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SCHOLAR Study Guide

# **National 5 Mathematics**

## **Course Materials**

### **Topic 8: Expanding brackets**

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## Topic 8

# Expanding brackets

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**Learning objective**

By the end of this topic, you should be able to:

- multiply out single brackets;
- multiply out double brackets.

## 8.1 Looking back at National 4: Expressions involving brackets

### Expressions Involving Brackets

Go online



First let us look at how to multiply an expression involving brackets.

4 threes =  $4 \times 3 = 3 + 3 + 3 + 3 = 12$ : Multiplying by 4 is the same as adding 3 four times.

It is the same for letters...

4 *d*'s =  $4 \times d = d + d + d + d = 4d$ : Multiplying by 4 is the same as adding the letter four times.

Let's look at what happens with expressions...

$$4(d + 3) = 4 \times (d + 3) = (d + 3) + (d + 3) + (d + 3) + (d + 3)$$

Add the expression four times...

$$4(d + 3) = 4 \times (d + 3) = d + 3 + d + 3 + d + 3 + d + 3$$

Gather like terms together...

$$4(d + 3) = 4 \times (d + 3) = d + d + d + d + 3 + 3 + 3 + 3$$

$$4(d + 3) = 4 \text{ } d\text{'s} + 4 \text{ threes} = 4d + 12$$

$$4(d + 3) = 4d + 12$$

Now look at how to simplify an expression involving brackets.

Before you can simplify, get rid of any brackets...

$$3(x + 5) + 2 = 3x + 3 \times 5 + 2$$

$$= 3x + 15 + 2$$

$$a = 3x + 17$$

Another example...

$$4(x + 3) + 2x = 4x + 4 \times 3 + 2x$$

$$= 4x + 12 + 2x$$

$$= 6x + 12$$

### Examples

1.

**Problem:**

Multiply out the brackets  $5(x - 2)$ .

**Solution:**

$$5(x - 2) = 5x - 5 \times 2$$

$$= 5x - 10$$

.....

2.

**Problem:**Simplify  $5(x + 1) - 3x$ .**Solution:**

$$\begin{aligned} 5(x + 1) - 3x &= 5x + 5 \times 1 - 3x \\ &= 5x + 5 - 3x \\ &= 2x + 5 \end{aligned}$$

**Key point**

Remember:

- each term inside the bracket is multiplied by the term outside the bracket;
- simplify by collecting like terms after you have expanded the bracket.

**Q1:**Multiply out the brackets  $6(x + 4)$ .

.....

**Q2:**Simplify  $7(x + 1) - 2x$ .

## 8.2 Expand single bracket expressions

### Multiplying by a number

Go online



The following examples shows you how to multiply algebraic expressions by a number.

$$6 \text{ fours} = 6 \times 4 = 4 + 4 + 4 + 4 + 4 + 4$$

$$6g = 6 \times g = g + g + g + g + g + g$$

$$\begin{aligned} 6(g + 4) &= 6 \times (g + 4) \\ &= (g + 4) + (g + 4) + (g + 4) + (g + 4) + (g + 4) + (g + 4) \\ &= g + g + g + g + g + g + 4 + 4 + 4 + 4 + 4 + 4 \end{aligned}$$

$$\begin{aligned} 6(g + 4) &= 6g + 6 \times 4 \\ &= 6g + 24 \end{aligned}$$



$$\begin{aligned}
 5(d + b) &= 5 \times (d + b) \\
 &= (d + b) + (d + b) + (d + b) + (d + b) + (d + b) \\
 &= d + d + d + d + d + b + b + b + b + b \\
 5(d + b) &= 5d + 5b
 \end{aligned}$$

**Examples**

1.

**Problem:**

Expand  $3(x + 4)$ .

**Solution:**

$$\begin{aligned}
 3(x + 4) &= (x + 4) + (x + 4) + (x + 4) \\
 &= x + 4 + x + 4 + x + 4 \\
 &= 3x + 3 \times 4 \\
 &= 3x + 12
 \end{aligned}$$

2.

**Problem:**

Expand  $-2(x - 3)$ .

