Are you ready for Year 11 Maths ???

Do you need something to do over the holidays ???

Would you like a head start ???

Well here it is !!!!

"486 ± 250 Algebra Exercises"

Do a selection - Do them all

Assumed knowledge for next year !!!

Mathematical

XTC

[Cor]^{2}an Productions

Exercise 1F

1. Simplify:

(a) $\frac{3}{7} + \frac{5}{6}$

(b) $\frac{2}{3} - \frac{5}{8}$

(c) $\frac{3}{8} - \frac{5}{6}$

(d) $\frac{7}{10} + \frac{3}{4}$

(e) $1\frac{1}{2} - 2\frac{1}{4}$

(f) $1\frac{1}{4} + 3\frac{1}{3}$

(g) $2\frac{1}{6} + 1\frac{1}{4}$

(h) $1\frac{4}{9} - 2\frac{1}{6}$

(i) $\frac{3}{a} + \frac{4}{5}$

(j) $\frac{7}{b} - \frac{5}{8}$

(k) $\frac{5}{2a} - \frac{3}{4}$

(l) $\frac{3}{5} + \frac{2}{7a}$

(m) $\frac{7}{9a} + \frac{4}{5b}$

(n) $\frac{3}{2a} - \frac{5}{b}$

(o) $\frac{4}{7x} - \frac{9}{5y}$

(p) $\frac{1}{4m} + \frac{3}{5n}$

(q) $\frac{x+1}{4} + \frac{x-2}{3}$

(r) $\frac{x+5}{4} - \frac{x-3}{2}$

(s) $\frac{2x+1}{2} - \frac{x+1}{3}$

(t) $\frac{3x-2}{5} + \frac{x+4}{3}$

(u) $\frac{4x-2}{3} + \frac{1-4x}{5}$

(v) $\frac{4-2x}{3} - \frac{4x+5}{7}$

(w) $\frac{5x+3}{7} - \frac{x+3}{5}$

(x) $\frac{7x-1}{3} + \frac{x-3}{4}$

(y) $\frac{3x-2}{4} - \frac{x-2}{2}$

(z) $\frac{5x-3}{6} - \frac{3x-2}{4}$

2. Simplify:

(a) $\frac{1}{x+1} + \frac{2}{x-3}$

(b) $\frac{3}{x-2} + \frac{4}{x-1}$

(c) $\frac{4}{x-3} - \frac{7}{x+5}$

(d) $\frac{3}{2x-1} - \frac{1}{x-4}$

(e) $\frac{7}{3x-2} - \frac{5}{1-x}$

(f) $\frac{4}{1-2x} + \frac{5}{3x-1}$

(g) $\frac{4}{x+7} + \frac{3}{5-x}$

(h) $\frac{9}{x-1} + \frac{7}{3-x}$

(i) $\frac{2}{x+1} - \frac{1}{2-x}$

(j) $\frac{5}{6-x} - \frac{3}{2x-1}$

(k) $\frac{5}{1-x} - \frac{4}{2+3x}$

(l) $\frac{4}{3-x} - \frac{4}{3+2x}$

(m) $\frac{8}{2x-3} - \frac{4}{4-3x}$

(n) $\frac{6}{1-2x} - \frac{3}{3x-2}$

*3. Simplify:

