- CLEAR AND CONCISE
- GRADED EXERCISES
- COMPREHENSIVE
- VERY USER FRIENDLY
- SOLUTIONS AT BACK

ADVANCED EDITION

UNDERSTANDING YEAR 10 MATHS

SAMPLE

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(There are partly worked solutions to the more difficult questions.)

Note (i): The Australian National Curriculum has been split into 3 major strands:

1. Number & Algebra	2. Measurement & Geometry	3. Statistics & Probability
(NA)	(MG)	(SP)

Note (ii): Some schools may choose not to teach ALL of the last 4 topics, because they are primarily intended for students who wish to study higher levels of Maths in later years.

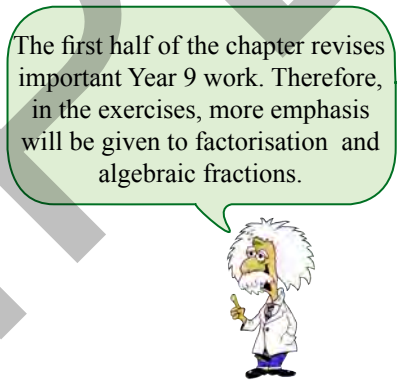
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FURTHER ALGEBRA AND FACTORISATION

The 'Australian Curriculum Mathematics' (ACM) references for this sub-strand of 'Number and Algebra' (NA) are given below. This chapter may contain additional extension work which the author feels will be beneficial to the student.

- *Factorise algebraic expressions by identifying the HCF (ACMNA 191).*
- *The index laws (ACMNA 209, 231, 264).*
- *Expanding binomial products (ACMNA 213).*
- *Simplify algebraic fractions involving the 4 operations (ACMNA 232).*
- *Special binomial products (ACMNA 233).*
- *Factorising trinomials and special binomial products (ACMNA 269).*
- *Factorising algebraic expressions involving fractions (NSW).*

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Leonard Euler (1707 – 1783)

Euler was a Swiss mathematician, physicist, astronomer, geographer, logician and engineer who made important and influential discoveries in many branches of mathematics, such as calculus, graph theory, topology and number theory. He is also famous for his work in mechanics, fluid dynamics , optics, astronomy and music theory. He was one of the most eminent mathematicians of the 18th century and some people consider him to be the greatest of all time. He was also the most prolific with his collected works filling 92 volumes, more than any other mathematician. He spent much of his adult life in St Petersburg, which was at that time the capital of Russia.



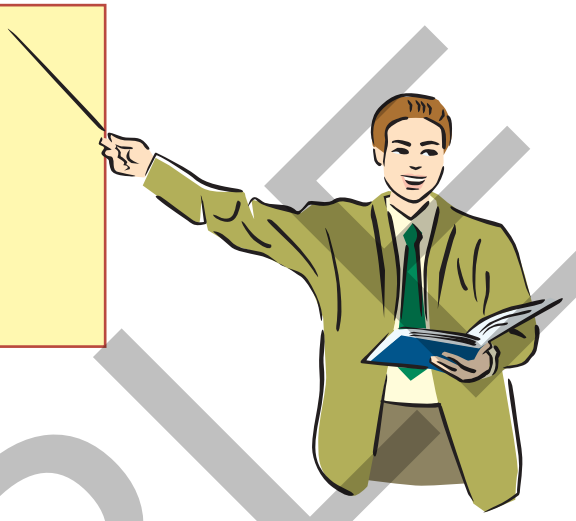
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THE BASIC INDEX LAWS

Most students will already know all of these laws, as they should have been taught in earlier years. Rather than memorising them, it is very much more important to know how to apply them to typical questions.

1. $a^m \times a^n = a^{m+n}$
2. $a^m \div a^n = a^{m-n}$
3. $(a^m)^n = a^{mn}$
4. $(ab)^m = a^m b^m$
5. $a^0 = 1$



Examples:

