CHAPTER 3

Exponents

MathU Teaching® Emporium

CONTENTS

April 20, 2021

1 REVISION

1.1 Exponential notation

NOTE

Instead of writing $3 \times 3 \times 3 \times 3 \times 3 \times 3$ we can write 3^6.

We read this as " 3 to the power of 6". The number 3 is the **base** ,and 6 is the **exponent**.

When we write $3 \times 3 \times 3 \times 3 \times 3 \times 3$ as 3^6, we are using **exponential notation**.

1.2 Squares

NOTE

To square a number is to multiply it by itself. The square of 8 is 64 because 8×8 equals 64.

We write 8×8 as 8^2 in exponential form.

We read 8^2 as **eight squared**

1.3 Cubes

NOTE

To cube a number is to multiply it by itself and then by itself again. The cube of 3 is 27 because $3 \times 3 \times 3$ equals 27.

We write $3 \times 3 \times 3$ as 3^3 in exponential form.

We read 3^3 as **three cubed**

1.4 Square and Cube roots

NOTE

To find the square root of a number we ask the question: Which number was multiplied by itself to get a square?

The square root of 16 is 4 because $4 \times 4 = 16$.

The question: **Which number was multiplied by itself to get 16?** is written mathematically as $\sqrt{16}$.

The answer to this question is written as $\sqrt{16} = 4$

NOTE

To find the cube root of a number we ask the question: Which number was multiplied by itself and again by itself to get a cube?

The cube root of 64 is 4 because $4 \times 4 \times 4 = 64$.

The question: **Which number was multiplied by itself and again by itself(or cubed) to get 64?** is written mathematically as $\sqrt[3]{64}$.

The answer to this question is written as $\sqrt[3]{64} = 4$

2 WORKING WITH INTEGERS

2.1 Representing integers in exponential form

NOTE

The calculator "understands" $-\mathbf{5^2}$ and $(-\mathbf{5})^\mathbf{2}$ as two different numbers.

It understands $-\mathbf{5^2}$ as $-\mathbf{5} \times \mathbf{5} = -\mathbf{25}$ and $(-\mathbf{5})^\mathbf{2}$ as $-\mathbf{5} \times -\mathbf{5} = \mathbf{25}$

3 LAWS OF EXPONENTS

3.1 Products of powers

NOTE

The base (3) is a repeated factor.The exponents (2 and 4) tells us the number of times each factor is repeated.

We can explain the solution in the following manner:

$3^2 \times 3^4 = \underbrace{3 \times 3}_{\text{2 factors}} \times \underbrace{3 \times 3 \times 3 \times 3}_{\text{4 factors}} = \underbrace{3 \times 3 \times 3 \times 3 \times 3 \times 3}_{\text{6 factors}} = 3^6$

NOTE

When you multiply two or more powers that have the same base, the answer has the same base, but its exponent is equal to the sum of the exponents of the numbers you are multiplying.
We can express $a^m \times a^n = a^{m+n}$, where m and n are natural numbers and a is not zero

3.2 Raising a power to a power

NOTE

$(a^m)^n = a^{m \times n}$, where m and n are natural numbers and a is not equal to zero.

To simplify $(x^2)^5$ we can write it out as a product of powers or we can use a shortcut.

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

$= \underbrace{x \times x}_{} \times \underbrace{x \times x}_{} \times \underbrace{x \times x}_{} \times \underbrace{x \times x}_{} \times \underbrace{x \times x}_{} = x^{10}$

2×5 factors = 10 factors

3.3 Power of a product

12^2 can be written in terms of its factors $(2 \times 6)^2$ or as $(3 \times 4)^2$
We already know that $12^2 = 144$
What this tells us is that both $(2 \times 6)^2$ and $(3 \times 4)^2$ also equal 144
We write (12):

$$\begin{aligned} 12^2 &= (2 \times 6)^2 \\ &= 2^2 \times 6^2 \\ &= 4 \times 36 \\ &= 144 \end{aligned}$$

or

$$\begin{aligned} 12^2 &= (3 \times 4)^2 \\ &= 3^2 \times 4^2 \\ &= 9 \times 16 \\ &= 144 \end{aligned}$$

NOTE

A product raised to a power is the product of the factors each raised to the same power.
Using symbols, we write $(a \times b)^m = a^m \times b^m$,where m is a natural number and a and b are not equal to zero

NOTE

To calculate 4^{5-3} we first do the calculation in the exponent, that is, we subtract 3 from 5. Then we can calculate 4^2 as $4 \times 4 = 16$.

NOTE

$a^m \div a^n = a^{m-n}$.
where m and n are natural numbers and m is a number greater than n and a is not zero.

3.4 The power of zero

NOTE

We define $a^0 = 1$
Any number raised to the power zero is always 1.

4 SQUARES, CUBES AND ROOTS OF RATIONAL NUMBERS

4.1 Squaring a fraction

NOTE

Squaring or cubing a fraction or a decimal fraction is no different from squaring or cubing an integer.

4.2 Finding the square root of a fraction

4.3 Cubing a fraction

NOTE

One half cubed is equal to one eighth.
We write this as $(\frac{1}{2})^3 = \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{8}$

1.

2. 1 Use the fact that $0,6$ can be written $\frac{6}{10}$ to calculate $(0,6)^3$.
2. 2 Use the fact that $0,8$ can be written as $\frac{8}{10}$ to calculate $(0,8)^3$
2. 3 Use the fact that $0,7$ can be written as $\frac{7}{10}$ to calculate $(0,7)^3$

5 SCIENTIFIC NOTATION

5.1 Very large numbers

Example: $7,56 \times 100$ can be written as 756

NOTE

We can write $136\ 000\ 000$ as $1,36 \times 10^8$.
$1,36 \times 10^8$ is called the **scientific notation** for $136\ 000\ 000$.
In scientific notation, a number is expressed in two parts: a number between 1 and 10 multiples by a power of 10. The exponent must always be an integer.

For example: $3,4 \times 10^5$ written in the ordinary way is $340\ 000$

NOTE

Because it is easier to multiply powers of ten without a calculator, **scientific notation** makes it possible to do calculations in your head.

