Edexcel GCSE Physics

Your notes

Expressing Quantities & SI Units

Contents

Units & Prefixes

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SI Units

- There are a seemingly endless number of units in Physics
  - These can all be reduced to six base units from which every other unit can be derived
- These seven units are referred to as the SI Base Units; this is the only system of measurement that is officially used in almost every country around the world

SI Base Quantities Table

QUANTITY	SI BASE UNIT	SYMBOL
MASS	KILOGRAM	kg
LENGTH	METRE	m
TIME	SECOND	s
CURRENT	AMPERE	A
TEMPERATURE	KELVIN	K
AMOUNT OF SUBSTANCE	MOLE	mol

- These base units are then used to derive other common units
- These units have special names, for example:
  - Newtons, **N** [kg m / s^2]
  - Joules, **J** [N m]
  - Pascals, **Pa** [kg / m s^2]

Common Units Table

Quantity	Unit	Abbreviation
Frequency	hertz	Hz
Force	newton	N
Energy	joule	J
Power	watt	W
Pressure	pascal	Pa
Electric Charge	coulomb	C
Electric Potential Difference	volt	V
Electric Resistance	ohm	Ω
Magnetic Flux Density	tesla	T

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Examiner Tips and Tricks

Sometimes marks in an exam question are given for the unit, so make sure you remember which is the correct one for the quantity in your answer eg. If the answer is a force, it must have the units of **Newtons** (N)

Prefixes

- Physical quantities can span a huge range of values

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- For example, the diameter of an atom is about 10^{-10} m (0.0000000001 m), whereas the width of a galaxy may be about 10^{21} m (1,000,000,000,000,000,000,000 m)
  - This is a difference of 31 powers of ten
- Powers of ten are numbers that can be achieved by multiplying 10 times itself
- These come under two categories of units:
  - **Multiples** eg. 10^2, 10^3
  - **Sub-multiples** eg. 10^{-1}, 10^{-2}
- Each power of ten is defined by a **prefix**, these are listed in the table below:

Prefixes Table

Prefix	Abbreviation	Power of ten
Giga–	G	10^9
Mega–	M	10^6
Kilo–	k	10^3
Centi–	c	10^{-2}
Milli–	m	10^{-3}
Micro–	μ	10^{-6}
Nano–	n	10^{-9}

Example Conversions

- 12 **G**Pa = 12 **giga**pascals = 12 × 10^9 Pa (12 000 000 000 Pa)
- 5 **k**N = 5 **kilo**newtons = 5 × 10^3 N (5000 N)

- 0.1 **μ**A = 0.1 **micro**amps = 1×10^{-7} A (0.0000001 A)
- 7 **n**C = 7 **nano**coulombs = 7×10^{-9} C (0.000000007 C)

Examiner Tips and Tricks

You will often see very large or very small numbers categorised by powers of ten, so it is very important you become familiar with these as getting these prefixes wrong is a very common exam mistake!

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Conversions & Standard Form

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Conversions

- As well as prefix (powers of ten) conversions (eg. km into m) there are also common **unit** conversions
- One such unit conversion are those for **time**
  - The main time conversions are shown in the table below:

Time Conversions Table

1 year	365 days
1 day	24 hours
1 hour	60 minutes
1 minute	60 seconds

Hours & Seconds

- A common time unit conversion is between hours and seconds
  - 1 hour = 60 minutes
  - 1 minute = 60 seconds
- Therefore 1 hour = 60 × 60 = 3600 seconds
  - To convert from hours → seconds, **multiply** by 3600
  - To convert from seconds → hours, **divide** by 3600

Hours × 3600 = Seconds

Seconds ÷ 3600 = Hours

Kelvin & Degrees Celsius

- A common temperature unit conversion is between Kelvin and degrees Celsius (°C)

- The scale is defined as: 0 K = -273.15 °C
  - To convert from Kelvin → Celsius, **subtract** 273.15
  - To convert from Celsius → Kelvin, **add** 273.15

$$\mathbf{K - 273.15 = {}^\circ C}$$

$$\mathbf{{}^\circ C + 273.15 = K}$$

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Worked Example

A cyclist takes 3.5 hours to travel to their destination. Calculate their time travelled in seconds.