(a) $\frac{1}{x-3} + \frac{2}{3-x}$

(b) $\frac{4}{3-2x} + \frac{5}{2x-3}$

(c) $\frac{4}{5x-2} - \frac{3}{2-5x}$

(d) $\frac{7}{1-3x} - \frac{3}{3x-1}$

(e) $\frac{5}{4+3x} - \frac{4}{3x+4}$

(f) $\frac{1}{2x+4} - \frac{3}{4+2x}$

(g) $\frac{3}{x-4} + \frac{5}{4-x}$

(h) $\frac{3}{2-x} + \frac{5}{x-2}$

(i) $\frac{1}{2x-3} - \frac{3}{3-2x}$

(j) $\frac{4}{4x-1} - \frac{2}{1-4x}$

(k) $\frac{5}{7+x} - \frac{2}{x+7}$

(l) $\frac{8}{3+4x} + \frac{4}{4x+3}$

(m) $\frac{2}{1-5x} - \frac{3}{5x-1}$

(n) $\frac{7}{2-7x} - \frac{5}{7x-2}$

Exercise 1G

1. Simplify:

(a) $\frac{2}{(x+1)(x+2)} + \frac{4}{(x+2)(x+3)}$

(b) $\frac{7}{(x+1)(x-1)} + \frac{2}{(x-1)(x+2)}$

(c) $\frac{5}{(x-1)(x-7)} + \frac{3}{(x-7)(x+3)}$

(d) $\frac{3}{(2x-1)(3x+2)} + \frac{1}{(3x+2)(4x+1)}$

(e) $\frac{3}{(x-3)(x-4)} - \frac{2}{(x-4)(x+1)}$

(f) $\frac{5}{(x+2)(2x-1)} - \frac{3}{(2x-1)(2x+1)}$

(g) $\frac{4}{(3x-2)(2x+1)} - \frac{3}{(2x+1)(x+3)}$

(h) $\frac{2}{(x-3)(2x+1)} - \frac{3}{(2x+1)(2x-1)}$

(i) $\frac{4}{(2-3x)(3+2x)} + \frac{5}{(3+2x)(1+x)}$

(j) $\frac{2}{(5-3x)(1+2x)} + \frac{4}{(1+2x)(1+x)}$

2. Simplify:

(a) $\frac{1}{(x+2)^2} + \frac{3}{x+2}$

(b) $\frac{7}{(2x+3)^2} + \frac{1}{2x+3}$

(c) $\frac{4}{x+3} - \frac{2}{(x+3)^2}$

(d) $\frac{2}{3x-1} - \frac{1}{(3x-1)^2}$

(e) $\frac{5}{(x+5)^2} - \frac{2}{x+5}$

(f) $\frac{4}{(x+3)^2} - \frac{3}{x+3}$

(g) $\frac{5}{(x+1)^2} + \frac{3}{(x+1)(x+2)}$

(h) $\frac{7}{(2x+1)^2} + \frac{5}{(2x+1)(x+1)}$

(i) $\frac{1}{(x+1)(x+2)} - \frac{2}{(x+1)^2}$

(j) $\frac{2}{(2x-1)^2} - \frac{4}{(2x-1)(x+2)}$

(k) $\frac{3}{(x+2)^2} + \frac{4}{(x+2)(x+1)}$

(l) $\frac{7}{(x-3)^2} + \frac{2}{(x-3)(x+2)}$

3. Simplify:

(a) $\frac{4}{7} + \frac{3}{4} - \frac{1}{2}$

(b) $\frac{5}{6} - \frac{4}{3} + \frac{7}{2}$

(c) $1\frac{4}{5} + 2\frac{1}{3} - 1\frac{4}{15}$

(d) $1\frac{5}{8} - 2\frac{1}{4} - 3\frac{1}{2}$

(e) $\frac{x+3}{2} + \frac{x-3}{3} - \frac{4+x}{5}$

(f) $\frac{x}{3} + \frac{2x}{5} + \frac{4x+1}{2}$

(g) $\frac{2x-1}{4} + \frac{x-1}{3} + \frac{x}{3}$

(h) $\frac{3x-1}{2} - \frac{4x+1}{8} - \frac{1-3x}{4}$

4. Simplify:

(a) $\frac{1}{x} + \frac{2}{3x} - \frac{3}{2x}$

(b) $\frac{1}{4x} + \frac{1}{5x} - \frac{4}{x}$

(c) $\frac{2}{3x} - \frac{1}{x} + \frac{4}{5x}$

(d) $\frac{7}{3x} - \frac{3}{4x} + \frac{1}{2x}$

(e) $\frac{5}{x} - \frac{3}{4x} - \frac{1}{2x}$

(f) $\frac{2}{5x} - \frac{3}{x} - \frac{7}{2x}$

(g) $\frac{1}{x+1} + \frac{3}{x+2} - \frac{4}{x-1}$

(h) $\frac{4}{x-4} - \frac{3}{x+1} + \frac{2}{x+2}$

(i) $\frac{3}{x+5} + \frac{2}{x+1} - \frac{3}{x-1}$

(j) $\frac{2}{x-2} + \frac{3}{x+2} - \frac{4}{x-1}$

*(k) $\frac{2}{x+4} + \frac{3}{2x-1} - \frac{4}{1-2x}$

*(l) $\frac{2}{3-x} + \frac{4}{3+x} + \frac{1}{x-3}$

(m) $\frac{2}{x+1} - \frac{3}{1+x} - \frac{4}{x-1}$

(n) $\frac{5}{x+2} - \frac{3}{x-2} + \frac{1}{2+x}$

*(o) $\frac{5}{x(x+1)} + \frac{4}{x-3} + \frac{2}{3-x}$

(p) $\frac{5}{(x+1)(x+2)} - \frac{1}{(x+2)(x-2)} + \frac{3}{(x-2)(x+4)}$

(q) $\frac{7}{(x+5)(x-1)} + \frac{1}{(x-1)(x+7)} + \frac{3}{(x+2)(x+7)}$

(r) $\frac{4}{(x-3)(x+5)} + \frac{1}{(x-1)(x+4)} - \frac{1}{(x+4)(x-3)}$

Exercise 1H

1. Simplify each of the following:

(a) $\frac{4}{5} \times \frac{15}{16}$

(b) $\frac{3}{7} \times \frac{28}{27}$

(c) $1\frac{5}{6} \times 1\frac{1}{2}$

(d) $1\frac{4}{7} \times 3\frac{1}{2}$

(e) $\frac{4a}{3} \times \frac{9}{a}$

(f) $\frac{7a}{15} \times \frac{21}{a}$

(g) $\frac{15b}{16a} \times \frac{64a}{45b}$

(h) $\frac{32a}{9b} \times \frac{27b}{48a}$

(i) $\frac{(x+1)}{2} \times \frac{3}{(x+1)}$

(j) $\frac{(3x-2)}{3} \times \frac{4}{(3x-2)}$

(k) $\frac{(2x+1)}{4} \times \frac{8}{(2x+1)}$

(l) $\frac{(9x-2)}{7} \times \frac{21}{(9x-2)}$

(m) $\frac{(x+1)}{(x+2)} \times \frac{(x+3)}{(x+4)}$

(n) $\frac{(x+2)}{(2x+1)} \times \frac{(2x+1)}{(x+3)}$

(o) $\frac{(2x-3)(3x+1)}{(x+2)} \times \frac{(x+2)}{(3x+1)}$

(p) $\frac{(5x-6)(x+1)}{(x+2)} \times \frac{(x+2)(x+3)}{(x+1)}$

*(q) $\frac{(x+4)(x-1)}{(x-3)} \times \frac{(3-x)}{(x-1)}$

*(r) $\frac{(5-2x)(x+3)}{(x+7)} \times \frac{(x+7)}{(2x-5)}$

*(s) $\frac{(3-4x)(x+2)}{(x+5)} \times \frac{(5+x)}{(4x-3)}$

*(t) $\frac{(y+7)(y-3)}{(2-7y)} \times \frac{(7y-2)}{(7+y)}$

*(u) $\frac{(4x+3)(4x-3)}{(x+2)} \times \frac{(x-2)}{(3-4x)(3+4x)}$

*(v) $\frac{(2x+7)}{(2x-7)} \times \frac{(7-2x)}{(2x+7)}$

2. Simplify each of the following.

(a) $\frac{4}{15} \div \frac{2}{5}$

(b) $\frac{3}{14} \div \frac{12}{35}$

(c) $-1\frac{4}{5} \div 4\frac{1}{2}$

(d) $3\frac{2}{3} \div -3\frac{1}{7}$

(e) $\frac{a}{4} \div \frac{3a}{8}$

(f) $\frac{4a}{3} \div \frac{8a}{21}$

(g) $\frac{-4a}{5b} \div \frac{-42a}{35b}$

(h) $\frac{-9a}{22b} \div \frac{54a}{-55b}$

(j) $\frac{x+1}{3} \div \frac{x+1}{9}$

(j) $\frac{x-3}{4} \div \frac{x-3}{12}$

(k) $\frac{3x-2}{4} \div \frac{4x-1}{4}$

(l) $\frac{5x-3}{7} \div \frac{6x-2}{21}$

(m) $\frac{7x-2}{4x-3} \div \frac{7x-2}{x+1}$

(n) $\frac{8x-1}{3x} \div \frac{8x-1}{7x+1}$

(o) $\frac{(3x+2)(x+1)}{x+3} \div \frac{(x+1)(x-3)}{x+4}$

(p) $\frac{(4x+1)(x+2)}{(3x-1)(3x+1)} \div \frac{(4x+1)(4x-1)}{(3x+1)(x+3)}$

*(q) $\frac{(5x-2)(x+3)}{(3x-1)(x+5)} \div \frac{(x+3)(2-5x)}{(1-3x)(x+5)}$

*(r) $\frac{(4-x)(x+4)}{(x-2)(x+1)} \div \frac{x(x-4)}{3(x-2)}$

*(s) $\frac{(5a-3)(2a+1)}{(a+1)(a-2)} \div \frac{(3-5a)(1+a)}{(2-a)(1+a)}$

*(t) $\frac{(6a-1)(2a-3)}{(3a-4)(a-2)} \div \frac{(3-2a)(a+2)}{(2-a)(4-3a)}$

3. Simplify

(a) $\frac{4}{3} \times \frac{27}{16} \div \frac{4}{9}$

(b) $\frac{7}{6} \times \frac{18}{28} \div \frac{9}{5}$

(c) $1\frac{1}{4} \times 4\frac{3}{5} \div \frac{3}{5}$

(d) $1\frac{4}{7} \div \frac{6}{7} \div 1\frac{3}{4}$

(e) $\frac{x+3}{4} \times \frac{16}{x} \times \frac{x}{x+3}$

(f) $\frac{4x+3}{7} \times \frac{21}{4x+3} \div 3$

(g) $\frac{(x+1)(x+2)}{(x-3)} \times \frac{(x-3)(x+2)}{(x+4)} \div \frac{(x+1)}{(x+4)}$

*(h) $\frac{(x+5)}{(x+6)} \times \frac{(x+3)(x-1)}{(x+5)} \div \frac{(x+3)(1-x)}{x(x+6)}$

(i) $\frac{(x+7)(x-7)}{(x-3)(x-4)} \times \frac{(x-5)(x-4)}{2x-1} \div \frac{(x-7)(x-5)}{x-3}$

*(j) $\frac{(2x-3)(x+1)}{1-x} \times \frac{4x-3}{2x} \div \frac{3-2x}{x(x-1)}$

Exercise 1I Miscellaneous Exercise on Algebraic Simplification

1. Expand:
   (a) $4(p + 7)$
   (b) $3(m + 5)$
   (c) $-5(2a + 3)$
   (d) $-6(3b + 4)$
   (e) $4(3 - 5g)$
   (f) $8(5 - 4p)$
   (g) $(a + 9)(a + 7)$
   (h) $(a + 3)(a + 8)$
   (i) $(2a - 5)(a - 3)$
   (j) $(4b - 3)(b - 7)$
   (k) $(p + 9)^2$
   (l) $(b + 7)^2$
   (m) $(2m - 3)^2$
   (n) $(4m - 9)^2$

2. Expand and simplify:
   (a) $5(h - 3) + 6(h - 2)$
   (b) $4(p - 3) + 2(p - 7)$
   (c) $3(2b - 5) + 2(4 + 3b)$
   (d) $5(h + 7) + 3(4 - 5h)$
   (e) $5(3 + 2h) - 2(h - 4)$
   (f) $6(p - 3) - 2(p + 4)$
   (g) $8(m - 7) - 3(5 - m)$
   (h) $7(3h - 2) - 4(5 - 2h)$
   (i) $(a + 5)(a - 5) + (a + 3)(a - 3)$
   (j) $(a + 6)(a - 6) - (a + 1)(a - 1)$
   (k) $(h - 3)(h + 5) - (h - 2)(h + 7)$
   (l) $(h + 8)(h - 3) - (h - 2)(h + 5)$
   (m) $(g - 8)(g + 3) - (g + 2)(g - 3)$
   (n) $(c + 5)(c - 3) - (c - 2)(c - 1)$
   (o) $(h - 1)^2 + (h - 3)^2$
   (p) $(m - 7)^2 + (m + 5)^2$

3. Expand:
   (a) $3(m + 5)(m - 7)$
   (b) $5(a + 3)(a - 8)$
   (c) $(a + 1)(a - 3)(a + 5)$
   (d) $(c - 4)(c - 3)(c + 1)$
   (e) $(a + 7)(a + 1)(a - 1)$
   (f) $(g + 2)(g - 2)(g - 1)$

4. Simplify:
   (a) $\dfrac{3(a + 1)}{4a} + \dfrac{a + 5}{a + 1}$
   (b) $\dfrac{m + 3}{m - 7} - \dfrac{m + 7}{m + 3}$
   *(c) $\dfrac{(g + 5)(g - 3)}{2g + 3} \times \dfrac{g}{(5 + g)(3 - g)}$
   *(d) $\dfrac{d(d + 1)}{3d - 2} \times \dfrac{2 - 3d}{(1 + d)(d + 4)}$
   *(e) $\dfrac{(m + 2)(m - 5)}{m - 4} \div \dfrac{(5 - m)(m - 3)}{4 - m}$
   *(f) $\dfrac{(p - 4)(p + 2)}{(p + 7)(p + 1)} \div \dfrac{(4 - p)(2 + p)}{p(p + 7)}$
   (g) $\dfrac{a(a - 2)}{3} \div \dfrac{a(a + 7)}{9} \times \dfrac{(a + 7)(a - 1)}{(a - 2)}$
   (h) $\dfrac{(y - 2)(y + 3)}{(y - 5)} \div \dfrac{(y - 2)(y - 1)}{y(y + 1)} \times \dfrac{y(y - 1)}{(y + 1)}$

Exercise 2M

1. Simplify, expressing your answers with positive indices:
   (a) $x^{-6}y^4 \times x^2y^{-2}$
   (b) $a^{-3}b^{-5} \times a^5b^{-3}$
   (c) $3x^{-2}y^5 \times 5x^{-7}y^{-2}$
   (d) $2a^{-1}b^5 \times 7ab^{-3}$
   (e) $7a^3m^{-4} \times 8a^{-5}m^{-3}$
   (f) $3r^2s^3 \times 4r^{-3}s^5$
   (g) $\dfrac{8a^{-4}}{2a^6}$
   (h) $\dfrac{16a^{-4}}{8a^5}$
   (i) $\dfrac{18a^{-4}}{4a^5}$
   (j) $\dfrac{27m^{-3}}{9m^{-2}}$
   (k) $\dfrac{56t^{-7}}{8t^{-2}}$
   (l) $\dfrac{36h^{-9}}{9h^{-4}}$
   (m) $\dfrac{144x^7y^5}{12x^{-3}y^4}$
   (n) $\dfrac{72a^4b^{-3}}{36ab^{-2}}$
   (o) $\dfrac{7a^2b^{-3}c^{-4}}{21a^5b^{-7}c^{-9}}$
   (p) $\dfrac{9m^3n^4p^{-5}}{21m^{-3}n^4p^2}$
   (q) $(3x)^{-2}$
   (r) $(4y)^{-3}$
   (s) $(2^2y^3)^{-5}$
   (t) $(5^{-2}x^3)^{-5}$
   (u) $(7^{-2}ab^2)^{-3}$
   (v) $(3^{-3}a^2b^{-1})^{-4}$
   (w) $\left(\dfrac{a^3}{b^2}\right)^{-2}$
   (x) $\left(\dfrac{a^4}{p^5}\right)^{-2}$
   (y) $\left(\dfrac{3a^{-2}}{b^3}\right)^{-3}$
   (z) $\left(\dfrac{5g^2}{h^{-3}}\right)^{-2}$

