 - x$	$y = x + 1$	$y = 6 - 2x$

3. Solve by elimination

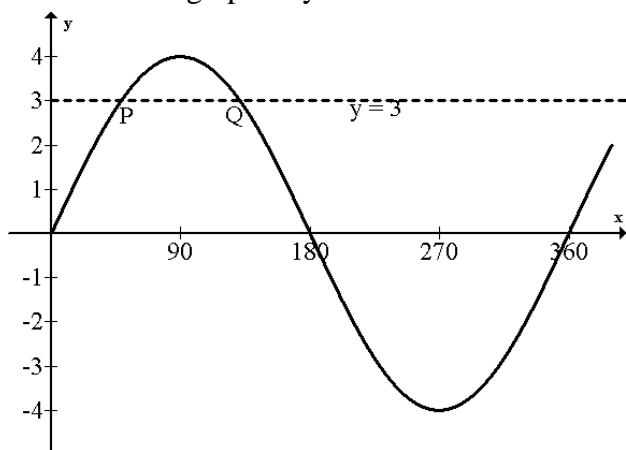
a) $x + y = 10$	b) $2x + y = 1$	c) $3x + 4y = 20$	d) $6p + 7q - 5 = 0$
$x - y = 3$	$5x + y = 4$	$4x - 3y = 10$	$7p + 8q - 6 = 0$

Trigonometric Equations

1. Solve the following equations for $0^\circ \leq x^\circ \leq 360^\circ$

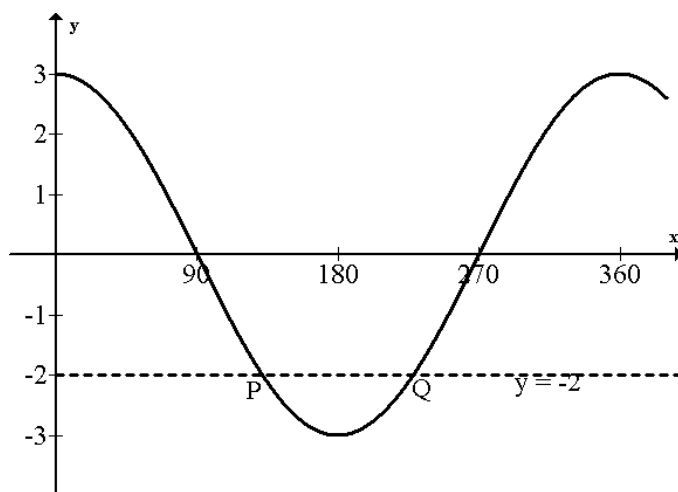
- | | | |
|---|--|--|
| (a) $2\sin x^\circ - 1 = 0$ | (b) $4\cos x^\circ - 3 = 0$ | (c) $5\tan x^\circ - 12 = 0$ |
| (d) $3\sin x^\circ + 6 = 7$ | (e) $4\tan x^\circ - 3 = 10$ | (f) $6\cos x^\circ - 2 = 3$ |
| (g) $3\cos x^\circ + 4 = 2$ | (h) $7\tan x^\circ + 3 = 0$ | (i) $6\sin x^\circ + 5 = 0$ |
| (j) $10\cos x^\circ + 12 = 6$ | (k) $4 + 3\tan x^\circ = 2$ | (l) $8 + 7\sin x^\circ = 2$ |
| (m) $7 + 9\cos x^\circ = 8$ | (n) $6\cos x^\circ + 3\tan 45^\circ = 0$ | (o) $2\sin x^\circ - \cos 80^\circ = 0$ |
| (p) $10\sin 75^\circ + 3\tan x^\circ = 0$ | (q) $7\tan 50^\circ + 3\tan x^\circ = 2$ | (r) $4\cos 45^\circ = 1 - 8\sin x^\circ$ |
| (s) $4\tan x^\circ = 12 - 2\tan x^\circ$ | (t) $7\sin x^\circ + 3 = 3\sin x^\circ$ | |

2. The diagram shows the graph of $y = 4 \sin x$.



The line $y = 3$ has been drawn on the graph. Find the coordinates of P and Q.

3. The graph of $y = 3\cos x$ is shown below.



The line $y = -2$ has been drawn on the graph. Find the coordinates of P and Q.