**Solution:**

$$\begin{aligned}
 -2(x - 3) &= -2 \times x + -2 \times -3 \\
 &= -2x + 6
 \end{aligned}$$

**Multiplying by a number practice**

Go online



**Q3:** Expand  $2(x - 1)$ .

.....

**Q4:** Expand  $4(5x - 2)$ .

**Multiplying by a letter**

Go online



The following example shows you how to multiply algebraic expressions by a letter.

$a(b + f) = a \times (b + f)$	$b(c + d) = b \times (c + d)$
$= a \times b + a \times f$	$= b \times c + b \times d$
$a(b + f) = ab + af$	$b(c + d) = bc + bd$

**Examples**

1.

**Problem:**Expand  $x(3x + 2)$ .**Solution:**

$$\begin{aligned} x(3x + 2) &= x \times 3x + x \times 2 \\ &= 3x^2 + 2x \end{aligned}$$

.....

2.

**Problem:**Expand  $x(3x + 4y)$ .**Solution:**

$$\begin{aligned} x(3x + 4y) &= x \times 3x + x \times 4y \\ &= 3x^2 + 4xy \end{aligned}$$

**Multiplying by a letter practice**

Go online

**Q5:** Expand  $y(3y + 1)$ 

.....

**Q6:** Expand  $y(3y + 5k)$ .**Multiplying by a number and a letter**

Go online



The following example shows you how to multiply algebraic expressions by a number and a letter.

$$\begin{aligned} 3a(a + 4) &= 3a \times (a + 4) \\ &= 3a \times a + 3a \times 4 \end{aligned}$$

$$3a(a + 4) = 3a^2 + 12a$$

**Examples**

1.

**Problem:**Expand  $5g(3g - 2)$

**Solution:**

$$5g(3g - 2) = 5g \times 3g + 5g \times (-2)$$

$$= 15g^2 - 10g$$

.....

**2.**

**Problem:**

Expand  $2h^2(4h + 2k)$

**Solution:**

$$2h^2(4h + 2k) = 2h^2 \times 4h + 2h^2 \times 2k$$

$$= 8h^3 + 4h^2k \text{ or } 8h^3 + 4kh^2$$

**Multiplying by a number and a letter practice**

Go online



**Q7:** Expand  $7w(2w + 3)$

.....

**Q8:** Expand  $2m(3m^2 - 9n)$

**Single bracket expressions**

Go online



The following example shows you how to multiply single bracket algebraic expressions.

$$3(b + 2) + 4(b + 1) = 3 \times b + 3 \times 2 + 4 \times b + 4 \times 1$$

$$= 3b + 6 + 4b + 4$$

$$3(b + 2) + 4(b + 1) = 7b + 10$$

The following example shows you how to multiply negative single bracket algebraic expressions.

$$4(3p - 1) - 2(p - 5) = 4 \times 3p + 4 \times (-1) + (-2) \times p + (-2) \times (-5)$$

$$= 12p - 4 - 2p + 10$$

$$4(3p - 1) - 2(p - 5) = 10p + 6$$

**Examples**

**1.**

**Problem:**

Expand and simplify  $3(3t + 5) + 4(2t - 1)$

**Solution:**

$$\begin{aligned}
 3(3t + 5) + 4(2t - 1) &= 3 \times 3t + 3 \times 5 + 4 \times 2t + 4 \times (-1) \\
 &= 9t + 15 + 8t + (-4) \\
 &= 17t + 11
 \end{aligned}$$

.....

2.

**Problem:**Expand and simplify  $r(5r + 4) + 3(r - 2)$ **Solution:**

$$\begin{aligned}
 r(5r + 4) + 3(r - 2) &= r \times 5r + r \times 4 + 3 \times r + 3 \times (-2) \\
 &= 5r^2 + 4r + 3r - 6 \\
 &= 5r^2 + 7r - 6
 \end{aligned}$$

.....

3.

**Problem:**Expand and simplify  $5(3d - 2) - 3(d + 6)$ **Solution:**

$$\begin{aligned}
 5(3d - 2) - 3(d + 6) &= 5 \times 3d + 5 \times (-2) + (-3) \times d + (-3) \times 6 \\
 &= 15d - 10 - 3d - 18 \\
 &= 12d - 28
 \end{aligned}$$

**Expanding single brackets practice**

Go online

**Q9:** Expand and simplify  $10(z + 3) + 2(z - 12)$ 

.....