2. Simplify, expressing your answer with positive indices:
   (a) $(3a^2b^{-2})^3 \times (2a^4)^{-2}$
   (b) $(5x^4y^6)^{-3} \times (5^2xy^{-1})^3$
   (c) $(5m^2n^{-3})^{-2} \times 2(m^{-2}n^3)^2$
   (d) $(6a^5b^{-4})^{-3} \times 2(a^3b^{-3})^2$
   (e) $\dfrac{(x^2)^2}{y} \times \dfrac{(y^2)^{-3}}{x^3}$
   (f) $\dfrac{(2x^3)^{-2}}{y^4} \times \dfrac{(2x^7)^2}{3y^5}$
   (g) $\dfrac{(2a^4b^{-2})^3}{c^2} \times \dfrac{(2^2a^{-3}b^2)^{-1}}{c}$
   (h) $\dfrac{(m^2n^3)^2}{p^{-3}} \times (mnp^{-2})^{-3}$
   (i) $\dfrac{(a^2)^3}{b^3} \div \left(\dfrac{a}{b^2}\right)^{-2}$
   (j) $\dfrac{(2a^4)^2}{b^7} \div \dfrac{(a^2)^{-3}}{2b}$
   (k) $\dfrac{(4c^4d^{-3})^2}{9} \div \dfrac{(3c)^{-2}}{d}$
   (l) $\dfrac{(3m^2n^3)^{-2}}{p^4} \div \dfrac{p^{-3}}{m}$
   (m) $\dfrac{(5a^4b^{-3})^2}{a^{-2}b} \div \dfrac{5(a^{-1}b)^{-3}}{ab^{-4}}$
   (n) $\dfrac{6(m^2n^{-2})^{-3}}{mn^{-4}} \div \dfrac{(6m^{-3}n)^2}{m^{-2}n}$

Exercise 3Q Miscellaneous Exercise on Factorisation

Factorisation over the real field:

1. $3a + 6b$
2. $r^2 + 3r - 28$
3. $2y^2 - 8$
4. $x^2 - 16$
5. $a^2 + 9a + 20$
6. $2p - 4q$
7. $p^2 - 9$
8. $ax - ay + bx - by$
9. $5ab - 5c - 2c^2 + 2abc$
10. $a^2 - 2$
11. $x^2 - 5$
12. $x^2 + 2x + 1 - c^2$
13. $x^2y - xy$
14. $25a^2 - 16$
15. $3x - ay + ax + 3y$
16. $a^2 - 10a + 22$
17. $4x^2 - 1$
18. $(x - 2)^2 - 3$
19. $a^2 - 2ab + b^2 - 4$
20. $4x^3 - x^2 + 12x - 3$
21. $m^2 - 4m - 45$
22. $-5ab - 10a^2b^2$
23. $y^2 - 2y - 4$
24. $x^4 - 5x^3 + 6x^2$
25. $(x - 2)^2 - (x - 2) - 12$
26. $3a^2 - 27$
27. $5x^3 - 10x^2 + x + 2$
28. $x^2 - 4x - 2$
29. $3(a + b) - x(a + b)$
30. $p^2 - q^2 - 4pb + 4b^2$
31. $18x^2 - 2$
32. $a^2 + 8ab + 15b^2$
33. $(a + 1)^2 - 5$
34. $6bc + 3d + 6bd + 3c$
35. $4x^2 - 36y^2$
36. $3(x - b) + 2y(x - b)$
37. $(x + y)^2 - 4z^2$
38. $xy - 1 - y + x$
39. $3 + 5y - 2y^2$
40. $(x - 1)^2 - (x - 1) - 30$
41. $b^2 - 2b - 2$
42. $(x - 2)^2 - 4$
43. $3a^3 - 6a^2 + a$
44. $-x^2 - 4x + 2$
45. $(x - b)^2 + x - b$
46. $14 + 31x - 10x^2$
47. $(a + 3)^2 - 16$
48. $2y^2 - 18$
49. $a^3 + a^2 - 72a$
50. $(x + a)^2 - x - a$
51. $25 - (x + 1)^2$
52. $4x^2y^2 - 20xy^2 + 25y^2$
53. $2x^2 + 4x + 1$
54. $125 - 5(2x + 1)^2$
55. $(x - y)^2 - (2x - y)^2$
56. $3x^2 + 6x + 2$
57. $4a^2 + 9 - 12a - c^2$
58. $(2x - 3y)^2 - (x - y)^2$
59. $a^2 - 16b^2 + a - 4b$
60. $9a^2 - 6ab - c^2 + b^2$

Exercise 3R

1. Simplify the following algebraic fractions.

(a) $\frac{2a + 2}{2}$

(b) $\frac{3a + 6}{3}$

(c) $\frac{4a + 12}{4}$

(d) $\frac{6a - 18}{6}$

(e) $\frac{15a - 5}{10}$

(f) $\frac{12a - 8}{8}$

(g) $\frac{16a - 4}{8}$

(h) $\frac{24a - 16}{4}$

(i) $\frac{4}{4a + 4}$

(j) $\frac{3}{3a + 6}$

(k) $\frac{5}{10a + 15b}$

(l) $\frac{9}{6a - 6b}$

(m) $\frac{4a + 12b}{a + 3b}$

(n) $\frac{2a + 10b}{a + 5b}$

(o) $\frac{6a + 9b}{4a + 6b}$

(p) $\frac{11a - 22b}{5a - 10b}$

(q) $\frac{15a - 9b}{10a - 6b}$

(r) $\frac{7a - 14b}{3a - 6b}$

(s) $\frac{2a - 2b}{3b - 3a}$

(t) $\frac{5a - 10b}{4b - 2a}$

(u) $\frac{18a - 3b}{6b - 36a}$

(v) $\frac{8a - 24b}{12b - 4a}$

2. Simplify the following algebraic fractions.

(a) $\frac{x^2 + 3x + 2}{x + 2}$

(b) $\frac{x^2 - 7x + 12}{x - 4}$

(c) $\frac{x^2 - 9}{x - 3}$

(d) $\frac{x^2 - 16}{x + 4}$

(e) $\frac{x^2 - x - 6}{x + 2}$

(f) $\frac{x^2 - 4x - 12}{x + 2}$

(g) $\frac{2x^2 + 7x + 3}{2x + 1}$

(h) $\frac{3x^2 - 5x + 2}{3x - 2}$

(i) $\frac{5x^2 - 6x - 8}{x - 2}$

(j) $\frac{4x^2 + 5x - 6}{x + 2}$

(k) $\frac{x^2 + 3x + 2}{x^2 - 4}$

(l) $\frac{x^2 - 4x + 3}{x^2 - 9}$

(m) $\frac{x^2 + 5x + 6}{x^2 - 9}$

(n) $\frac{x^2 + 7x + 12}{x^2 - 16}$

(o) $\frac{x^2 + 4x - 21}{x^2 + 10x + 21}$

(p) $\frac{x^2 + 7x + 10}{x^2 + 3x - 10}$

(q) $\frac{2x^2 + x - 3}{3x^2 + 2x - 5}$

(r) $\frac{12x^2 + 5x - 2}{4x^2 - 5x + 1}$

(s) $\frac{6x^2 + 5x - 6}{3x^2 + 10x - 8}$

(t) $\frac{20x^2 + 23x - 21}{12x^2 + 13x - 14}$

3. Simplify the following.

(a) $\frac{2x + 4}{3x - 9} \times \frac{7x - 21}{4x + 8}$

(b) $\frac{3x - 12}{4x - 2} \times \frac{6x - 3}{9}$

(c) $\frac{5x + 35}{6x + 8} \times \frac{12x + 16}{10}$

(d) $\frac{8x - 20}{9x + 3} \times \frac{18x + 6}{10x - 25}$

(e) $\frac{2 - 2x}{15x - 10} \times \frac{5}{2 - 2x}$

(f) $\frac{12 - 9x}{2x + 6} \times \frac{4x - 2}{24 - 18x}$

(g) $\frac{35x - 10}{9x - 3} \times \frac{12x - 4}{2x - 8}$

(h) $\frac{12 - 8x}{30x - 6} \times \frac{15x - 3}{6 - 2x}$

(i) $\frac{8x - 12}{7x - 7} \times \frac{5 - 5x}{4x - 6}$

(j) $\frac{3x - 15}{4 - 12x} \times \frac{2 - 6x}{x - 5}$

(k) $\frac{5x + 35}{6x - 3} \times \frac{6 - 12x}{5x + 15}$

(l) $\frac{24x - 32}{8x + 4} \times \frac{3 + 6x}{6x - 8}$

(m) $\frac{x^2 + 3x + 2}{x^2 - 1} \times \frac{x^2 - 2x + 1}{x^2 - 4}$

(n) $\frac{x^2 + 5x + 6}{x^2 + 2x - 3} \times \frac{x^2 + 3x - 4}{x^2 + 3x + 2}$

(o) $\frac{x^2 + 12x + 35}{x^2 + 7x + 12} \times \frac{x^2 + 5x + 4}{x^2 + 6x + 5}$

(p) $\frac{x^2 + 5x + 4}{x^2 - 1} \times \frac{x^2 - x - 6}{x^2 + x - 12}$

(q) $\frac{x^2 + 8x + 15}{x^2 + 6x + 9} \times \frac{x^2 + 5x + 6}{x^2 + 7x + 10}$

(r) $\frac{x^2 + 8x + 16}{x^2 + 5x + 4} \times \frac{x^2 + 4x + 3}{x^2 + 7x + 12}$

(s) $\frac{4x^2 - 1}{2x^2 - 5x - 3} \times \frac{x^2 - x - 6}{4x^2 - 4x + 1}$

(t) $\frac{4x^2 - 5x - 6}{x^2 + 3x - 10} \times \frac{2x^2 + 9x - 5}{4x^2 - 25x - 21}$

(u) $\frac{3x^2 - 17x + 10}{6x^2 + 5x - 6} \times \frac{x^2 - 1}{x^2 - 6x + 5}$

(v) $\frac{6x^2 + x - 12}{2x^2 + 17x + 21} \times \frac{x^2 + 3x - 28}{2x^2 - 5x - 12}$

(w) $\frac{1 - 4x^2}{1 + x - 6x^2} \times \frac{3x^2 - 7x + 2}{2x^2 - 9x - 5}$

(x) $\frac{1 - 4x + 3x^2}{x^2 - 1} \times \frac{2x^2 + 3x + 1}{1 - x - 6x^2}$

4. Simplify the following.

(a) $\frac{3a + 6}{5} \div \frac{a + 2}{15}$

(b) $\frac{5a + 15}{7} \div \frac{a + 3}{14}$

(c) $\frac{4m + n}{7} \div \frac{8m + 2n}{14}$

(d) $\frac{3p - 4q}{2} \div \frac{9p - 12p}{6}$

(e) $\frac{4a - 12b}{a} \div \frac{a - 3b}{5a}$

(f) $\frac{7m - 3n}{2m} \div \frac{14m - 6n}{8m}$

(g) $\frac{4h - 25}{6a + 5b} \div \frac{h - 5}{6a + 5b}$

(h) $\frac{3m - n}{4m + 8n} \div \frac{5m - n}{2m + 4n}$

(i) $\frac{14a - 12b}{6a + 3b} \div \frac{7a - 6b}{2a + b}$

(j) $\frac{mn - m^2}{n} \div \frac{n - m}{n^2}$

(k) $\frac{pq + q^2}{pq} \div \frac{p + q}{p^2q}$

(l) $\frac{a^2b^2 + ab}{a} \div \frac{ab + a^2b^2}{b}$

(m) $\frac{x^2 - 1}{x^2 - 4} \div \frac{x + 1}{x - 2}$

(n) $\frac{x^2 - 9}{x^2 - 16} \div \frac{x - 3}{x + 4}$

(o) $\frac{x^2 + 2x + 1}{x^2 + 5x + 6} \div \frac{x + 1}{x + 3}$

(p) $\frac{x^2 + 5x + 6}{x^2 - 9} \div \frac{x^2 - 4}{x^2 - 6x + 9}$

(q) $\frac{p^2 + 8p + 15}{p^2 + 10p + 21} \div \frac{p^2 + 2p - 3}{p^2 + 5p - 14}$