(i)	$a^6 \times a^2$	$= a^{6+2}$	$=$	a^8	(law 1)
(ii)	$(a^2)^3$	$= a^{2\times 3}$	$=$	a^6	(law 3)
(iii)	$3m^0$	$= 3 \times 1$	$=$	3	(law 5)
(iv)	$(3m)^0$	$= 3^0 \times m^0$	$=$	1	(law 4, then law 5)
(v)	$a^{10} \div a^2$	$= a^{10-2}$	$=$	a^8	(law 2)
(vi)	$(3a^4)^2$	$= 3^2(a^4)^2$	$=$	$9a^8$	(law 4, then law 3)
(vii)	$\frac{12x^8}{4x^2}$	$= 3x^{8-2}$	$=$	$3x^6$	(law 2)
(viii)	$5m^2 \times 4m^3$	$= 20m^{2+3}$	$=$	$20m^5$	(law 1)
(ix)	$3^{m+2} \div 3^m = 3^{(m+2)-m}$	$= 3^2$	$=$	9	(law 2)
(x)	$\frac{(a+b)^2}{a+b}$	$= (a+b)^{2-1}$	$=$	$a+b$	(law 2)
(xi)	$\frac{6m^3}{8m^{-2}}$	$= \frac{3m^{3-(-2)}}{4}$	$=$	$\frac{3m^5}{4}$	(law 2)

Note: $a + b = (a + b)^1$.

SAMPLE

FRACTIONAL AND NEGATIVE INDICES

The 5 laws in this section are harder, but they are important to understand, because most test and exams will contain questions which require their application.

6.	$a^{\frac{1}{2}}$	=	$\sqrt{a}$
7.	$a^{\frac{1}{3}}$	=	$\sqrt[3]{a}$
8.	$a^{\frac{p}{q}}$	=	$\sqrt[q]{a^p}$
9.	a^{-n}	=	$\frac{1}{a^n}$
10.	$(\frac{a}{b})^{-1}$	=	$\frac{b}{a}$



The student is expected to know how to change from 'index notation' to 'surd notation' and vice versa.

Examples:

(i) $81^{\frac{1}{2}} = \sqrt{81} = 9$ (law 6)

(ii) $8^{\frac{1}{3}} = \sqrt[3]{8} = 2$ (law 7)

(iii) $64^{\frac{2}{3}} = \sqrt[3]{64^2} = 16$ (law 8)

(iv) $3^{-2} = \frac{1}{3^2} = \frac{1}{9}$ (law 9)

(v) $10^{-3} = \frac{1}{10^3} = \frac{1}{1\,000}$ (law 9)

(vi) $16^{-\frac{3}{4}} = \frac{1}{16^{\frac{3}{4}}} = \frac{1}{\sqrt[4]{16^3}} = \frac{1}{8}$ (law 9 then law 8)

(vii) $\left(\frac{3}{4}\right)^{-1} = \frac{4}{3}$ law 10

Note: With negative fractions, the best method is to first change the negative fraction to a positive fraction by using law 9. Then apply law 8 to the positive fractional index in the denominator.

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FURTHER TYPICAL EXAM QUESTIONS



It would be very worthwhile going through each of these examples carefully, in order to understand how the final answer was obtained.

Examples: Simplify the following expressions:

(i) $5a^2b^3 \times 3ab^4 = 15a^{2+1}b^{3+4} = 15a^3b^7$

(ii) $(5a^3)^2 = 5^2(a^3)^2 = 25a^6$

(iii) $18m^6 \div 3m^2 = 6m^{6-2} = 6m^4$

(iv) $6m^0 - (3a)^0 = 6 \times 1 - 1 = 5$

(v) $49^{\frac{1}{2}} + 27^{\frac{1}{3}} = \sqrt{49} + \sqrt[3]{27} = 7 + 3 = 10$

(vi) $5^{-2} = \frac{1}{5^2} = \frac{1}{25}$

(vii) $9^{-\frac{1}{2}} = \frac{1}{9^{\frac{1}{2}}} = \frac{1}{\sqrt{9}} = \frac{1}{3}$

(viii) $125^{\frac{2}{3}} = \sqrt[3]{125^2} = 25$

(ix) $\left(\frac{2}{3}\right)^{-1} = \frac{1}{\left(\frac{2}{3}\right)^1} = \frac{3}{2}$

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

(xi) $8^{-\frac{2}{3}} = \frac{1}{8^{\frac{2}{3}}} = \frac{1}{\sqrt[3]{8^2}} = \frac{1}{4}$

(xii) $\frac{1}{2^{-3}} = 2^3 = 8$

Note: $a^{-n} = \frac{1}{a^n}$ and also $\frac{1}{a^{-n}} = a^n$.

Examples: Express the following in scientific notation:

a) 860 000 ➡ 8.6×10^5

b) 0.000 58 ➡ 5.8×10^{-4}

c) 35 000 000 ➡ 3.5×10^7



Some further revision of Year 9 theory.