6 EXERCISES

6.1 Exercise 1

1.1 Calculate the following

(a) $2 \times 2 \times 2$

(b) $2 \times 2 \times 2 \times 2 \times 2 \times 2$

(c) $3 \times 3 \times 3$

(d) $3 \times 3 \times 3 \times 3 \times 3 \times 3$

1.2 Write each of the following in exponential form:

(a) $2 \times 2 \times 2$

(b) $2 \times 2 \times 2 \times 2 \times 2 \times 2$

(c) $3 \times 3 \times 3$

(d) $3 \times 3 \times 3 \times 3 \times 3 \times 3$

1.3 Calculate each of the following:

(a) 5^2

(b) 2^5

(c) 10^2

(d) 15^2

(e) 3^4

(f) 4^3

(g) 2^3

(h) 3^2

1.4 Copy and complete the following table:

Number	Square the number	Exponential form	Square
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

1.5 Calculate each of the following:

(a) $3^2 \times 4^2$

(b) $2^2 \times 3^2$

(c) $2^2 \times 5^2$

(d) $2^2 \times 4^2$

1.6 Complete the following statements:

(a) $3^2 \times 4^2 = \ldots$

(b) $2^2 \times 3^2 = \ldots$

(c) $2^2 \times 5^2 = \ldots$

(d) $2^2 \times 4^2 = \ldots$

6.2 Exercise 2

1. Calculate each of the following:

(a) $2^3 \times 3^3$

(b) $2^3 \times 5^3$

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

(d) $1^3 \times 9^3$

2. Which of the following statements are true? If a statement is false, rewrite it as a true statement.

(a) $2^3 \times 3^3 = 6^3$

(b) $2^3 \times 5^3 = 7^3$

(c) $2^3 \times 4^3 = 8^3$

(d) $1^3 \times 9^3 = 10^3$

3. To cube a number is to multiply itself and then by itself again. The cube of 3 is 27 because $3 \times 3 \times 3$ equals 27. We write $3 \times 3 \times 3$ as 3^3 in exponential form. Answer the following questions:

   (a) What is the cube of 1?

   (b) Write 1 cubed in exponential form.

   (c) What is the cube of 2?

   (d) Write 2 cubed in exponential form.

   (e) What is the cube of 3?

   (f) Write 3 cubed in exponential form.

   (g) What is the cube of 4?

   (h) Write 4 cubed in exponential form.

   (i) What is the cube of 5?

   (j) Write 5 cubed in exponential form.

   (k) What is the cube of 6?

   (l) Write 6 cubed in exponential form.

   (m) What is the cube of 7?

   (n) Write 7 cubed in exponential form.

   (o) What is the cube of 8?

   (p) Write 8 cubed in exponential form.

   (q) What is the cube of 9?

   (r) Write 9 cubed in exponential form.

   (s) What is the cube of 10?

   (t) Write 10 cubed in exponential form.

6.3 Exercise 3

1. Answer each of the following questions:

   (a) What is the square of 1 ?

   (b) What is the square root of 1?

   (c) What is the square of 2

(d) What is the square root of 4?

(e) What is the square of 3

(f) What is the square root of 9?

(g) What is the square of 4

(h) What is the square root of 16?

(i) What is the square of 5

(j) What is the square root of 25?

(k) What is the square of 6

(l) What is the square root of 36?

(m) What is the square of 7

(n) What is the square root of 49?

(o) What is the square of 8

(p) What is the square root of 64?

(q) What is the square of 9

(r) What is the square root of 81?

(s) What is the square of 10

(t) What is the square root of 100?

(u) What is the square of 11

(v) What is the square root of 121?

(w) What is the square of 12

(x) What is the square root of 144?

2. Calculate the following and justify your answer.

(a) $\sqrt{144}$

(b) $\sqrt{100}$

(c) $\sqrt{81}$

(d) $\sqrt{64}$

3. Complete the following table:

Number	Cube of the number	Cube root of the cube of the number	Reason
1			
2			
3			
4	64	4	$4\times4\times4=64$
5			
6			
7			
8			
9			
10			

4. Calculate the following and give reasons for your answers:

   (a) $\sqrt[3]{216}$

   (b) $\sqrt[3]{8}$

   (c) $\sqrt[3]{125}$

   (d) $\sqrt[3]{27}$

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

   (f) $\sqrt[3]{1000}$

6.4 Exercise 4

1. Calculate the following, without using a calculator:

   (a) $-2\times-2\times-2$

   (b) $-2\times-2\times-2\times-2$

   (c) -5×-5

   (d) $-5\times-5\times-5$

   (e) $-1\times-1\times-1\times-1$

   (f) $-1\times-1\times-1$

2. Calculate each of the following:

   (a) -2^2

   (b) $(-2)^2$

   (c) $(-5)^3$

   (d) -5^3

3. Use your calculator to work out the answer to question 2.
   • Are your answers to question 2(a) and (b) different of the same of those of the calculator?
   • If your answers are different to those of a calculator, try to explain how the calculator did the calculations differently from you.

4. Write the following in exponential form:

   (a) $-2 \times -2 \times -2$

   (b) $-2 \times -2 \times -2 \times -2$

   (c) -5×-5

   (d) $-5 \times -5 \times -5$

   (e) $-1 \times -1 \times -1 \times -1$

   (f) $-1 \times -1 \times -1$

5. Calculate each of the following:

   (a) $(-3)^2$

   (b) $(-3)^3$

   (c) $(-2)^4$

   (d) $(-2)^6$

   (e) $(-2)^5$

   (f) $(-3)^4$

6. Say whether the sign of the answer is negative or positive. Explain why.

   (a) $(-3)^6$

   (b) $(-5)^{11}$

   (c) $(-4)^{20}$

   (d) $(-7)^5$

7. Say whether the following statements are true or false. If the statement is false, rewrite it as a correct statement.

   (a) $(-3)^2 = 9$

   (b) $-3^2 = 9$

   (c) $\left(-5^2\right) = -5^2$

   (d) $(-1)^3 = -1^3$

   (e) $(-6)^3 = -18$

   (f) $(-2)^6 = 2^6$

6.5 Exercise 5

1. A product of 2s is given below. Describe it using exponential notation, that is, write it as a power of 2.
   $2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$

2. Express each of the following as a product of the powers of 2, as indicated by the brackets.

   (a) $(2 \times 2 \times 2) \times (2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2)$

   (b) $(2 \times 2 \times 2 \times 2 \times 2 \times 2) \times (2 \times 2 \times 2 \times 2 \times 2 \times 2) \times (2 \times 2)$

   (c) $(2 \times 2) \times (2 \times 2) \times (2 \times 2) \times (2 \times 2) \times (2 \times 2) \times (2 \times 2)$

   (d) $(2 \times 2 \times 2) \times (2 \times 2 \times 2) \times (2 \times 2 \times 2) \times (2 \times 2 \times 2)$

   (e) $(2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2) \times (2 \times 2)$

3. Copy and complete the following statements so that they are true. You may want to refer to your answers to question $2(a)$ to (e) to help you.