**Q10:** Expand and simplify  $3(f + 4) - (f - 3)$ 

.....

**Q11:** Expand and simplify  $e(2e + 8) - 2(e - 5)$ **Expanding single brackets exercise**

Go online



These questions are for practice only.

**Q12:** Expand  $2(x - 1)$ 

.....

**Q13:** Expand  $5(-4x + 1)$ 

.....

**Q14:** Expand  $x(2x + 4)$

.....

**Q15:** Expand  $x(-2x + y)$

.....

**Q16:** Expand  $2x(5x - 3)$

.....

**Q17:** Expand  $3y(4y + 2z)$

.....

**Q18:** Expand  $7y(2x + 3y - z)$

.....

**Q19:** Expand and simplify  $3(x - 5) + 4(x + 3)$

.....

**Q20:** Expand and simplify  $y(2y + 3) + 2(3y - 1)$

.....

**Q21:** Expand and simplify  $6(3z + 4) - 5(z - 2)$

### 8.3 Expand double bracket expressions

#### Multiplying expressions

Go online



The following example shows how to multiply algebraic expressions by an expression.

$$\begin{aligned}(ax + b) \times (cx + d) &= ax(cx + d) + b(cx + d) \\ &= acx^2 + adx + bcx + bd\end{aligned}$$

$$\begin{aligned}(x + 5)(x + 2) &= x(x + 2) + 5(x + 2) \\ &= x^2 + 2x + 5x + 10\end{aligned}$$

$$(x + 5)(x + 2) = x^2 + 7x + 10$$

The method above has three lines of working but there are lots of other methods for multiplying out double brackets and some of these require very little working.

**Top tip**

The method called **FOIL** tells you which terms to multiply together:

- **F** - First terms
- **O** - Outer terms
- **I** - Inner terms
- **L** - Last terms

The Rainbow method requires you to link the terms you multiply together with a loop.

Try the activity below and use the method you prefer.

**Using the FOIL/rainbow method**

Go online



$$(x + 5)(x + 2)$$

**Examples****1.****Problem:**

Expand and simplify  $(x + 4)(x + 1)$

**Solution:**

$$\begin{aligned} (x + 4)(x + 1) &= x(x + 1) + 4(x + 1) \\ &= x^2 + x + 4x + 4 \\ &= x^2 + 5x + 4 \end{aligned}$$

.....

**2.****Problem:**

Expand and simplify  $(x + 4)(x - 1)$

**Solution:**

$$\begin{aligned} (x + 4)(x - 1) &= x(x - 1) + 4(x - 1) \\ &= x^2 - x + 4x - 4 \\ &= x^2 + 3x - 4 \end{aligned}$$

.....

3.

**Problem:**

Expand and simplify  $(x - 4)(x - 2)$

**Solution:**

$$\begin{aligned} (x - 4)(x - 2) &= x(x - 2) - 4(x - 2) \\ &= x^2 - 2x - 4x + 8 \\ &= x^2 - 6x + 8 \end{aligned}$$

.....

4.

**Problem:**

Expand and simplify  $(2x + 3)(x - 5)$

**Solution:**

$$\begin{aligned} (2x + 3)(x - 5) &= 2x(x - 5) + 3(x - 5) \\ &= 2x^2 - 10x + 3x - 15 \\ &= 2x^2 - 7x - 15 \end{aligned}$$

**Multiplying double bracket expressions practice**

Go online



**Q22:** Expand and simplify  $(x + 6)(x + 4)$

.....

**Q23:** Expand and simplify  $(a + 3)(a - 4)$

.....

**Q24:** Expand and simplify  $(g - 2)(g + 3)$

.....

**Q25:** Expand and simplify  $(k - 1)(k - 5)$

.....

**Q26:** Expand  $(2x + 1)(x + 3)$

.....

**Q27:** Expand and simplify  $(3h - 2)(h + 1)$

.....

**Q28:** Expand and simplify  $(2m - 3)(2m - 1)$

.....