Surds

1. Simplify

(a) $\sqrt{24} + \sqrt{600}$

(b) $4\sqrt{3} - \sqrt{27}$

(c) $\sqrt{32} + 2\sqrt{8}$

(d) $3\sqrt{5} + \sqrt{20} - 2\sqrt{18}$

(e) $\sqrt{300} - 5\sqrt{12} + 2\sqrt{27}$

(f) $\sqrt{28} - \sqrt{1000} + 3\sqrt{63}$

(g) $2\sqrt{12} + \sqrt{40} + 3\sqrt{90}$

(h) $\sqrt{500} - 2\sqrt{45} + \sqrt{63}$

(i) $\sqrt{700} - 5\sqrt{28}$

2. $f(x) = 4\sqrt{x}$.

(a) Evaluate $f(45)$.(b) Given $f(a) = 24$, find a .

3. $f(x) = 3\sqrt{x}$

(a) Find $f(18)$ (b) Given $f(x) = 2$, find x .

4. Expand the brackets and simplify

(a) $\sqrt{2}(\sqrt{6} + \sqrt{2})$

(b) $\sqrt{3}(2\sqrt{3} - 5)$

(c) $\sqrt{6}(4 - \sqrt{3})$

(d) $\sqrt{5}(2\sqrt{5} - 3)$

(e) $\sqrt{6}(3\sqrt{10} - 2\sqrt{6})$

(f) $2\sqrt{2}(\sqrt{14} + 5\sqrt{2})$

(g) $\sqrt{x}(\sqrt{x} - 3)$

(h) $\sqrt{u}(2\sqrt{u} + 5)$

(i) $3\sqrt{2}(2\sqrt{2} - 4\sqrt{10})$

(j) $2\sqrt{3}(3\sqrt{3} + \sqrt{8})$

(k) $(\sqrt{3} + \sqrt{2})^2$

(l) $(\sqrt{5} - 2)^2$

(m) $(\sqrt{7} - 2)(\sqrt{7} + 2)$

(n) $(\sqrt{3} + \sqrt{2})(\sqrt{3} - \sqrt{2})$

(o) $(2\sqrt{5} - 1)(2\sqrt{5} + 1)$

5. Express with a rational denominator in its simplest form

(a) $\frac{1}{\sqrt{3}}$

(b) $\frac{2}{\sqrt{5}}$

(c) $\frac{6}{\sqrt{2}}$

(d) $\frac{21}{\sqrt{7}}$

(e) $\frac{10}{3\sqrt{5}}$

(f) $\frac{14}{5\sqrt{2}}$

(g) $\frac{\sqrt{2}}{\sqrt{14}}$

(h) $\frac{\sqrt{3}}{\sqrt{24}}$

(i) $\frac{\sqrt{2}}{\sqrt{40}}$

(j) $\frac{\sqrt{5}}{2\sqrt{30}}$

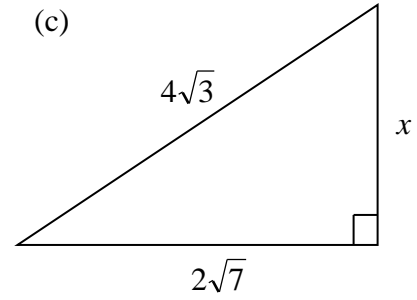
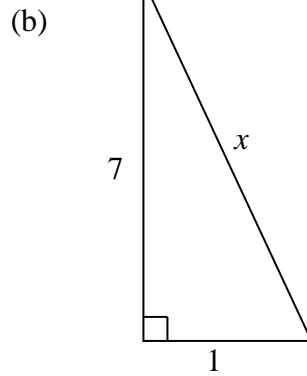
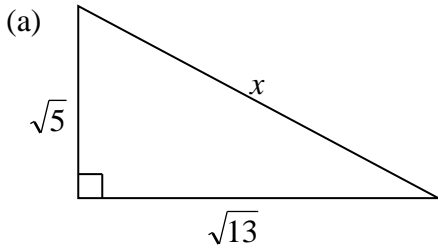
6. $f(x) = \frac{2}{\sqrt{x}}$

(a) Express $f(3)$ with a rational denominator.(b) Given $f(x) = 4$, find x .