SAMPLE

REMOVING GROUPING SYMBOLS

'Grouping symbols' means exactly the same as 'BRACKETS'. You will often be asked to remove grouping symbols from a particular algebraic expression.
This is done by multiplying the term outside the brackets by each of the terms inside the brackets. The word 'EXPAND' is often used instead of 'remove grouping symbols'.

THE GENERAL RULES

$$a(b + c) = a \times b + a \times c = ab + ac$$
$$a(b - c) = a \times b - a \times c = ab - ac$$

Examples: Expand the following:

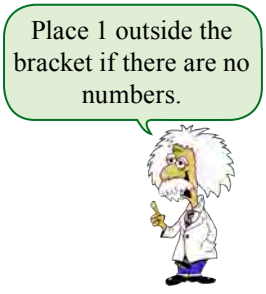
i) $6(a - 3) = 6 \times a - 6 \times 3$
$= 6a - 18$

ii) $4m(m + 5) = 4m \times m + 4m \times 5$
$= 4m^2 + 20m$

iii) $-5(p + 2) = -5 \times p + (-5) \times 2$
$= -5p - 10$

iv) $-3(2a - 5) = -3 \times 2a + (-3) \times (-5)$
$= -6a + 15$

v) $-(2 + 3y) = -1(2 + 3y)$
$= -1 \times 2 + (-1) \times (3y)$
$= -2 - 3y$



The last three examples are important to understand because they occur regularly in algebra.

A minus sign outside of a bracket reverses the signs inside of the bracket.

SAMPLE

LEVEL 1 — FURTHER ALGEBRA AND FACTORISATION

EASIER QUESTIONS

Note: Only turn back to page number shown if you have difficulty.

Page

Q1. Simplify the following: 2 - 4

a) $(3m^3)^2$ b) $18x^2y \div 3xy$ c) $8p^3q^2 + 2pq^2$

d) $\dfrac{5m^4 \times 3m^7 \times 2m^8}{4m^6}$ e) $\dfrac{36n^7t^5}{9nt^6}$ f) $\left(\dfrac{36ab^4}{45a^3b}\right)^{-1}$

g) $(m^2n^{-2})^{-1}$ h) $n^{2x+1} \times n^{3-2x}$ i) $5x^0$

Q2. Evaluate: 2 - 4

a) $8^{\frac{2}{3}}$ b) $16^{-\frac{3}{4}}$ c) $64^{-\frac{2}{3}}$ d) $1\,000^{-\frac{1}{3}}$

e) $\left(9^{-3}\right)^{\frac{1}{2}}$ f) $\left(27^{\frac{2}{3}}\right)^{-2}$ g) $\left(8^{-\frac{2}{3}}\right)^{-2}$ h) $\left(\dfrac{3m}{2}\right)^0$

Q3. Rewrite the following in surd form: 2 - 4

a) $\left(64x\right)^{\frac{1}{3}}$ b) $5x^{-\frac{1}{2}}$ c) $\left(16p^2\right)^{-\frac{3}{4}}$ d) $\left(x^{-2}\right)^{\frac{1}{6}}$

Q4. Express the following in scientific notation: 4

a) 73 000 b) 0.000 49 c) 0.000 000 83

d) 178 000 000 e) 0.000 068 f) 3 480 000

Q5. Rewrite the following as ordinary numbers: 4

a) 3.86×10^{-3} b) 6.92×10^{5} c) 7.4×10^{-6}

Q6. Expand and simplify when possible: 5, 6

a) $3m(m + 5)$ b) $8x(3 - 2x)$ c) $-5n(n - 7)$

d) $3(4x + 2) - 2(3x + 5)$ e) $4(3m - 7) - (2m - 6)$ f) $3a(2a - 1) - 5(4 + a)$

Q7. Expand and simplify: 7 - 10

a) $(3x + 2)(x - 5)$ b) $(2x - 7)(5x - 4)$ c) $(3m + 6)^2$

d) $(4n - 3)^2$ e) $(5x - 4)(5x + 4)$ f) $2(x + 8)(x - 7)$

g) $x(3x - 2)^2$ h) $(5 - 4m)(5 + 4m)$ i) $3x(5x - 1)(4x - 3)$

Q8. Simplify the following: Revision of Year 9

a) $\dfrac{m - 5}{4} + \dfrac{4 + m}{3}$ b) $\dfrac{x + 4}{2} - \dfrac{8 + x}{5}$ c) $\dfrac{n + 1}{3} - \dfrac{n - 3}{5}$

d) $\dfrac{2a + 1}{4} + \dfrac{3a - 5}{6}$ e) $\dfrac{2 - 5x}{3} - \dfrac{5 + 4x}{8}$ f) $\dfrac{6x + 5}{7} - \dfrac{4x + 8}{6}$

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LEVEL 3 — FURTHER ALGEBRA AND FACTORISATION

AVERAGE QUESTIONS

Note: Only turn back to page number shown if you have difficulty.