**Q29:** Expand and simplify  $(4t + 1)(2t - 3)$

We are now going to look at a special case when expanding brackets.

### A special case: The difference of two squares

Go online



The following example shows the difference of two squares.

$$\begin{aligned}(p + m)(p - m) &= p(p - m) + m(p - m) \\ &= p^2 - mp + mp - m^2 \\ &= p^2 - m^2\end{aligned}$$

### Examples

1.

**Problem:**

Expand and simplify  $(x + 5)(x - 5)$

**Solution:**

$$\begin{aligned}(x + 5)(x - 5) &= x(x - 5) + 5(x - 5) \\ &= x^2 - 5x + 5x - 25 \\ &= x^2 - 25\end{aligned}$$

.....

2.

**Problem:**

Expand and simplify  $(2a + 3)(2a - 3)$

**Solution:**

$$\begin{aligned}(2a + 3)(2a - 3) &= 2a(2a - 3) + 3(2a - 3) \\ &= 4a^2 - 6a + 6a - 9 \\ &= 4a^2 - 9\end{aligned}$$

### Difference of two squares practice

Go online



**Q30:** Expand and simplify  $(b + 4)(b - 4)$

.....

**Q31:** Expand and simplify  $(2g + 7)(2g - 7)$

### Expanding more complex double brackets

We are now going to look at another example of a special case when expanding brackets.



**Multiplying more complex expressions**

Go online



The following example shows how to multiply more complex algebraic expressions.

$$(x + 2)(x^2 + 3x - 1) = x(x^2 + 3x - 1) + 2(x^2 + 3x - 1)$$

*Multiply the second bracket by x then by +2*

$$= x^3 + 3x^2 - x + 2x^2 + 6x - 2$$

*Multiply out the single brackets*

$$= x^3 + 5x^2 - 5x - 2$$

*Collect like terms*

**Top tip**

You should show **all** working for this type of question if you hope to gain full marks.

**Examples**

1.

**Problem:**

Expand and simplify  $(y + 3)(y^2 - 2y + 4)$

**Solution:**

$$\begin{aligned} (y + 3)(y^2 - 2y + 4) &= y(y^2 - 2y + 4) + 3(y^2 - 2y + 4) \\ &= y^3 - 2y^2 + 4y + 3y^2 - 6y + 12 \\ &= y^3 + y^2 - 2y + 12 \end{aligned}$$

.....

2.

**Problem:**

Expand and simplify  $(g - 5)(g^2 + 3g - 1)$

**Solution:**

$$\begin{aligned} (g - 5)(g^2 + 3g - 1) &= g(g^2 + 3g - 1) - 5(g^2 + 3g - 1) \\ &= g^3 + 3g^2 - g - 5g^2 - 15g + 5 \\ &= g^3 - 2g^2 - 16g + 5 \end{aligned}$$

**Expanding double brackets practice**

Go online



**Q32:** Expand and simplify  $(b + 2)(b^2 - 4b + 3)$

.....

**Q33:** Expand and simplify  $(g - 3)(2g^2 + 5g - 7)$

## Expanding double brackets exercise

Go online



These questions are for practice only.

**Q34:** Expand and simplify  $(x - 6)(x + 3)$

.....

**Q35:** Expand and simplify  $(y + 3)(y - 5)$

.....

**Q36:** Expand and simplify  $(t - 2)(t - 7)$

.....

**Q37:** Expand and simplify  $(2x + 6)(x - 2)$

.....

**Q38:** Expand and simplify  $(3r - 1)(2r + 5)$

.....

**Q39:** Expand and simplify  $(w + x)(y + z)$

.....

**Q40:** Expand and simplify  $(2y + 4)(2y - 4)$

.....

**Q41:** Expand and simplify  $(x + 5)(x - 5)$

.....

**Q42:** Expand and simplify  $(x + 2)(x^2 + 3x - 5)$

.....

**Q43:** Expand and simplify  $(a - 3)(a^2 - a - 6)$

.....

**Q44:** Expand and simplify  $(2f + 3)(3f^2 + 4f - 1)$

## 8.4 Learning points

When expanding a **single bracket** remember that every item inside the bracket is multiplied by the term outside the bracket.