   (a) $2^3 \times \ldots = 2^{12}$

   (b) $2^5 \times \ldots \times 2^2 = 2^{12}$

   (c) $2^2 \times 2^2 \times 2^2 \times 2^2 \times 2^2 \times 2^2 = \ldots$

   (d) $2^8 \times \cdots = 2^{12}$

   (e) $2^3 \times 2^3 \times 2^3 \times \ldots = 2^{12}$

   (f) $2^6 \times \cdots = 2^{12}$

   (g) $2^2 \times 2^{10} = \ldots$

4. Complete the following table:

Product of powers	Repeated factor	Total number of times the factor is repeated	Simplified form
$2^7 \times 2^3$	2		
$5^2 \times 5^4$	5		
$4^1 \times 4^5$	4	6	4^6
$6^3 \times 6^2$	6		
$2^5 \times 2^2$	2		
$5^3 \times 5^3$	5		
$4^2 \times 4^4$	4		
$2^1 \times 2^0$	2		

5. What is wrong with these statements? Correct each one.

   (a) $2^3 \times 2^4 = 2^{12}$

   (b) $10 \times 10^2 \times 10^3 = 10^{1 \times 2 \times 3} = 10^6$

   (c) $3^2 \times 3^3 = 3^6$

(d) $5^3 \times 5^2 = 15 \times 10$

6. Express each of the following numbers as a single power of 10.
   Example: $1\ 000\ 000$ as a power of 10 is 10^6

   (a) 100

   (b) $1\ 000$

   (c) $10\ 000$

   (d) $10^2 \times 10^3 \times 10^4$

   (e) $100 \times 1000 \times 10000$

   (f) $1\ 000\ 000\ 000$

7. Write each of the following products in exponential form:

   (a) $x \times x \times x \times x \times x \times x \times x \times x \times x \times x$

   (b) $(x \times x) \times (x \times x \times x) \times (x \times x \times x \times x)$

   (c) $(x \times x \times x \times x) \times (x \times x) \times (x \times x) \times x$

   (d) $(x \times x \times x \times x \times x \times x) \times (x \times x \times x)$

   (e) $(x \times x \times x) \times (y \times y \times y)$

   (f) $(a \times a) \times (b \times b)$

8. Complete the following table:

Product of powers	Repeated factor	Total number of times the factor is repeated	Simplified form
$x^7 \times x^3$	x		
$x^2 \times x^4$	x		
$x^1 \times x^5$	x		
$x^3 \times x^2$	x		
$x^k \times x^2$	x		
$x^3 \times x^3$	x		
$x^1 \times x^9$	x		

6.6 Exercise 6

1. Copy and complete the table of powers of 2 :

x	1	2	3	4	5	6	7	8	9	10	11	12
2^x												

2. Copy and complete the table of powers of 3:

x	1	2	3	4	5	6	7	8	9
3^x									

3. Copy and complete the table. You can read the values from the tables you made in questions 1 and 2.

Product of powers	Repeated factor	Power of power notation	Total number of repetitions	simplified form	Value
$2^4 \times 2^4 \times 2^4$	2	$(2^4)^3$	12	2^{12}	$4\,096$
$3^2 \times 3^2 \times 3^2 \times 3^2$					
$2^3 \times 2^3 \times 2^3 \times 2^3 \times 2^3$					
$3^4 \times 3^4 \times 3^4$					
$2^6 \times 2^6 \times 2^6$					

4. Copy and complete by using your table of powers of 2 to find the answers for the following:

   (a) $2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = \ldots = \ldots$

   (b) $(2 \times 2 \times 2 \times 2) \times (2 \times 2 \times 2 \times 2) \times (2 \times 2 \times 2 \times 2) = \ldots = \ldots$

   (c) $16^3 = \ldots = \ldots = \ldots$

5. Use your table of powers of 2 to find the answers for the following:

   (a) Is $16^3 = 2^{12}$?

   (b) Is $2^4 \times 2^4 \times 2^4 = 2^{12}$?

   (c) Is $2^4 \times 2^3 = 2^{12}$?

   (d) Is $\left(2^4\right)^3 = 2^4 \times 2^4 \times 2^4$?

   (e) Is $\left(2^4\right)^3 = 2^{12}$?

   (f) Is $\left(2^4\right)^3 = 2^{4+3}$?

   (g) Is $\left(2^4\right)^3 = 2^{4\times 3}$?

   (h) Is $\left(2^2\right)^5 = 2^{2+5}$?

6. Answer the following questions:

   (a) Express 8^5 as a power of 2. It may help to first express 8 as a power of 2.

(b) Can $(2^3) \times (2^3) \times (2^3) \times (2^3) \times (2^3)$ be expressed as $(2^3)^5$?

(c) Is $(2^3)^5 = 2^{3+5}$ or is $(2^3)^5 = 2^{3\times5}$?

7. Answer the following questions:

   (a) Express 4^3 as a power of 2.

   (b) Calculate $2^2 \times 2^2 \times 2^2$ and express your answer as a single power of 2.

   (c) Can $(2^2) \times (2^2) \times (2^2)$ be expressed as $(2^2)^3$?

   (d) Is $\left(2^2\right)^3 = 2^{2+3}$ or is $\left(2^2\right)^3 = 2^{2\times3}$?

8. Simplify the following: Example: $\left(10^2\right)^2 = 10^2 \times 10^2 = 10^{2+2} = 10^4 = 10000$

   (a) $(3^3)^2$

   (b) $(4^3)^2$

   (c) $(2^4)^2$

   (d) $(9^2)^2$

   (e) $(3^3)^3$

   (f) $(4^3)^3$

   (g) $(5^4)^3$

   (h) $(9^2)^3$

9. Simplify:

   (a) $(5^4)^{10}$

   (b) $(10^4)^5$

   (c) $(6^4)^4$

   (d) $(5^4)^{10}$

10. Write 5^{12} as a power of powers of 5 in four different ways.

To simplify $(x^2)^5$ we can write it out as a product of powers or we can use a shortcut.

11. .