7. $f(x) = \frac{10}{3\sqrt{x}}$

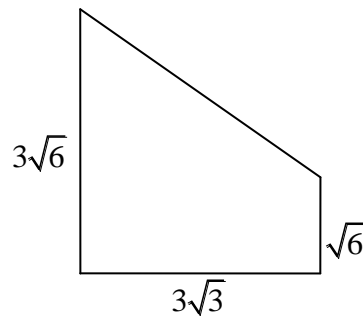
(a) Express $f(5)$ with a rational denominator in its simplest form.(b) Given $f(a) = 2$, find a .

8. Calculate the length of the side marked x in each triangle below.



9. The shape below consists of a rectangle and a right-angled triangle.

Calculate the area of this shape. Give your answer as a surd in its simplest form.



Indices

1. Simplify

(a) $5d^{-3} \times 2d^{-4}$

(b) $20h^3 \div 4h^6$

(c) $3m^4 \times 2m$

(d) $18p^{-3} \div 3p^{-7}$

(e) $\frac{5n^{-2} \times 4n^5}{10n^{-3}}$

(f) $\frac{24n^9}{2n^3 \times 4n^{-1}}$

(g) $\frac{18p^7}{(3p^2)^2}$

(h) $\frac{4a \times 3a^{-5}}{6a^{-2}}$

(i) $\frac{(4u)^2}{8u^{-3}}$

(j) $\frac{(c^2)^4}{c^3}$

(k) $\frac{y^8}{(y^2)^3}$

(l) $\frac{(b^{-4})^2}{b \times b^3}$

(m) $(3n^{-3})^2$

(n) $(a^4)^{\frac{1}{2}}$

(o) $6u^{\frac{3}{4}} \times 3u^{\frac{1}{4}}$

(p) $10x^{\frac{7}{2}} \div 2x^{\frac{1}{2}}$

(q) $\frac{4a^{\frac{1}{2}} \times 5a^{\frac{7}{2}}}{10a}$

(r) $\frac{6c^{\frac{2}{3}} \times 3c^{\frac{1}{3}}}{9c^2}$

(s) $\frac{(4d^{\frac{2}{3}})^2}{8d^{\frac{1}{3}}}$

(t) $\frac{24h^4}{(2h^{\frac{1}{2}})^2}$

(u) $m^{-4} \div \sqrt{m}$

(v) $u^2 \times \sqrt[3]{u^2}$

(w) $\sqrt[4]{c^5} \times c$

(x) $f^{-2} \div \sqrt[4]{f}$

(y) $\sqrt[3]{k^2} \div k$

(z) $4p^{-2} \div 2\sqrt[3]{p}$

2. Expand the brackets

(a) $x(x^3 - 4)$

(b) $2y^2(3y^4 + 5y^{-2})$

(c) $3a^{-1}(4a^3 + 2a)$

(d) $3c(4c^3 - 6c^{-4})$

(e) $m(2m^{-1} - 4m^{-4})$

(f) $2u^{-5}(u + 3u^5)$

(g) $5n^4(n^{-2} + \frac{2}{n^3})$

(h) $2w^5\left(\frac{1}{w} + 4w^{-2}\right)$

(i) $p^4\left(3p^{-4} - \frac{2}{p^3}\right)$

(j) $4d^{1/2}(3d^{3/2} - d^{-1/2})$

(k) $e^{7/3}(e^{7/3} - 2e^{2/3})$