(r) $\frac{p^2 + 7p + 6}{p^2 + 6p + 5} \div \frac{p^2 + 5p - 6}{p^2 - 2p - 15}$

(s) $\frac{2x^2 - x - 1}{6x^2 - x - 2} \div \frac{x - 1}{3x^2 - 2x}$

(t) $\frac{x^2 - x}{x^2 - 2x + 1} \div \frac{x^2 + x - 2}{x^2 - 1}$

(u) $\frac{6m^2 + m - 15}{2m^2 + m - 6} \div \frac{6m^2 + 7m - 5}{2m^2 + 3m - 2}$

(v) $\frac{6a^2 - 11a - 2}{a^2 - 1} \div \frac{6a^2 - 5a - 1}{a^2 + 3a + 2}$

Revision Exercise for Chapters 1–3

1. Simplify:
   (a) $5m + 12m - 8m$
   (b) $17a^2 - 5a - 3a^2 + 2a$
   (c) $m^2n^2 + 2m^2n - 3mn^2 + 2m^2n^2 - 2mn^2$
2. Expand and collect like terms:
   (a) $2(x + 5) + 7(2 - x)$
   (b) $4(3x - 2) - 2(x + 1)$
   (c) $(x + 5)(x + 7)$
   (d) $(3x - 2)(2x + 1)$
   (e) $(x - 4)^2$
   (f) $(2x + 3)^2$
   (g) $(3x + 2)(3x - 2)$
   (h) $2(x + 3)^2$
   (i) $(x + 5)(x + 3) + (x + 7)(x + 1)$
   (j) $(p - 3)(p - 5) + (p + 2)(p + 3)$
   (k) $5(m - 7)(2m - 3)$
   (l) $3(p + 5)(3p - 2)$
   (m) $(a + 1)(a - 3)(a + 2)$
   (n) $(g + 3)(g + 2)(g - 4)$
3. Simplify:
   (a) $\frac{4}{9} + \frac{3}{4}$
   (b) $\frac{2}{3} + \frac{7}{11}$
   (c) $1\frac{2}{3} - 2\frac{3}{4}$
   (d) $3\frac{1}{8} - 5\frac{1}{3}$
   (e) $2\frac{2}{3} \times 1\frac{1}{8}$
   (f) $5\frac{1}{4} \times 2\frac{1}{7}$
   (g) $3\frac{1}{8} \div 1\frac{1}{4}$
   (h) $2\frac{2}{5} \div 1\frac{1}{11}$
4. Simplify:
   (a) $\frac{3}{2a} - \frac{5}{6}$
   (b) $\frac{2}{3m} + \frac{5}{2n}$
   (c) $\frac{x + 3}{2} + \frac{2x + 1}{3}$
   (d) $\frac{2x - 5}{4} - \frac{x + 2}{2}$
   (e) $\frac{2}{x - 1} + \frac{3}{x + 2}$
   (f) $\frac{2}{2x - 1} - \frac{5}{x - 1}$
   *(g) $\frac{3}{1 - x} + \frac{2}{x - 1}$
   *(h) $\frac{5}{2x - 3} - \frac{1}{3 - 2x}$
   (i) $\frac{2}{(x + 1)^2} - \frac{3}{x + 1}$
   (j) $\frac{3}{(x + 1)(x - 2)} - \frac{2}{(x - 2)(x + 3)}$
5. Simplify:
   (a) $\frac{(a - 3)(a + 5)}{(a - 7)} \times \frac{(a - 7)}{(a - 3)}$
   (b) $\frac{(p + 7)(p + 2)}{(2 + p)} \times \frac{3}{p(p + 7)}$
   *(c) $\frac{y(y - 2)}{(y + 2)} \times \frac{(2 + y)}{(2 - y)}$
   *(d) $\frac{(m + 7)(m + 8)}{9 - m} \times \frac{m - 9}{(7 + m)(8 + m)}$
   (e) $\frac{(a + 3)(a + 7)}{(a + 4)(a - 1)} \div \frac{(a + 3)(a + 7)}{(a + 4)(a - 1)}$
   *(f) $\frac{(a + 2)(a - 3)}{(a - 2)(2 - a)} \div \frac{(3 - a)(3 + a)}{(a + 3)(a - 2)}$

Exercise 4A

1. Use the index laws to simplify the following expressions, giving your answer in terms of positive indices:
   (a) $x^3 \times x^4 \times x^5$
   (b) $a^2 \times a^3 \times a^7$
   (c) $y^2 \times z^3 \times y^4 \times z^{-5}$
   (d) $x^3 \times y^{-5} \times x^2 \times y$
   (e) $3a^{-2}b^{-3} \times 2a^4b^{-1}$
   (f) $2x^{-5}y^{-2} \times 3x^2y^{-3}$
   (g) $a^{-3}b^{-4} \times a^{-6}b^{-2}$
   (h) $p^{-2}q^{-5} \times p^{-4}q^{-7}$
   (i) $\frac{p^4q^5}{p^3q^4}$
   (j) $\frac{a^3b^5}{a^2b^4}$
   (k) $\frac{15m^3n^4p^7}{5m^2n^5p}$
   (l) $\frac{12x^2y^5z^2}{4x^4y^4z}$
   (m) $\frac{18c^4d^2}{3c^3d^{-2}}$
   (n) $\frac{15b^3c^4}{3bc^{-4}}$
   (o) $\frac{4g^{-3}h^{-5}}{12g^{-5}h^3}$
   (p) $\frac{7m^{-2}n^{-3}}{14m^{-4}n^2}$
   (q) $(3x^2b^3)^4$
   (r) $(2a^4b^2)^3$
   (s) $(a^2y^{-3})^{-2}$
   (t) $(x^3b^{-5})^{-4}$
   (u) $\left(\frac{3a^3b^4}{a^{-5}}\right)^{-1}$
   (v) $\left(\frac{2a^2b^3}{b^{-3}}\right)^{-1}$
   (w) $\frac{(-2a^3b^2)^3}{(3ab^{-1})^2} \times \frac{6a^2b^{-1}}{(a^{-2}b)^4}$
   (x) $\frac{(-3x^2y^3)^2}{(2x^{-1}y)^3} \times \frac{4x^4y^{-3}}{(x^{-1}y)^3}$
   (y) $\frac{6a^3b^{-2}}{(-4a^2b)^2} \div \frac{12a^{-3}b^{-2}}{8a^{-2}b^{-1}}$
   (z) $\frac{7a^{-5}b^2}{(-2a^3b)^3} \div \frac{21a^{-3}b^2}{4a^{-1}b}$

