Mathematics in GCSE Sciences

AQA have always assessed mathematics on science papers. There are changes, however, to the way that mathematics is assessed in the new specifications.

The regulatory requirements now states the percentage of marks that needs to be assigned to them on the different papers:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>10%</td>
</tr>
<tr>
<td>Chemistry</td>
<td>20%</td>
</tr>
<tr>
<td>Physics</td>
<td>30%</td>
</tr>
<tr>
<td>Combined Science: Trilogy and Synergy</td>
<td>20%</td>
</tr>
</tbody>
</table>

The level of demand of assessment of mathematical skills is also set now by the DfE(Ofqual).

The guidance being:
- In Foundation Tier papers, the level of maths is ‘not lower than that expected at Key Stage 3’
- In Higher Tier papers, the level of maths is ‘not lower than that of questions and tasks in assessments for the Foundation Tier in a GCSE Qualification in Mathematics’

**What changes will you and your students see?**

There will be more maths on the papers and the level of challenge of this maths will be more challenging.

This is because what was considered as maths in the current specification does not cover all the skills /criteria now set by the DfE and some of the questions we currently designate as maths no longer meet the requirements, for example reading a single value off a graph. This type of question will still appear where appropriate, but will not count against the mathematics requirement for that paper.

**Appropriate types of mathematics for GCSE Science papers at Higher Tier:**

- Calculations of empirical formula
- Rate of reaction graphs including gradients
- Multi-step calculations*
- Calculations of the speed from a graph using a tangent

**Inappropriate** to be gridded as mathematics in GCSE Science papers at either tier but will still appear on the paper as working scientifically skills

- Reading scales
- Measuring length/distance
- Recalling equations
- Recalling units
• Counting and/or tally charts
• Simple arithmetic – addition or subtraction of numbers
• Diagrams which are scientific models eg dot/cross diagrams, molecular models
• Interpreting a straight line graph as (directly) proportional (with no other analysis)
• Reading a single value from a graph
• “Give the value of the anomalous result” is unlikely to be mathematical

Appropriate for **Foundation Tier** only

• Simple ratios (eg in balancing equations, phenotype ratios)
• Calculating means
• Simple division or multiplication
• Repeated simple division (eg no. of cells in 3 stages mitosis, number of atoms after x half-lives)
• Interpreting / describing trends from simple graphs and tables to draw conclusions

The following questions exemplify some of these points

1. The recall of equations, which although not actually classed as a maths skill by Ofqual is required to access some maths marks
2. Percentage change
3. Using tangents to calculate the gradient of a curve (Higher tier only)
4. Constructing vector diagrams (Higher tier only)
5. simple readings from a graph - , students may be asked to give a range between two readings for a mark
6. Calculations can now be multi-step and may require the recall or selection of two equations to complete
7. Increased use of standard form, significant figures and decimal places. The question will indicate how many significant figures the answer needs to be given to
8. Questions may involve two simple steps to be called maths eg unit conversion and simple subtraction

To support the teaching and learning of mathematics, AQA has developed a set of power points and teacher guidance around groups of the skills. This development work has been done in conjunction with Teachit and our GCSE Maths advocates. It should be seen as a starting point for teachers, which centres can develop with their Maths department.

These resources can be found on under the teach section of our resources page:

Things that are new to maths questions in the new GCSE Sciences

1. The recall of equations (not actually classed as a maths skill by Ofqual but required to access some maths marks)

Ways recall of equations may be asked:

Low demand (infrequent)

Which equation links acceleration, mass and resultant force? [1 mark]

Tick one box.

resultant force = mass + acceleration
resultant force = mass × acceleration
resultant force = mass + acceleration
resultant force = mass ÷ acceleration

Standard demand

Write down the equation which links compression, force and spring constant. [1 mark]

At medium high and high demand, marks will not be given for recall of equation alone but rather for recalling and using the equation correctly

When flying, the pressure inside the cabin of an aircraft is kept at 70 kPa. The aircraft window has an area of 810 cm².

Use data from Figure 17 to calculate the resultant force acting on an aircraft window when the aircraft is flying at an altitude of 12 km.

Give your answer to two significant figures [5 marks]

Resultant force = ____________ N
### Rearranging equations at Foundation tier (mostly Physics)

Eg (this question also has a mark for correct conversion of a unit, hence 4 marks)

The weight of the child causes the spring to compress elastically from a length of 30cm to a new length of 23cm.

Calculate the spring constant of the spring.

Give your answer in newtons per metre.

\[ \text{Spring constant} = \frac{343}{0.07} \]

\[ k = 4900 \]

allow 4900 with no working shown for 4 marks
allow 49 with no working shown for 3 marks

<table>
<thead>
<tr>
<th>09.6</th>
<th>compression = 0.07m</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>343 = k \times 0.07</td>
<td>AO2/1</td>
</tr>
<tr>
<td></td>
<td>k = 343 ÷ 0.07</td>
<td>AO2/1</td>
</tr>
<tr>
<td></td>
<td>k = 4900</td>
<td>AO2/1</td>
</tr>
<tr>
<td></td>
<td>allow 4900 with no working shown for 4 marks</td>
<td>4.5.3</td>
</tr>
<tr>
<td></td>
<td>allow 49 with no working shown for 3 marks</td>
<td></td>
</tr>
</tbody>
</table>
2. Percentage change

A student investigated the effect of different sugar solutions on potato tissue.