Answer:

Step 1: State the conversion

$$1 \text{ hour} = 3600 \text{ s}$$

$$\text{Seconds} = \text{Hours} \times 3600$$

Step 2: Calculate the time in seconds

$$3.5 \times 3600 = 12\,600 \text{ s}$$

Examiner Tips and Tricks

You will be expected to remember these unit conversions in your exam and to confidently convert between them, so make to practice these to achieve full marks in the calculation questions.

Significant Figures & Standard Form

Significant Figures

- The significant digits are the digits in a number that contributes to the value of that number
  - These are sometimes called **significant figures (s.f)**
- In physics, values are rounded to a certain number of significant figures instead of decimal places
- **Non-zero digits are always significant**
  - 123 is 3 s.f

  - 1.78 is 3 s.f
- **Any zeros between two significant digits are significan**t
  - 108 is 3 s.f
  - 10003 is 5 s.f
  - 1.006 is 4 s.f
- **Only a final zero or trailing zeros in the decimal portion (after the decimal point) are significant**
  - 0.183 is 3 s.f (the zero is before the decimal - so is not significant)
    - 1,8 and 3 are the significant figures
  - 1390 is 3 s.f. (the final zero is not after a decimal point - so is not significant)
    - 1,3 and 9 are the significant figures
  - 1.40 is 3 s.f (the final zero is after the decimal point - so is significant)
    - 1,4 and 0 are all the significant figures
  - 0.012 is 2 s.f (the zeros are either before the decimal point or is not the final zero - so not significant)
    - 1 and 2 are the significant figures
  - 1.9000 is 5 s.f (the trailing zeros are after the decimal point - so is significant)
    - 1, 9, 0, 0 and 0 are all the significant figures
- When rounding to a certain number of significant figures, this is done in a similar way to round to decimal places using the following procedure:

1. Find the number of significant figures to round to
2. Go to the digit for this significant figure
3. Look at the value **after** this digit

- If the value is 5 or greater, round this significant digit **up**
- If the value is less than 5, **leave** this significant digit as it is

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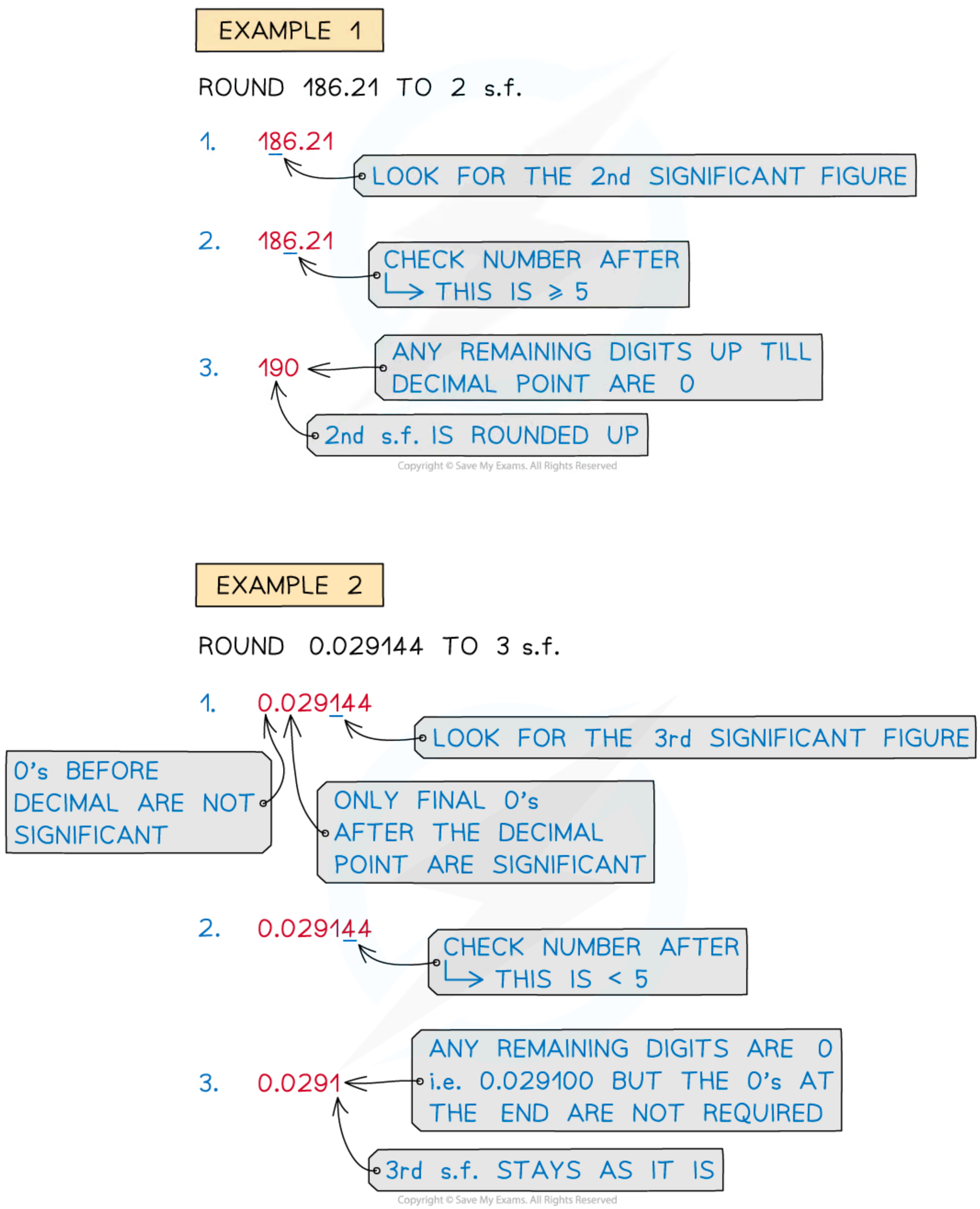