Expression	Write as a product of the powers and then simplify	Use the rule $(a^m)^n$ to simplify
$(a^4)^5$		
$(b^{10})^5$	$b^{10} \times b^{10} \times b^{10} \times b^{10} \times b^{10}$ $= b^{10+10+10+10+10}$ $= b^{50}$	
$(x^7)^3$		
$(s^6)^4$		
$(y^3)^7$		

6.7 Exercise 7

1. Complete the following table. You may use your calculator when you are not sure of a value,

x	1	2	3	4	5
2^x					
3^x					
6^x					

2. Use the table in question 1 to answer the questions below. Are these statements true or false? If a statement is false, rewrite it as a correct statement.

   (a) $6^2 = 2^2 \times 3^2$

   (b) $6^3 = 2^3 \times 3^3$

   (c) $6^5 = 2^5 \times 3^5$

   (d) $6^8 = 2^4 \times 3^4$

3. Complete the following table:

Expression	The bases of the expression are factors of ...	Equivalent expression
$2^6 \times 5^6$	10	10^6
$3^2 \times 4^2$		
$4^2 \times 2^2$		
$7^5 \times 8^5$		
$2^3 \times 15^5$		
$3^5 \times x^5$		
$7^2 \times z^2$		
$4^3 \times y^3$		
$2^6 \times m^6$		
$2^3 \times m^3$		
$2^{10} \times y^{10}$		

4. Write each of the following expressions as an expression with one base. Example: $3^{10} \times 2^{10} = (3 \times 2)^{10} = 6^{10}$

   (a) $3^2 \times 5^2$

   (b) $5^3 \times 2^3$

   (c) $7^4 \times 4^4$

   (d) $2^3 \times 6^3$

   (e) $4^4 \times 2^4$

   (f) $5^2 \times 7^2$

5. Write the following as a product of powers. Example: $(3x)^3 = 3^3 \times x^3 = 27x^3$

   (a) 6^3

   (b) 15^2

   (c) 21^4

   (d) 6^5

   (e) 18^2

   (f) $(st)^7$

   (g) $(ab)^3$

   (h) $(2x)^2$

   (i) $(3y)^5$

   (j) $(3c)^2$

   (k) $(gh)^4$

   (l) $(4x)^3$

6. Simplify the following expressions. Example: $3^2 \times m^2 = 9 \times m^2 = 9m^2$

   (a) $3^5 \times b^5$

   (b) $2^6 \times y^6$

   (c) $x^2 \times y^2$

   (d) $10^4 \times x^4$

   (e) $3^3 \times x^3$

   (f) $5^2 \times t^2$

   (g) $6^3 \times m^7$

   (h) $12^2 \times a^2$

   (i) $n^3 \times p^9$

6.8 Exercise 8

1. Consider the following table:

x	1	2	3	4	5	6
2^x	2	4	8	16	32	64
3^x	3	9	27	81	243	729
5^x	5	25	125	625	3125	15625

   Answer questions 1 to 4 by referring to the table when needed.

   Give the value of each of the following:

(a) 3^4

(b) 2^5

(c) 5^6

(d) Calculate $3^6 \div 3^3$. (Read the values of 3^6 and 3^3 from the table and then divide. You may use a calculator where necessary).

(e) Calculate 3^{6-3}

(f) Is $3^\circ \div 3^3$ equal to $3^{?}$ Explain.

2. Answer the following:

(a) Calculate the value of 2^{6-2}.

(b) Calculate the value of $2^6 \div 2^2$

(c) Calculate the value of 2^{6+2}

(d) Read the value of 2^3 from the table.

(e) Read the value of 2^4 from the table.

(f) Which of the statements below is true?Give an explanation for your answer.

A. $2^6 \div 2^2 = 2^{6-2} = 2^4$

B. $2^6 \div 2^2 = 2^{6\div 2} = 2^3$

3. Say which of the statements below are true and which are false. Rewrite false statements as correct statements.

(a) $5^6 \div 5^4 = 5^{6\div 4}$

(b) $3^{4-1} = 3^4 \div 3$

(c) $5^6 \div 5 = 5^{6-1}$

(d) $2^5 \div 2^3 = 2^2$

4. Simplify the following. Do not use a calculator. Example: $3^{17} \div 3^{12} = 3^{17-12} = 3^5 = 243$

(a) $2^{12} \div 2^{10}$

(b) $6^{17} \div 6^{14}$

(c) $10^{30} \div 10^{14}$

(d) $5^{11} \div 5^8$

5. Simplify the following:

(a) $x^{12} \div x^{10}$

(b) $y^{17} \div y^{14}$

(c) $t^{20} \div t^{14}$

(d) $n^{11} \div n^5$

6.9 Exercise 9

1. Simplify the following:
   (a) $2^{12} \div 2^{12}$
   (b) $6^{17} \div 6^{17}$
   (c) $6^{14} \div 6^{14}$
   (d) $2^{10} \div 2^{10}$
2. Simplify the following:
   (a) 100°
   (b) x^0
   (c) $(100x)^0$
   (d) $\left(5x^3\right)^0$

6.10 Exercise 10

Simplify the following:

1. $3^3 + \sqrt[3]{-27} \times 2$
2. $5 \times (2+3)^2 + (-1)^0$
3. $3^2 \times 2^3 + 5 \times \sqrt{100}$
4. $\frac{\sqrt[3]{1000}}{\sqrt{100}} + (4-1)^2$
5. $\sqrt{16} \times \sqrt{16} + \sqrt[3]{216} + 3^2 \times 10$
6. $4^3 \div 2^3 + \sqrt{144}$

6.11 Exercise 11

1. Complete the following table:

Fraction	Square the fraction	Value of the square of the fraction
$\frac{1}{2}$	$\frac{1}{2} \times \frac{1}{2}$	$\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$
$\frac{2}{3}$		
$\frac{3}{4}$		
$\frac{2}{5}$		
$\frac{3}{5}$		
$\frac{2}{6}$		
$\frac{3}{7}$		
$\frac{11}{12}$		

2. Calculate each of the following:

   (a) $\left(\frac{3}{2}\right)^2$

   (b) $\left(\frac{4}{5}\right)^2$

   (c) $\left(\frac{7}{8}\right)^2$

3. Answer the following questions:

   (a) Use the fact that $0,6$ can be written as $\frac{6}{10}$ to calculate $(0,6)^2$.

   (b) Use the fact that $0,8$ can be written as $\frac{8}{10}$ to calculate $(0,8)^2$.