2. Simplify, expressing your answer with positive indices and lowest bases:

(a) $\dfrac{8 \times 2^{-5} \times 3^{-5}}{9 \times 2^{-7} \times 81}$

(b) $\dfrac{16 \times 3^{-1} \times 32}{2^{-7} \times 9}$

(c) $\dfrac{25 \times 15 \times 3^2}{5^{-3} \times 3^{-7} \times 27}$

(d) $\dfrac{12 \times 15 \times 2^7}{3^{-2} \times 5^{-2} \times 2^{-2}}$

(e) $(-3 \times 2^{-5})^2$

(f) $(-2 \times 3^{-4})^4$

(g) $(2^4 \times -5)^{-1}$

(h) $(3^5 \times -7)^{-3}$

(i) $\left(\dfrac{8 \times 3^5}{2^{-7} \times 9}\right)^{-2}$

(j) $\left(\dfrac{27 \times 2^{-5}}{64 \times 3^{-5}}\right)^{-1}$

3. Simplify each of the following:

(a) $\dfrac{a^{2m} \times a^n}{a^{2m+n}}$

(b) $\dfrac{b^{3m} \times b^{2n}}{b^{3m+2n}}$

(c) $\dfrac{a^{3x} \times a^{-y}}{a^{2x} \times a^{3y}}$

(d) $\dfrac{b^{-2x} \times b^{3y}}{b^x \times b^{-2y}}$

(e) $\dfrac{7a^{2m} \times 3a^{-n}}{42a^{5m-6n}}$

(f) $\dfrac{3b^{3x} \times 2b^{-2y}}{24b^{2x-3y}}$

(g) $\dfrac{12^n}{4^n}$

(h) $\dfrac{15^m}{3^m}$

(i) $\dfrac{6^{2-x} \times 2^x}{3^{1-x}}$

(j) $\dfrac{4^{1-x} \times 6^x}{3^{2-x}}$

(k) $\dfrac{12^{3m} \times 8^{-2}}{9^m \times 4^{-2m} \times 6^n}$

(l) $\dfrac{6^{2n} \times 9^{-3}}{27^n \times 8^{-n} \times 16^n}$

(m) $\dfrac{10^{-2n}(100^{n+1})^{-2}}{(10^{-1})^{2n}(10^2)^{-3n-1}}$

(n) $\dfrac{10^{4n}(100^{n-1})^{-1}}{(10^{-2})^{3n}(10^2)^{n+1}}$

4. Simplify each of the following:

(a) $1 + x^{-1}$

(b) $1 - x^{-1}$

(c) $(1 - x^{-1})^2$

(d) $(1 + x^{-1})^2$

(e) $(a^{-1} + b^{-1})(a^{-1} - b^{-1})$

(f) $(a^{-1} + a)^2$

(g) $\dfrac{a^{-1} + b^{-1}}{a^{-1}b^{-1}}$

(h) $\dfrac{a^{-1} - b^{-1}}{a^{-1}b^{-1}}$

(i) $\dfrac{x^{-1}}{(1 + x^{-1})^2}$

(j) $\dfrac{x + 4 + 4x^{-1}}{1 + 2x^{-1}}$

(k) $\dfrac{(x + h)^{-1} - x^{-1}}{h}$

(l) $\dfrac{(a + b)^{-1} - b^{-1}}{b}$

*(m) $\dfrac{3^{n+1} - 3^n}{2}$

*(n) $\dfrac{2^{n+1} + 2^n}{3}$

*(o) $\dfrac{3^{n+1} + 3^{n-1}}{3^{n+2} + 3^n}$

*(p) $\dfrac{2^{n-1} - 2^{n+1}}{2^{n+2} + 2^n}$

Exercise 4C

1. Find the value of:

(a) $343^{-\frac{1}{3}}$

(b) $32^{-\frac{1}{5}}$

(c) $\left(\dfrac{25}{9}\right)^{-1.5}$

(d) $\left(\dfrac{9}{16}\right)^{-2.5}$

(e) $\left(\dfrac{-8}{27}\right)^{-\frac{1}{3}}$

(f) $\left(\dfrac{-27}{8}\right)^{-\frac{2}{3}}$

2. Simplify each of the following, expressing your answer with positive indices:

(a) $a^{\frac{1}{2}} \times a^{\frac{1}{2}} \times a^{\frac{1}{2}}$

(b) $x^{\frac{1}{3}} \times x^{\frac{1}{3}} \times x^{\frac{1}{3}}$

(c) $b^{\frac{1}{2}} \times c^{\frac{1}{2}} \times b^{\frac{1}{2}} \times c^{-\frac{1}{2}}$

(d) $y^{\frac{1}{3}} \times z^{-\frac{1}{3}} \times y^{\frac{1}{3}} \times z$

(e) $2x^{-\frac{1}{2}}y^{-\frac{1}{2}} \times 3x^{\frac{1}{2}}y^{-\frac{1}{2}}$

(f) $5a^{-\frac{1}{2}}b^{-\frac{1}{2}} \times 2a^{\frac{1}{2}}b^{-\frac{1}{2}}$

(g) $\dfrac{xy}{x^{\frac{1}{2}}y^{\frac{1}{2}}}$

(h) $\dfrac{a^{\frac{1}{2}}b^{-\frac{1}{2}}}{ab^{-\frac{1}{2}}}$

(i) $\dfrac{9x^{-\frac{1}{2}} \times 2x^{\frac{1}{2}}}{6x^{-\frac{1}{2}}}$

(j) $\dfrac{12x^{\frac{1}{3}} \times 2x^{-\frac{1}{3}}}{9x^{-\frac{1}{3}}}$

(k) $(a^{\frac{1}{2}})^{\frac{1}{2}}(b^{-\frac{1}{2}})^3$

(l) $(a^{\frac{1}{3}})^{-\frac{1}{2}}(b^{-\frac{1}{3}})^{\frac{1}{2}}$

(m) $\left(\dfrac{x^{-2}}{y^2}\right)^{-\frac{1}{2}}$

(n) $\left(\dfrac{x^{-4}}{y^{-6}}\right)^{-\frac{1}{2}}$

(o) $(2a^2b^{-\frac{1}{2}})^3 \times (\frac{1}{2}a^8b^7)^{\frac{1}{2}}$

(p) $(3xb^{-\frac{1}{2}})^{\frac{1}{2}} \times (\frac{1}{3}x^{\frac{1}{2}}b^{-3})^{\frac{1}{2}}$

(q) $\dfrac{(\sqrt[3]{x})^2(-2y^{\frac{1}{2}})^3}{(2y^{-\frac{1}{2}})^2x^{\frac{1}{2}}}$

(r) $\dfrac{(\sqrt[3]{x})^3 \times x^{-\frac{1}{2}}}{x^{-\frac{2}{3}} \times \sqrt{x^3}}$

(s) $\dfrac{\sqrt[3]{8a^{-9}b^6}}{(\frac{1}{2}a^3b^{-2})^{-1}}$

(t) $\dfrac{\sqrt[4]{81a^{-8}b^8}}{(\frac{1}{4}a^2b^{-3})^{-1}}$

(u) $\dfrac{(3a^{\frac{1}{2}}b^{\frac{1}{2}})^3}{(2ab^{-1})^{\frac{1}{2}}} \times \dfrac{2^{\frac{1}{2}}a^{\frac{1}{2}}b^{-1}}{(a^{-\frac{1}{2}}b)^{\frac{1}{2}}}$

(v) $\dfrac{(-2x^{\frac{1}{2}}y^{\frac{1}{2}})^2}{(3x^{-1}y)^{\frac{1}{2}}} \times \dfrac{4x^{\frac{1}{2}}y^{-\frac{1}{2}}}{(x^{-1}y)^{\frac{1}{2}}}$

3. Simplify, expressing your answer with positive indices and lowest bases:

(a) $\sqrt{5} \times \sqrt[3]{5} \times \sqrt[4]{5}$

(b) $\sqrt{2} \times \sqrt[4]{2} \times \sqrt[5]{2}$

(c) $\dfrac{8^{\frac{1}{3}} \times 32^{\frac{1}{5}}}{\sqrt[3]{4}}$

(d) $\dfrac{27^{\frac{1}{3}} \times 9^{\frac{1}{2}}}{\sqrt{3}}$

(e) $\dfrac{25^{\frac{1}{2}} 10^{\frac{1}{2}}}{20^{-\frac{1}{2}}}$

(f) $\dfrac{8^{\frac{1}{2}} 6^{-\frac{1}{2}}}{18^{\frac{1}{2}}}$

4. Simplify each of the following:

(a) $x^{\frac{1}{2}}(x^{\frac{1}{2}} + 4x^{-\frac{1}{2}})$

(b) $a^{\frac{1}{2}}(a^{\frac{1}{2}} - 2a^{-\frac{1}{2}})$

(c) $(x^{\frac{1}{2}} - y^{\frac{1}{2}})(x^{\frac{1}{2}} + y^{\frac{1}{2}})$

(d) $(x^{\frac{1}{2}} + y^{\frac{1}{2}})^2$

(e) $a^{-\frac{1}{2}} - b^{-\frac{1}{2}}$

(f) $\dfrac{1}{a^{-\frac{1}{2}} - b^{-\frac{1}{2}}}$

(g) $\dfrac{x^{-\frac{1}{2}} - y^{-\frac{1}{2}}}{x^{-\frac{1}{2}} + y^{-\frac{1}{2}}}$

(h) $\dfrac{a - b}{a^{\frac{1}{2}} - b^{\frac{1}{2}}}$

5. Express in the form of a quadratic trinomial and hence simplify:

(a) $2^{2x} + 2 \times 2^x + 1$

(b) $3^{2x} - 6 \times 3^x + 9$

(c) $\dfrac{3^{2x} + 5 \times 3^x + 6}{3^x + 3}$

(d) $\dfrac{2^{2x} - 2^x - 12}{2^x - 4}$

*(e) $\dfrac{a + 2a^{\frac{1}{2}}b^{\frac{1}{2}} + b}{a^{\frac{1}{2}} + b^{\frac{1}{2}}}$

*(f) $\dfrac{x - 2x^{\frac{1}{2}}y^{\frac{1}{2}} + y}{x^{\frac{1}{2}} - y^{\frac{1}{2}}}$