(l) $3m^{3/2}\left(m^{3/2} + \frac{3}{m^{1/2}}\right)$

(m) $n^{1/3}\left(2n^{4/3} - \frac{1}{\sqrt[3]{n^2}}\right)$

(n) $x^{1/3}\left(2x^{9/5} + \frac{3}{\sqrt[3]{x}}\right)$

(o) $2a^{3/5}\left(\frac{1}{\sqrt[3]{a^2}} - 4\sqrt[3]{a^4}\right)$

(p) $x^{1/2}(2x - 3)$

(q) $3a\left(a^{1/2} + 2a^{-2}\right)$

(r) $u^{1/2}(3u + u^3)$

(s) $b^{1/3}(b^2 + 2b^{-1})$

(t) $2p^{3/4}(p^{1/4} - p)$

3. Find the value of

(a) $\sqrt[3]{27^2}$

(b) $\sqrt[4]{16^5}$

(c) $\sqrt[2]{100^3}$

(d) $\sqrt[3]{8^6}$

(e) $\sqrt[3]{64^{-2}}$

(f) $\sqrt[3]{1^5}$

(g) $\sqrt{4^{-5}}$

(h) $\sqrt[3]{1000^{-2}}$

(i) $\sqrt[3]{\frac{1}{8}}$

(j) $\sqrt[4]{\frac{1}{16}}$

(k) 8^{-2}

(l) $25^{3/2}$

(m) $32^{3/5}$

(n) $9^{5/2}$

(o) $16^{-3/4}$

(p) $125^{-2/3}$

(q) $1^{7/2}$

(r) $\left(\frac{1}{4}\right)^{3/2}$

(s) $\left(\frac{8}{27}\right)^{2/3}$

(t) $\left(\frac{1}{8}\right)^{3/5}$

Exact values

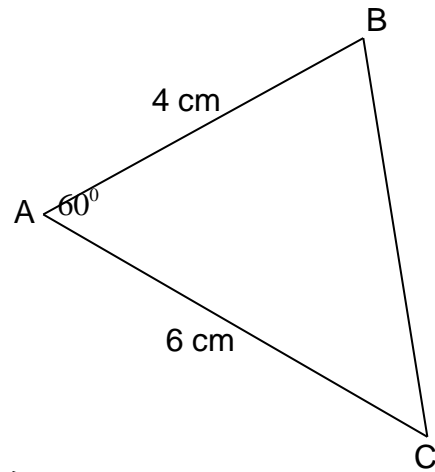
Use the table opposite to help answer the questions below.

	30^0	45^0	60^0
sin	$\frac{1}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{\sqrt{3}}{2}$
cos	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{1}{2}$
tan	$\frac{1}{\sqrt{3}}$	1	$\sqrt{3}$

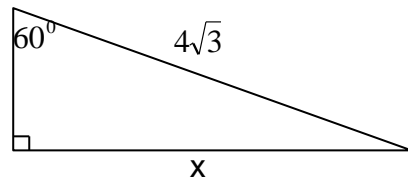
1. The diagram opposite shows a triangle ABC.

Calculate the length of BC.

Give your answer as a surd in its simplest form.

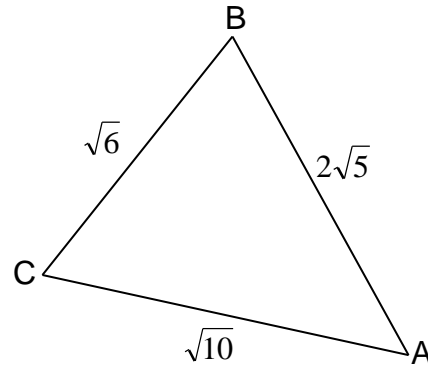


2. Calculate x in the triangle opposite.



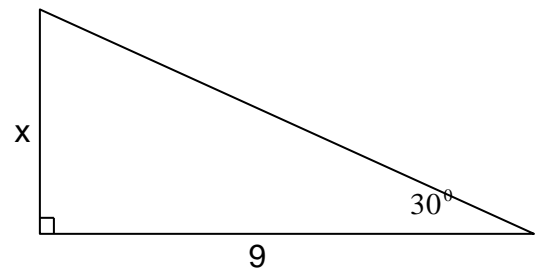
3. The diagram shows triangle ABC.

Show that $\cos BAC = \frac{3\sqrt{2}}{5}$



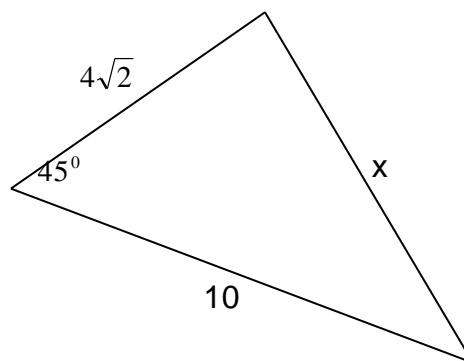
4. Calculate the length of x in the triangle opposite.

Give your answer as a surd expressed with a rational denominator.