6.12 Exercise 12

1. Complete the following table.

Fraction	Writing the fraction as a product of factors	Square root
$\frac{81}{121}$		
$\frac{64}{81}$		
$\frac{49}{169}$		
$\frac{100}{225}$		

2. Determine the following:

   (a) $\sqrt{\frac{25}{16}}$

   (b) $\sqrt{\frac{81}{144}}$

   (c) $\sqrt{\frac{400}{900}}$

   (d) $\sqrt{\frac{36}{81}}$

3. Answer the following questions:

   (a) Use the fact that $0,01$ can be written as $\frac{1}{100}$ to calculate $\sqrt{0,01}$.

   (b) Use the fact that $0,49$ can be written as $\frac{49}{100}$ to calculate $\sqrt{0,49}$

4. Calculate each of the following:

   (a) $\sqrt{0,09}$

   (b) $\sqrt{0,64}$

   (c) $\sqrt{1,44}$

6.13 Exercise 13

1. Calculate each of the following:
   (a) $\left(\frac{2}{3}\right)^3$
   (b) $\left(\frac{5}{10}\right)^3$
   (c) $\left(\frac{5}{6}\right)^3$
   (d) $\left(\frac{4}{5}\right)^3$
2. Answer the following questions:
   (a) Use the fact that $0,6$ can be written as $\frac{6}{10}$ to find $(0,6)^3$.
   (b) Use the fact that $0,8$ can be written as $\frac{8}{10}$ to calculate $(0,8)^3$
   (c) Use the fact that $0,7$ can be written as $\frac{7}{10}$ to calculate $(0,7)^3$

6.14 Exercise 14

1. Express each of the following as a single number. Do not use a calculator. Example: $7,56 \times 100$ can be written as 756.
   (a) $3,45 \times 100$
   (b) $3,45 \times 10$
   (c) $3,45 \times 1000$
   (d) $2,34 \times 10^2$
   (e) $2,34 \times 10$
   (f) $2,34 \times 10^3$
   (g) $10^4 \times 10^2$
   (h) $10^0 \times 10^6$
   (i) $3,4 \times 10^5$
2. Write the following numbers in scientific notation:
   (a) $367\,000\,000$
   (b) $21\,900\,000$
   (c) $600\,000\,000\,000$
   (d) $1\,78$
3. Write each of the following numbers in the ordinary way. For example: $3,4 \times 10^5$ written in the ordinary way is $340\,000$

(a) $1,24 \times 10^8$

(b) $9,2074 \times 10^4$

(c) $1,04 \times 10^6$

(d) $2,05 \times 10^3$

4. The universe is $15\ 000\ 000\ 000$ years old. Express the age of the universe in scientific notation.

5. The average distance from the earth to the sun is $149\ 600\ 000$ km. Express this distance in scientific notation.

6. Explain why the number 24×10^3 is not in scientific notation.

7. Calculate the following. Do not use a calculator.
   Example:
   $300000 \times 90000000 = 3 \times 10^6 \times 9 \times 10^7 = 3 \times 9 \times 10^{6+7} = 27 \times 10^{13} = 270000000000000$

   (a) 13000×150000

   (b) 200×6000000

   (c) 120000×120000000

   (d) $2,5 \times 40000000$

8. Copy the statements and use $>$ or $<$ to compare these numbers:

   (a) $1,3 \times 10^9 \ldots 2,4 \times 10^7$

   (b) $6,9 \times 10^2 \ldots 4,5 \times 10^3$

   (c) $7,3 \times 10^4 \ldots 7,3 \times 10^2$

   (d) $3,9 \times 10^6 \ldots 3,7 \times 10^7$

7 ANSWERS TO EXERCISES

7.1 Exercise 1

1.1 8

1.2 64

1.3 27

1.4 729

2.1 2^3

2.2 2^6

2.3 3^3

2.4 3^6

3.1 25

3.2 32

3.3 100

3.4 225

3.5 81

3.6 64

3.7 8

3.8 9

4. Table:

Number	Square the number	Exponential form	Square
1	1×1	1^2	1
2	2×2	2^2	4
3	3×3	3^2	9
4	4×4	4^2	16
5	5×5	5^2	25
6	6×6	6^2	36
7	7×7	7^2	49
8	8×8	8^2	64
9	9×9	9^2	81
10	10×10	10^2	100
11	11×11	11^2	121
12	12×12	12^2	144

5.1 144

5.2 36

5.3 100

5.4 64

6.1 12^2

6.2 6^2

6.3 10^2

6.4 8^2

7.2 Exercise 2

1.1 216

1.2 $1\,000$

1.3 512

1.4 729

2.1 True

2.2 False, $2^3 \times 5^3 = 1\,000$ (Which is 10^3)

2.3 True

2.4 False, $1^3 \times 9^3 = 9^3 = 729$ (and not $10^3(1\,000)$)

3.1 1

3.2 1^3

3.3 8

3.4 2^3

3.5 27

3.6 3^3

3.7 64

3.8 4^3

3.9 125

3.10 5^3

3.11 216

3.12 6^3

3.13 343

3.14 7^3

3.15 512

3.16 8^3

3.17 729

3.18 9^3

3.19 $1\,000$

3.20 10^3

7.3 Exercise 3

1.1 1

1.2 1

1.3 4

1.4 2

1.5 9

1.6 3

1.7 16

1.8 4

1.9 25

1.10 5

1.11 36

1.12 6

1.13 49

1.14 7

1.15 64

1.16 8

1.17 81

1.18 9

1.19 100

1.20 10

1.21 121

1.22 11

1.23 144

1.24 12

2.1 12, because $12 \times 12 = 144$

2.2 10, because $10 \times 10 = 100$

2.3 9, because $9 \times 9 = 81$

2.4 8, because $8 \times 8 = 64$

3. Table:

Number	Cube of the number	Cube root of the cube of the number	Reason
1	1	1	$1 \times 1 \times 1 = 1$
2	8	2	$2 \times 2 \times 2 = 8$
3	27	3	$3 \times 3 \times 3 = 27$
4	64	4	$4 \times 4 \times 4 = 64$
5	125	5	$5 \times 5 \times 5 = 125$
6	216	6	$6 \times 6 \times 6 = 216$
7	343	7	$7 \times 7 \times 7 = 343$
8	512	8	$8 \times 8 \times 8 = 512$
9	729	9	$9 \times 9 \times 9 = 729$
10	1000	10	$10 \times 10 \times 10 = 1000$