Exercise 4D

1. Solve the following equations for x:

(a) $5^x = 25$

(b) $3^x = 243$

(c) $49^x = 7$

(d) $125^x = 5$

(e) $27^x = \sqrt{3}$

(f) $16^x = \sqrt{2}$

(g) $3^{3x} \times 9^{-2x+1} = 27$

(h) $2^{-4x} \times 4^{3x-2} = 16$

(i) $4^x \times 8^{x-2} = 2^{-x}$

(j) $5^{3x} \times 125^{x+1} = 5^{-2x}$

(k) $16^x = \dfrac{2^{\frac{1}{2}} \times 4^{\frac{1}{2}}}{8^{\frac{1}{3}}}$

(l) $27^x = \dfrac{3^{\frac{1}{2}} \times 9^{\frac{1}{2}}}{27^{-1}}$

(m) $2^{2x} - 3 \times 2^x + 2 = 0$

(n) $5^{2x} - 6 \times 5^x + 5 = 0$

(o) $5^{2x} + 4 \times 5^x - 5 = 0$

(p) $3^{2x} - 2 \times 3^x - 3 = 0$

(q) $4^x - 2^{x+2} + 4 = 0$

(r) $9^x - 2 \times 3^{x+1} + 9 = 0$

2. Solve for x:

(a) $x^4 = 256$

(b) $x^7 = 128$

(c) $x^{-2} = 81$

(d) $x^{-3} = 27$

(e) $x^{\frac{1}{3}} = 3$

(f) $x^{\frac{1}{3}} = 5$

(g) $x^{\frac{1}{3}} = 8$

(h) $x^{\frac{1}{3}} = 16$

(i) $x^{-\frac{1}{3}} = 25^{-\frac{1}{10}} 9^{\frac{1}{3}}$

(j) $x^{-\frac{1}{4}} = 16^{-\frac{1}{8}} 3^{\frac{1}{4}}$

(k) $(x - 3)^{\frac{1}{3}} = 8^{\frac{1}{2}} 27^{-\frac{1}{2}}$

(l) $(x + 1)^{\frac{1}{3}} = 81^{-\frac{1}{2}} 16^{-1}$

Answers

Exercise 1F

1. (a) $1\frac{11}{42}$ (b) $\frac{1}{24}$ (c) $-\frac{11}{24}$ (d) $1\frac{9}{20}$ (e) $-\frac{3}{4}$ (f) $4\frac{7}{12}$ (g) $3\frac{5}{12}$ (h) $-\frac{13}{18}$ (i) $\frac{4a+15}{5a}$
(j) $\frac{56-5b}{8b}$ (k) $\frac{10-3a}{4a}$ (l) $\frac{21a+10}{35a}$ (m) $\frac{35b+36a}{45ab}$ (n) $\frac{3b-10a}{2ab}$ (o) $\frac{20y-63x}{35xy}$ (p) $\frac{5n+12m}{20mn}$
(q) $\frac{7x-5}{12}$ (r) $\frac{-x+11}{4}$ (s) $\frac{4x+1}{6}$ (t) $\frac{14x+14}{15}$ (u) $\frac{8x-7}{15}$ (v) $\frac{-26x+13}{21}$ (w) $\frac{18x-6}{35}$
(x) $\frac{31x-13}{12}$ (y) $\frac{x+2}{4}$ (z) $\frac{x}{12}$ 2. (a) $\frac{3x-1}{(x+1)(x-3)}$ (b) $\frac{7x-11}{(x-2)(x-1)}$ (c) $\frac{-3x+41}{(x-3)(x+5)}$
(d) $\frac{x-11}{(2x-1)(x-4)}$ (e) $\frac{-22x+17}{(3x-2)(1-x)}$ (f) $\frac{2x+1}{(1-2x)(3x-1)}$ (g) $\frac{-x+41}{(x+7)(5-x)}$
(h) $\frac{-2x+20}{(x-1)(3-x)}$ (i) $\frac{-3x+3}{(x+1)(2-x)}$ (j) $\frac{13x-23}{(6-x)(2x-1)}$ (k) $\frac{19x+16}{(1-x)(2+3x)}$ (l) $\frac{12x}{(3-x)(3+2x)}$
(m) $\frac{-32x+44}{(2x-3)(4-3x)}$ (n) $\frac{24x-15}{(1-2x)(3x-2)}$ 3. (a) $\frac{-1}{x-3}$ (b) $\frac{-1}{3-2x}$ (c) $\frac{7}{5x-2}$ (d) $\frac{10}{1-3x}$
(e) $\frac{1}{4+3x}$ (f) $\frac{-2}{2x+4}$ (g) $\frac{-2}{x-4}$ (h) $\frac{2}{x-2}$ (i) $\frac{4}{2x-3}$ (j) $\frac{6}{4x-1}$ (k) $\frac{3}{x+7}$ (l) $\frac{12}{4x+3}$
(m) $\frac{-5}{5x-1}$ (n) $\frac{-12}{7x-2}$

Exercise 1G

1. (a) $\frac{6x+10}{(x+1)(x+2)(x+3)}$ (b) $\frac{9x+16}{(x+1)(x-1)(x+2)}$ (c) $\frac{8x+12}{(x-1)(x-7)(x+3)}$
(d) $\frac{14x+2}{(2x-1)(3x+2)(4x+1)}$ (e) $\frac{x+9}{(x-3)(x-4)(x+1)}$ (f) $\frac{7x-1}{(x+2)(2x-1)(2x+1)}$
(g) $\frac{-5x+18}{(3x-2)(2x+1)(x+3)}$ (h) $\frac{x+7}{(2x+1)(x-3)(2x-1)}$ (i) $\frac{-11x+14}{(2-3x)(3+2x)(1+x)}$
(j) $\frac{-10x+22}{(5-3x)(1+2x)(1+x)}$ 2. (a) $\frac{3x+7}{(x+2)^2}$ (b) $\frac{2x+10}{(2x+3)^2}$ (c) $\frac{4x+10}{(x+3)^2}$ (d) $\frac{6x-3}{(3x-1)^2}$ (e) $\frac{-2x-5}{(x+5)^2}$
(f) $\frac{-3x--5}{(x+3)^2}$ (g) $\frac{8x+13}{(x+1)^2(x+2)}$ (h) $\frac{17x+12}{(2x+1)^2(x+1)}$ (i) $\frac{-x-3}{(x+1)^2(x+2)}$ (j) $\frac{-6x+8}{(2x-1)^2(x+2)}$
(k) $\frac{7x+11}{(x+2)^2(x+1)}$ (l) $\frac{9x+8}{(x-3)^2(x+2)}$ 3. (a) $\frac{23}{28}$ (b) 3 (c) $2\frac{13}{15}$ (d) $-4\frac{1}{8}$ (e) $\frac{19x-9}{30}$
(f) $\frac{82x+15}{30}$ (g) $\frac{14x-7}{12}$ (h) $\frac{14x-7}{8}$ 4. (a) $\frac{1}{6x}$ (b) $\frac{-71}{20x}$ (c) $\frac{7}{15x}$ (d) $\frac{25}{12x}$ (e) $\frac{15}{4x}$ (f) $\frac{-61}{10x}$
(g) $\frac{-11x-13}{(x+1)(x+2)(x-1)}$ (h) $\frac{3x^2+12x+24}{(x-4)(x+1)(x+2)}$ (i) $\frac{2x^2-10x-28}{(x+5)(x+1)(x-1)}$ (j) $\frac{x^2-7x+18}{(x-2)(x+2)(x-1)}$
(k) $\frac{11x+26}{(x+4)(2x-1)}$ (l) $\frac{3x-15}{(3+x)(x-3)}$ (m) $\frac{-5x-3}{(1+x)(x-1)}$ (n) $\frac{3x-18}{(x+2)(x-2)}$ (o) $\frac{2x^2+7x-15}{x(x+1)(x-3)}$
(p) $\frac{7x^2+14x-38}{(x+1)(x+2)(x-2)(x+4)}$ (q) $\frac{11x^2+82x+93}{(x+5)(x-1)(x+7)(x+2)}$ (r) $\frac{4x^2+10x-26}{(x-3)(x+5)(x-1)(x+4)}$

Exercise 1H

1. (a) $\frac{3}{4}$ (b) $\frac{4}{5}$ (c) $2\frac{3}{4}$ (d) $5\frac{1}{2}$ (e) 12 (f) $9\frac{4}{5}$ (g) $1\frac{1}{3}$ (h) 2 (i) $1\frac{1}{2}$ (j) $1\frac{1}{3}$ (k) 2 (l) 3
(m) $\frac{(x+1)(x+3)}{(x+2)(x+4)}$ (n) $\frac{x+2}{x+3}$ (o) $2x-3$ (p) $(5x-6)(x+3)$ (q) $-(x+4)$ (r) $-(x+3)$ (s) $-(x+2)$
(t) $-(y-3)$ (u) $-\frac{x-2}{x+2}$ (v) -1 2. (a) $\frac{2}{3}$ (b) $\frac{5}{8}$ (c) $-\frac{2}{5}$ (d) $-1\frac{1}{6}$ (e) $\frac{2}{3}$ (f) $3\frac{1}{2}$ (g) $\frac{2}{3}$
(h) $\frac{5}{12}$ (i) 3 (j) 3 (k) $\frac{3x-2}{4x-1}$ (l) $\frac{3(5x-3)}{6x-2}$ (m) $\frac{x+1}{4x-3}$ (n) $\frac{7x+1}{3x}$ (o) $\frac{(3x+2)(x+4)}{(x+3)(x-3)}$
(p) $\frac{(x+2)(x+3)}{(3x-1)(4x-1)}$ (q) 1 (r) $\frac{-3(x+4)}{x(x+1)}$ (s) $\frac{2a+1}{a+1}$ (t) $\frac{-(6a-1)}{a+2}$ 3. (a) $5\frac{1}{16}$ (b) $\frac{5}{12}$ (c) $9\frac{7}{12}$
(d) $1\frac{1}{21}$ (e) 4 (f) 1 (g) $(x+2)^2$ (h) $-x$ (i) $\frac{x+7}{2x-1}$ (j) $\frac{(x+1)(4x-3)}{2}$

Exercise 1I

1. (a) $4p+28$ (b) $3m+15$ (c) $-10a-15$ (d) $-18b-24$ (e) $12-20g$ (f) $40-32p$
(g) $a^2+16a+63$ (h) $a^2+11a+24$ (i) $2a^2-11a+15$ (j) $4b^2-31b+21$ (k) $p^2+18p+81$
(l) $b^2+14b+49$ (m) $4m^2-12m+9$ (n) $16m^2-72m+81$ 2. (a) $11h-27$ (b) $6p-26$ (c) $12b-7$
(d) $-10h+47$ (e) $8h+23$ (f) $4p-26$ (g) $11m-71$ (h) $29h-34$ (i) $2a^2-34$ (j) -35 (k) $-3h-1$
(l) $2h-14$ (m) $-4g-18$ (n) $5c-17$ (o) $2h^2-8h+10$ (p) $2m^2-4m+74$ 3. (a) $3m^2-6m-105$
(b) $5a^2-25a-120$ (c) $a^3+3a^2-13a-15$ (d) $c^3-6c^2+5c+12$ (e) a^3+7a^2-a-7 (f) g^3-g^2-4g+4
4. (a) $\frac{7a^2+26a+3}{4a(a+1)}$ (b) $\frac{6m+58}{(m-7)(m+3)}$ (c) $\frac{-g}{2g+3}$ (d) $\frac{-d}{d+4}$ (e) $\frac{m+2}{m-3}$ (f) $\frac{-p}{p+1}$ (g) $3(a-1)$
(h) $\frac{y^2(y+3)}{y-5}$

Exercise 2M

1. (a) $\frac{y^2}{x^4}$ (b) $\frac{a^2}{b^8}$ (c) $\frac{15y^3}{x^9}$ (d) $14b^2$ (e) $\frac{56}{a^2m^7}$ (f) $\frac{12s^8}{r}$ (g) $\frac{4}{a^{10}}$ (h) $\frac{2}{a^9}$ (i) $\frac{9}{2a^9}$ (j) $\frac{3}{m}$
(k) $\frac{7}{t^5}$ (l) $\frac{4}{h^5}$ (m) $12x^{10}y$ (n) $\frac{2a^3}{b}$ (o) $\frac{b^4c^5}{3a^3}$ (p) $\frac{3m^6}{7p^7}$ (q) $\frac{1}{9x^2}$ (r) $\frac{1}{4^3y^3}$ (s) $\frac{1}{2^{10}y^{15}}$
(t) $\frac{5^{10}}{x^{15}}$ (u) $\frac{7^6}{a^3b^6}$ (v) $\frac{3^{12}b^4}{a^8}$ (w) $\frac{b^4}{a^6}$ (x) $\frac{p^{10}}{a^8}$ (y) $\frac{a^6b^9}{3^3}$ (z) $\frac{1}{5^2g^4h^6}$ 2. (a) $\frac{27}{4a^2b^6}$ (b) $\frac{125}{x^9y^{21}}$
(c) $\frac{2n^{12}}{25m^8}$ (d) $\frac{b^6}{108a^9}$ (e) $\frac{x}{y^7}$ (f) $\frac{x^8}{3y^9}$ (g) $\frac{2a^{15}}{b^8c^3}$ (h) mn^3p^9 (i) $\frac{a^8}{b^7}$ (j) $\frac{8a^{14}}{b^6}$ (k) $\frac{16c^{10}}{d^5}$
(l) $\frac{1}{9m^3n^6p}$ (m) $\frac{5a^7}{b^9}$ (n) $\frac{n^9}{6m^3}$