When expanding **double brackets** remember that each term in the second bracket is multiplied by each term in the first bracket by turning the expression into two single bracket expressions or using the **rainbow method** or **FOIL**.

## 8.5 End of topic test

### End of topic 8 test

[Go online](#)**Q45:**

- a) Expand  $3(x + 1)$
  - b) Expand  $x(-2x - 3)$
  - c) Expand  $3y(2y - 7)$
  - d) Expand  $2y(5y + 3z)$
  - e) Expand and simplify  $6a(2a + 3b - c^2)$
  - f) Expand and simplify  $3(b - 4) + 4(b + 3)$
  - g) Expand and simplify  $c(2c + 3) + 2(3c - 1)$
  - h) Expand and simplify  $d(3d + 4) - 5(d - 2)$
- .....

**Q46:** Expand and simplify

- a)  $(w + x)(y + z)$
- b)  $(x - 3)(x - 6)$
- c)  $(x + 1)(x - 1)$
- d)  $(2y - 1)(y + 3)$
- e)  $(3y - 4)(2y + 3)$
- f)  $(z + 4)(z^2 + z - 1)$
- g)  $(z - 2)(z^2 + 2z - 5)$
- h)  $(2x + 5)(3x^2 + 2x - 4)$

## Answers to questions and activities

### Topic 8: Expanding brackets

#### Answers from page 4.

**Q1:**  $6x+24$

**Q2:**  $5x+7$

#### Multiplying by a number practice (page 5)

**Q3:**

$$\begin{aligned}2(x - 1) &= 2 \times x - 2 \times 1 \\ &= 2x - 2\end{aligned}$$

**Q4:**

$$\begin{aligned}4(5x - 2) &= 4 \times 5x - 4 \times 2 \\ &= 20x - 8\end{aligned}$$

#### Multiplying by a letter practice (page 6)

**Q5:**

$$\begin{aligned}y(3y + 1) &= y \times 3y + y \times 1 \\ &= 3y^2 + y\end{aligned}$$

**Q6:**

$$\begin{aligned}y(3y + 5k) &= y \times 3y + y \times 5k \\ &= 3y^2 + 5ky\end{aligned}$$

#### Multiplying by a number and a letter practice (page 7)

**Q7:**

$$\begin{aligned}7w(2w + 3) &= 7w \times 2w + 7w \times 3 \\ &= 14w^2 + 21w\end{aligned}$$

**Q8:**

$$\begin{aligned}2m(3m^2 - 9n) &= 2m \times 3m^2 + 2m \times (-9n) \\ &= 6m^3 - 18mn\end{aligned}$$

**Expanding single brackets practice (page 8)****Q9:**

$$\begin{aligned} 10(z + 3) + 2(z - 12) &= 10 \times z + 10 \times 3 + 2 \times z + 2 \times (-12) \\ &= 10z + 30 + 2z - 24 \\ &= 12z + 6 \end{aligned}$$

**Q10:**

$$\begin{aligned} 3(f + 4) - (f - 3) &= 3(f + 4) - 1(f - 3) \\ &= 3 \times f + 3 \times 4 + (-1) \times f + (-1) \times (-3) \\ &= 3f + 12 - f + 3 \\ &= 2f + 15 \end{aligned}$$

Remember that if there is no number in front of a bracket it means there is a 1. It is very important to put it in place.

**Q11:**

$$\begin{aligned} e(2e + 8) - 2(e - 5) &= e \times 2e + e \times 8 + (-2) \times e + (-2) \times (-5) \\ &= 2e^2 + 8e - 2e + 10 \\ &= 2e^2 + 6e + 10 \end{aligned}$$

**Expanding single brackets exercise (page 8)**

**Q12:**  $2x - 2$

**Q13:**  $-20x + 5$

**Q14:**  $2x^2 + 4x$

**Q15:**  $-2x^2 + xy$

**Q16:**  $10x^2 - 6x$

**Q17:**  $12y^2 + 6yz$

**Q18:**  $14xy + 21y^2 - 7yz$

**Q19:**  $7x - 3$

**Q20:**  $2y^2 + 9y - 2$

**Q21:**  $13z + 34$

**Multiplying double bracket expressions practice (page 11)****Q22:**

$$\begin{aligned} (x + 6)(x + 4) &= x^2 + 4x + 6x + 24 \\ &= x^2 + 10x + 24 \end{aligned}$$