Page

Q1. Expand the brackets and simplify the following expressions: 5, 6

a) $5(x + 3) - 3(x - 1)$ b) $-3a(a - 3) + 2(a + 1)$ c) $2m(1 - m) - 3m$

d) $b(b + 1) - 4(b - 8)$ e) $-(m - 1) - (3m - 5)$ f) $x(y - 6) + y(x + 2)$

g) $8a(3a - 1) - 2(a + 8)$ h) $xy(x - y) - x(xy - 1)$ i) $-5(3 - m) + (m - 3)$

Q2. Expand and simplify: 7 - 10

a) $(2x + 1)(x - 5)$ b) $(4a + 3)^2$ c) $(3b - 2)(3b + 2)$

d) $(5n - 4)(9 - n)$ e) $(3x + 7)(3 - 4x)$ f) $(9p - 1)^2$

g) $(6a - 5)(6a + 5)$ h) $(x + 2y)(3x - 5y)$ i) $(4m - 3n)(4m + 3n)$

j) $(7 - 5x)^2$ k) $(3m + 5)^2$ l) $5x(2x - 7)^2$

Q3. Factorise these expressions: 11, 12

a) $24m^2 + 18m$ b) $a^3 - a^2b - a$ c) $81x^2 - 49y^2$

d) $8n^2 + 12n - 6$ e) $-48x - 16x^2$ f) $p^2q - pq^2 + pq$

g) $6ab^2 - 15ab + 12b$ h) $32x^2 - 2$ i) $-2m^2 - 50$

Q4. Factorise these trinomials: 13 - 17

a) $2x^2 + 10x - 72$ b) $5a^2 - 30a + 40$ c) $-x^2 + x + 12$

d) $6b^2 + 13b + 6$ e) $15 + 11m - 12m^2$ f) $a^2 - 2ab + b^2$

g) $8x^2 - 52x + 80$ h) $2m^2 + 5mn + 2n^2$ i) $20m^2 - m - 1$

Q5. Factorise these four term expressions: 15

a) $x^2 - yz - xy + xz$ b) $8a + b - 2 - 4ab$ c) $n^3 - n^2 + n - 1$

d) $m - mn - m^2 + n$ e) $ab + 3bc - 5a - 15c$ f) $4xy - 3yz + 2xz - 6y^2$

Q6. Simplify the following expressions: 18

a) $\dfrac{xy + 2x - y^2 - 2y}{x^2 + 2x - xy - 2y}$ b) $\dfrac{x^2 + x - 6}{x^2 - 4x + 4}$ c) $\dfrac{3x^2 - 8x - 3}{3x^3 + x^2}$

d) $\dfrac{4x^2 - 4}{3x^2 - 9x - 12}$ e) $\dfrac{18x^2 - 3x - 3}{9x^2 + 6x + 1}$ f) $\dfrac{2x^3 - 8x}{2x^3 - 8x^2 + 8x}$

g) $\dfrac{2a^2 - 5ab + 2b^2}{2ab - b^2 + 4a - 2b}$ h) $\dfrac{a + ab - a^2 - b}{a - a^3}$ i) $\dfrac{x^3 - x}{x - x^3}$

Q7. Simplify: 19, 20

a) $\dfrac{3}{x^2 - x} - \dfrac{1}{x + 1}$ b) $x + \dfrac{5x}{x + 6}$ c) $\dfrac{5}{27 - 3x} \div \dfrac{9}{18 - 2x}$

d) $\dfrac{2}{x^2 - x} + \dfrac{3}{x - x^2}$ e) $\dfrac{3x - 6}{4x^3} \times \dfrac{8}{4 - 2x}$ f) $\dfrac{x^2 - x}{x^2 - 2x - 8} \div \dfrac{x - 1}{x^2 - 4x}$

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LEVEL 5 — FURTHER ALGEBRA AND FACTORISATION