4.1 6, because $6 \times 6 \times 6 = 216$

4.2 2, because $2 \times 2 \times 2 = 8$

4.3 5, because $5 \times 5 \times 5 = 125$

4.4 3, because $3 \times 3 \times 3 = 27$

4.5 4, because $4 \times 4 \times 4 = 64$

4.6 10, because $10 \times 10 \times 10 = 1\,000$

7.4 Exercise 4

1.1 -8

1.2 16

1.3 25

1.4 -125

1.5 1

1.6 -1

2.1 -4

2.2 4

2.3 -125

2.4 -125

3. (a) -4
   (b) 4

4.1 $(-2)^3$

4.2 $(-2)^4$

4.3 $(-5)^2$

4.4 $(-5)^3$

4.5 $(-1)^4$

4.6 $(-1)^3$

5.1 9

5.2 -27

5.3 16

5.4 64

5.5 -32

5.6 81

6.1 Positive. The power is even.

6.2 Negative. The power is odd.

6.3 Positive. The power is even.

6.4 Negative. The power is odd.

7.1 False. $(-3)^2 = -3 \times -3 = 9$

7.2 False. $-3^2 = -9$ because $-3^2 = -(3^2)$

7.3 True. Both are equal to -25 .

7.4 True. Both are equal to -1 .

7.5 False. $-6 \times -6 \times -6 = -216$

7.6 True. Both are equal to 64 .

7.5 Exercise 5

1. 2^{12}

2.1 $2^3 \times 2^9$

2.2 $2^5 \times 2^5 \times 2^2$

2.3 $2^2 \times 2^2 \times 2^2 \times 2^2 \times 2^2 \times 2^2$

2.4 $2^3 \times 2^3 \times 2^3 \times 2^3$

2.5 $2^{10} \times 2^2$

3.1 $2^3 \times 2^9 = 2^{12}$

3.2 $2^5 \times 2^5 \times 2^2 = 2^{12}$

3.3 $2^2 \times 2^2 \times 2^2 \times 2^2 \times 2^2 \times 2^2 = 2^{12}$

3.4 $2^8 \times 2^4 = 2^{12}$

3.5 $2^3 \times 2^3 \times 2^3 \times 2^3 = 2^{12}$

3.6 $2^6 \times 2^6 = 2^{12}$

3.7 $2^2 \times 2^{10} = 2^{12}$

4. Table:

Product of powers	Repeated factor	Total number of times the factor is repeated	Simplified form
$2^7 \times 2^3$	2	10	2^{10}
$5^2 \times 5^4$	5	6	5^6
$4' \times 4^5$	4	6	4^6
$6^3 \times 6^2$	6	5	6^5
$2^5 \times 2^2$	2	7	2^7
$5^3 \times 5^3$	5	6	5^6
$4^2 \times 4^4$	4	6	4^6
$2^1 \times 2^9$	2	10	2^{10}

5.1 $2^{3+4} = 2^7$

5.2 $10^{1+2+3} = 10^6$

5.3 $3^{2+3} = 3^5$

5.4 $5^{3+2} = 5^5$

6.1 10^2

6.2 10^3

6.3 10^4

6.4 $10^{2+3+4} = 10^9$

6.5 $10^2 \times 10^3 \times 10^4 = 10^9$

6.6 10^9

7.1 x^9

7.2 $x^2 \times x^3 \times x^4 = x^{2+3+4} = x^9$

7.3 $x^4 \times x^2 \times x^2 \times x = x^{4+2+2+1} = x^9$

7.4 $x^6 \times x^3 = x^{6+3} = x^9$

7.5 $x^3 \times y^3$

7.6 $a^2 \times b^2$

8. Table:

Product of powers	Repeated factor	Total number of times the factor is repeated	Simplified form
$x^7 \times x^3$	x	10	x^{10}
$x^2 \times x^4$	x	6	x^6
$x^1 \times x^5$	x	6	x^6
$x^3 \times x^2$	x	5	x^5
$x^8 \times x^2$	x	10	x^{10}
$x^3 \times x^3$	x	6	x^6
$x^1 \times x^9$	x	10	x^{10}

7.6 Exercise 6

1. Table:

x	1	2	3	4	5	6	7	8	9	10	11	12
2^x	2	4	8	16	32	64	128	256	512	1024	2048	4096
	2^1	2^2	2^3	2^4	2^5	2^6	2^7	2^8	2^9	2^{10}	2^{11}	2^{12}

2. Table:

x	1	2	3	4	5	6	7	8	9
3^x	3	9	27	81	243	729	2187	6561	19683
	3^1	3^2	3^3	3^4	3^5	3^6	3^7	3^8	3^9

3. Table:

Product of powers	Repeated factor	Power of power notation	Total number of repetitions	simplified form
$2^4 \times 2^4 \times 2^4$	2	$\left(2^4\right)^3$	12	2^{12}
$3^2 \times 3^2 \times 3^2 \times 3^2$	3	$\left(3^2\right)^4$	8	3^8
$2^3 \times 2^3 \times 2^3 \times 2^3 \times 2^3$	2	$\left(2^3\right)^5$	15	2^{15}
$3^4 \times 3^4 \times 3^4$	3	$\left(3^4\right)^3$	12	3^{12}
$2^6 \times 2^6 \times 2^6$	2	$\left(2^6\right)^3$	18	2^{18}

4.1 $2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 2^{12} = 4\,096$

4.2 $(2 \times 2 \times 2 \times 2) \times (2 \times 2 \times 2 \times 2) \times (2 \times 2 \times 2 \times 2) = 2^{12} = 4\,096$

4.3 $16^3 = \left(2^4\right)^3 = 2^{12} = 4\,096$

5.1 Yes

5.2 Yes

5.3 No

5.4 Yes

5.5 Yes

5.6 No

5.7 Yes

5.8 No

6.1 $8 = 2^3$. So $8^5 = 2^3 \times 2^3 \times 2^3 \times 2^3 \times 2^3 = 2^{3+3+3+3+3} = 2^{3\times5} = 2^{15}$

6.2 $4 \times 4 \times 4 = 64$ and $64 = 2^6$

6.3 $2^{2\times3}$

7.1 $4 \times 4 \times 4 = 64$ and $64 = 2^6$.