This is the method used.

1. Add 30 cm³ of 0.8 mol dm⁻³ sugar solution to a boiling tube.
2. Repeat step 1 with equal volumes of 0.6, 0.4 and 0.2 mol dm⁻³ sugar solutions.
3. Use water to give a concentration of 0.0 mol dm⁻³.
4. Cut five cylinders of potato of equal size using a cork borer.
5. Weigh each potato cylinder and place one in each tube.
6. Remove the potato cylinders from the solutions after 24 hours.
7. Dry each potato cylinder with a paper towel.
8. Reweigh the potato cylinders.

Table 2 shows the results.

<table>
<thead>
<tr>
<th>Concentration of sugar solution in mol dm⁻³</th>
<th>Starting mass in g</th>
<th>Final mass in g</th>
<th>Change of mass in g</th>
<th>Percentage (%) change</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>1.30</td>
<td>1.51</td>
<td>0.21</td>
<td>16.2</td>
</tr>
<tr>
<td>0.2</td>
<td>1.35</td>
<td>1.50</td>
<td>0.15</td>
<td>X</td>
</tr>
<tr>
<td>0.4</td>
<td>1.30</td>
<td>1.35</td>
<td>0.05</td>
<td>3.8</td>
</tr>
<tr>
<td>0.6</td>
<td>1.34</td>
<td>1.28</td>
<td>−0.06</td>
<td>−4.5</td>
</tr>
<tr>
<td>0.8</td>
<td>1.22</td>
<td>1.11</td>
<td>−0.11</td>
<td>−9.0</td>
</tr>
</tbody>
</table>

Calculate the value of X in Table 2.

[2 marks]
3. Using tangents to calculate the gradient of a curve (Higher tier only)

Two girls, A and B, ran an 800 m race.

**Figure 1** shows how the distance changed with time.

Use **Figure 1** to determine Girl B’s speed at 60 s.

Show how you use the graph to obtain your answer.

**0 1. 7**

<table>
<thead>
<tr>
<th>Speed =</th>
<th>m/s</th>
</tr>
</thead>
</table>
4. Constructing vector diagrams (Higher tier only)

A skydiver jumps from an aeroplane.

There is a resultant vertical force of 300 N on the skydiver.

There is a horizontal force from the wind of 60 N.

Draw a vector diagram on Figure 5 to determine the magnitude and direction of the resultant force on the skydiver.

[4 marks]

Figure 5

Magnitude of resultant force = __________________________ N
Things that have become harder

5. We aren’t allowed to call simple readings from a graph maths, students may be asked to give a range between two readings for a mark now, eg

Use Figure 7 to determine the additional force needed to increase the extension of the spring from 5cm to 15cm.

Additional force = _____________________ N
6. Calculations can now be multi-step and may require the recall or selection of two equations to complete

Water vapour is a gas. Gases change state when they cool.

Figure 8 shows condensation on a cold bathroom mirror.

Figure 8

A volume of $2.5 \times 10^{-5}$ m$^3$ of condensation forms on the mirror.

Density of water = 1000 kg/m$^3$

Specific latent heat of vaporisation of water = $2.26 \times 10^6$ J/kg.

Calculate the energy released when the condensation forms. [5 marks]

$\text{Energy released} = \underline{\hspace{0.75\textwidth}}$ J
7. Increased use of standard form, significant figures and decimal places (the previous question is a good eg of standard form too...)

Standard form

Another student investigated the rate of reaction by measuring the change in mass.

**Figure 11** shows the graph plotted from this student’s results.

**Figure 11**

![Graph showing the rate of reaction over time](image)

Use **Figure 11** to determine the rate of reaction at 150 seconds.

Show your working on **Figure 11**.

Give your answer in standard form.

[4 marks]

\[
\text{Rate of reaction at 150 s} = \quad \text{g/s}
\]
Significant figures

Figure 6 shows the student’s results. The result for dye D is not shown.

**Figure 6**

Calculate the $R_f$ value of dye A

Give your answer to two significant figures.

0.7

[3 marks]
8. Questions may involve two simple steps to be called maths (eg unit conversion and simple subtraction)

Gold is mixed with other metals to make jewellery.

**Figure 2** shows the composition of different carat values of gold.

**Figure 2**

[Bar chart showing composition of 9 carat and 18 carat gold]

Give the percentage of silver in 18 carat gold.

[1 mark]

Use **Figure 2** to answer this question.

Percentage = _________________ %
The car travels a distance of 2040 metres in 2 minutes.

Use the following equation to calculate the mean speed of the car.

\[
\text{mean speed} = \frac{\text{distance}}{\text{time}}
\]

[2 marks]

Mean speed = _______________ m/s