HARDER QUESTIONS

Q1. Factorise each of the following:

a) $x^2 + yz - xy - xz$ b) $32x^2 - 2$ c) $12 + x - x^2$

d) $a^2 - 2ab + b^2$ e) $3x + 2 - 2x^2$ f) $8x^2 - 52x + 80$

g) $(3x + 1)^2 - 9$ h) $4ab - 3bc + 2ac - 6b^2$ i) $11x - 12x^2 + 15$

Q2. Factorise completely:

a) $2m^2 + 5mn + 2n^2$ b) $x^3 - x$ c) $a^4 - b^4$

d) $6p^2 - 17pq + 12pq^2$ e) $10a^2b + 11ab - 6b$ f) $4x^4 - 13x^2 - 12$

g) $x^8 - y^8$ h) $m^2 - n^2 - 4m + 4n$ i) $(x + 2)^2 - (x - 1)^2$

Q3. Simplify the following:

a) $\dfrac{x^2 - 3x - 10}{2x^2 - 8x - 10}$ b) $\dfrac{18p^2 - 3p - 3}{9p^2 + 6p + 1}$ c) $\dfrac{2a^2 - 5ab + 2b^2}{2ab - b^2 + 4a - 2b}$

d) $\dfrac{m^4 - 16}{m^3 + 4m + 2m^2 + 8}$ e) $\dfrac{(x + 3)^2 - y^2}{x^2 + 3x - xy}$ f) $\dfrac{2x^3 - 8x}{2x^3 - 8x^2 + 8x}$

Q4. Simplify these:

a) $\dfrac{x^2 - 2x - 3}{x^2 - 1} \div \dfrac{x^2 - 6x + 9}{x^2 + x - 2}$ b) $\dfrac{x^4 - 9x^2}{4x^2 - 16x + 12} \times \dfrac{x^2 - 2x + 1}{3x^3 + 9x^2}$

c) $\dfrac{a^2 - b^2 + a + b}{a - a^3} \times \dfrac{1 - a^2}{a - b + 1}$ d) $\dfrac{(x - 1)^2 - (x + 1)^2}{x - 1} \div \dfrac{x^3 - 4x^2 + 4x}{x^3 - 4x - x^2 + 4}$

e) $\dfrac{4x^2 - y^2}{2x^2 + 3xy - 2y^2} \times \dfrac{x^2 + 2xy}{xy - 2x^2}$ f) $\dfrac{x^2 - y^2 - 2x - 2y}{x^2 - 2xy - 3y^2} \times \dfrac{xy - 3y^2}{y - x + 2}$

Q5. Simplify:

a) $\dfrac{x^2}{4x^2 + 7x + 3} + \dfrac{3x}{4x + 3}$ b) $\dfrac{3x}{2x^2 + 13x + 20} - \dfrac{2x}{x^2 + 6x + 8}$

c) $\dfrac{6x^2 + 5x - 6}{6x^2 + 13x + 6} + \dfrac{3x^2 - 4x + 4}{3x^2 + 8x + 4}$ d) $\dfrac{2x^2 - x^3 - x}{x^3 - x} - \dfrac{x^3 - x}{x + x^3}$

e) $\dfrac{2}{x^2 - x} + \dfrac{3}{x - x^2}$ f) $\dfrac{1}{x^2 - 4} - \dfrac{1}{x^2 + 3x + 2}$

Q6. The formula to factorise the difference of two squares is $a^2 - b^2 = (a + b)(a - b)$.
Factorise the following:

a) $(x + 1)^2 - 4$ b) $(x - 1)^2 - 16$ c) $3(x + 2)^2 - 3$ d) $36(x + 3)^2 - 1$

e) $9(x - 3)^2 - 36$ f) $(ax)^2 - (ay)^2$ g) $(ax)^2 - a(y)^2$ h) $3a^2 - 2b^2$

Q7. Find the exact value of $\dfrac{a^4c}{b^4}$ where $a = \left(\dfrac{2}{3}\right)^2$, $b = \left(\dfrac{4}{3}\right)^4$ and $c = \left(\dfrac{8}{3}\right)^7$.