5. In the triangle shown, prove that

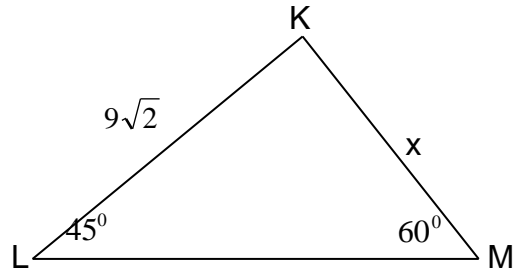
$$x = 2\sqrt{13}$$



6. The diagram opposite shows triangle KLM.

Show that

$$x = 6\sqrt{3}$$



Equation of a Line

1. For each question below, find the coordinates of the point where the line cuts the y-axis.

(a) $y = 2x - 6$

(b) $y = 5x + 3$

(c) $2y = 5x - 8$

(d) $3y = 7x - 4$

(e) $5y = 2x - 11$

(f) $2x + 3y = 12$

(g) $4x + 3y - 5 = 0$

(e) $6x - 3y - 15 = 0$

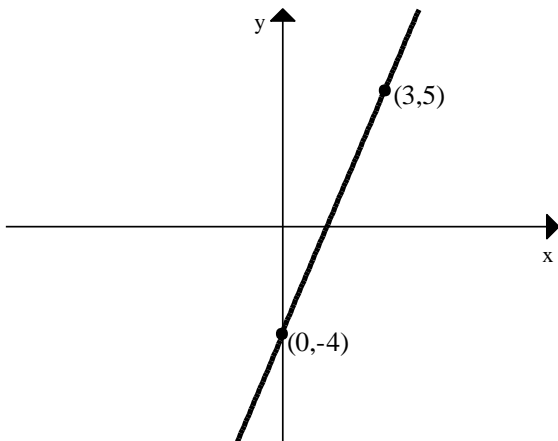
2. A line has equation $y = 3x - 9$.

(a) Does the point $(6,9)$ lie on this line?

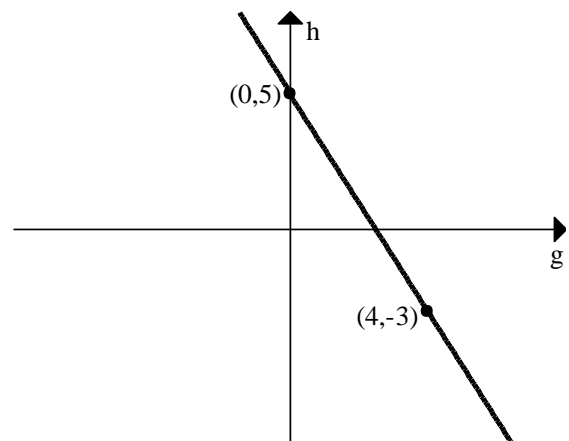
(b) The point $(m,4m)$ lies on this line. Find the value of m .

3. Find the equation of each line below.

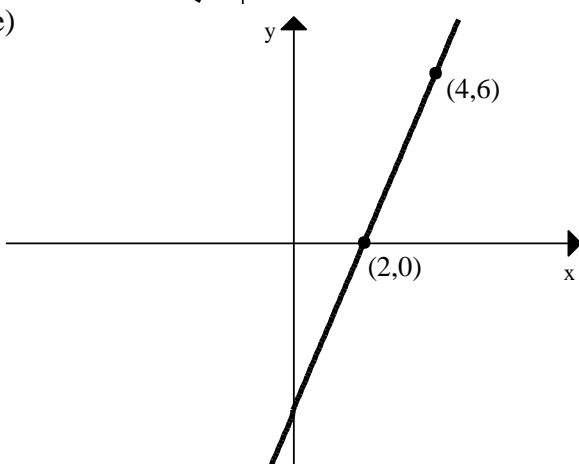
(a)



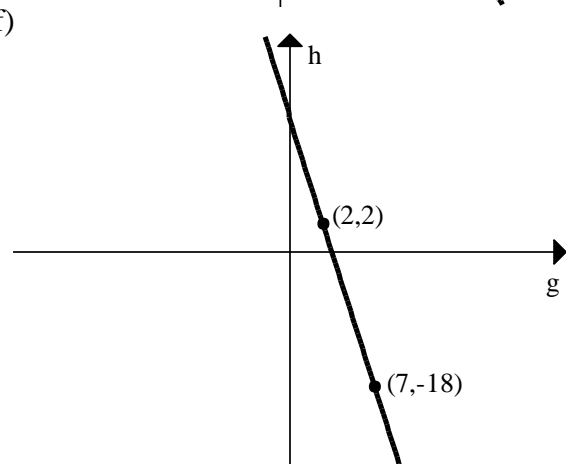
(b)