7.2 $4 \times 4 \times 4 = 64$ and $64 = 2^6$

7.3 Yes

7.4 $2^{2\times3}$

8.1 $3^3 \times 3^3 = 3^{3+3} = 3^6$

8.2 $4^3 \times 4^3 = 4^{3+3} = 4^6$

8.3 $2^4 \times 2^4 = 2^{4+4} = 2^8$

8.4 $9^2 \times 9^2 = 9^{2+2} = 9^4$

8.5 $3^3 \times 3^3 \times 3^3 = 3^{3+3+3} = 3^9$

8.6 $4^3 \times 4^3 \times 4^3 = 4^{3+3+3} = 4^9$

8.7 $5^4 \times 5^4 \times 5^4 = 5^{4+4+4} = 5^{12}$

8.8 $9^2 \times 9^2 \times 9^2 = 9^{2+2+2} = 9^6$

9.1 5^{40}

9.2 10^{20}

9.3 6^{16}

9.4 5^{40}

10. $(5^4)^3$; $\left(5^3\right)^4$; $\left(5^2\right)^6$; $\left(5^6\right)^2$

11. Table:

Expression	Write as the product of powers and then simplify	Use the rule $(a^m)^n$ to simplify
$(a^4)^5$	$a^4 \times a^4 \times a^4 \times a^4 \times a^4$ $= a^{4+4+4+4+4}$ $= a^{20}$	$a^{4\times5}$ $= a^{20}$
$(b^{10})^5$	$b^{10} \times b^{10} \times b^{10} \times b^{10} \times b^{10}$ $= b^{10+10+10+10+10}$ $= b^{50}$	$b^{10\times5}$ $= b^{50}$
$(x^7)^3$	$x^7 \times x^7 \times x^7$ $= x^{7+7+7}$ $= x^{21}$	$x^{7\times3}$ = x^{21}
$(s^6)^4$	$s^6 \times s^6 \times s^6 \times s^6$ $= s^{6+6+6+6}$ $= s^{24}$	$s^{6\times4}$ $= s^{24}$
$(y^3)^7$	$y^3 \times y^3 \times y^3 \times y^3 \times y^3 \times y^3 \times y^3$ $= y^{3+3+3+3+3+3+3}$ $= y^{21}$	$y^{3\times7}$ $= y^{21}$

7.7 Exercise 7

1. Table:

x	1	2	3	4	5
2^x	$2^1 = 2$	$2^2 = 4$	$2^3 = 8$	$2^4 = 16$	$2^5 = 32$
3^x	$3^1 = 3$	$3^2 = 9$	$3^3 = 27$	$3^4 = 81$	$3^5 = 243$
6^x	$6^1 = 6$	$6^2 = 36$	$6^3 = 216$	$6^4 = 1296$	$6^5 = 7776$

2.1 True. $36 = 4 \times 9$

2.2 True. $216 = 8 \times 27$

2.3 True. $7\,776 = 32 \times 243$

2.4 False. $2^4 \times 3^4 = 6^4$ not 6^8

3. Table:

Expression	The bases of the expression are factors of ...	Equivalent expression
$2^6 \times 5^6$	10	10^6
$3^2 \times 4^2$	12	12^2
$4^2 \times 2^2$	8	8^2
$7^5 \times 8^5$	56	56^5
$2^3 \times 15^3$	30	30^3
$3^5 \times x^5$	$3x$	$(3x)^5$
$7^2 \times z^2$	$7z$	$(7z)^2$
$4^3 \times y^3$	$4y$	$(4y)^3$
$2^6 \times m^6$	$2m$	$(2m)^6$
$2^3 \times m^3$	$2m$	$(2m)^3$
$2^{10} \times y^{10}$	$2y$	$(2y)^{10}$