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LEVEL 1 – Further Algebra and Factorisation

Q1. a) $9m^6$ b) $6x$ c) $4p^2$ d) $\frac{15m^{13}}{2}$ e) $\frac{4n^6}{t}$

f) $\frac{45a^3b}{36ab^4} = \frac{5a^2}{4b^3}$ g) $m^{-2}n^2 = \frac{n^2}{m^2}$ h) $n^{(2x+1)+(3-2x)} = n^4$ i) $5 \times 1 = 5$

Q2. a) $\sqrt[3]{8^2} = 4$ b) $\frac{1}{\sqrt[4]{16^3}} = \frac{1}{8}$ c) $\frac{1}{\sqrt[3]{64^2}} = \frac{1}{16}$ d) $\frac{1}{\sqrt[3]{1\,000}} = \frac{1}{10}$

e) $9^{-\frac{3}{2}} = \frac{1}{\sqrt{9^3}} = \frac{1}{27}$ f) $27^{-\frac{4}{3}} = \frac{1}{81}$ g) $8^{\frac{4}{3}} = 16$ h) $\frac{1}{2}$

Q3. a) $4\sqrt[3]{x}$ b) $\frac{5}{\sqrt{x}}$ c) $\frac{1}{8\sqrt{p^3}}$ d) $x^{-\frac{1}{3}} = \frac{1}{\sqrt[3]{x}}$

Q4. a) 7.3×10^4 b) 4.9×10^{-4} c) 8.3×10^{-7}

d) 1.78×10^8 e) 6.8×10^{-5} f) 3.48×10^6

Q5. a) 0.00368 b) 692 000 c) 0.0000074

Q6. a) $3m^2 + 15m$ b) $24x - 16x^2$ c) $-5n^2 + 35n$

d) $12x + 6 - 6x - 10$ e) $12m - 28 - 2m + 6$ f) $6a^2 - 3a - 20 - 5a$

$= 6x - 4$ $= 10m - 22$ $= 6a^2 - 8a - 20$

Q7. a) $3x^2 - 13x - 10$ b) $10x^2 - 43x + 28$ c) $9m^2 + 36m + 36$

d) $16n^2 - 24n + 9$ e) $25x^2 - 16$ f) $2x^2 + 2x - 112$

g) $9x^3 - 12x^2 + 4x$ h) $25 - 16m^2$ i) $60x^3 - 57x^2 + 9x$

Q8. a) $\frac{7m+1}{12}$ b) $\frac{3x+4}{10}$ c) $\frac{2n+14}{15}$

d) $\frac{12a-7}{12}$ e) $\frac{1-52x}{24}$ f) $\frac{64x-26}{42}$

LEVEL 2 – Further Algebra and Factorisation

Q1. a) $6(x+4)$ b) $5(1-3x)$ c) $6(3x+5y)$

d) $2x(2+3x)$ e) $3p(3-5q)$ f) $2xy(7-4y)$

Q2. a) $(x-4)(x+4)$ b) $(2x-y)(2x+y)$ c) $(7-5m)(7+5m)$

d) $(3a-2b)(3a+2b)$ e) $(mn-6)(mn+6)$ f) $2(x-1)(x+1)$

Q3. a) $(x+3)(x+4)$ b) $(x-5)(x+2)$ c) $(m-4)(m-7)$

d) $(b-8)(b+3)$ e) $3(a+6)(a-1)$ f) $2(x+9)(x-4)$

Q4. a) $(a+b)(b-c)$ b) $(x+2y)(3z+1)$ c) $(6-m)(2n+m)$

d) $(x-3)(x+y)$ e) $(2a+b)(3b+c)$ f) $(5x-y)(y-5)$

Q5. a) $(2x+1)(x-5)$ b) $(x-3)(3x-1)$ c) $(5x+2)(x+4)$

d) $(2x+3)(3x-2)$ e) $(3x-4)(4x-1)$ f) $(4x-1)(4x+5)$

Q6. a) $\frac{x(x-4)}{(x+4)(x-4)}$ b) $\frac{3(2x-1)}{5(2x-1)}$ c) $\frac{x(y+2)-y(y+2)}{x(x+2)-y(x+2)}$

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

$= \frac{y+2}{x+2}$

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

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

Q7. a) $\frac{x+5}{(x+1)(x-5)} \times \frac{x(x-5)}{(x+5)(x+5)}$ b) $\frac{2x+1}{(2x+3)(x-3)} \times \frac{2(x-3)(x-3)}{5(2x+1)}$

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

c) $\frac{(a+6)(a-6)}{(a+2)(a-6)} \times \frac{2(a-6)}{3(a+6)}$ d) $\frac{(x-5)(x+4)}{(x-5)(x+5)} \times \frac{x(x+5)}{(x+4)}$

$= \frac{2(a-6)}{3(a+2)}$ $= x$

SAMPLE