(e)

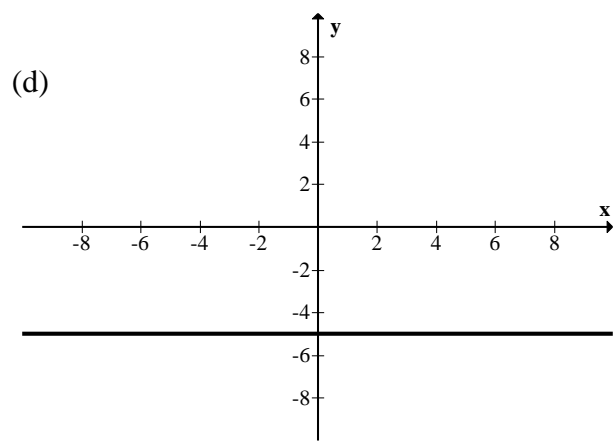
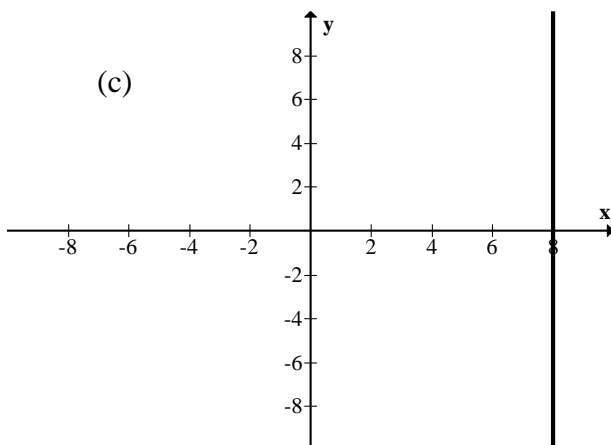
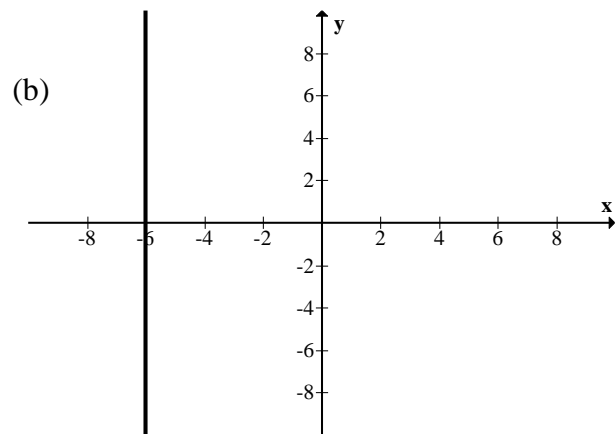
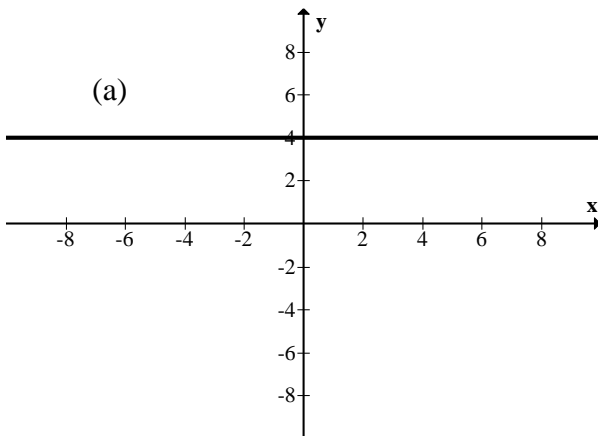


(f)



4. (a) Find the equation of the line joining the points $(-2,3)$ and $(1,12)$.
 (b) Find the equation of the line joining the points $(0,-4)$ and $(2,8)$.
 (c) Find the equation of the line joining the points $(2,3)$ and $(8,6)$.
 (d) Find the equation of the line joining the points $(0,-2)$ and $(2,1)$.
 (e) Find the equation of the line joining the points $(2,5)$ and $(-1,9)$.