Exercise 3Q

1. $3(a+2b)$ 2. $(r-4)(r+7)$ 3. $2(y-2)(y+2)$ 4. $(x-4)(x+4)$ 5. $(a+4)(a+5)$ 6. $2(p-2q)$
7. $(p-3)(p+3)$ 8. $(a+b)(x-y)$ 9. $(5+2c)(ab-c)$ 10. $(a-\sqrt{2})(a+\sqrt{2})$ 11. $(x-\sqrt{5})(x+\sqrt{5})$
12. $(x+1-c)(x+1+c)$ 13. $xy(x-1)$ 14. $(5a-4)(5a+4)$
15. $(3+a)(x+y)$ 16. $(a-5-\sqrt{3})(a-5+\sqrt{3})$ 17. $(2x-1)(2x+1)$ 18. $(x-2-\sqrt{3})(x-2+\sqrt{3})$
19. $(a-b-2)(a-b+2)$ 20. $(x^2+3)(4x-1)$ 21. $(m-9)(m+5)$ 22. $-5ab(1+2ab)$
23. $(y-1-\sqrt{5})(y-1+\sqrt{5})$ 24. $x^2(x-3)(x-2)$ 25. $(x-6)(x+1)$ 26. $3(a-3)(a+3)$
27. $(5x^2+1)(x+2)$ 28. $(x-2-\sqrt{6})(x-2+\sqrt{6})$ 29. $(a+b)(3-x)$ 30. $(p-2b-q)(p-2b+q)$
31. $2(3x-1)(3x+1)$ 32. $(a+5b)(a+3b)$ 33. $(a+1-\sqrt{5})(a+1+\sqrt{5})$ 34. $3(c+d)(2b+1)$
35. $4(x-3y)(x+3y)$ 36. $(x-b)(3+2y)$ 37. $(x+y-2z)(x+y+2z)$ 38. $(y+1)(x-1)$
39. $(3-y)(1+2y)$ 40. $(x-7)(x+4)$ 41. $(b-1-\sqrt{3})(b-1+\sqrt{3})$ 42. $x(x-4)$
43. $3a\left(a-1-\frac{\sqrt{6}}{3}\right)\left(a-1+\frac{\sqrt{6}}{3}\right)$ 44. $-(x+2-\sqrt{6})(x+2+\sqrt{6})$ 45. $(x-b)(x-b+1)$
46. $(7-2x)(2+5x)$ 47. $(a+7)(a-1)$ 48. $2(y-3)(y+3)$ 49. $a(a+9)(a-8)$ 50. $(x+a)(x+a-1)$
51. $(4-x)(6+x)$ 52. $y^2(2x-5)^2$ 53. $2\left(x+1-\frac{\sqrt{2}}{2}\right)\left(x+1+\frac{\sqrt{2}}{2}\right)$ 54. $20(2-x)(3+x)$
55. $-x(3x-2y)$ 56. $3\left(x+1-\frac{\sqrt{3}}{3}\right)\left(x+1+\frac{\sqrt{3}}{3}\right)$ 57. $(2a-3-c)(2a-3+c)$ 58. $(x-2y)(3x-4y)$
59. $(a-4b)(a+4b+1)$ 60. $(3a-b-c)(3a-b+c)$

Exercise 3R

1. (a) $a+1$ (b) $a+2$ (c) $a+3$ (d) $a-3$ (e) $\frac{3a-1}{2}$ (f) $\frac{3a-2}{2}$ (g) $\frac{4a-1}{2}$ (h) $2(3a-2)$
(i) $\frac{1}{a+1}$ (j) $\frac{1}{a+2}$ (k) $\frac{1}{2a+3b}$ (l) $\frac{3}{2(a-b)}$ (m) 4 (n) 2 (o) $\frac{3}{2}$ (p) $\frac{11}{5}$ (q) $\frac{3}{2}$ (r) $\frac{7}{3}$
(s) $-\frac{2}{3}$ (t) $-\frac{5}{2}$ (u) $-\frac{1}{2}$ (v) -2. 2. (a) $x+1$ (b) $x+3$ (c) $x+3$ (d) $x-4$ (e) $x-3$
(f) $x-6$ (g) $x+3$ (h) $x-1$ (i) $5x+4$ (j) $4x-3$ (k) $\frac{x+1}{x-2}$ (l) $\frac{x-1}{x+3}$ (m) $\frac{x+2}{x-3}$
(n) $\frac{x+3}{x-4}$ (o) $\frac{x-3}{x+3}$ (p) $\frac{x+2}{x-2}$ (q) $\frac{2x+3}{3x+5}$ (r) $\frac{3x+2}{x-1}$ (s) $\frac{2x+3}{x+4}$ (t) $\frac{5x-3}{3x-2}$ 3. (a) $\frac{7}{6}$
(b) $\frac{x-4}{2}$ (c) $x+7$ (d) $\frac{8}{5}$ (e) $\frac{1}{3x-2}$ (f) $\frac{2x-1}{2(x+3)}$ (g) $\frac{10(7x-2)}{3(x-4)}$ (h) $\frac{3-2x}{3-x}$ (i) $\frac{-10}{7}$
(j) $\frac{3}{2}$ (k) $\frac{-2(x+7)}{x+3}$ (l) 3 (m) $\frac{x-1}{x-2}$ (n) $\frac{x+4}{x+1}$ (o) $\frac{x+7}{x+3}$ (p) $\frac{x+2}{x-1}$ (q) 1 (r) 1
(s) $\frac{x+2}{2x-1}$ (t) $\frac{2x-1}{x-7}$ (u) $\frac{x+1}{2x+3}$ (v) $\frac{3x-4}{2x+3}$ (w) $\frac{(3x-1)(x-2)}{(3x+1)(x-5)}$ (x) -1 4. (a) 9 (b) 10
(c) 1 (d) 1 (e) 20 (f) 2 (g) $\frac{4h-25}{h-5}$ (h) $\frac{3m-n}{2(5m-n)}$ (i) $\frac{2}{3}$ (j) mn (k) pq (l) $\frac{b}{a}$
(m) $\frac{x-1}{x+2}$ (n) $\frac{x+3}{x-4}$ (o) $\frac{x+1}{x+2}$ (p) $\frac{x+3}{x-2}$ (q) $\frac{(p+5)(p-2)}{(p+3)(p-1)}$ (r) $\frac{(p+3)(p-5)}{(p+5)(p-1)}$ (s) x
(t) $\frac{x(x+1)}{(x-1)(x+2)}$ (u) 1 (v) $\frac{(a-2)(a+2)}{(a-1)^2}$

Revision Exercise for Chapters 1–3

1. (a) $9m$ (b) $14a^2-3a$ (c) $3m^2n^2-5mn^2+2m^2n$ 2. (a) $-5x+24$ (b) $10x-10$ (c) $x^2+12x+35$
(d) $6x^2-x-2$ (e) $x^2-8x+16$ (f) $4x^2+12x+9$ (g) $9x^2-4$ (h) $2x^2+12x+18$ (i) $2x^2+16x+22$
(j) $2p^2-3p+21$ (k) $10m^2-85m+105$ (l) $9p^2+39p-30$ (m) a^3-7a-6 (n) $g^3+g^2-14g-24$