4.1 $(3 \times 5)^2 = 15^2$

4.2 $(5 \times 2)^3 = 10^3$

4.3 $(7 \times 4)^4 = 28^4$

4.4 $(2 \times 6)^3 = 12^3$

4.5 $(4 \times 2)^4 = 8^4$

4.6 $(5 \times 7)^2 = 35^2$

5.1 $(2 \times 3)^3 = 2^3 \times 3^3$

5.2 $(3 \times 5)^2 = 3^2 \times 5^2$

5.3 $(3 \times 7)^4 = 3^4 \times 7^4$

5.4 $(2 \times 3)^5 = 2^5 \times 3^5$

5.5 $(2 \times 9)^2 = 2^2 \times 9^2$ or $(3 \times 6)^2 = 3^2 \times 6^2$

5.6 $s^7 t^7$

5.7 $a^3 b^3$

5.8 $2^2 x^2 = 4x^2$

5.9 $3^5 y^5 = 243y^5$

5.10 $3^2 c^2 = 9c^2$

5.11 $g^4 h^4$

5.12 $3^5 y^5 = 243y^5$

6.1 $243b^5$

6.2 $64y^6$

6.3 $x^2 y^2$

6.4 $10\,000x^4$

6.5 $27x^2$

6.6 $25t^2$

6.7 $216m^7$

6.8 $144a^2$

6.9 $n^3 p^9$

7.8 Exercise 8

1.1 81

1.2 32

1.3 $15\,625$

1.4 $3^6 \div 3^3 = 729 \div 27 = 27$

1.5 $3^{6-3} = 3^3 = 27$

1.6 Yes, they are both equal to 27 .

2.1 $2^4 = 16$

2.2 $2^4 = 16$

2.3 $2^8 = 256$

2.4 8

2.5 16

2.6 A, $2^6 \div 2^2 = 16 = 2^4 = 2^{6-2}$

3.1 False. $5^6 \div 5^4 = 15625 \div 625 = 25; 5^{6-4} = 5^2$

3.2 True. $3^{4-1} = 3^3 = 27; 3^4 \div 3 = 81 \div 3 = 27$

3.3 True

3.4 True

4.1 $2^{12-10} = 2^2 = 4$

4.2 $6^{17-14} = 6^3 = 216$

4.3 $10^{30-14} = 10^{16} = 10000000000000000$

4.4 $5^{11-8} = 5^3 = 125$

5.1 $x^{12-10} = x^2$

5.2 $y^{17-14} = y^3$

5.3 $t^{20-14} = t^6$

5.4 $n^{11-5} = n^6$

7.9 Exercise 9

1.1 $2^{12-12} = 2^0$

1.2 $6^{17-17} = 6^0$

1.3 $6^{14-14} = 6^0$

1.4 $2^{10-10} = 2^0$

2.1 1

2.2 1

2.3 1

2.4 1

7.10 Exercise 10

1.1 $27 - (-3) \times 2 = 27 + 6 = 33$

1.2 $5 \times 5^2 + 1 = 125 + 1 = 126$

1.3 $9 \times 8 + 5 \times 10 = 72 + 50 = 122$

1.4 $\frac{10}{10} + 3^2 = 1 + 9 = 10$

1.5 $4 \times 4 + 6 + 9 \times 10 = 16 + 6 + 90 = 112$

1.6 $64 \div 8 + 12 = 8 + 12 = 20$

7.11 Exercise 11

1. Table:

Fraction	Square the fraction	Value of the square of the fraction
$\frac{1}{2}$	$\frac{1}{2} \times \frac{1}{2}$	$\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$
$\frac{2}{3}$	$\frac{2}{3} \times \frac{2}{3}$	$\frac{4}{9}$
$\frac{3}{4}$	$\frac{3}{4} \times \frac{3}{4}$	$\frac{9}{16}$
$\frac{2}{5}$	$\frac{2}{5} \times \frac{2}{5}$	$\frac{4}{25}$
$\frac{3}{5}$	$\frac{3}{5} \times \frac{3}{5}$	$\frac{9}{25}$
$\frac{2}{6}$	$\frac{2}{6} \times \frac{2}{6}$	$\frac{4}{36}$
$\frac{3}{7}$	$\frac{3}{7} \times \frac{3}{7}$	$\frac{9}{49}$
$\frac{11}{12}$	$\frac{11}{12} \times \frac{11}{12}$	$\frac{121}{144}$

2.1 $\frac{3}{2} \times \frac{3}{2} = \frac{9}{4}$

2.2 $\frac{4}{5} \times \frac{4}{5} = \frac{16}{25}$

2.3 $\frac{7}{8} \times \frac{7}{8} = \frac{49}{64}$

3.1 $(0,6)^2 = \left(\frac{6}{10}\right)^2 = \frac{36}{100} = 0,36$

3.2 $(0,8)^2 = \left(\frac{8}{10}\right)^2 = \frac{64}{100} = 0,64$

7.12 Exercise 12

1. Table:

Fraction	Writing the fraction as a product of factors	Square root
$\frac{81}{121}$	$\frac{9}{11} \times \frac{9}{11}$	$\sqrt{\frac{81}{121}} = \frac{9}{11}$
$\frac{64}{81}$	$\frac{8}{9} \times \frac{8}{9}$	$\sqrt{\frac{64}{81}} = \frac{8}{9}$
$\frac{49}{169}$	$\frac{7}{13} \times \frac{7}{13}$	$\sqrt{\frac{49}{169}} = \frac{7}{13}$
$\frac{100}{225}$	$\frac{10}{15} \times \frac{10}{15}$	$\sqrt{\frac{100}{225}} = \frac{10}{15}$

2.1 $\frac{5}{4}$

2.2 $\frac{9}{12}$

2.3 $\frac{20}{30}$

2.4 $\frac{6}{9}$

3.1 $\sqrt{0,01} = \sqrt{\frac{1}{100}} = \frac{1}{10} = 0,1$

3.2 $\sqrt{0,49} = \sqrt{\frac{49}{100}} = \frac{7}{10} = 0,7$

4.1 $\sqrt{\frac{9}{100}} = \frac{3}{10} = 0,3$

4.2 $\sqrt{\frac{64}{100}} = \frac{8}{10} = 0,8$

4.3 $\sqrt{\frac{144}{100}} = \frac{12}{10} = 1,2$

7.13 Exercise 13

1.1 $\frac{2}{3} \times \frac{2}{3} \times \frac{2}{3} = \frac{8}{27}$

1.2 $\frac{5}{10} \times \frac{5}{10} \times \frac{5}{10} = \frac{125}{1\,000}$

1.3 $\frac{5}{6} \times \frac{5}{6} \times \frac{5}{6} = \frac{125}{216}$

1.4 $\frac{4}{5} \times \frac{4}{5} \times \frac{4}{5} = \frac{64}{125}$

2.1 $(0,6)^3 = \left(\frac{6}{10}\right)^3 = \frac{216}{100} = 0,216$

2.2 $(0,8)^3 = \left(\frac{8}{10}\right)^3 = \frac{512}{1\,000} = 0,512$

2.3 $(0,7)^3 = \left(\frac{7}{10}\right)^3 = \frac{343}{100} = 0,343$

7.14 Exercise 14

1.1 345

1.2 $34,5$

1.3 $3\ 450$

1.4 234

1.5 $23,4$

1.6 $2\ 340$

1.7 $10^6 = 1\ 000\ 000$

1.8 $1 \times 1\ 000\ 000 = 1\ 000\ 000$

1.9 $340\ 000$

2.1 $3,67 \times 10^8$

2.2 $2,19 \times 10^7$

2.3 6×10^{11}

2.4 $1,78 \times 10^2$

3.1 $124\ 000\ 000$

3.2 $92\ 074$

3.3 $1\ 040\ 000$

3.4 $2\ 050$

4. $1,5 \times 10^{10}$ years

5. $1,496 \times 10^8$ km

6. It is not in scientific notation because 24 is not a number between 1 and 10 .

7.1 $13 \times 10^3 \times 15 \times 10^4 = 13 \times 15 \times 10^3 \times 10^4 = 13 \times 15 \times 10^{3+4} = 195 \times 10^7 \ = 1\ 950\ 000\ 000$

7.2 $2 \times 10^2 \times 6 \times 10^6 = 2 \times 6 \times 10^2 \times 10^6 = 2 \times 6 \times 10^{2+6} = 12 \times 10^8 \ = 1\ 200\ 000\ 000$

7.3 $12 \times 10^4 \times 12 \times 10^7 = 12 \times 12 \times 10^4 \times 10^7 = 144 \times 10^{4+7} = 144 \times 10^{11} \ = 14\ 400\ 000\ 000\ 000$

7.4 $2,5 \times 4 \times 10^7 = 10 \times 10^7 = 10^8 = 100\ 000\ 000$

8.1 $1,3 \times 10^9 > 2,4 \times 10^7$

8.2 $6,9 \times 10^2 < 4,5 \times 10^3$

8.3 $7,3 \times 10^4 > 7,3 \times 10^2$

8.4 $3,9 \times 10^6 < 3,7 \times 10^7$