5. Write down the equation of each line below.



Vectors – Basics

1. $\mathbf{p} = \begin{pmatrix} 3 \\ 2 \end{pmatrix}$ and $\mathbf{q} = \begin{pmatrix} 6 \\ -4 \end{pmatrix}$

- (a) Sketch the vectors \mathbf{p} and \mathbf{q} .
 (b) Sketch the vectors $-\mathbf{p}$ and $-\mathbf{q}$.
 (c) Given $\mathbf{u} = \mathbf{p} + \mathbf{q}$, sketch the vector \mathbf{u} .
 (d) Given $\mathbf{v} = \mathbf{p} - \mathbf{q}$, sketch the vector \mathbf{v} .

2. $\mathbf{a} = \begin{pmatrix} 5 \\ -2 \end{pmatrix}$ and $\mathbf{b} = \begin{pmatrix} -7 \\ -4 \end{pmatrix}$

- (a) Sketch the vectors \mathbf{a} and \mathbf{b} .
 (b) Given $\mathbf{u} = \mathbf{a} + \mathbf{b}$, sketch the vector \mathbf{u} .
 (c) Given $\mathbf{v} = \mathbf{a} - \mathbf{b}$, sketch the vector \mathbf{v} .

3. $\mathbf{a} = \begin{pmatrix} 2 \\ 2 \\ -1 \end{pmatrix}$ and $\mathbf{b} = \begin{pmatrix} 6 \\ -8 \\ 0 \end{pmatrix}$.

Find (a) $3\mathbf{a}$ (b) $-\mathbf{b}$ (c) $2\mathbf{a} + 3\mathbf{b}$ (d) $4\mathbf{b} - \mathbf{a}$ (e) $-\frac{1}{2}\mathbf{b}$ (f) $|\mathbf{b}|$ (g) $|2\mathbf{a}|$ (h) $|\mathbf{b} + 2\mathbf{a}|$

4. Find \mathbf{p} and \mathbf{q} in each equation below

(a) $\begin{pmatrix} \mathbf{p} \\ \mathbf{q} \end{pmatrix} + \begin{pmatrix} 2 \\ -1 \end{pmatrix} = \begin{pmatrix} 6 \\ 4 \end{pmatrix}$ (b) $\begin{pmatrix} \mathbf{p} \\ \mathbf{q} \end{pmatrix} - \begin{pmatrix} 3 \\ -4 \end{pmatrix} = \begin{pmatrix} 8 \\ -4 \end{pmatrix}$ (c) $\begin{pmatrix} -3 \\ 1 \end{pmatrix} - \begin{pmatrix} \mathbf{p} \\ \mathbf{q} \end{pmatrix} = 3\begin{pmatrix} -2 \\ -1 \end{pmatrix}$

5. Find \mathbf{p} , \mathbf{q} and \mathbf{r} in each of the following

(a) $\begin{pmatrix} \mathbf{p} \\ \mathbf{q} \\ \mathbf{r} \end{pmatrix} + \begin{pmatrix} 3 \\ -2 \\ 5 \end{pmatrix} = \begin{pmatrix} 6 \\ 4 \\ 1 \end{pmatrix}$ (b) $\begin{pmatrix} \mathbf{p} \\ \mathbf{q} \\ \mathbf{r} \end{pmatrix} + 2\begin{pmatrix} 1 \\ -4 \\ 0 \end{pmatrix} = \begin{pmatrix} 2 \\ 5 \\ 3 \end{pmatrix}$

6. A is the point (2,1,-2) and B is the point (0,-3,4).

- (a) Write down the components of \mathbf{a} and \mathbf{b} , the position vectors of A and B.
 (b) Calculate (i) $-2\mathbf{a} + \mathbf{b}$ (ii) $|-2\mathbf{a} + \mathbf{b}|$
 (c) Find the vector \overrightarrow{AB}

7. P is the point (1,-1,2), Q is (2,0,-5) and R is (1,1,0).

- (a) Write down the components of \mathbf{p} , \mathbf{q} and \mathbf{r} the position vectors of P, Q and R.
 (b) Find the vectors (i) \overrightarrow{QP} (ii) \overrightarrow{QR} (iii) \overrightarrow{PR}

8. M is the point (2,3,-5), N is (1,1,0) and R is (-4,2,-2).

- (a) Write down the components of \mathbf{m} , \mathbf{n} and \mathbf{r} the position vectors of M, N and R.
 (b) Find the vectors (i) \overrightarrow{MN} (ii) \overrightarrow{RN} (iii) \overrightarrow{MR}

9. PQRS is a parallelogram with vertices P(3,4,0), Q(7,6,-3) and R(8,5,2).

Find the coordinates of S. (Hint: $\overrightarrow{PQ} = \overrightarrow{SR}$).