3. (a) $1\frac{7}{36}$ (b) $1\frac{10}{33}$ (c) $-1\frac{1}{12}$ (d) $-2\frac{5}{24}$ (e) 3 (f) $11\frac{1}{4}$ (g) $2\frac{1}{2}$ (h) $2\frac{1}{5}$ 4. (a) $\frac{9-5a}{6a}$
(b) $\frac{4n+15m}{6mn}$ (c) $\frac{7x+11}{6}$ (d) $\frac{-9}{4}$ (e) $\frac{5x+1}{(x-1)(x+2)}$ (f) $\frac{-8x+3}{(2x-1)(x-1)}$ (g) $\frac{1}{1-x}$ (h) $\frac{6}{2x-3}$
(i) $\frac{-1-3x}{(x+1)^2}$ (j) $\frac{x+7}{(x+1)(x-2)(x+3)}$ 5. (a) $a+5$ (b) $\frac{3}{p}$ (c) $-y$ (d) -1 (e) 1 (f) $-\frac{a+2}{2-a}$
6. (a) $0.\dot{8}$ (b) $\frac{73}{200}$ 7. (a) 4.899 (b) 15.49 (c) 0.4899 (d) 0.1549 (e) 2.884 (f) 7
8. (a) $2\sqrt{3}$ (b) $2\sqrt{6}$ (c) $3\sqrt{5}$ (d) $5\sqrt{3}$ (e) $a\sqrt{a}$; $a>0$ (f) $p\sqrt{q}$ 10. (a) $\sqrt{12}$ (b) $\sqrt{50}$
(c) $\sqrt{a^2b}$ (d) $\sqrt{p^3}$ 9. (a) $9\sqrt{2}$ (b) $7\sqrt{3}-3$ (c) $-4\sqrt{3}+10\sqrt{2}$ (d) $-2(a-4)\sqrt{2a}$; $a>0$
11. (a) $\sqrt{14}$ (b) $5\sqrt{3}$ (c) $\sqrt{6}+2$ (d) $9\sqrt{6}-3\sqrt{10}$ (e) 4 (f) $10+2\sqrt{21}$ (g) -1
(h) $5\sqrt{10}+16$ 12. (a) $\frac{\sqrt{5}}{5}$ (b) $\frac{\sqrt{3}}{6}$ (c) $\frac{2\sqrt{7}}{21}$ (d) $\frac{5+\sqrt{10}}{5}$ (e) $\frac{\sqrt{5}+\sqrt{3}}{2}$ (f) $4\sqrt{3}-4\sqrt{2}$
(g) $\frac{12+2\sqrt{2}}{17}$ (h) $\frac{5+3\sqrt{5}}{-4}$ (i) $-(5+2\sqrt{6})$ (j) $\frac{29+5\sqrt{35}}{17}$ 13. (a) $\frac{7\sqrt{2}+2\sqrt{7}}{14}$ (b) $\frac{\sqrt{6}+6}{6}$
(c) $-4\sqrt{6}$ (d) $\frac{2\sqrt{15}+\sqrt{10}-4}{10}$ 14. (a) a^{10} (b) $6b^7$ (c) $10x^6y^5$ (d) a^5 (e) $\frac{1}{2}m^3n$ (f) a^{10}
(g) $64a^9b^6$ (h) $\frac{x^8}{y^{12}}$ (i) 2 (j) 1 (k) $a^2b^9c^7$ (l) $3a^7b^4c$ 15. (a) $\frac{1}{x^5}$ (b) $\frac{2}{m^2}$ (c) a^3 (d) $5x^2$
(e) $\frac{1}{25x^7}$ (f) a (g) $\frac{6}{a^3}$ (h) $\frac{7y^5}{x^6}$ (i) $\frac{a^4}{16b^6}$ (j) $\frac{a^{10}}{b^{11}}$ (k) $\frac{3}{2}a^8b^2$ (l) $\frac{27m^7}{8n^{12}}$ 16. (a) 1.56×10^4
(b) 1.11×10^{-4} (c) 1.3×10^1 (d) 1.3×10^0 17. (a) 4.38×10^{10} (b) 1.148×10^4 (c) 3.0×10^9
(d) 5.88×10^3 (e) 7.56×10^7 (f) 1.2×10^3 18. (a) 56.21 (b) 9.227 (c) 20.24 (d) 444.4 (e) 8.597
(f) 13.28 (g) 0.4731 (h) 0.8265 (i) 5.599 (j) 1.972 (k) 0.002808 (l) 0.2627 (m) 0.8544
(n) 0.9778 (o) 0.07379 (p) 2.4303 19. (a) $3(x+2y)$ (b) $3(3x-5)$ (c) $a(a-2)(a+2)$
(d) $2x(x+1)$ (e) $ab(3b+2a-6ab)$ (f) $(x+y)^2$ (g) $\sqrt{3}(x+3y)$ (h) $(x-5)(x+5)$
(i) $(2x-7)(2x+7)$ (j) $3(1-3x)(1+3x)$ (k) $(ab-3c)(ab+3c)$ (l) $(x-y-2)(x-y+2)$
(m) $(a+7)(a+2)$ (n) $(b-7)(b-8)$ (o) $(x+14y)(x-2y)$ (p) $(x-9b)(x+6b)$
(q) $(3x-1)(2x+5)$ (r) $(3x+5)(2x-7)$ (s) $(3x-5)^2$ (t) $(1-3x)(2+3x)$
20. (a) $(x-\sqrt{21})(x+\sqrt{21})$ (b) $(x-2\sqrt{5})(x+2\sqrt{5})$ (c) $3(y-3\sqrt{3})(y+3\sqrt{3})$
(d) $(x-2-\sqrt{5})(x-2+\sqrt{5})$ (e) $(a+2-\sqrt{3})(a+2+\sqrt{3})$ (f) $(b-4-\sqrt{21})(b-4+\sqrt{21})$
(g) $\left(a-\frac{1}{2}-\frac{\sqrt{13}}{2}\right)\left(a-\frac{1}{2}+\frac{\sqrt{13}}{2}\right)$ (h) $\left(x+\frac{5}{2}-\frac{\sqrt{5}}{2}\right)\left(x+\frac{5}{2}+\frac{\sqrt{5}}{2}\right)$ (i) $2(y-1-\sqrt{3})(y-1+\sqrt{3}$
(j) $-\left(a-\frac{3}{2}-\frac{\sqrt{33}}{2}\right)\left(a-\frac{3}{2}+\frac{\sqrt{33}}{2}\right)$ 21. (a) $(2-c)(a+b)$ (b) $(x^2+1)(x-2)$ (c) $(x-y)(x+y+3)$
(d) $(xy-1)(y-1)$ (e) $(a-3-b)(a-3+b)$ (f) $(3c-d+4f)(3c+d-4f)$ 22. (a) $\frac{7}{5}$ (b) $x+7$
(c) $\frac{3x-2}{x}$ (d) $\frac{x+2}{x-3}$ (e) $\frac{(4x-3)(x+1)}{(x-5)(x+3)}$ (f) $\frac{3}{2}$ (g) 1

Exercise 4A

1. (a) x^{12} (b) a^{12} (c) $\frac{y^6}{z^2}$ (d) $\frac{x^5}{y^4}$ (e) $\frac{6a^2}{b^4}$ (f) $\frac{6}{x^3y^5}$ (g) $\frac{1}{a^9b^6}$ (h) $\frac{1}{p^6q^{12}}$ (i) pq (j) ab
(k) $\frac{3mp^6}{n}$ (l) $\frac{3yz}{x^2}$ (m) $6cd^4$ (n) $5b^2c^8$ (o) $\frac{g^2}{3h^8}$ (p) $\frac{m^2}{2n^5}$ (q) $81x^8b^{12}$ (r) $8a^{12}b^6$
(s) $\frac{y^6}{a^4}$ (t) $\frac{b^{20}}{x^{12}}$ (u) $\frac{1}{3b^4a^8}$ (v) $\frac{1}{2a^2b^6}$ (w) $-\frac{16a^{17}b^3}{3}$ (x) $\frac{9x^{14}}{2y^3}$ (y) $\frac{1}{4b^3}$ (z) $-\frac{1}{6a^{12}b^2}$
2. (a) $\frac{2^5}{3^{11}}$ (b) $\frac{2^{16}}{3^3}$ (c) 3^75^6 (d) $2^{11}3^45^3$ (e) $\frac{3^2}{2^{10}}$ (f) $\frac{2^4}{3^{16}}$ (g) $\frac{-1}{2^4\times5}$ (h) $\frac{-1}{3^{15}\times7^3}$
(i) $\frac{1}{2^{20}3^6}$ (j) $\frac{2^{11}}{3^8}$ 3. (a) 1 (b) 1 (c) a^{x-4y} (d) b^{-3x+5y} (e) $\frac{a^{-3m+5n}}{2}$ (f) $\frac{b^{x+y}}{4}$ (g) 3^n
(h) 5^m (i) $3\times2^2=12$ (j) $2^{2-x}3^{2x-2}$ (k) $2^{10m-n-6}3^{m-n}$ (l) $3^{-n-6}2^n$ (m) 10^{2n-2} (n) 10^{6n}
4. (a) $\frac{x+1}{x}$ (b) $\frac{x-1}{x}$ (c) $\left(\frac{x-1}{x}\right)^2$ (d) $\left(\frac{x+1}{x}\right)^2$ (e) $\frac{(b-a)(b+a)}{a^2b^2}$ (f) $\frac{(a^2+1)^2}{a^2}$
(g) $b+a$ (h) $b-a$ (i) $\frac{x}{(x+1)^2}$ (j) $x+2$ (k) $\frac{-1}{x(x+h)}$ (l) $\frac{-a}{b^2(a+b)}$ (m) 3^n (n) 2^n
(o) $\frac{1}{3}$ (p) $-\frac{3}{10}$

Exercise 4C

1. (a) $\frac{1}{7}$ (b) $\frac{1}{2}$ (c) $\frac{27}{125}$ (d) $\frac{1024}{243}$ (e) $-\frac{243}{32}$ (f) $-\frac{16}{81}$ 2. (a) $a^{\frac{1}{2}}$ (b) $x^{\frac{11}{6}}$ (c) $\frac{b^{\frac{1}{2}}}{c^{\frac{1}{2}}}$ (d) $y^{\frac{1}{2}}z^{\frac{1}{2}}$
(e) $\frac{6}{x^{\frac{1}{2}}y^{\frac{1}{2}}}$ (f) $\frac{10a^{\frac{1}{2}}}{b^{\frac{1}{2}}}$ (g) $\frac{x^{\frac{1}{2}}}{y^{\frac{1}{2}}}$ (h) $\frac{b^{\frac{1}{2}}}{a^{\frac{1}{2}}}$ (i) 3 (j) $\frac{8}{3}$ (k) $\frac{a^{\frac{1}{2}}}{b^{\frac{1}{2}}}$ (l) $\frac{1}{a^{\frac{1}{2}}b^{\frac{1}{2}}}$ (m) xy (n) $\frac{x}{y^{\frac{1}{2}}}$
(o) $2^{\frac{11}{2}}a^8b$ (p) $\frac{3^{\frac{1}{2}}x^{\frac{7}{12}}}{b^{\frac{1}{2}}}$ (q) $-2x^{\frac{1}{2}}y^{\frac{1}{2}}$ (r) $\frac{1}{x^{\frac{1}{2}}}$ (s) 1 (t) $\frac{3}{4b}$ (u) $27a^{\frac{1}{2}}b^{\frac{1}{2}}$ (v) $\frac{16x^2}{3^{\frac{1}{2}}y^{\frac{1}{2}}}$ 3. (a) $5^{\frac{11}{6}}$
(b) $2^{\frac{19}{8}}$ (c) $2^{\frac{11}{2}}$ (d) $3^{\frac{1}{2}}$ (e) $5^{\frac{11}{2}}2^{\frac{1}{2}}$ (f) $\frac{1}{3^{\frac{1}{2}}2^{\frac{1}{2}}}$ 4. (a) $x+4$ (b) $a-2$ (c) $x-y$
(d) $x+y+2\sqrt{xy}$ (e) $\frac{1}{\sqrt{a}}-\frac{1}{\sqrt{b}}=\frac{\sqrt{b}-\sqrt{a}}{\sqrt{ab}}$ (f) $\frac{\sqrt{ab}}{\sqrt{b}-\sqrt{a}}$ (g) $\frac{\sqrt{y}-\sqrt{x}}{\sqrt{y}+\sqrt{x}}$ (h) $\sqrt{a}+\sqrt{b}$
5. (a) $(2^x+1)^2$ (b) $(3^x-3)^2$ (c) 3^x+2 (d) 2^x+3 (e) $\sqrt{a}+\sqrt{b}$ (f) $\sqrt{x}-\sqrt{y}$

Exercise 4D

1. (a) 2 (b) 5 (c) $\frac{1}{2}$ (d) $\frac{1}{3}$ (e) $\frac{1}{6}$ (f) $\frac{1}{8}$ (g) -1 (h) 4 (i) 1 (j) $-\frac{3}{8}$ (k) $\frac{1}{8}$
(l) $\frac{25}{12}$ (m) 1, 0 (n) 1, 0 (o) 0 (p) 1 (q) 1 (r) 1 2. (a) ±4 (b) 2 (c) $\pm\frac{1}{9}$
(d) $\frac{1}{3}$ (e) 243 (f) 125 (g) 32 (h) 64 (i) $\frac{5}{9}$ (j) $\frac{4}{3}$ (k) $\frac{11}{3}$ (l) $-\frac{95}{96}$