Rounding to 2 or 3 significant figures

Examples:

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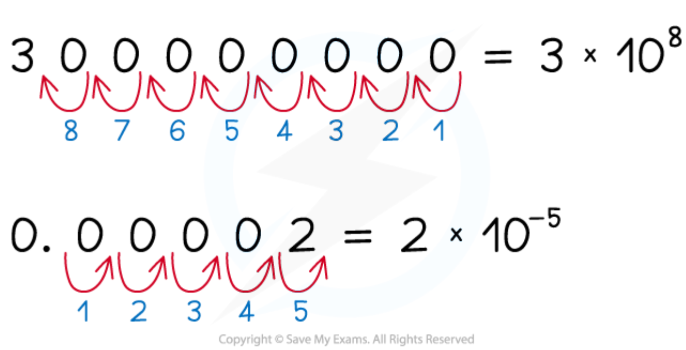
- The value 7.8 is 2 s.f
  - To 1 s.f this is equal to 8
- The value 9.12 is 3 s.f
  - To 2 s.f this is equal to 9.1
- The value 3.65×10^{-4} is equal to 3.s.f
  - To 2 s.f this is equal to 3.7×10^{-4}
- The value 1020 is equal to 3 s.f
  - To 2 s.f this is equal to 1000

Standard Form

- **Standard form** is a system of writing large and small numbers which is useful for working with very large or very small numbers
  - This also means writing whole lines of zeros can be avoided
- Numbers in standard form are in written as:

$$\mathbf{a \times 10^n}$$

- They follow these rules:
  - **a** is a number between **1** and **10**
  - **n** > 0 for **large** numbers i.e how many times **a** is multiplied by 10
  - **n** < 0 for **small** numbers i.e how many times **a** is divided by 10
- For example:
  - 3×10^8 = 300 000 000 (3 multiplied by 10, 8 times)
  - 2×10^{-5} = 0.00002 (2 divided by 10, 5 times)



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- When rounding a number in standard form to a certain number of significant figures, only the value of **a** is rounded (the **× 10**^{n} value will not be significant)
  - For example, 5.18×10^6 to 2 s.f. is 5.2×10^6

Worked Example

Write the number 143 000 000 in standard form to 2 significant figures

Answer:

Step 1: Write the number in standard form

- Standard form should look like: $a \times 10^n$
- a is a number between 1 and 10, so for this number, it will be 1.43
- **n** is how many times 1.43 is multiplied by 10 to give 143 000 000
  - This is 8 times

$$1.43 \times 10^8$$

Step 2: Write the number to 2 s.f

- The 2nd significant figure in this value is the 4
- The value after is 3, which is < 5 therefore the 4 is left as it is

$$1.4 \times 10^8$$

Examiner Tips and Tricks

In exam questions, always round your answer to the **lowest** number of significant figures quoted in the question text For example, if the question uses the values 2.3 (2 s.f) and 4.667 (4 s.f), then the answer should be given to 2 s.fIf in doubt, it is normally wise to give the answer to 2 or 3 s.f!