10. A is the point (2,1,-6), B is (3,1,-9) and C is (0,1,6).

Given $\overrightarrow{AD} = \frac{2}{3}\overrightarrow{BC}$, find the coordinates of D.

11. P is the point (-4,2,2), Q is (-1,8,14) and R is (-5,2,10).

Given $\overrightarrow{PQ} = \frac{3}{4}\overrightarrow{RS}$, find the coordinates of S.

12. (a) Calculate the magnitude of the vector $\mathbf{u} = \begin{pmatrix} 3 \\ 4 \end{pmatrix}$.

(b) Find a unit vector parallel to the vector \mathbf{u} .

13. (a) Calculate the magnitude of the vector $\mathbf{w} = \begin{pmatrix} -6 \\ 2 \\ 3 \end{pmatrix}$

(b) Find a unit vector parallel to \mathbf{w} .

14. (a) Calculate $|\mathbf{a}|$ where $\mathbf{a} = \begin{pmatrix} -2 \\ -1 \\ 0 \end{pmatrix}$

(b) Find a unit vector parallel to \mathbf{a} .

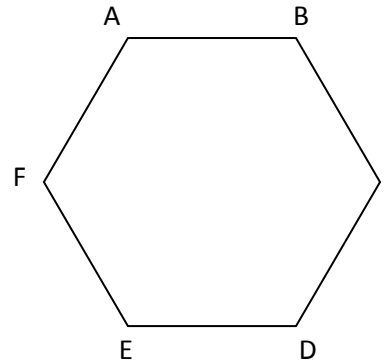
15. The diagram shows a regular hexagon.

(i) Write down another vector equal to

(a) \overrightarrow{AB} (b) \overrightarrow{CD}

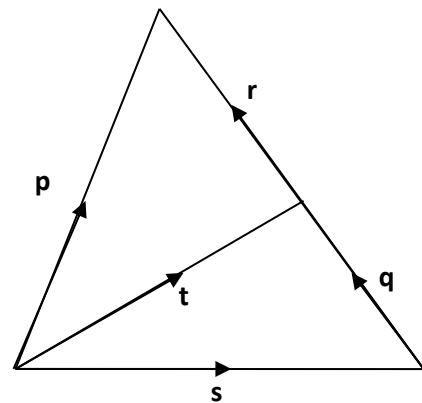
(ii) Find a vector equal to

(a) $\overrightarrow{AB} + \overrightarrow{BC}$ (b) $\overrightarrow{AB} + \overrightarrow{BC} + \overrightarrow{CD}$ (c) $\overrightarrow{FE} + \overrightarrow{ED}$
 (d) $\overrightarrow{FA} + \overrightarrow{ED}$ (e) $\overrightarrow{ED} + \overrightarrow{DC} + \overrightarrow{EF}$ (f) $\overrightarrow{BC} - \overrightarrow{DC}$



16. Use the diagram opposite to name the vector that represents

- (a) $\mathbf{p} - \mathbf{r}$ (b) $\mathbf{r} - \mathbf{p}$ (c) $\mathbf{t} - \mathbf{q}$ (d) $\mathbf{s} - \mathbf{t}$
 (e) $\mathbf{p} - \mathbf{r} - \mathbf{q}$ (f) $\mathbf{t} + \mathbf{r} - \mathbf{p}$ (g) $\mathbf{s} - \mathbf{p} + \mathbf{q}$



18. The diagram shows a cuboid ABCD EFGH.

(a) Express in terms of \mathbf{u} , \mathbf{v} and \mathbf{w} .

- (i) \overrightarrow{DC} (ii) \overrightarrow{ED}
 (iii) \overrightarrow{FH} (iv) \overrightarrow{HA}

(b) Express in terms of ABCD EFGH

- (i) $\mathbf{u} + \mathbf{v}$ (ii) $\mathbf{u} - \mathbf{w}$ (iii) $\mathbf{w} - \mathbf{u} + \mathbf{v}$