**Q23:**

$$\begin{aligned}(a + 3)(a - 4) &= a^2 - 4a + 3a - 12 \\ &= a^2 - a - 12\end{aligned}$$

**Q24:**

$$\begin{aligned}(g - 2)(g + 3) &= g^2 + 3g - 2g - 6 \\ &= g^2 + g - 6\end{aligned}$$

**Q25:**

$$\begin{aligned}(k - 1)(k - 5) &= k^2 - 5k - k + 5 \\ &= k^2 - 6k + 5\end{aligned}$$

**Q26:**

$$\begin{aligned}(2x + 1)(x + 3) &= 2x^2 + 6x + x + 3 \\ &= 2x^2 + 7x + 3\end{aligned}$$

**Q27:**

$$\begin{aligned}(3h - 2)(h + 1) &= 3h^2 + 3h - 2h - 2 \\ &= 3h^2 + h - 2\end{aligned}$$

**Q28:**

$$\begin{aligned}(2m - 3)(2m - 1) &= 4m^2 - 2m - 6m + 3 \\ &= 4m^2 - 8m + 3\end{aligned}$$

**Q29:**

$$\begin{aligned}(4r + 1)(2t - 3) &= 8t^2 - 12t + 2t - 3 \\ &= 8t^2 - 10t - 3\end{aligned}$$

**Difference of two squares practice (page 12)****Q30:**

$$\begin{aligned}(b + 4)(b - 4) &= b(b - 4) + 4(b - 4) \\ &= b^2 - 4b + 4b - 16 \\ &= b^2 - 16\end{aligned}$$

**Q31:**

$$\begin{aligned}(2g + 7)(2g - 7) &= 2g(2g - 7) + 7(2g - 7) \\ &= 4g^2 - 14g + 14g - 49 \\ &= 4g^2 - 49\end{aligned}$$

**Expanding double brackets practice (page 13)****Q32:**

$$\begin{aligned}(b + 2)(b^2 - 4b + 3) &= b(b^2 - 4b + 3) + 2(b^2 - 4b + 3) \\ &= b^3 - 4b^2 + 3b + 2b^2 - 8b + 6 \\ &= b^3 - 2b^2 - 5b + 6\end{aligned}$$

**Q33:**

$$\begin{aligned}(g - 3)(2g^2 + 5g - 7) &= g(2g^2 + 5g - 7) - 3(2g^2 + 5g - 7) \\ &= 2g^3 + 5g^2 - 7g - 6g^2 - 15g + 21 \\ &= 2g^3 - g^2 - 22g + 21\end{aligned}$$

**Expanding double brackets exercise (page 14)**

**Q34:**  $x^2 - 3x - 18$

**Q35:**  $y^2 - 2y - 15$

**Q36:**  $t^2 - 9t + 14$

**Q37:**  $2x^2 + 2x - 12$

**Q38:**  $6r^2 + 13r - 5$

**Q39:**  $wy + xy + wz + xz$

**Q40:**  $4y^2 - 16$

**Q41:**  $x^2 - 25$

**Q42:**  $x^3 + 5x^2 + x - 10$

**Q43:**  $a^3 - 4a^2 - 3a + 18$

**Q44:**  $6f^3 + 17f^2 + 10f - 3$

**End of topic 8 test (page 16)****Q45:**

a)  $3x + 3$

b)  $-2x^2 - 3x$

c)  $6y^2 - 21y$

d)  $10y^2 + 6yz$

e)  $12a^2 + 18ab - 6ac^2$

f)  $7b$

g)  $2c^2 + 9c - 2$

h)  $3d^2 - d + 10$



**Q46:**

a)  $wy + xy + wz + xz$

b)  $x^2 - 9x + 18$

c)  $x^2 - 1$

d)  $2y^2 + 5y - 3$

e)  $6y^2 + y - 12$

f)  $z^3 + 5z^2 + 3z - 4$

g)  $z^3 - 9z + 10$

h)  $6x^3 + 19x^2 + 2x - 20$