GCSE Maths – Number

Standard Form

Notes

WORKSHEET

Standard Form

Standard form is a system of writing numbers. It is most commonly used when dealing with very **large** or very **small** numbers, as it makes the numbers easier to read and use.

Standard form has the format $\boldsymbol{A \times 10^n}$.

For example,

$$2000 = 2 \times 10^3$$
$$0.000045 = 4.5 \times 10^{-5}$$

This is a more practical way of writing numbers such as 2000 and 0.000045, respectively.

The first part of standard form, $\boldsymbol{A}$, is called the **base number**. The **base number** must be **greater than or equal to 1**, and **less than 10**: $1 \leq A < 10$

The second part of standard form is 10^n. Whatever number n takes tells us what **power** of 10 we **multiply** the base number by. The value n must be an **integer** (a whole number).

Example: Convert 37000 to standard form

The base number must be more than or equal to 1*, but less than* 10*. Therefore, it must be* 3.7 *as we take the initial part of the number* 37000*.*

We now work out what power of 10 *we multiply* 3.7 *by to get* 37000*.*

$$3.7 \times 10000 = 37000$$

$$10000 = 10^4$$

So, 37000 *in standard form is*

$$\boldsymbol{3.7 \times 10^4}.$$

Example: Convert 7.94×10^6 from standard form into ordinary form

$$10^6 = 1000000$$

$$7.94 \times 10^6 = 7.94 \times 1000000 = \boldsymbol{7940000}$$

The number that n takes, referring to the power of 10, can be **positive** or **negative**.

- Positive values of n mean that the actual number is usually **very large**.
- Negative values of n mean that the number is a **small decimal**. A negative value of n does not mean that the number is negative!

Example: Convert 2.4×10^{-3} from standard form to ordinary form

$$10^{-3} = \frac{1}{1000} = 0.001$$

$$2.4 \times 10^{-3} = 2.4 \times 0.001 = 0.0024$$

Calculations with Standard Form

Now that we can interpret standard form and convert both ways, we need to be able to perform operations with numbers in standard form.

Adding and Subtracting

When **adding** or **subtracting** two numbers that are both written in standard form, there are usually three steps:

1. First, we must **convert** both numbers from standard form to normal form.
2. We then **perform the operation** (addition or subtraction).
3. Finally, if the question asks for the answer in standard form, we **convert** it back.

Example: Calculate $9.8 \times 10^3 + 6.1 \times 10^2$.
Write the answer in standard form.

1. Convert from standard form to ordinary numbers.

$$9.8 \times 10^3 = 9.8 \times 1000 = 9800$$
$$6.1 \times 10^2 = 6.1 \times 100 = 610$$

2. Perform the operation.

$$9800 + 610 = 10410$$

3. Convert back to standard form.

$$10410 = 1.041 \times 10^4$$

Multiplying and Dividing

Multiplying or **dividing** two numbers written in standard form is slightly different. We do not convert to an actual number. Again, there are three steps:

1. Perform the operation (multiplication or division) on the base numbers (the part written as A).
2. Perform the operation on the index 10^n part.
3. Check that the final answer is still written in standard form (if the question requires it).

Example: Calculate $(5.3 \times 10^5) \times (2.9 \times 10^3)$.
Give the final answer in standard form.

1. Multiply the base numbers.

$$5.3 \times 2.9 = 15.37$$

2. Multiply the 10^n index parts.

When multiplying numbers with a power like this, we follow rules of indices and add the powers together.

$$10^5 \times 10^3 = 10^{5+3} = 10^8$$

3. Check the answer is in standard form.

The answer we have is 15.37×10^8.
Recall that the base number, A, ***must be less than 10***.
Therefore, we divide the base number 15.37 *by* 10, *and add another power to* 10^n.

This gives us $\mathbf{1.537 \times 10^9}$

Example: Calculate $(4.5 \times 10^{-4}) \div (3.6 \times 10^{-8})$.
Give the answer as an ordinary number, not in standard form.

1. *Divide the base numbers.*

$$4.5 \div 3.6 = 1.25$$

2. Divide the 10^n index parts.

When dividing the same number with different powers, we follow rules of indices and subtract the second power from the first:

$$10^{-4} \div 10^{-8} = 10^{-4--8} = 10^{-4+8} = 10^4$$

3. Check the answer is in the correct form.

1.25×10^4 *is the answer in standard form.*

However, the question asked for the answer in ordinary form:

$$1.25 \times 10^4 = 1.25 \times 10000 = \mathbf{12500}$$

Key points to remember when using standard form:

- The base number, A, must be greater than or equal to 1, but less than 10: $1 \leq A < 10$
- n refers to the power of 10 and must be an integer.
- Negative values of n do not mean that the number is negative, just very small!

Standard Form - Practice Questions

1. Write 3200000 in standard form.

2. Write 0.014 in standard form.

3. Convert 1.02×10^6 from standard form to an ordinary number.

4. Convert 6.6×10^{-5} from standard form to an ordinary number.

5. Write $(1.2 \times 10^3) + (5.4 \times 10^2)$ in standard form.

6. Write $(4.5 \times 10^{-1}) - (3.9 \times 10^{-2})$ in standard form.

7. Write $(5 \times 10^3) \times (7 \times 10^4)$ in standard form.

8. Write $(9 \times 10^9) \div (3 \times 10^6)$ in standard form.

Worked solutions for the practice questions can be found amongst the worked solutions for the corresponding worksheet file.